APPENDIX A – ENGINEERING
for
RIO GRANDE DE MANATI FLOOD RISK MANAGEMENT STUDY, CIALES, PUERTO RICO

INTEGRATED FEASIBILITY REPORT AND ENVIRONMENTAL ASSESSMENT

FLOOD RISK MANAGEMENT STUDY

May 2020

US Army Corps of Engineers®

RIO GRANDE DE MANATI FLOOD RISK MANAGEMENT STUDY, CIALES, PUERTO RICO

Engineering Appendix

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RIO GRANDE DE MANATI FLOOD RISK MANAGEMENT STUDY, CIALES, PUERTO RICO

Engineering Appendix

1 STUDY AREA – GENERAL BACKGROUND AND EXISTING CONDITIONS

1.1 GENERAL BACKGROUND

The Municipality of Ciales (Municipality) on the island of Puerto Rico is located on the northern slopes of the Central Mountain Range, approximately 25 miles southwest of San Juan and has a population of approximately 19,000 (Figure 1). During an initial site visit conducted on 26 October 2018, members of the Project Delivery Team (PDT), with input from the Municipality, defined the limits of the study as the flood-prone area (i.e., within the 500-year floodplain) extending approximately 12,500 linear feet along the Rio Grande de Manati from the PR-145 Bridge downstream to the PR-6685 Bridge. The study area encompasses several communities, including the City of Ciales, Residencial Dos Rios, Dos Rios, and Alturas De Ciales.

Puerto Rico has a long history of flooding. The most damaging historic flooding events for Dos Rios were associated with Hurricanes Hugo (1989), Hortense (1996), and Georges (1998). In response to recurring flooding, the Municipality contracted for the development of plans and specifications for a flood protection works project (henceforth referred to as the 'Original Flood Protection Works') designed to manage recurring flood risk within the communities of Dos Rios and Alturas de Ciales. The Original Flood Protection Works anticipated construction of a project that included a combined levee, floodwall, retention pond, interior drainage system and river widening along the Dos Rios community. Plans for the Original Flood Protection Works is included as Attachment 1 to this Appendix. Due to Puerto Rico's financial crisis, funding for construction was never obtained.

Extensive flooding and associated damages to Dos Rios and other communities within the Municipality (i.e., Alturas de Ciales and City of Ciales) during hurricane Maria in 2017 led the Municipality to request flood risk reduction assistance from the U.S. Army Corps of Engineers (USACE). In response to this request, USACE was authorized through the Supplemental Appropriations in the Bipartisan Budget Act of 2018 (Public Law 115-123) to conduct Flood Risk Management (FRM) feasibility study (Study) of which this Engineering Appendix is part.

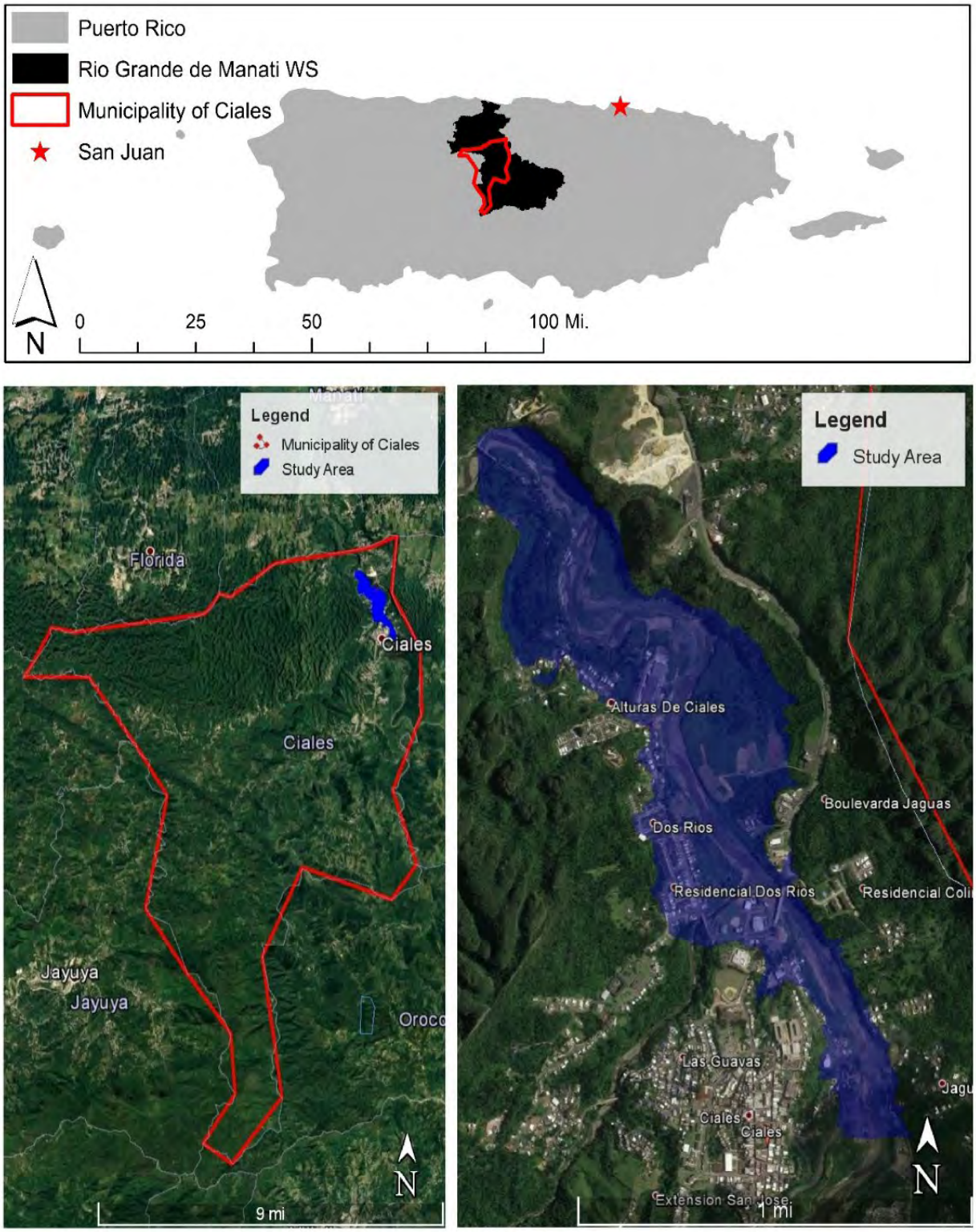

Figure 1. Location of the Rio Grande de Manati watershed, Municipality of Ciales, and Study Area.

The 26 October 2018 site visit resulted in identification of the following concerns to be addressed by the current FRM Study. These areas of concern are identified as "Problems" in the Main Report.

- Elevated flood risk for structures within the floodplain. There are 157 structures within the Study Area (i.e., 0.002 AEP floodplain; Figure 2), including private homes, businesses, industrial sites, and public facilities (i.e., sewage treatment plant).

- Inundation of transportation infrastructure. Several major access and evacuation routes are located within the 0.01- and 0.02 AEP floodplains (Figure 2). Inundation of and damage to roadways and bridges increases life safety risk both during (evacuation) and after (recovery) flood events.

- Extensive flood-induced bank failure. Hurricane Maria resulted in extensive flood-induced bank failure that is currently placing key pieces of transportation infrastructure at elevated risk of failure (i.e., loss of use due to damage or safety) within two zones throughout the study area (Figure 2). Bank failure in Zone 1 is threatening the PR-149 Bridge and PR-145, while failure in Zone 2 is threatening PR-6685. Transportation infrastructure at elevated risk of failure as a result of flood-induced bank failure are integral to key access and evacuation routes for municipal residents both within and outside of the Study Area.

Given these concerns, the overall goal of this FRM Study is to identify and recommend risk reduction and protective actions for areas identified as high-risk as a result of recent and historic flooding. The PDT then identified the following specific objectives:

- Reduce risks to life safety associated with inundation of structures, as well as transportation routes required for evacuation and post-flood recovery within Dos Rios, Ciales Pueblo, and Alturas de Ciales over the next 50 years.

- Reduce risk of flood damage to structures and public infrastructure within the communities of Dos Rios, Ciales Pueblo, and Alturas de Ciales over the next 50 years.

The Study Area was divided into four focal areas (Figure 2). The areas as well as the flooding-related problems associated with each are summarized below:

- Focal Area 1: Focal Area 1 extends approximately 0.58 miles from the site of the PR-145 Bridge downstream to the PR-149 Bridge. Flooding-related problems in Focal Area 1 include elevated flood risk for structures in the floodplain, inundation of major access roads (i.e., PR-145 and PR-149), and extensive flood-induced bank failure threatening structures and transportation infrastructure (i.e., PR-145 and PR-149 Bridge). The PR-149 Bridge at the downstream extent of Focal Area 1 may act as a pinch point, causing upstream water back-up and inundation.

- Focal Area 2: Focal Area 2 extends approximately 0.42 miles downstream of the PR-149 Bridge and includes the communities of Dos Rios and Alturas de Ciales. The original flood protection works plan was entirely within Focal Area 2. Flooding-related problems in Focal Area 2 include elevated flood risk for structures in the floodplain and inundation of major access roads (i.e., PR-146, PR-6685) and infrastructure (The PRSA Waste Water Treatment Plant (WWTP)).

- Focal Area 3: Focal Area 3 extends approximately 0.44 miles and includes a large industrial facility. Flooding-related problems include increased flood risk for structures within the floodplain, inundation of major access roads (i.e., PR-6685), and extensive flood-induced bank failure threatening PR-6685, as well as residential structures and the industrial facilities. The large river bend in Focal Area 3 may be causing water backup and increased inundation upstream.

- Focal Area 4: Extends approximately 0.87 miles to the PR-6685 Bridge. Flooding-related problems include elevated flood risk for structures within the floodplain and inundation of PR-6685, which results in the isolation of communities outside of the floodplain.

This Engineering Appendix documents the preliminary engineering analyses used in determining measures associated with the Alternatives considered. Review of these measures and other factors will ultimately result in a Tentatively Selected Plan (TSP; also known as the Recommended Plan)

Included in this Appendix are sections related to Geotechnical, Hydrologic and Hydraulic (H&H), Structural and general Civil Engineering aspects of the Alternatives considered.

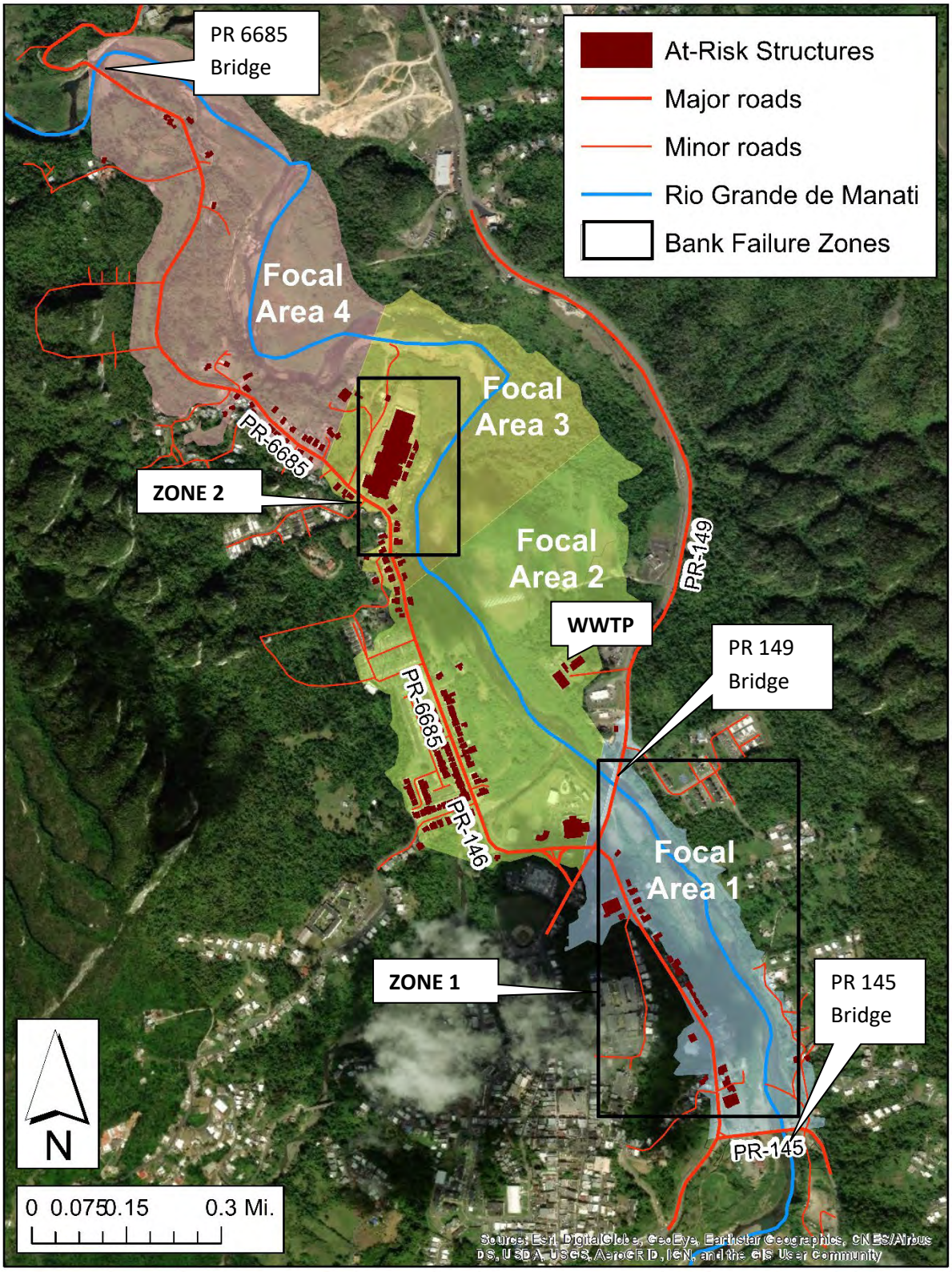

Figure 2- Focal Areas and Bank Failure Zones within the Study Area

1.2 EXISTING CONDITIONS

1.2.1 GEOTECHNICAL

For this Study, available geotechnical information from a 1971 Subsurface Investigation Report for the PR 149 Bridge and from a 2012 Flood Protection Works project, in and around the Study Area were reviewed to evaluate the type and condition of subsurface materials. Area geology and seismicity, subsurface soil/ bedrock types, laboratory test results, and other pertinent geotechnical information contained in the reports are summarized in this Section.

1.2.1.1 Geology and Seismicity

Puerto Rico has a volcanic past. The oldest rocks exposed within the limits of the Municipalities are young from a geologic standpoint. The town of Ciales sits over Granodiorite, a Plutonic igneous rock. East and west of the Ciales-Dos Rios are large extensions of Lares Limestone. This is a massive hard crystalline pale-orange to nearly white coralline limestone where sinkholes are abundant. Quaternary alluvium and colluvium border the river and talus slopes at the interior face of the Lares Escarpment.

Because of its volcanic origin, the island of Puerto Rico is also seismically highly active. According to (Uniform Building Code) (UBC), Puerto Rico lies within Seismic Zone 3 and as such peak ground acceleration of 0.3g should be considered in the evaluation of civil infrastructure and flood protection.

Geology of the study area is primarily of the Cretaceous to middle Tertiary age (upper and middle Oligocene and lower Miocene) and Quaternary period. Cretaceous and Tertiary age rocks include stratified limestone and marly limestone containing lenses of calcareous sand and gravel and terrigneous clastics (USGS, 1965). The northern end of the study area includes Quaternary period (Holocene-Pleistocene) landslide deposits and unconsolidated alluvium. (Figure 3.) The alluvium is comprised of unconsolidated silt, sand, gravel, cobbles, and boulders along the stream and stream valley and angular rock debris and rock-slide debris on and at the base of steep slopes and are the most recent geological deposits in the Ciales region (USGS, 1965). The San Sebastian Formation (middle-upper Oligocene) is also identified in the northern part of the study area and includes clay, sand, gravel, and sandy limestone, shaley clay, sandstone, and conglomerate. The southern end of the study area includes the intrusive mass (Morovis and Ciales stocks) of plutonic granodiorite and unconsolidated alluvium. A small portion of the southern end of the study area includes the Los Negros Formation composed of basaltic hyaloclastite-breccia with basaltic lava, volcanic sandstone, and siltstone (USGS, 1998).

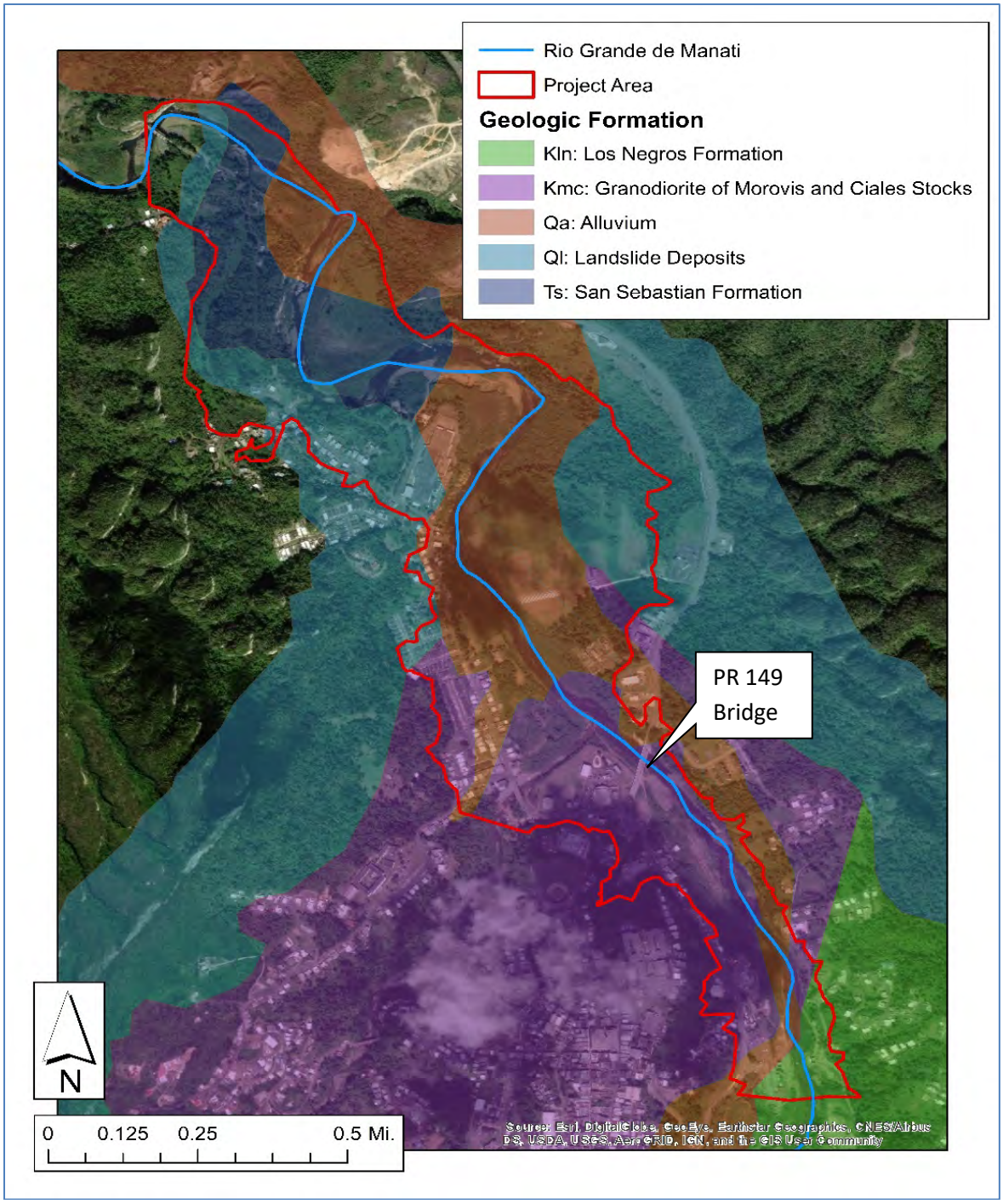

Figure 3 – Underlying Geology associated with the Study Area

The topography of the area around PR 149 Bridge is level ground towards the south where the river can extend during heavy flood. Toward the bridge's north abutment where residual soil is encountered, the area consists of a hilly section where erosion of the river banks is minimal. Subsurface soil and prior investigations relating to existing conditions are discussed below.

1.2.1.2 Prior Subsurface Investigation Summary

As part of the 1971 Report on the Subsoil Investigation Performed at the Site of Proposed Bridge over Manati River, five borings were taken as part of subsoil investigation. The investigation was conducted to gather subsurface information at the abutments and piers of the bridge in order to provide foundation recommendations for the construction of the structure. Borings B-1 and B-5 were drilled for left and right abutments, respectively. Borings B-4, B-3 and B-2 were drilled for intermediate piers P-1, P-2 and P-3, respectively. The borings were drilled to depths ranging from 28 ft. to 55 ft. In the field, standard penetration test (SPT) blow counts (N value) were measured in the borings. SPT blow count is a measure of soil consistency (fine grained soils, i.e., clay and silt) and density (coarse grained soils, i.e., sand and gravel) and is often used to derive soil's parameters for design, such as bearing capacity. Coring was performed in the borings after auger refusal was met. Generally used correlation of SPT N value with the soils relative density for coarse grained soil and, consistency and shear strength for fine grained soil is presented in Table 1 below.

Table 1 – 1971 Investigation SPT N-Value and its Correlation to Coarse Grained and Fine Grained Soils.

Relative Density of Coarse Grained Soils (Sand and Gravel)		**Consistency of Fine-Grained Soils (Clay and Silt)**		
Descriptive Term	**SPT N-Value**	**Descriptive Term**	**Unconfined Compressive Strength (psf)**	**SPT N-Value**
Very Loose	0 - 4	Very Soft	Less than 500	Less than 2
Loose	4 – 10	Soft	500 - 1000	2 - 4
Medium Dense	10 – 30	Medium Stiff	1,000 – 2,000	4 – 8
Dense	30 – 50	Stiff	2,000 – 4,000	8 – 15
Very Dense	50 and over	Very Stiff	4,000 – 8,000	15 - 30
		Hard	Greater than 8,000	> 30

As part of the 2012 Original Flood Protection Works project investigation, subsurface investigation was performed for the design of proposed flood control structures in Ciales, Puerto Rico. Altogether, 17 borings were drilled to depths varying from 20 to 40 feet along the banks of the Rio Grande de Manati River. Eleven borings (Boring 1 thru Boring 11), were drilled on the southern side of the river and six borings (Boring 12 thru Boring 17), were drilled on the northern side of the river. Field and laboratory tests were conducted during the investigation. Field test consist of measurement of SPT N values and pocket penetrometer tests. Laboratory

test consist of moisture content, specific gravity, unit weight, plasticity and grain size analysis tests on the selected samples from the borings.

1.2.1.3 Subsurface Soils

The subsurface conditions at the location of the soil borings drilled for flood protection indicated two main strata of alluvial soils. The upper stratum is comprised of interbedded layers of silty and sandy clay and clayey and silty sand. The lower layer consists of sandy gravel with cobbles and trace layers of clay and silt.

Based on the review of borings, the upper stratum of fine grained materials are present to depths ranging from 2 to 15 feet below the ground surface. Weathered rock was encountered in some of the borings below the coarse grained soils at an approximate depth of 5 feet.

Depending on the location along the project alignment within the Study Area, bedrock may be present near surface or as deep as 35 feet as indicated by the available boring information.

Table 2 – Soil Composition Summary - of the Original Flood Protection Works project.

Boring	Depth (feet)	Gravel (%)	Sand (%)	Fine Grain (%)
B-11	2	0	44	56
B-14	2	4	68	28
B-4	4	0	61	39
B-12	4	14	50	36
B-16	4	11	69	20
B-4	6	0	50	50
B-13	6	0	54	46
B-6	8	82	13	5
B-12	8	72	23	5
B-13	8	61	26	13
B-10	9	5	32	63
B-4	13	0	66	34
B-7	13	0	68	32
B-2	18	3	88	9
B-3	18	58	37	5
B-3	18	32	63	5
B-6	18	47	48	5
B-1	23	26	69	5
B-2	23	27	61	12
B-5	33	64	29	7

Additional geotechnical information including field /laboratory test results and preliminary parameters are in Attachment 2 to this Appendix.

1.2.2 STRUCTURAL

1.2.2.1 Buildings or Structures in Study Area

There are over 157 structures (residential, commercial, industrial and public facility) within the Study Area. The material used in construction of these structures ranges from cast-in-place concrete to wood framing (Figures 4 and 5).

Figure 4 – Residential Structures along left bank of Rio Grande de Manati

Many of these structures have experienced recurring and severe flooding. Flooding of the waste water treatment plant results in discharges of raw sewage to the Rio Grande de Manati. Figure 6 shows where these at-risk structures are within the focus areas and floodplain. Refer to the Real Estate Appendix (Appendix E) for more information related to residential structures and property.

Figure 5 – Residential Structure along eroded bank of Rio Grande de Manati River

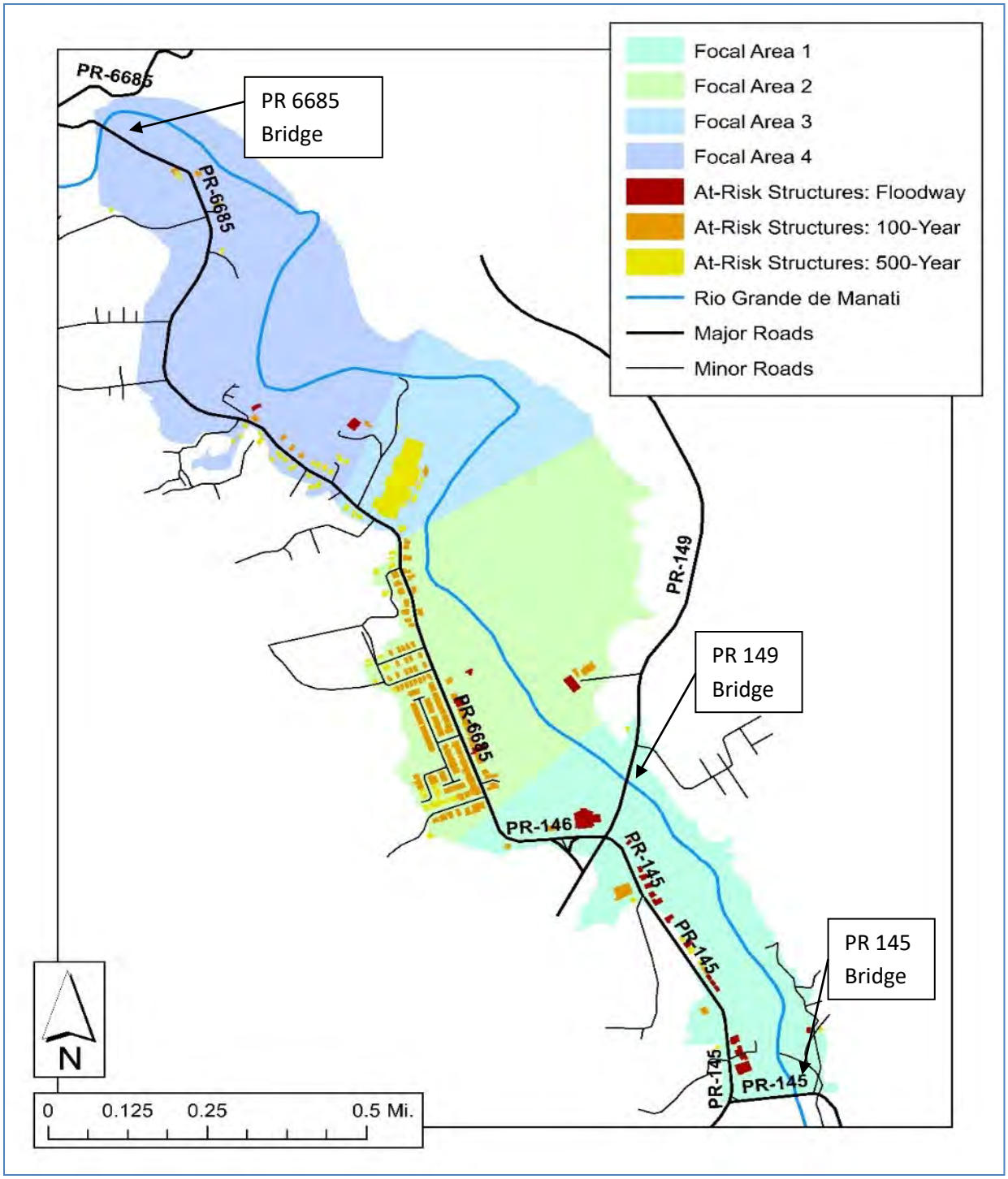

Figure 6 – Map of Study Area Focus Areas and at-risk structures.

Additional at-risk structures within the Study Area not associated with buildings are those related to transportation. Three bridge structures are located within the Study Area. These bridges carry traffic along PR-149, PR-145 and PR-6685.

1.2.2.1.1 PR 149 Bridge

The most at-risk bridge structure is Puerto Rico Highway and Transportation Authority (PRHTA) Bridge 1374 (PR 149 Bridge) (See Figures 7 thru 11).

The PR 149 Bridge was constructed in 1975. It is four-span precast concrete bridge with two spill-through abutments and three pile bents. The bridge superstructure is composed of a concrete flat slab deck poured in place over concrete, pre-cast, pre-stressed girders. Each concrete-reinforced pier is composed of a concrete column with round tip supported on piles. Intermediate bridge piers are founded on concrete pile caps supported by vertical and battered driven steel HP 12x53 piles. Piles are assumed to be driven and capped in very dense sand and gravel/boulder to volcanic rock. The right abutment is founded on spread footing bearing on weathered rock. The left abutment is founded on vertical and battered driven steel HP 12x53 piles. Information on bridge construction was obtained from the PRHTA Scour Phase 1 Bridge 1374.

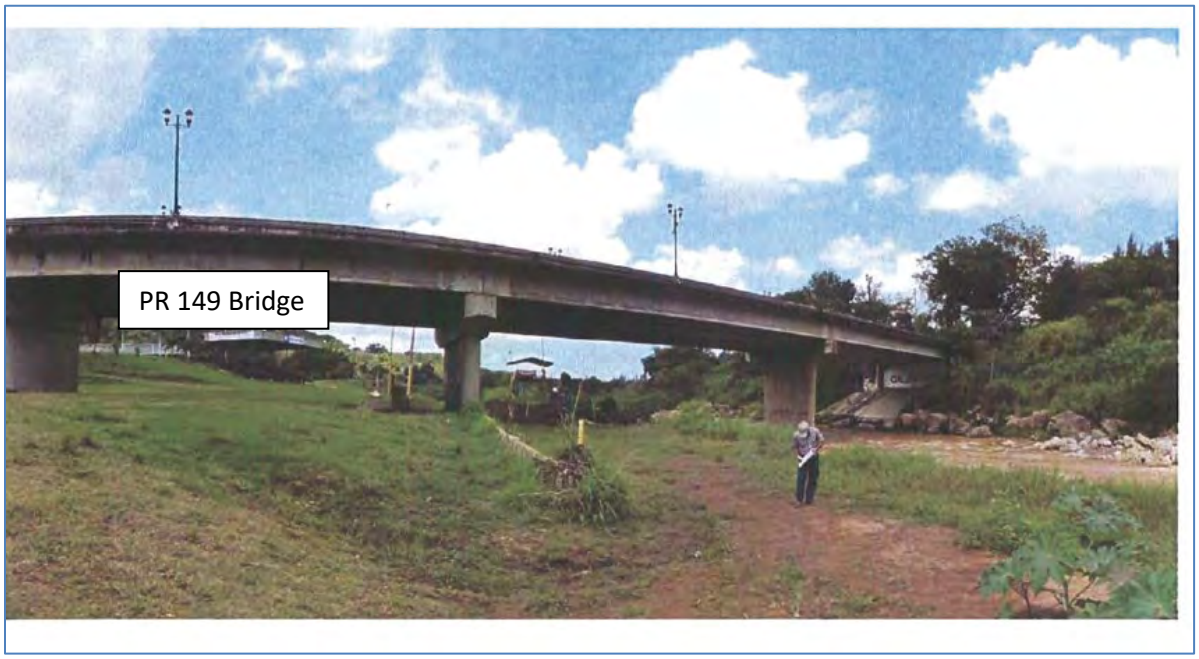

Figure 7 - Photo of PR 149 Bridge looking downstream from left bank, pre-Hurricane Maria

Figure 8 – Photo of PR 149 Bridge looking upstream from left bank, pre-Hurricane Maria

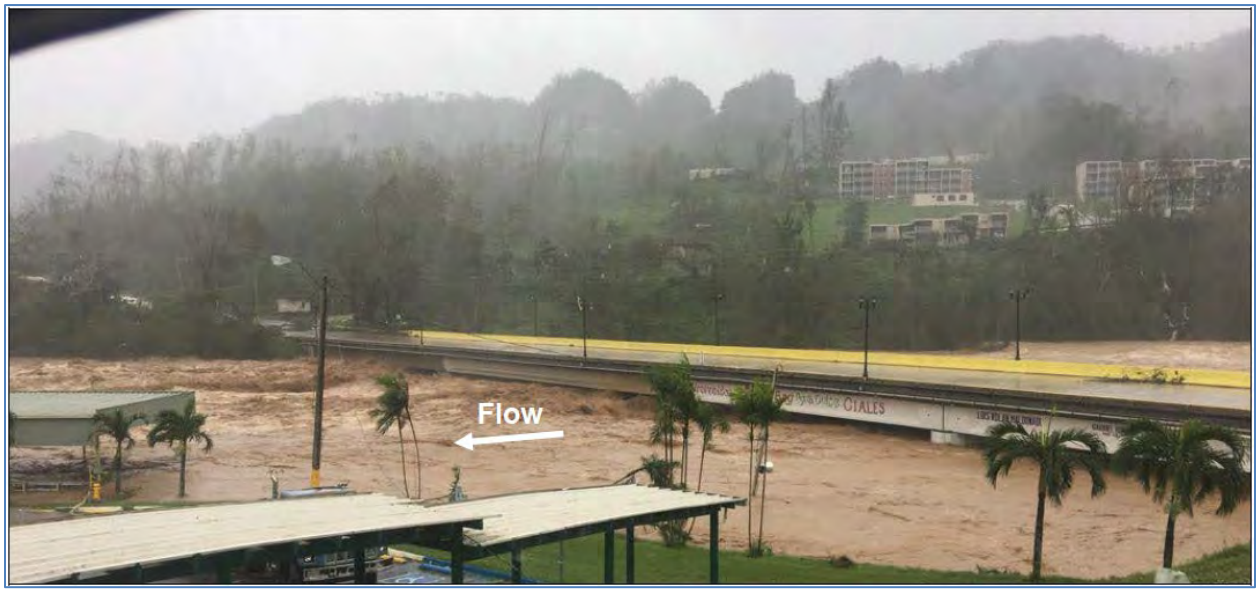

Figure 9 – PR 149 Bridge during Hurricane Maria

Figure 10 – PR 149 Bridge Pier 2 scour post-Hurricane Maria

Figure 11 – PR 149 Bridge Pier 3 scour post-Hurricane Maria

1.2.2.2 Below Ground Structures

Based on information provided by the Puerto Rico Department of Natural and Environmental Resources, utilities exist within or adjacent to the Study Area. Specifically, a wastewater treatment plant (WWTP) is located above the right bank of the Rio Grande de Manati, and a pump station is located along the left bank, both approximately 500 feet downstream of the confluence with the Cialitos River. Connecting these two structures is one abandoned and one active 10-inch diameter force main runs under the de Manati, from the pump station to the WWTP.

Any excavation within the de Manati or along the WWTP side of the river may require relocation of the active force main.

See Attachment 1 for locations of underground structures and infrastructure.

1.2.3 WATER RESOURCES

1.2.3.1 Surface Water

The Municipality has a long history of flooding during severe storm and hurricane events. United States Geological Survey (USGS) data indicate the Rio Grande de Manati has reached flood stage 35 times within the past 50 years. A study was completed in 2007 for the Federal Emergency Management Agency (FEMA) by the URS Group, Inc. and Dewberry to develop new flood hazard information in the wake of flooding caused by Tropical Storm Jeanne in 2004.

The study included updating the hydrology and creating a 1-dimensional (1D), steady state hydraulic model in HEC-RAS (URS Group, Inc., 2006; URS Group, Inc., 2007). USACE obtained the HEC-RAS model, and supporting hydrology and hydraulic files, in 2019.

The HEC-RAS model covers approximately 21 miles of the Rio Grande de Manati (from Route 145 to its confluence with Atlantic Ocean). This study focuses on the upstream extent of the Rio Grande de Manati, which spans from the Route 145 Bridge to the Route 6685 bridge. Input for the existing conditions hydraulic model retrieved from FEMA is summarized below. Very minimal updates to the retrieved model were made, as stated below, so previous calibration and verification runs of the existing conditions model are assumed to be relevant.

Figure 12 shows the Study Area portion of the HEC-RAS model (with HEC-RAS River Stations / Sections identified).

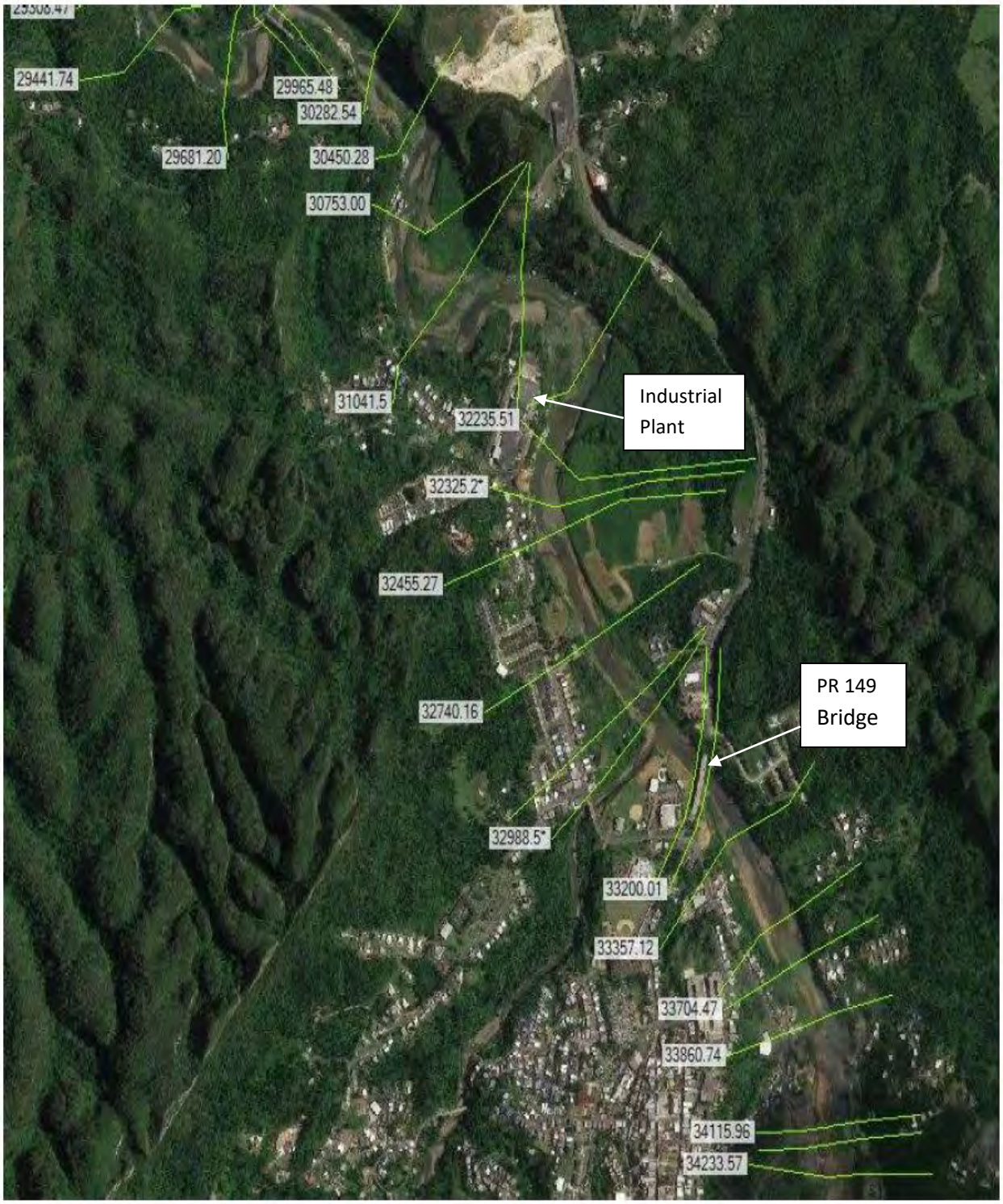

Figure 12 – Rio Grande de Manati showing HEC-RAS River Station Cross-section Locations

1.2.3.2 Model Input

1.2.3.2.1 Geometry

For the existing conditions (also defined as Alternative 0 elsewhere in this report) geometry data, a Triangular Irregular Network (TIN) developed from Pre-Maria Light Detection and Ranging (LiDAR) data was used to prepare the Rio Grande de Manati hydraulic model.

Post-Maria LiDAR was not available at the commencement of this study so pre-Maria LiDAR was used in order to meet the condensed timeline. More discussion on LiDAR usage with respect to Alternatives and modeling is included in Attachment 3.

The hydraulic cross-sections were cut from the digital terrain model for the HEC-RAS hydraulic model. Generally, the survey data were used to develop the channel portion of the cross-section geometry while the TIN was the source of overbank topography (URS Group, Inc., 2007). This study is primarily focused on the upstream extent of the hydraulic model that was completed for FEMA in 2007. The primary area of interest for this study is between the Route 145 Bridge and the Route 6685 bridge along the Rio Grande de Manati. The inclusion of two interpolated cross-sections were added to the existing conditions model in order to sufficiently model the alternatives and compare with the existing conditions model. The geometry for the two interpolated cross-sections were based solely on the adjacent cross-sections in the existing conditions model.

Manning's roughness coefficient values were determined for each cross-section using the Cowan (1956) procedure outlined in "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains". The ground photographs acquired during a field survey were used in conjunction with the 2004 aerial images to estimate Manning's roughness coefficients for the channel and overbank areas. Assigned channel Manning's n roughness coefficients ranged from 0.035 to 0.058, and overbank values ranged from 0.015 to 0.19, all of which were in a reasonable range for the terrain being evaluated (URS Group, Inc., 2007).

There are seven total bridges in the FEMA model, although only three of those are within the Study Area: Route 6685, Route 149, and Route 145. It was noted that the most upstream bridge crossing, Route 145, was washed out as a result of Hurricane Maria in 2017, and a temporary bridge is currently located in the same approximate location. No design information is available for the temporary and/or proposed bridge crossing at that approximate location, so Route 145 was retained in the model to be conservative.

Note that Post-Maria LiDAR was not available at the commencement of this study, and the PDT was directed by the vertical team to use available, pre-Maria LiDAR due to the condensed timeline. It is recommended that post-Maria LiDAR be incorporated into the hydraulic model, wherever available, and that new wet sections be surveyed. Based on imagery pre- and post-

Maria, the overbank land cover appear to be similar, although the channel geometry is noticeably different in certain areas, particularly around bends due to sediment erosion and deposition.

The hydraulic model was retrieved from FEMA and was previously calibrated based on the available data at the time. No new data was available at the commencement of this study, so the FEMA model was assumed to be representative of existing conditions. The PDT is aware of the limitations of the FEMA model and highly recommends the incorporation of new LiDAR and survey data and re-calibration during the design phase.

1.2.3.2.2 Steady State Flow Data

The existing conditions model included four flow profiles for Rio Grande de Manati at locations along the studied reach, the 10%, 2%, 1%, and 0.2% annual chance peak flow discharges. The discharges were based on the Log Pearson Type III statistical analysis of systematic annual peak flow data recorded at the Ciales and Highway 2 gages. The discharges at un-gaged sites along the reach were calculated using the transfer equation based on drainage area ratio to a specific power, and the power was driven from the one-variable (drainage area) regression equation defined in USGS WRI 99-4142 (URS Group, Inc., 2006).

Additional flows (50%, 20%, 4% and 0.5% annual chance peak flow discharges) were calculated for locations of interest for this study, primarily because eight flows are required for economic analysis of alternatives. In accordance with the previously calculated flow profiles, these additional flows were also calculated using the transfer equation based on drainage area ratio to a specific power. Upon closer review of the flows assigned to specific flow change locations, it was determined that some of the flow change locations, as described in the FEMA FIS, did not align with their associated descriptions and drainage areas. Therefore, in addition to inclusion of four additional flow profiles, it was also decided to correct the cross-sections associated with flows based on associated descriptions and drainage areas. Overall changes to the resulting water surface profiles in the existing conditions model was, on average, less than one foot. Specifically, water surface elevation difference ranged from 0.1 ft. (0.3% during the 50-yr event) to 2.7 ft. (4.4% during the 500-yr event) within the Study Area.

1.2.3.2.3 Boundary Conditions

The original existing conditions model included a downstream boundary condition at the San Juan Tidal Gage (URS Group, Inc., 2006). One boundary condition allows the hydraulic model to be run in a subcritical flow regime. In the interest of running the model in a mixed flow regime (capturing both sub- and super- critical flow regimes), an upstream boundary condition, set to critical depth, was also incorporated.

The hydraulic model was switched from subcritical to mixed flow due to potential impacts from the steep terrain. Based on comparing the water surface elevations from the runs using a subcritical flow regime and the runs using a mixed flow regime, there are no differences in the

water surface elevations in the study area, such that the resulting alternatives and associated analyses were not impacted.

1.2.3.2.4 Model Output

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

1.2.3.3 Groundwater

Groundwater interactions with surface water are not incorporated in the hydraulic model used for this study. Typical groundwater levels within the project extents should be considered for any proposed alteration to the existing channel and adjacent banks.

1.2.3.4 Flood Plains

The 1% and 0.2% floodplains were delineated previously for the FEMA FIS (URS Group, Inc., 2007). Based on that study, the TIN created from the LiDAR data was converted to a 5-by-5 meter grid cell digital elevation model (DEM). This ground surface was then intersected with 5-by-5-meter grid cell water-surface representations of the 1% and 0.2% annual chance floods, respectively. Figure 13 illustrate the final 1% chance floodplain developed based on this study.

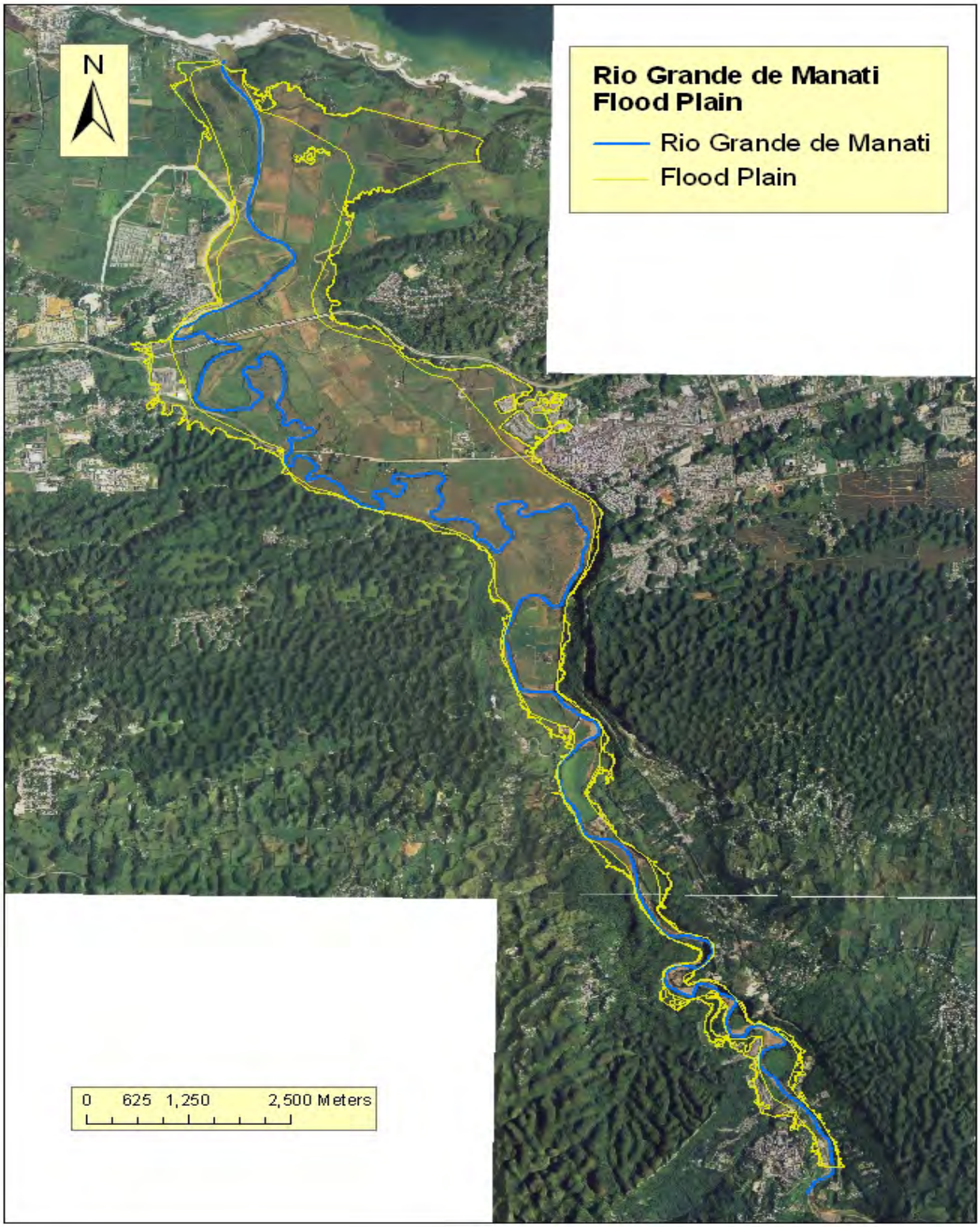

Figure 13 - Rio Grande de Manati 1% Annual Chance Floodplain.

1.2.3.5 Climate Change Assessment

As referenced in ECB 2018-14, more extreme seasonal conditions of rainfall and runoff and altered snow volume and melt have been observed in some regions. As a result, the assumptions of stationary climatic baselines and a fixed range of natural variability as captured in the historical hydrologic record are no longer appropriate for long-term project planning in some locations. Therefore, qualitative and quantitative analyses have been conducted and are presented in Appendix A – Attachment 3, in compliance with ECB 2018-14 & ETL 1110-2-3. A summary of the sea level rise analysis is also included below.

1.2.3.6 Sea Level Rise

There is high confidence that sea levels are rising and will continue to do so (PRCCC, 2013). In accordance with Engineering Regulation (ER) 1100-2-8162, a quantitative assessment of sea level rise must be considered for waterways with oceanic astronomical tidal influence, as well as connected waterways with base-level controlled by sea level. Although the downstream extent of the study area is approximately 16 miles upstream of the mouth of Rio Grande de Manati, a sea level rise assessment is still required by Engineering Manual (EM) 1110-2-1416 because the river profile computation begins at the outlet of a stream influenced by tidal fluctuations.

Using the USACE Sea Level Change Calculator, Figure 14 shows that for a 100-year planning horizon with sea level rise. USACE low to high estimates ranging from 0.69 to 6.77 feet above current mean sea level by the year 2120 at the San Juan, PR gage (datum PRVD02).

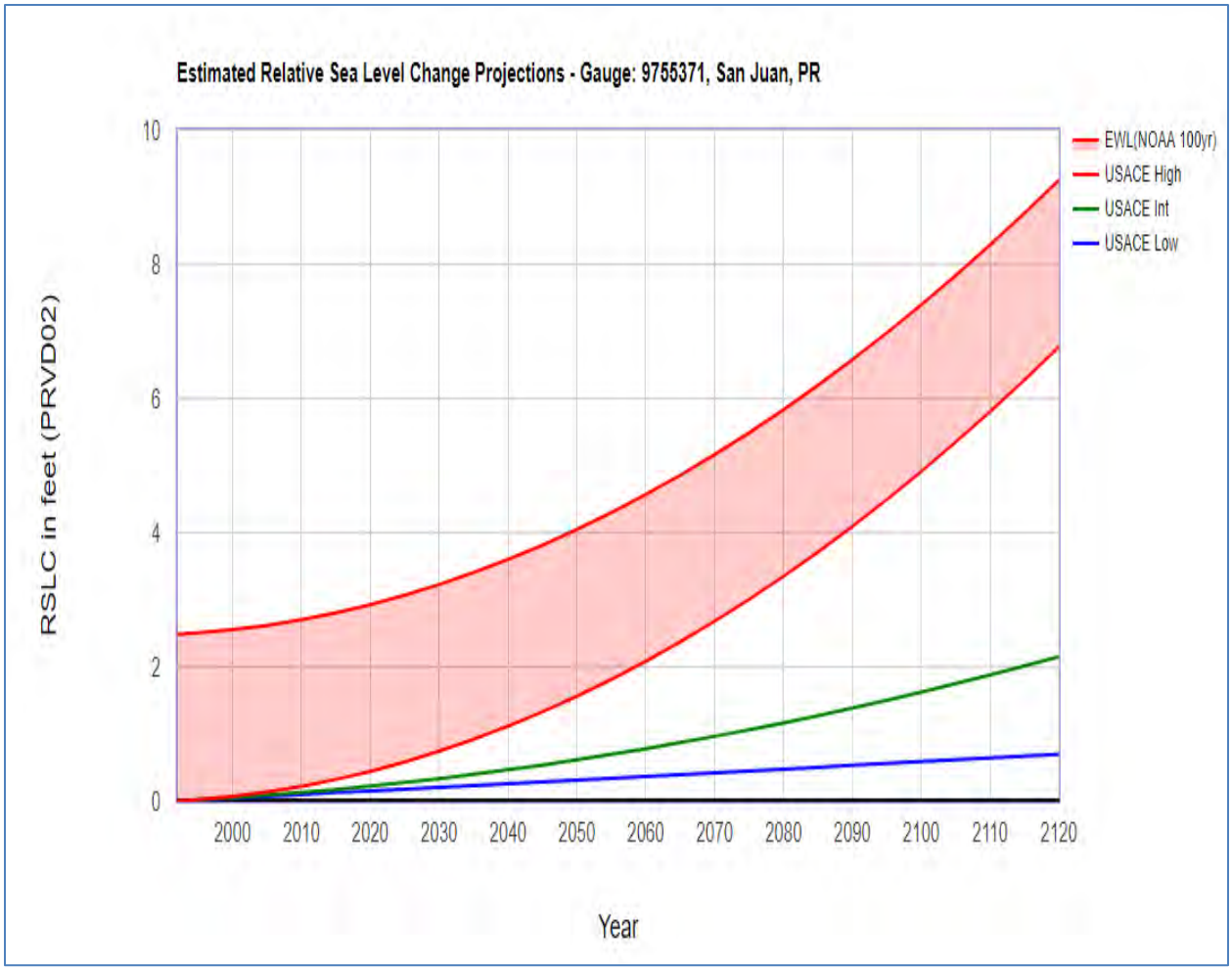

Figure 14 - USACE Sea Level Change Curve Calculator at Gage Closest to Ciales, Puerto Rico.

Although the study area downstream extents are approximately 16 miles upstream of the mouth of Rio Grande de Manati, the downstream boundary of the existing conditions hydraulic model obtained from FEMA goes to the ocean. Therefore, consistent with Engineering Regulation (ER) 1100-2-8162, sea level rise was incorporated into the downstream boundary condition in the hydraulic model The summation of the sea level change (SLC), high tide for each of the three scenarios (low, intermediate and high, as determined from the Sea Level Change Calculator), and the NOAA 100 yr (i.e. 1% AEP) estimated extreme water level (EWL) was used to estimate downstream boundary conditions for the base year and year 2120 (100-year project lifespan). Initially, the low, intermediate, and high values for the base year (0.15 ft, 0.22 ft, and 0.44 ft, respectively) were each combined with the EWL (2.49 ft) and MHHW (0.81 ft). These scenarios for the base year are estimated to range from 3.45 ft to 3.74 ft. Then, the low, intermediate, and high values for the 2120 scenario (0.69 ft, 2.15 ft, and 6.77 ft) were analyzed, yielding totals of 3.99 ft to 10.07 ft. Although the base year scenarios were initially analyzed, ultimately the most conservative value from the 2120 scenarios (10.07 ft) was the highest downstream boundary condition used for the analysis and was compared with the MHHW initially incorporated in the existing conditions hydraulic model. There was no increase

in water surface elevation in the study area extents for the future without- and with- project conditions. Therefore, additional analysis with regards to incorporating sea level rise was not completed.

2 PLAN FORMULATION

2.1 MANAGEMENT MEASURES CONSIDERED TO ACHIEVE PLANNING OBJECTIVES

Management measures (Measures) in the context of this Appendix (and Report) are features or activities implemented at specific locations to address one or more of the planning objectives. From an exhaustive list of measures, 17 distinct structural, non-structural, and nature-based measures were identified as having the potential to address one or more of the study objectives. Measures considered for each focal area are listed in the main report and are included here in Tables 3 and 4.

2.1.1 Structural Measures

Structural measures are physical constructs or features that alter the characteristics of a flood and reduce the probability of flooding in a location of interest. They reduce the likelihood or impact of flooding and include items such as dams, levees, floodwalls, and other appurtenant "structures".

Table 3- Structural Management Measures

Management Measure	Category	Description
Measures to reduce risk and damages associated with flood inundation		
Channelization/Channel Modification	Structural	Channelization and channel modification can include channel widening, deepening straightening, and/or relocating, as well as channel lining to maintain the desired geometry and decrease roughness, expediting water movement through the system.
Floodwalls	Structural	Construction of a concrete wall along the watercourse or around critical infrastructure to exclude temporary flood waters from protected areas.
Levees	Structural	Construction of an earthen embankment along the watercourse or around critical infrastructure (ring levee) to exclude temporary flood waters from protected areas.
Detention Basins	Structural	Detention basins reduce peak discharge and associated flood damages downstream by temporarily storing flood water throughout the watershed and releasing it slowly.
Upstream Retention	Structural	Upstream retention (i.e., reservoir) can be used to store large quantities of flood water, reducing peak discharges downstream.

2.1.2 Non-structural and Nature-Based Measures

Non-structural management measures can be both physical and non-physical features or actions that attempt to reduce the likelihood or impact of flooding. They include such items as hazard forecasting, land use planning, property acquisition and/or relocation, construction of natural systems; etc.

Table 4 - Non Structural and Nature Based Management Measures

Management Measure	Category	Description
Measures to reduce risk and damages associated with flood inundation		
Flood-Proofing	Non-structural	Combination of dry (i.e., keeping the water out of the structures) and wet (i.e., allowing water to flow through structures) flood-proofing to reduce damages to individual structures.
Structure Elevation	Non-structural	Raise structures such that the main living area will be above a design flood elevations.
Acquisition/Relocation	Non-structural	Acquisition and demolition of existing structures located within the floodplain. Floodplain residents would then be relocated outside of the floodplain. Participation in the program would be mandatory. The floodplain would be planted with native vegetation. The local sponsor would retain ownership of the acquired property and must ensure no future development or fill would occur; however, the acquired area could be deeded to the local government and/or converted to undeveloped public space.
Flood Warning & Planning	Non-structural	Develop and expand flood warning system and emergency planning (e.g., evacuation routes).
Off-Channel Detention	Nature-based	Create storage in floodplain to decrease flood stages downstream and adjacent to Dos Rios. Off-channel detention areas (which may be part of the floodplain, including wetlands or marshes) would temporarily store water diverted from the river channel. Off-channel detention could be implemented throughout the watershed, including within the study area, to reduce the magnitude of flooding.

All of the identified measures were then compared to certain selected performance criteria and "screened". A more in depth discussion of this screening process is included in the main Report.

2.1.3 Screening Criteria

The criteria against which the measures were compared are listed below:

- Effectiveness: A relative assessment of the extent to which each management measure alleviates one or more of the specified problems and achieves the specified opportunities.
- Cost: An assessment of the initial and ongoing cost of each management measure relative to the benefits gained and problems addressed.
- Acceptability: A relative assessment of the initial and long-term workability and viability of each management measure with respect to acceptance by local stakeholders.

- Environmental Impacts: A relative assessment of the potential for environmental impacts (e.g., loss of wetland or protected habitats) of each management measure, including effects to Federally-listed species.

2.1.4 Chosen Management Measures

Each measure was assessed based on the criteria listed above (effectiveness, cost, acceptability, and environmental impact) to determine whether a measure should be retained in or removed from the plan formulation process within and across Focal Areas. The results of the initial screening evaluations are listed in Table 5. Measures selected as well as how they would be generally constructed or implemented across the Focal Areas are also better defined in the succeeding paragraphs.

Table 5 - Summary of Management Measures retained based on screening.

Management Measure	Description	Decision	Apply to Focal Areas
Measures to reduce damages and life safety risk associated with flood inundation			
Channelization/Channel Modification	Channel straightening, widening, deepening, relocation, and lining could increase capacity and efficiency, alleviating flood risk. Environmental impact would be moderate to high. High initial and ongoing costs.	Retain	1, 2, 3, 4
Floodwalls	Floodwalls were included in the original flood protection works study to protect the Dos Rios community and would be effective at protecting large, high-cost structures. High initial and ongoing costs.	Retain	2
Levees	Levees were included in the original flood protection works plan to reduce flood risk in the Dos Rios community and would be effective at protecting large, high-cost structures. High initial and ongoing costs.	Retain	2
Upstream Retention	Upstream retention would be effective at decreasing peak discharge and flow velocity, alleviating risk of inundation and flood-induced bank failure. Constructing an upstream reservoir would be extremely expensive and would have significant environmental impacts.	Retain	Outside study area
Acquisition/Relocation	Removing all structures and residents from the floodplain would effectively eliminate flood risk and associated damages. Relocation would be complete in that it would not require any additional	Retain	1, 2, 3, 4

Acquisition/Relocation (cont'd)	investments or actions to achieve the planned reductions in flood risk for relocated structures. Feedback received during the public scoping meeting indicated that Relocation is locally-preferred over implementation of structural measures. Relocations would comply with laws, regulations, and policies. Relocation of public housing from Dos Rios and Alturas de Ciales would make this a more efficient solution in that fewer structures would need to be relocated.		

2.1.4.1 Channelization / Channel Modification

- Channelization involves construction of approximately 9,000 linear feet of concrete-lined channel throughout all Focal Areas within existing riverbank limits. This would require excavating the existing channel to a depth of 17 feet and width of 300 feet. The bottom of the trapezoidal channel would be 100 feet wide, and the slopes would extend to a height of 15 feet with a 3(H):1(V) side slope. The channel would be aligned to improve hydraulic conductivity. See Figure 15.

    - Channelization would reduce flood risk by increasing capacity and expediting water movement through the study area as well as preventing flood-induced bank failure and associated damages to transportation infrastructure. The channel would be designed to contain a 0.1 Annual Exceedance Probability (AEP) event (10-year storm). Construction would not significantly alter existing public and private infrastructure.

    - Concrete material would be sourced from a commercial batch plant(s) located within the region. Excavated material will be reused on site as fill and construction material to the extent possible. Any remaining material will be disposed of at a commercial landfill.

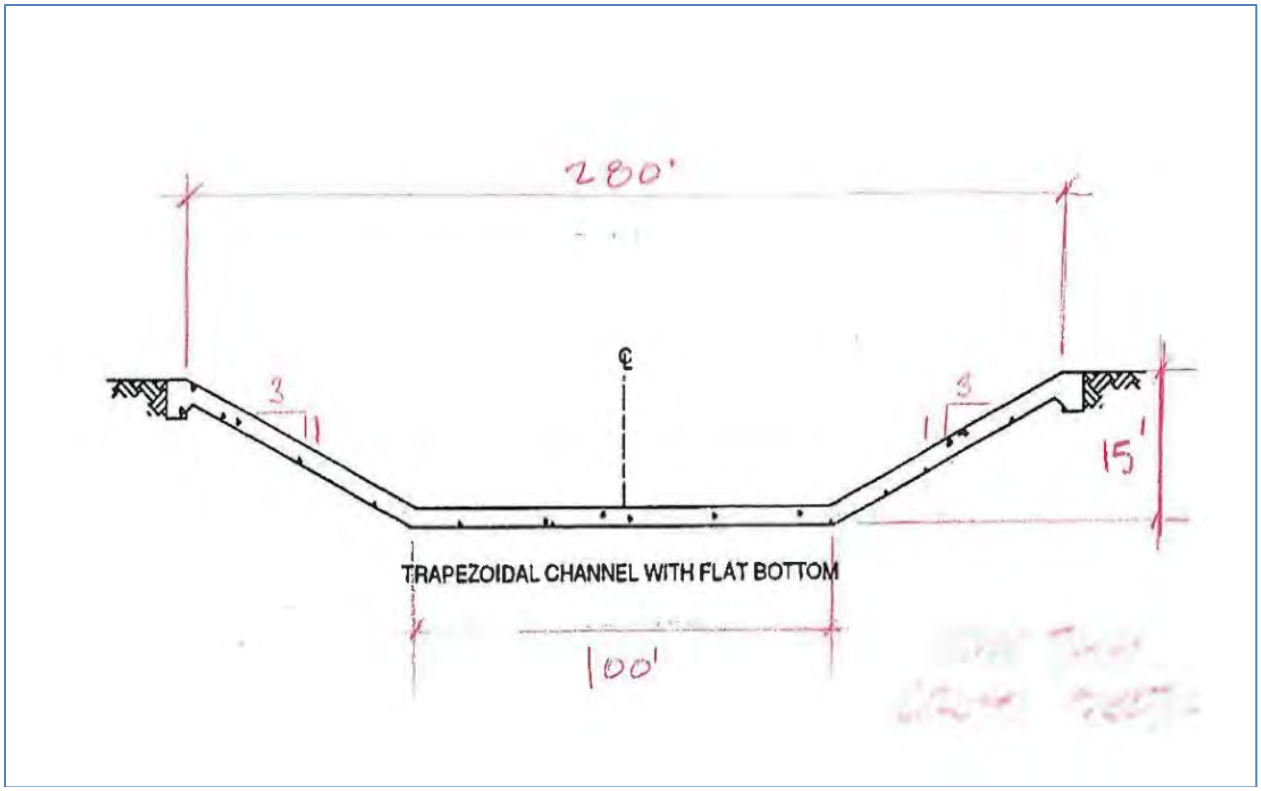

Figure 15 – Typical Trapezoidal Concrete (Channelization) Cross-section

- Channel Modification involves excavation and construction of approximately 7,800 feet of new, meandering low flow channel throughout all Focal Areas. The bottom of the trapezoidal channel would be approximately 200 feet wide and lined with natural river material. Natural river material would be reused from excavated material on site to the greatest extent possible. Channel slopes would be rock-lined at a 3(H):1(V) slope to a height of six feet. See Figure 16.

    - Material would be removed from the area adjacent to the constructed channel to flatten the floodplain and tie into existing grade. The newly constructed low flow channel and widening of the channel within the existing floodplain will increase channel capacity and improve floodplain connection. The channel will be aligned to improve hydraulic conductivity by avoiding large bends in order to prevent water backup and associated flood inundation.

    - The channel would be designed to maximize benefit within the existing channel morphology and to minimize the need to alter existing public and provide infrastructure.

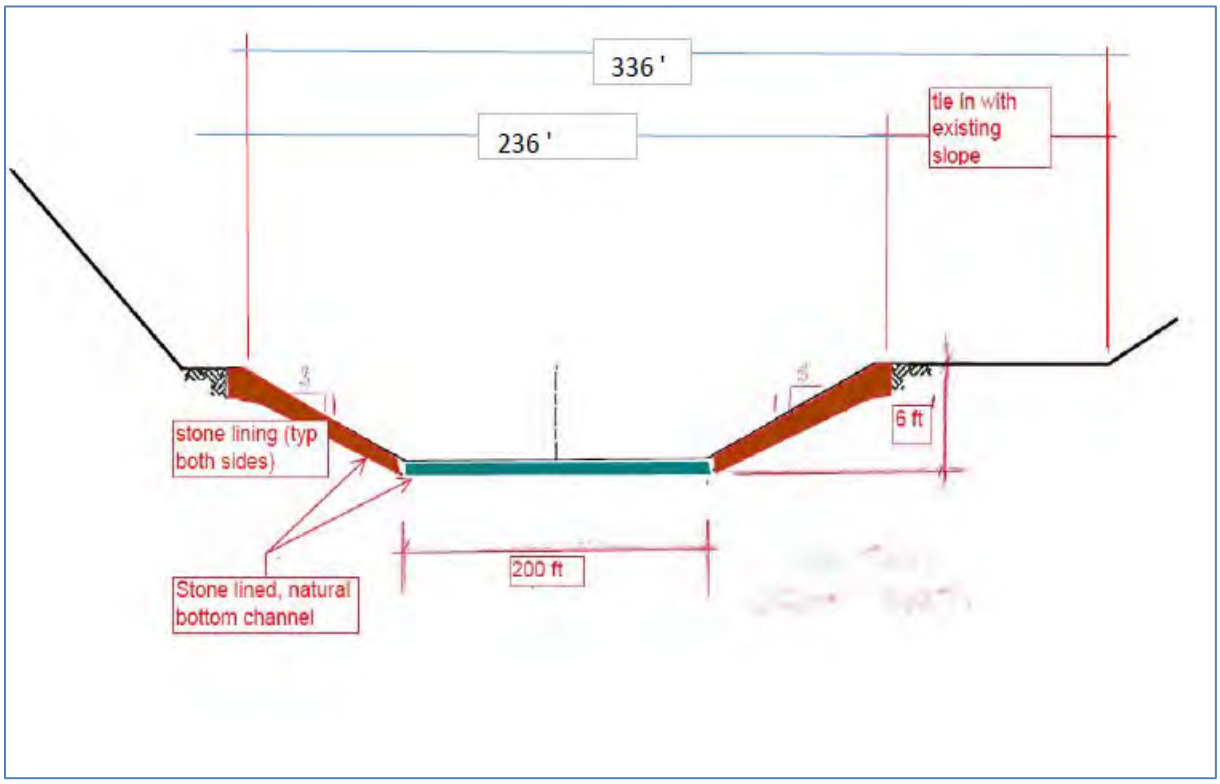

Figure 16 – Typical Channel Modification Cross Section

2.1.4.2 Flood Wall

The flood wall Option consists of constructing a 1,200-foot, concrete-capped, sheet pile "I-wall" (Figure 17) around the PRSA wastewater treatment plant (WWTP). Height of the floodwall will vary based on topography to maintain a constant elevation to be at or just above the 0.04 AEP event (25-year storm) elevation. Based on the limited topographical and subsurface information in the immediate area, a conservative maximum floodwall height would be eight feet. If implemented, detail survey and site investigation will be required during the design phase of the project. Such information will allow the height of the wall to be determined more accurately.

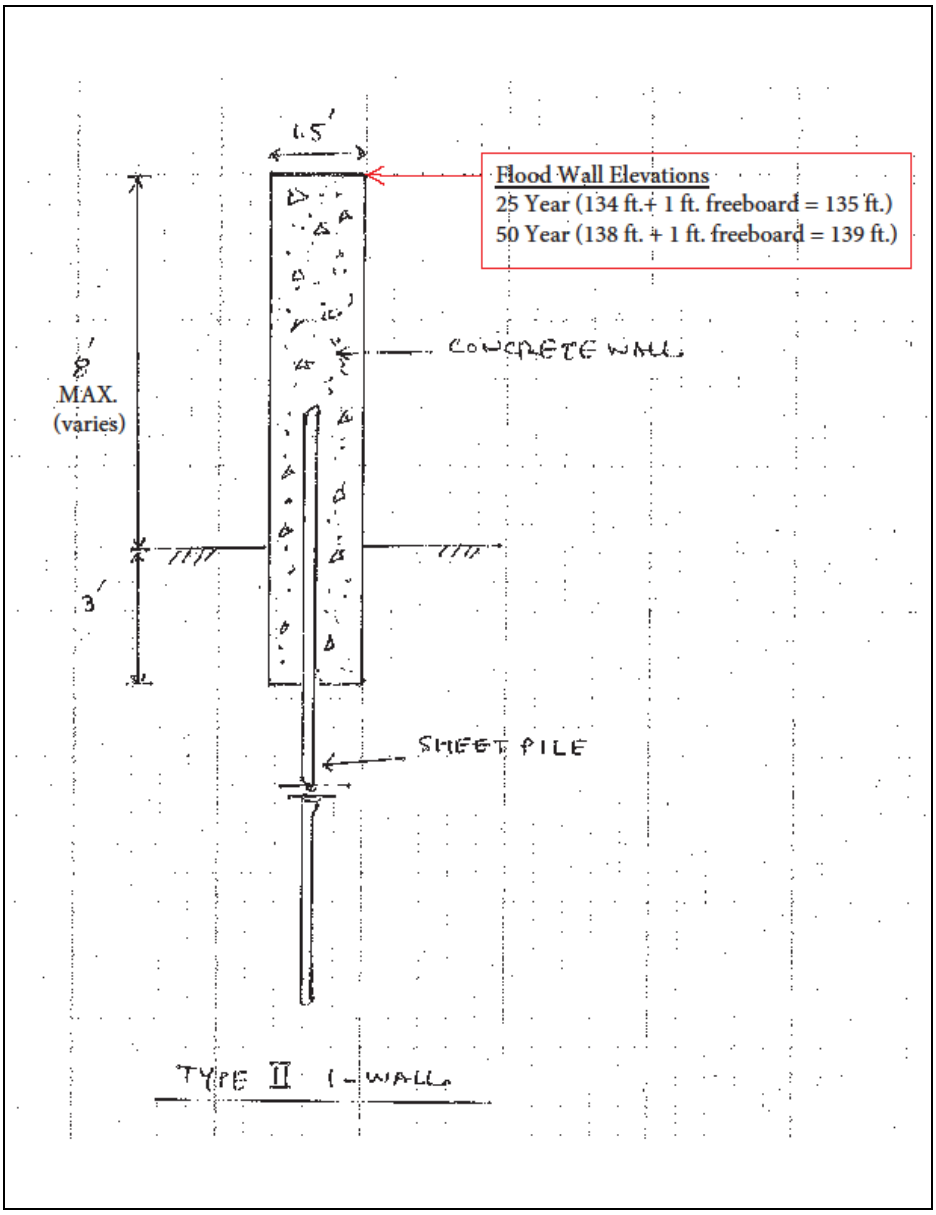

Figure 17 – Typical "I-Wall" Detail

2.1.4.3 Levees

The levee Option involves the construction of a levee (Figure 18) that is part of the locally-developed Original Flood Protection Works plan, which consists of a combined levee/floodwall system along the left bank area of the de Manati River just downstream of the confluence with the los Cialitos River.

Design plans and details for this option are included in Attachment 1 of this Appendix.

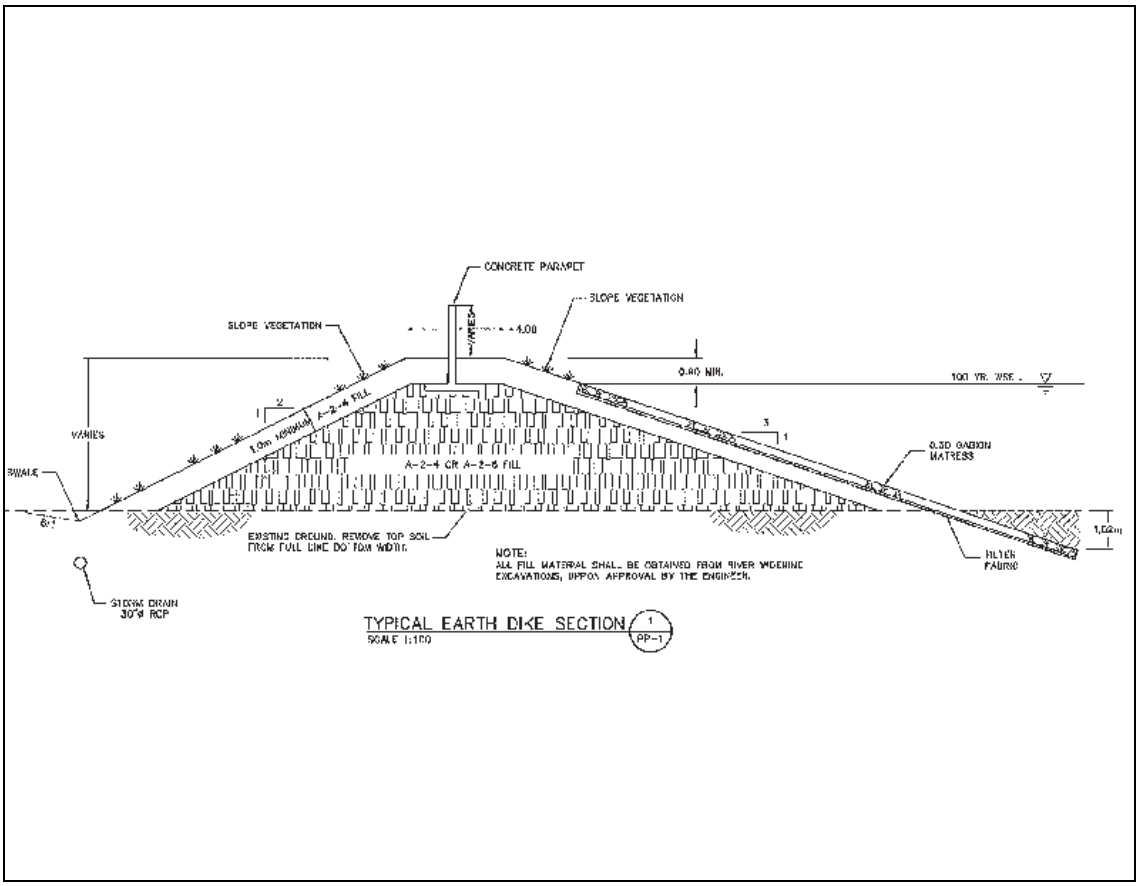

Figure 18 – Typical earth berm (Levee) and wall detail from Original Flood Protection Works project

2.1.5 Options within Focal Areas

After screening was completed, the Options, *consisting of combinations of the selected Measures* that addressed the problems identified within each focal area were developed. The combinations of Options per Focal Area are listed and shown graphically in the main report with the descriptions and summary reproduced here. (Table 6)

Table 6 – Focal Area Options and Alternatives

No Action	Focal Area 1	Focal Area 2	Focal Area 3	Focal Area 4	Comprehensive
	Option 1.1: Channel modification **Option 1.2:** Non-Structural Relocation	**Option 2.1:** Channel Modification, WWTP Floodwall **Option 2.2:** Levee / Floodwall system **Option 2.3:** Non-Structural Relocation, WWTP Floodwall	**Option 3.1:** Channel Modification **Option 3.2:** Non-Structural Relocation	**Option 4.1:** Channel Modification **Option 4.2:** Non-Structural Relocation	**Option C1:** Channelization **Option C2:** Upstream Reservoir

Alternative 0: No Action	Alternative 1: Levee / Floodwall System	Alternative 2: Channel Modification	Alternative 3: Non-Structural Relocations	Alternative 4: Channelization	Alternative 5: Reservoir
Assumes no new federal action. Activities to be pursued by local, state, and/or other Federal agencies (e.g., FEMA relocation of public housing) are assumed to be undertaken	Combination of: • Option 1.2 • Option 2.2 • Option 3.2 • Option 4.2 Construct levee/floodwall system to reduce risk to high-density housing in Focal Area 2. At-risk structures in other focal areas could be relocated to reduce residual risk. Build A floodwall around the WWTP.	Combination of: • Option 1.1 • Option 2.1 • Option 3.1 • Option 4.1 Modify channel throughout project area to increase capacity and hydraulic conductivity. Build A floodwall around the WWTP.	Combination of: • Option 1.2 • Option 2.3 • Option 3.2 • Option 4.2 High-risk housing would be bought out and relocated throughout the study area. Build A floodwall around the WWTP.	Construction of a concrete-lined channel across all focal areas to increase capacity and hydraulic conductivity.	Construction of upstream reservoir to decrease flood water volume and velocity throughout study area.

2.1.5.1 Focal Area 1 Options

- Option 1.1. Channel Modification: Channel modifications would include widening and deepening throughout the focal area and at the PR-149 Bridge to increase capacity and decrease water backup and inundation.

- Option 1.2. Relocation: High-risk structures within the floodplain would be bought out and residents relocated outside of the floodplain.

2.1.5.2 Focal Area 2 Options

- Option 2.1. Channel Modification, Wastewater Treatment Plant Floodwall: Channel modifications would include channel realignment through the field opposite of Dos Rios to regulate flow.. The channel would be designed to increase capacity and create improved floodplain connection. This option would include a floodwall or ring levee around the wastewater treatment plant to protect this critical infrastructure.

- Option 2.2. Levee/Floodwall System: This option would include construction of a floodwall/levee system similar to that proposed under the original Flood Protection Works plan. This option would include a floodwall or ring levee around the wastewater treatment plant to protect this critical infrastructure.

- Option 2.3. Relocation, Wastewater Treatment Plant Floodwall: High-risk structures within the Dos Rios and Altures de Ciales communities would be bought out and residents relocated outside of the floodplain. This option would include a floodwall or ring levee around the wastewater treatment plant to protect this critical infrastructure that also serves areas outside of Dos Rios and Altures de Ciales (e.g., City of Ciales).

2.1.5.3 Focal Area 3 Options

- Option 3.1. Channel Modification: Channel modifications would include channel widening to increase capacity and realignment to regulate flow and prevent water backup upstream of the existing river bend. A floodplain bench would also be constructed to restore natural floodplain processes.

- Option 3.2. Relocation: High-risk structures within the floodplain would be bought out and residents relocated outside of the floodplain.

2.1.5.4 Focal Area 4 Options

- Option 4.1. Channel Modification: Channel modifications would include channel realignment and widening to increase capacity and regulate flow. A floodplain bench would also be constructed to restore natural floodplain processes.

- Option 4.2. Relocation: High-risk structures within the floodplain would be bought out and residents relocated outside of the floodplain.

2.1.5.5 Comprehensive Area-wide Options

The PDT also developed a series of comprehensive options that would work to address identified problems across all focal areas.

- Option C1. Channelization: Channelization would involve channel improvements (i.e., widening and deepening) to increase capacity. The channel would be lined with concrete to decrease roughness, regulate flow, and maintain desired channel geometry and location. Channelization would be designed to reduce inundation of structures, infrastructure (i.e., roadways), and public facilities (i.e., wastewater treatment plant). Channelization would also reduce risks associated with flood-caused bank failure.

- Option C2. Upstream Reservoir: Construction of an upstream reservoir would decrease peak discharge and water velocity throughout the study area, alleviating risk and damages associated with both inundation and flood-caused bank failure.

2.1.6 Alternatives

Focal area-specific and comprehensive options were then combined into distinct alternatives and then compared to the "No Action" plan (see Table 6). Alternatives are named for the primary flood risk management measure included in each; however, other flood risk management measures are generally also included in each alternative. The Alternatives considered are more fully described and graphically presented in the main report and are summarized below.

- Alternative 0. - No Action
- Alternative 1. - Levee/Floodwall System
- Alternative 2. - Channel Modification
- Alternative 3. - Non-Structural Relocations
- Alternative 4 - Channelization

2.1.7 Recommended Plan

The Recommended Plan is defined as Alternative 3b (Figure 19). It is a modified (optimized) version of Alternative 3. More specifically, the Recommended Plan includes the following generalized scope of work:

- Non-Structural Relocations. Structures within the 0.04 AEP floodplain would be acquired and demolished. Affected residents would be relocated outside of the floodplain.

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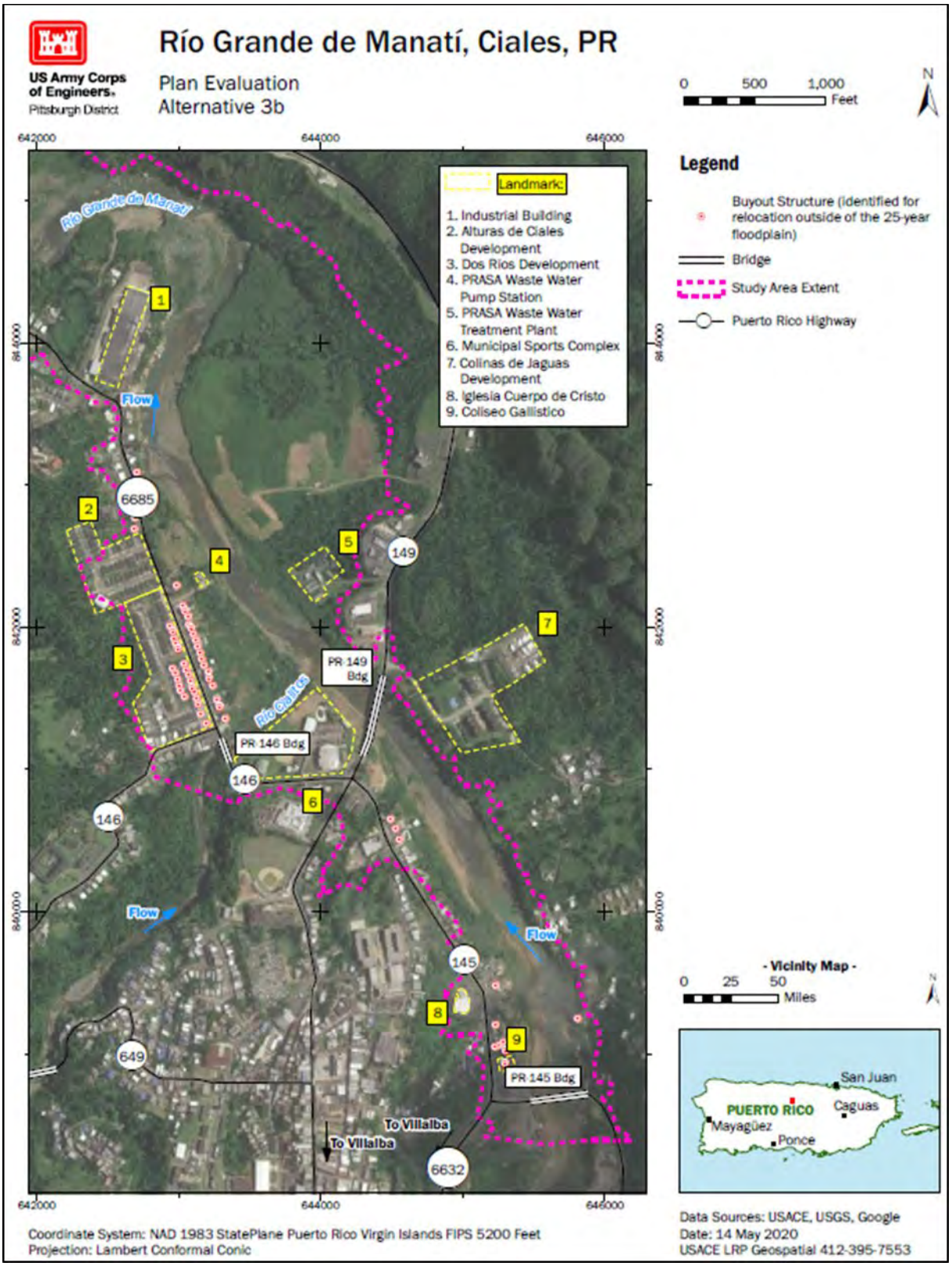

Figure 19 – Conceptual View of Recommended Plan

3 ENGINEERING CONSIDERATIONS RELATED TO THE DEVELOPMENT AND ANALYSIS OF ALTERNATIVES

3.1 GEOTECHNICAL CONSIDERATIONS

3.1.1 Assumptions

Preliminary analyses performed for this Feasibility Study are based on the existing data provided by the Municipality and shareholders. Available geotechnical information was used to interpret subsurface soil and rock types, and derive engineering parameters to formulate geotechnical recommendations for the measures included in the proposed Alternatives for the site.

A reference list of existing documents that were reviewed is provided at the end of this Appendix.

3.1.2 Preliminary Recommendations

Conceptual geotechnical design recommendations of measures included in the proposed Alternatives are described below. The recommendations are based on available geotechnical information in the vicinity of the project. Additional site specific exploration/ investigation will be needed during final design phase if the listed measure is to be part of the recommended plan. Relevant USACE Engineering Design Manuals used to develop the design assumptions/ recommendations are listed in the Reference Section of this Appendix.

3.1.2.1 Flood Wall

A flood wall ranging in height from six to eight feet is proposed for protection of the existing waste water treatment plant (WWTP). Subsurface investigation was performed in the vicinity of the WWTP. Based on the borings near the WWTP, a mixture of sandy and clayey soil was encountered. The top 4 feet of materials encountered in the boring may be fill consisting of sand, gravel and limestone fragments. SPT blow counts measured in the borings ranged from 22 to 61 in the medium dense and very dense soils, respectively. Pocket penetrometer tests in the clayey soils indicated undrained shear strength between 1,000 – 2,000 psf.

Based on the level of protection needed, an I-type flood wall is recommended in the area of the WWTP. I-walls are generally suitable for protection in narrow restricted areas where the exposed wall height is not more than 10 feet. I-walls consist of driven sheet piles capped by a concrete wall. The vast majority of I-walls within the USACE inventory fall into the Type II I-wall which is essentially the sheet pile wall with a concrete cap placed above ground with needed embedment for stability.

Alluvium soils consisting of sand, gravel and cobbles investigated in this area are highly permeable based on the laboratory grain size analysis results. Sheet pile may need to be extended to greater depth to provide effective seepage cutoff. In general, the sheet pile cut-off should penetrate the coarse grained alluvium which may be greater than 35 feet in depth.

3.1.3 Conclusions

Based on the existing data, erodible soils are present in the channel and flood plain of Rio Grande de Manati River.

The recommendation contained in the report is based on the review of the existing subsurface investigation and should only be considered as preliminary. Detail site specific subsurface investigation should be performed during the design phase of the project.

3.2 STRUCTURAL

3.2.1 At Risk Structures

3.2.1.1 Buildings

The Recommended Plan effectively eliminates flood risk for homes and businesses within the 0.04 AEP event—providing these individuals the opportunity to relocate to areas with zero flood risk. Residual risk remains for homes, businesses, and public facilities (i.e., wastewater treatment plant) outside of the 0.04 AEP floodplain.

- Of the structures affected by flooding only 59 properties are expected to be purchased and demolished with affected residents relocated. Finished floor elevations of the structures remaining in the Study Area and identified at risk will be surveyed and documented.

3.3 WATER RESOURCES

3.3.1 Considerations Related to Alternatives

3.3.1.1 No Action Alternative

The No Action Alternative is essentially the Existing Conditions. Input for the existing conditions is discussed previously in Section 1.2.3.2.

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

3.3.1.2 Alternative 1 (Levee / Floodwall System)

This alternative incorporates the locally-developed, original flood protection works plan and specifications, which included a combined levee/floodwall system, a drainage system and retention pond, as well as channel improvements to reduce flood risk within the community of Dos Rios. High-risk structures in other focal areas not protected by the levee/floodwall system may be relocated to reduce residual risk if incrementally justified.

Alternative 1 also incorporates a 1,200-foot concrete capped I-wall (Type II) around the wastewater treatment plant. Height of the floodwall will vary to maintain a constant elevation to protect against the 0.04 AEP event. Maximum height of the floodwall will be 8 feet.

3.3.1.2.1 Model Input

3.3.1.2.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), as described in section 1.2.3.2, and then the following adjustments were made: 1) inclusion of a levee feature from cross-section 32988 to 32455 on the left bank and channel widening from cross-section 32988 to 32325 on the right bank, to mimic the design from the 2008 Original Flood Protection Works Project; and 2) inclusion of a levee feature from cross-section 32918 to 32740 on the right bank, around the wastewater treatment plant.

3.3.1.2.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action) and is described in section 1.3.3.2.2.

3.3.1.2.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action) and is described in section 1.3.3.2.3.

3.3.1.2.2 Model Output

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

3.3.1.3 Alternative 2 (Channel Modification)

This alternative includes excavation and construction of approximately 7,800 feet of new, meandering low flow channel. The bottom of the trapezoidal channel would be 200 feet wide and lined with natural river material. Natural river material would be reused from excavated material from the site to the extent possible. Channel slopes would be rock-lined at a 3H: 1V slope to a height of 6 feet. Material would be removed from the area adjacent to the constructed channel to flatten the floodplain and tie into existing grade. The newly constructed low flow channel and widening of the channel within the existing floodplain will increase channel capacity and improve floodplain connection. The channel will be aligned to improve hydraulic conductivity by avoiding large bends in order to prevent water backup and associated flood inundation. The channel was designed to maximize benefit within the existing channel morphology and to minimize the need to alter existing public and private infrastructure.

Alternative 2 also incorporates a floodwall around the PRSA wastewater treatment plant as described under Alternative 1.

2.1.3.3.1 Model Input

2.1.3.3.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), with the following adjustments made: 1) inclusion of a levee feature from cross-section 32918 to 32740 on the right bank, around the wastewater treatment plant; and 3) channel widening/realignment from cross-section 32455 to 31041 on both the left and right banks.

2.1.3.3.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action).

2.1.3.3.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action).

2.1.3.3.2 Model Output

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

3.3.1.4 Alternative 3 (Non Structural Relocations)

Structures within the 0.04 AEP floodplain would be acquired and demolished. Residents would be relocated outside of the floodplain. The 0.04 AEP floodplain was selected to include those structures with the majority of recurring flood damages, as well as those with the greatest life and safety risk during major flood events.

Alternative 3 also incorporates a floodwall around the wastewater treatment plant, as described under Alternatives 1 and 2.

3.3.1.4.1 Model Input

3.3.1.4.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), with the following adjustments made: 1) inclusion of a levee feature from cross-section 32918 to 32740 on the right bank, around the wastewater treatment plant. No modifications to the geometry were made to account for the properties that are proposed to be bought out (relocation of residents in the 0.04 AEP floodplain) because early in the planning process it was uncertain whether the properties to be purchased would be demolished. Assuming that they would not be demolished was believed to be conservative relative to the Manning's n values used; demolition of the buildings would result in lower roughness values and ultimately lower water surface elevations.

3.3.1.4.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action).

3.3.1.4.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action).

3.3.1.4.2 Model Output

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

3.3.1.5 Alternative 4 (Channelization)

Channelization involves construction of approximately 9,000 linear feet of concrete-lined channel within existing riverbank limits. This alternative would require excavating the existing channel to a depth of 17 feet and width of 300 feet. The bottom of the trapezoidal channel would be 100 feet wide, and the side slopes would extend to a height of 15 feet at a 3H: 1V slope.

3.3.1.5.1 Model Input

3.3.1.5.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), with the following adjustments made: 1) modification to the channel geometry and manning’s n roughness coefficient from river cross-section 33704 to river cross-section 30753.

3.3.1.5.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action).

3.3.1.5.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action).

3.3.1.5.2 Model Output

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

3.3.1.6 Alternative 3b (Recommended Plan)

The tentatively selected plan (TSP or Recommended Plan) is the Alternative 3b (Non-Structural Relocations) Plan with modification. The modification includes removing the proposed floodwall around the WWTP.

3.3.1.6.1 Model Input

3.3.1.6.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 3 (Non-Structural Relocations), with the following adjustments made: 1) removal of the levee feature from cross-section 32918 to 32740 on the right bank, around the wastewater treatment plant..

3.3.1.6.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action).

3.3.1.6.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action).

3.3.2 Model Output

The water surface profiles, output table, and cross-sections for the project extents are summarized in Attachment 3.

4 REFERENCES

Environmental Assessment for the Construction of Flood Control Works in the “Dos Rios” Sector at Ciales, Puerto Rico, Quinones, Diez, Silva y Asociados, CSP, June 2005

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EM 1110-2-1902 USACE Engineering and Design, Slope Stability, October 2003

EM 1110-2-2502 USACE Engineering and Design, Retaining and Flood Walls, September 1989

EM 1110-2-1601 USACE Hydraulic Designs of Flood Control Channels, June 1994

Attachment 1
Original Flood Protection Works Project Plans

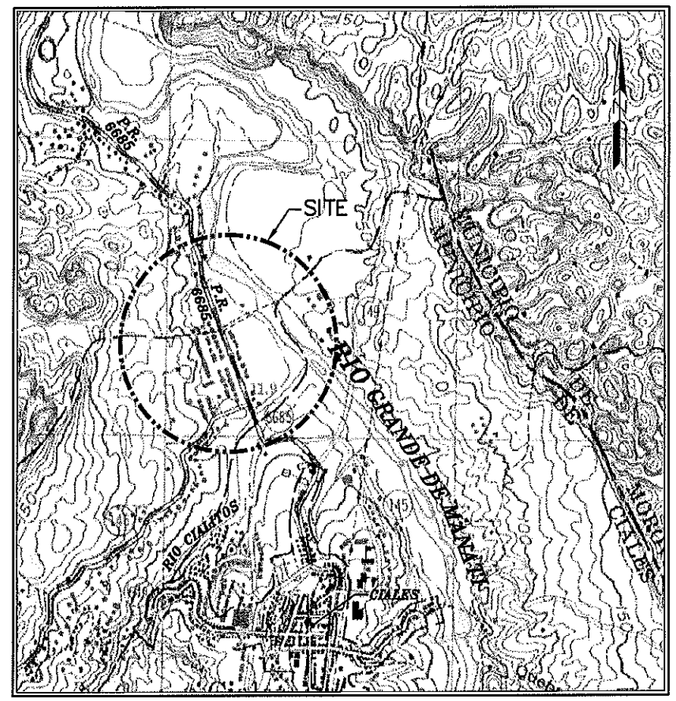
COMMONWEALTH OF PUERTO RICO

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES

AREA OF WATER AND MINERAL RESOURCES

SCHEDULE OF DRAWINGS

SHEET NO.	DWG. NO.	TITLE
1	G-01	TITTLE SHEET
2	G-02	GENERAL LAYOUT
3	SS-01	BORING LOCATION PLAN
4-12	SS-02 TO SS-10	BORING LOGS
13-14	PP-01 TO PP-02	DIKE PLAN AND PROFILE
15-17	CS-01 TO CS-03	CROSS SECTIONS (EARTH DIKE)
18-19	P-01 TO P-02	RIVER WIDENING PLAN AND PROFILE
20	P-03	RIVER WIDENING DATA TABLE, TYPICAL SECTION AND RETENTION POND ACCESS RAMP DETAILS
21-26	CW-01 TO CW-06	CROSS SECTIONS (CHANNEL WIDENING)
27-41	RW-01 TO RW-15	RETAINING WALLS
42-50	DR-01 TO DR-09	DRAINAGE PLANS AND DETAILS
51-54	MD-01 TO MD-04	MISCELLANEOUS DETAILS
55	US-01	10"ø SANITARY FORCE LINE RELOCATION
56	RD -- 01	TREE INVENTORY
57	RD -- 02	TREE PLANTING PLAN
58	RD - 03	TREE PLANTING DETAILS
59-64	MOT-01 TO MOT-06	MANAGEMENT OF TRAFFIC
65-68	ROW-01 TO ROW-04	LAND ACQUISITION PLANS



LOCATION PLAN
SCALE 1: 20,000

SUBMITTED:

DIRECTOR , DESIGN DIVISION — DATE

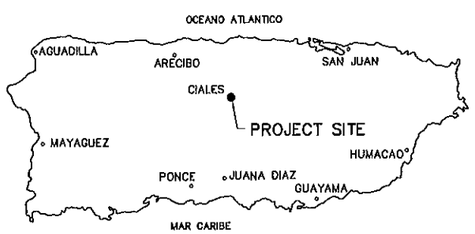
RECOMMENDED:

ASSISTANT ADMINISTRATOR OF WATER AND MINERAL RESOURCES AREA. — DATE

ADMINISTRATOR NATURAL RESOURCES ADMINISTRATION — DATE

APPROVED:

SECRETARY OF THE DEPARTMENT OF NATURAL AND ENVIROMENTAL RESOURCES — DATE



FINAL PLANS

FLOOD PROTECTION WORKS

DOS RIOS, CIALES P.R.

(INCLUDES STORM SEWERS AT PR-146 AND DOS RIOS HOUSING DEVELOPMENT)

QUIÑONES, DIEZ, SILVA Y ASOCIADOS
CONSULTING ENGINEERS
414 MUÑOZ RIVERA AVENUE
SAN JUAN, PUERTO RICO

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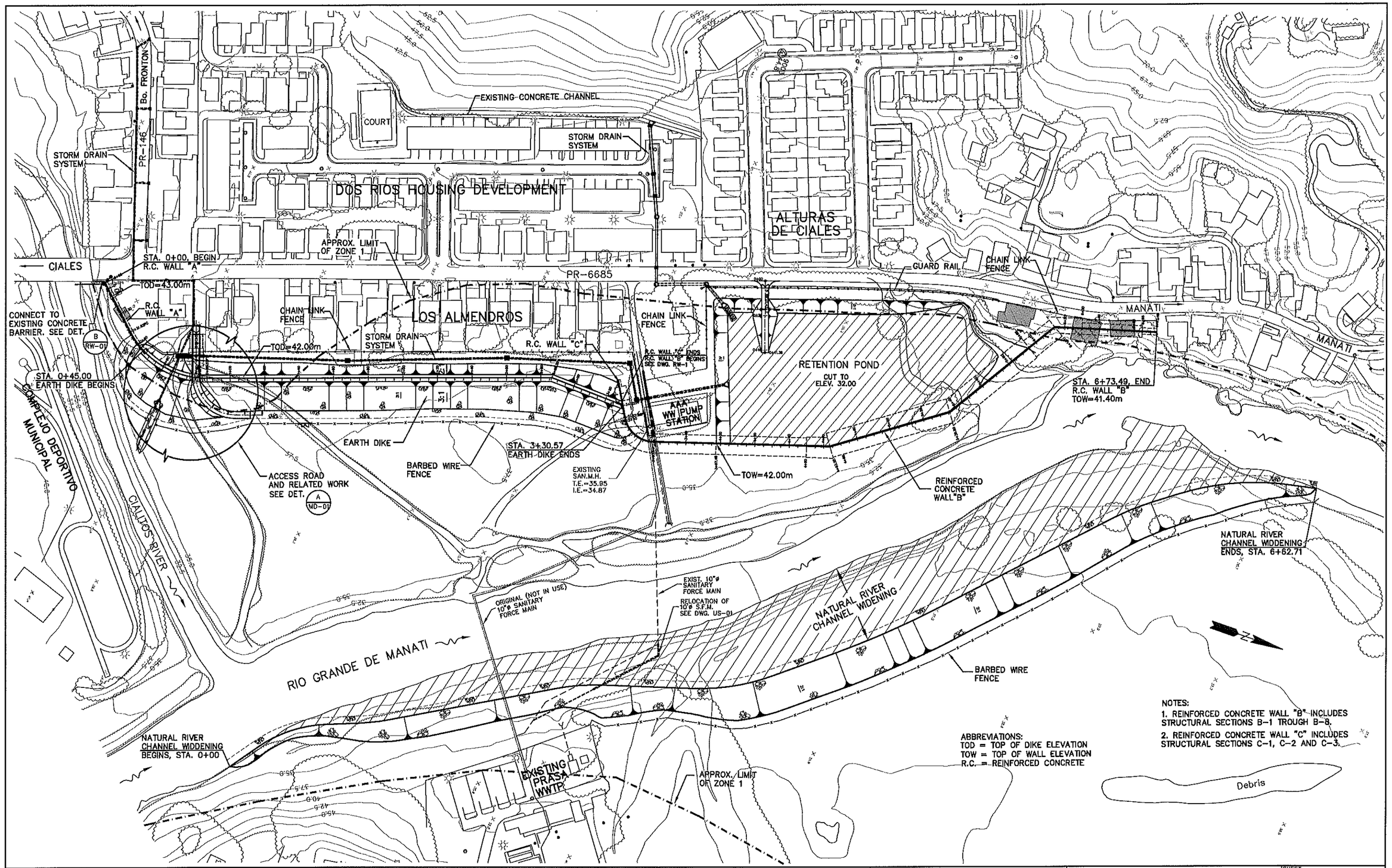

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						1:1000	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIAOOS
SAN JUAN, PUERTO RICO

GENERAL LAYOUT

SHEET: 2
DWG: G-02
DATE:
PROJ:

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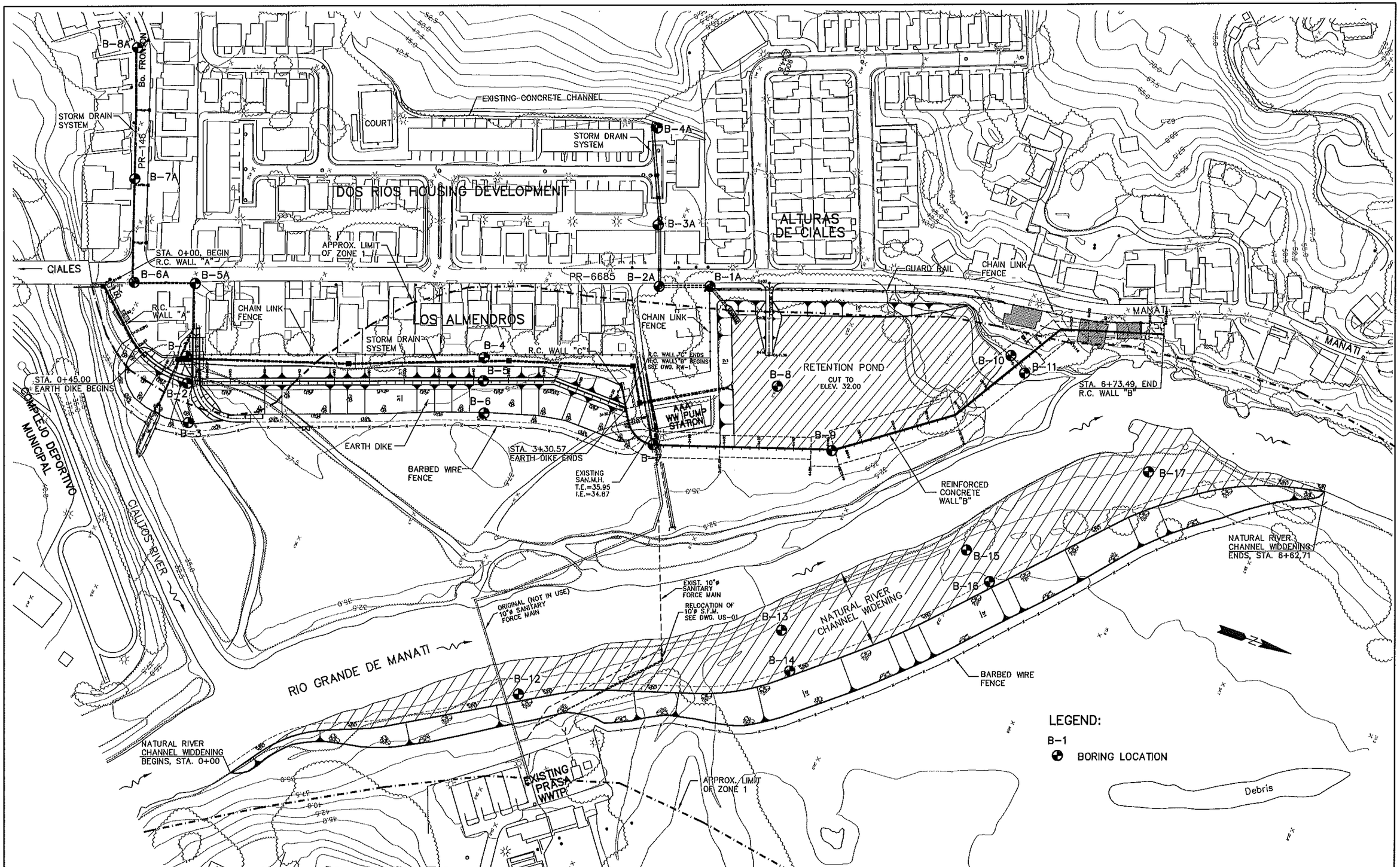

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						1:1000	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

BORING LOCATION PLAN

SHEET: 3
DWG: SS-01
DATE:
PROJ:

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LOG OF TEST BORING
BORING 1

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 1
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 36.0'
WATER DURING DRILLING: 30.0' AFTERWARDS:

DATE: 12/13/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 34.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	20/6 20/6 13/6	Dark yellowish brown clayey silty sand and gravel.	33			9.97
	22/6 13/6 26/6	Brown gravel, some fine to medium sand, little silt.	39			7.44
	9/6 6/6 7/6	(dark brown).	13			5.69
5	12/6 7/6 7/6	No recovery.	14			NOREC
	10/6 12/6 16/6	(brown gravel, some fine to medium sand & silt).	22			13.05
10						
	3/6 3/6 8/6	Top -Do-/ Bottom - brown sandy clay, some silt.	11			9.39
15						
	27/6 50/5	Brown sandy gravel, some silt.	50/5"			8.54
20						
	3/6 6/6 7/6	Brown fine to coarse sand, some fine gravel. (A-1-b; SW-SM). (5.3%-fines).	13			15.63
25						
	9/6 13/6 13/6	Do- (with a sandy silt pocket).	26			14.04
30						
	50/5	Fine to coarse gravelly sand.	50/5"			17.5
35						

Page No.1

Geotec

LOG OF TEST BORING
BORING 2

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
HORING NO: 2
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 40.0'
WATER DURING DRILLING: 15.0' AFTERWARDS:

DATE: 12/14/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	3/6 4/6 6/6	Brown, very stiff silty clay, little fine sand, occ. gravel.	10		3.5	21.27
	4/6 4/6 6/6	Do- (some fine sand).	10		1.25	22.04
5	7/6 6/6 8/6	Brown sandy clay, some silt, occ. fine gravel.	14		1.5	20.55
	8/6 8/6 5/6	Brown gravel, some medium to coarse sand, little silt, occ. clay lumps.	13			7.86
10	8/6 13/6 8/6	Brown fine to medium sandy gravel, some silty clay.	21			11.14
15	7/6 8/6 11/6	Brown gravel, some fine to medium sand, little silt.	19			7.08
20	8/6 12/6 9/6	Dark yellowish brown, fine to medium sand, some silt, trace fine gravel. (A-1-b; SW-SM) (9.1%-fines).	21			23.5
25	8/6 11/6 15/6	Dark yellowish brown gravelly sand, little silt. (A-1-b; SM) (12.1%-fines).	26			16.43
30	53/6 25/6 21/6	Rock cobble or boulder fragments, little silty sand, dark grayish brown.	46			16.12
35	26/6 30/6 43/6	Dark grayish brown, fine to medium sand, some gravel, trace silt.	73			21.59

Page No.1

Geotec

LOG OF TEST BORING
BORING 3

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 3
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 40.0'
WATER DURING DRILLING: 20.0' AFTERWARDS:

DATE: 12/15/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	2/6 5/6 5/6	Brown, stiff clayey silt, some fine sand.	13		1.5	38.51
	9/6 9/6 8/6	Do- (little fine sand). (LL=46%, PI=20%, A-7-6;CL)	17		1.5	31.83
5	4/6 4/6 5/6	Do.	9		1.75	27.45
	5/6 6/6 4/6	Do- (some sand to sandy).	10		1.0	35.69
10	4/6 8/6 5/6	Top- Do/ Bottom- brown fine gravel, some sand and silt.	13		1.0	33.93
15	40/6 39/6 32/6	Dark brown gravel, some fine to medium sand and silt, trace to little clay, moist.	71			13.88
20	18/6 18/6 10/6	(Gravel and/ or cobble fragments, few clay, some sand trace silt). (4.9%-fines). (A-1-a;GP).	28			27.39
25	18/6 9/6 6/6	Fine to coarse SAND & GRAVEL, trace silt. (A-1-a; SP-SM) (5%-fines)	15			15.24
30	50/2	No recovery.	50/2"			NOREC
35	50/4	Weathered rock broken by sampler into greenish gray, gravel size rock fragments, some silt and	50/4"			10.06

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Geotec

LOG OF TEST BORING
BORING 1

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 1
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 36.0'
WATER DURING DRILLING: 30.0' AFTERWARDS:

DATE: 12/13/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 34.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40						
45						

LOG OF TEST BORING
BORING 2

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 2
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 40.0'
WATER DURING DRILLING: 15.0' AFTERWARDS:

DATE: 12/14/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40	50/4	Weathered rock broken by sampler into olive gray rock fragments with some fine to medium sand, little silt, trace clay.	50/4"			10.97
45						

LOG OF TEST BORING
BORING 3

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 3
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 40.0'
WATER DURING DRILLING: 20.0' AFTERWARDS:

DATE: 12/15/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
		sand.				
40	50/3	Do.	50/3"			10.52
45						

DSGN:	NO.	DATE	REVISION	BY	APVD
DR:					
CHK:					
APVD:					

VERIFY SCALE
AS SHOWN

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

BORING LOGS

SHEET: 4
DWG: SS-02
DATE:
PROJ:

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LOG OF TEST BORING
BORING 4

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 1/21/05
BORING NO: 4 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: 23.0' AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	2/6 3/6 5/6	Brown, silty clay, little fine sand with occ. tiny roots.	8		1.0	28.1
	3/6 5/6 5/6	Do.	10		1.0	35.3
5	2/6 3/6 3/6	Do- (clayey sand). LL=38%, PI=12% (A-6;SC)	6		.75	27.7
	3/6 3/6 3/6	Do- LL=34%, PI=13% (A-6;SC)	6		.75	20.1
	3/6 3/6 4/6	Do- (sandy).	7		1.0	24.0
10						
	3/6 2/6 5/6	Brown silty sand, trace clay. (33.6%-fines). (A-2-4;SM)	5			28.1
15						
	56/6 50/3	No recovery- prob. rock cobbles or boulders.	50/3"			NOREC
20	26/6 18/6 22/6	Fine to coarse gravel trace silty sand.	40			8.3
	7/6 19/6 47/6	Fine to coarse gravel and/ or rock cobble fragments, trace silty sand.	66			ROCKS
25						
	29/6 33/6 20/6	Do-(sandy).	53			19.8
30						
	6/6 14/6 23/6	Do-(trace clay, sandy).	37			14.0
35						

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Geotec

LOG OF TEST BORING
BORING 5

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 1/24/05
BORING NO: 5 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	2/6 3/6 8/6	Brown, silty clay, trace fine sand, occ. tiny roots.	13		1.25	30.8
	8/6 9/6 9/6	Do- (some fine sand with a piece of medium gravel).	18		2.0	22.3
5	6/6 3/6 5/6	Brown sandy silty clay.	12	1.70		22.0
	3/6 4/6 4/6	Brown silty clay, trace fine sand.	8		1.5	26.4
	4/6 13/6 11/6	Do- (with a pocket of fine to medium sandy gravel).	24		2.0	23.5
10						
	50/0	No recovery- probable rock cobbles or boulders.	50/0"			NOREC
15						
	44/6 27/6 50/2	Rock cobble or boulder fragments, trace sand.	77/8"			7.1
20						
	13/6 44/6 50/6	Sandy gravel with rock cobble or boulder fragments, trace silt.	94			10.2
25						
	75/6 27/6 6/6	Olive gray sandy gravel with trace silt, occ. clay.	27			19.4
30						
	4/6 4/6 17/6	Do- brownish. (A-1-a; GW-GM) (6.8%-fines).	21			14.5
35						

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Geotec

LOG OF TEST BORING
BORING 6

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/07/05
BORING NO: 6 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 39.0' — CASED TO: 37.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	1/6 3/6 3/6	Brown, silty clay, trace sand with occ. tiny roots.	6	1.00		28.2
	3/6 5/6 4/6	Do. LL=41%, PI=18% (A-7-6; CL)	9		1.0	31.1
5	3/6 2/6 2/6	Brown sandy silty clay.	4		.75	23.0
	2/6 3/6 16/6	Brown, silty clay with a thin pocket of sand, trace fine gravel.	21		1.25	24.5
10	12/6 11/6 7/6	Fine to medium gravel with some silty sand. (A-1-a; GP-GM)	18			9.0
	31/6 43/6 30/6	ROCK cobble or boulder fragments, trace clayey silt and fine sand, moist.	79			ROCKS
15						
	5/6 7/6 11/6	Reddish brown, gravelly sand, trace silt. (5.3%-fines)	18			8.7
20						
	32/6 50/6 50/5	Sandy gravel and rock cobble or boulder fragments, little sand, trace silt.	100/ 11"			14.8
25						
	45/6 50/6 50/6	Do- (sandy gravel, trace silt, occ. clay).	50			10.6
30						
	44/6 45/6 47/6	Fine to coarse gravel, some silty sand and occ. rock cobble or boulder fragments.	92			20.8
35						

Page No.1

Geotec

LOG OF TEST BORING
BORING 4

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 1/21/05
BORING NO: 4 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: 23.0' AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40	24/6 34/6 30/6	Do-(sandy).	64			13.1
45						

LOG OF TEST BORING
BORING 5

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 1/24/05
BORING NO: 5 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40	50/1	Fine gravel and rock cobble or boulder fragments.	50/1"			15.2
45						

LOG OF TEST BORING
BORING 6

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/07/05
BORING NO: 6 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 39.0' — CASED TO: 37.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40	50/0	No recovery- Probable rock cobbles or boulders.	50/0"			NOREC
45						

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

BORING LOGS

SHEET: 5
DWG: SS-03
DATE:
PROJ:

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LOG OF TEST BORING
BORING 7

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 7
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 40.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 12/9/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	5/6 7/6 7/6	Dark yellowish brown sandy clayey silt, occ. limestone fragments (fill).	14			25.52
	9/6 50/1	Dark yellowish brown, hard clay with some silt, fine sand and faint clasts.	50/1"		4.0	19.06
5	4/6 4/6 3/6	Brown clayey sandy silt, moist.	7			22.58
	5/6 4/6 5/6	Do, (stiff).	9		1.0	31.81
	2/6 2/6 2/6	Brown sandy clayey silt to silty clay.	4		1.5	28.97
10						
	2/6 1/6 2/6	Brown very loose silty sand and clay pockets. (A-2-4; SC) LL=28%, PI=9%, (32.2%-fines).	3			18.76
15						
	50/3	No recovery.	50/3"			NOREC
20						
	50/2	Rock cobble or boulder fragments, trace sandy silt.	50/2"			16.45
25		Coarse gravel and rock cobbles Rec. 23%.				
30		Rock cobbles and/ or boulder fragments, and coarse gravel, Rec 20%				
35						

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Geotec

LOG OF TEST BORING
BORING 8

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 8
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 25.0'
WATER DURING DRILLING: 21.5' AFTERWARDS:

DATE: 1/14/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 23.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	1/6 3/6 8/6	Heterogeneous mixture of clay, gravel and org. matter (fill).	11			19.8
	7/6 11/6 14/6	Brown stiff silty clay, some fine sand.	25			31.3
5	13/6 9/6 5/6	(Sandy).	18		1.25	33.5
	4/6 3/6 3/6	(Medium to stiff silty clay). LL=51%, PI=25%, (A-7-6; CH)	6	0.60		37.5
	5/6 5/6 3/6	(With some sand, occ. fine gravel).	8		.5	34.5
10						
	18/6 5/6 2/6	No recovery.	5			NOREC
15						
	17/6 25/6 28/6	Dark gray rock cobble or boulder fragments with reddish brown silty sand.	50			7.7
20						
	50/0	No recovery- Probable rock cobbles or boulders.	50/0"			NOREC
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 9

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 9
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 39.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 1/17/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	3/6 2/6 2/6	Dark reddish brown, fine silty sand with clayey silt pockets.	4			22.2
	7/6 7/6 12/6	Yellow limestone gravel within olive stiff clayey silt matrix.	19			14.2
5	36/6 16/6 13/6	Do- (tannish stiff sandy silty clay matrix).	35		2.0	19.7
	10/6 9/6 8/6	Olive tan clayey silt with faint clasts and some gravel.	17		1.75	26.0
	13/6 10/6 10/6	Do- (silty clay, occ. fine gravel).	20		1.75	34.3
10						
	9/6 7/6 10/6	Pale yellow sandy clayey silt and limestone gravel with a thin lens of dark brown silty sand.	17			20.4
15						
	16/6 25/6 29/6	Fine to coarse gravel or rock cobble fragments and silty sand.	57			7.1
20						
		Coarse gravel and cobbles. Rec. 13.5%				
25						
		Do. Rec.33%				
30						
		Do. Rec.30%				
35						

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Geotec

LOG OF TEST BORING
BORING 7

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 7
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 40.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 12/9/04
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
		Rock cobbles and/ or boulder fragments. Rec. 25%.				
40						
45						

LOG OF TEST BORING
BORING 9

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 9
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 39.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 1/17/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 38.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
		Coarse gravel. Rec.30%				
40						
45						

DSGN:	NO.	DATE	REVISION	BY	APVD	VERIFY SCALE
DR:						AS SHOWN
CHK:						
APVD:						

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

BORING LOGS

SHEET: 6
DWG: SS-04
DATE:
PROJ:

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LOG OF TEST BORING
BORING 10

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/15/05
BORING NO: 10 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: 6.0' AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	1/6, 1/6, 1/6, 1/6, 2/6, 4/6, 4/6, 1/6, 1/6, 1/6, 1/6, 1/6, 1/12	Dk. brown clayey silt with little sand & concrete debris (fill).	2			51.7
			3			44.5
		Very soft clayey sandy silt, occ. fine gravel.	5			21.5
		Sandy clayey silt, some gravel.	2			38.5
5		Do- (with occ. small pebbles).				
		Dk. olive brown, slightly org. very soft silt, some clay, trace fine sand.	1			49.3
	1/6, 1/6, 1/6, 1/6, 1/6, 1/12	Do.	2			56.6
10		Dark olive, org. silt with little clay and sand lenses, few org. matter. LL=62%, PI=33%, OH	1		.25	52.4
	6/6, 10/6, 10/6	Fine to medium sandy gravel with little, org. silt.	20			23.7
15		ROCK cobbles and boulders, some fine to coarse gravel, Rec. 25%				
20		Do. Rec. 32%				
25		Do. Rec. 12%				
30						
35		Fine to coarse gravel, trace clayey sand. Rec. 30%				

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Geotec

LOG OF TEST BORING
BORING 11

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/10/05
BORING NO: 11 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	1/6, 1/18	Dark silty sand, trace fine gravel and very soft clayey silt.	1			15.5
	1/6, 1/6, 1/6, 1/6, 1/6, 1/6	Dark olive slightly org. clayey sandy silt. (A-4; MH)	2			54.1
		Do- (with few org. matter).	2			63.2
5	1/18	Do- (brown also).	1			48.0
	1/18	Do- (sandy).	1			56.8
	1/18	Do- (some sand).	1			62.0
10	3/6, 10/6, 20/6	Fine to medium silty sandy gravel with some slightly org. silt, trace clay.	30			15.9
		Fine to coarse gravel and rock cobbles. Rec. 17%				
15		Rock cobbles or boulder fragments and medium to coarse gravel. Rec. 40%				
20		Rock boulders and coarse gravel. Rec. 30%				
25		Rock cobbles and boulder fragments and coarse gravel. Rec. 27%				
30		Do. Rec. 30%				
35						

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Geotec

LOG OF TEST BORING
BORING 12

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/24/05
BORING NO: 12 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 20.0' — CASED TO: 18.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	2/6, 30/6, 6/6	Brown silty sand with some fine to medium gravel, trace clay.	36			26.1
	9/6, 20/6, 20/6	Fine to medium gravel and limestone fragments, some brown silty sand.	40			9.7
5	12/6, 8/6, 16/6	Brown clayey silty sand, trace gravel. (A-4; SC)	24		1.0	26.8
	5/6, 16/6, 6/6	Brown silty clay, little sand, occ. fine gravel. (A-7-6; CL)	22		2.0	27.7
10	14/6, 36/6, 23/6	Fine to coarse gravel, some silty sand, trace clay. (A-1-a; GP-GM) (5.3%-fines).	61			7.0
15		Rock cobbles, some medium to coarse gravel. Rec. 48.3%				
20		Medium to coarse gravel and rock cobbles. Rec. 66.7%				
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 10

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/15/05
BORING NO: 10 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: 6.0' AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40		Do. Rec.17%				
45						

LOG OF TEST BORING
BORING 11

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R. — DATE: 2/10/05
BORING NO: 11 — ELEV: UNKNOWN
DRILL METHOD USED: HOLLOW STEM AUGER — PROJECT NO: 3898
DEPTH TO CAVING: 40.0' — CASED TO: 38.5'
WATER DURING DRILLING: AFTERWARDS: — DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
40		Do. Rec. 19%				
45						

DSGN:				VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:				AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

BORING LOGS

SHEET: 7
DWG: SS-05
DATE:
PROJ:

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LOG OF TEST BORING
BORING 13

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 13
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 20.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 2/22/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 18.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	2/6 4/6 4/6	Brown silty clay with little fine sand.	8		1.25	26.7
	3/6 2/6 1/6	Do.	3		1.25	24.2
5	4/6 5/6 4/6	Do- (with some sand).	9	1.90		28.2
	4/6 6/6 4/6	Do- (clayey sand). (A-4; SC)	10			24.4
	5/6 14/6 6/6	Brown clayey gravel and sand. (A-1-a; GC)	20			21.8
10		Rock cobbles and boulders, little gravel. Rec. 43.3%				
15		Medium to coarse gravel and cobbles. Rec. 66.7%				
20						
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 14

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 14
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 20.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 2/18/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 18.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	3/6 2/6 3/6	Brown sandy silty clay.	5		1.0	23.7
	6/6 5/6 5/6	Brown clayey silt sand. (27.8%-fines). (A-2-6; SC)	10	1.70		19.1
5	4/6 5/6 6/6	Brown silty clay with thin sand lenses.	11		1.25	20.7
	5/6 7/6 6/6	Do.	13	1.50		29.6
	5/6 4/6 4/6	Do- top, bottom- brown silty sand, little clay.	8		1.0	25.1
10						
	30/6 50/3	Brown silty clay and fine to coarse gravel, trace sand.	50/3"			27.8
15		Rock cobbles and medium to coarse gravel. Rec. 30%				
20						
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 15

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 15
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 20.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 2/28/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 18.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	4/6 5/6 3/6	Brown cemented sandy silt, some clay.	9			15.6
	4/6 4/6 5/6	(Strongly cemented, clayey)	9	3.80		20.0
5	7/6 15/6 27/6	Fine to medium gravel and clayey silty sand.	46			11.7
	12/6 20/6 13/6	Do- (fine to coarse gravel).	20			10.3
	50/4"	Do.	50/4"			11.8
10		Coarse gravel and rock cobbles. Rec. 37.5%				
15		Coarse gravel, occ. rock cobbles. Rec. 46.7%				
		Do. Rec. 41.7%				
20						
25						
30						
35						

Page No.1

Geotec

DSGN:					VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:					AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

BORING LOGS

SHEET: 8
DWG: SS-06
DATE:
PROJ:

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LOG OF TEST BORING
BORING 16

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 16
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 20.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 2/18/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 18.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	1/6 3/6 4/6	Brown clayey silt, some sand.	7		1.5	24.9
	4/6 5/6 6/6	Brown silty clay,little fine sand, occ. fine gravel.	11		2.0	24.0
5	4/6 5/6 9/6	Brown silty sand, some clay, little fine gravel. (A-2-4; SM)	13			18.3
	18/6 18/6 30/6	Fine to coarse gravel or cobble fragments, trace silty sand.	40			3.8
	50/2	Rock cobbles, boulders and coarse gravel. Rec. 62.5%	50/2"			
10						
15		Rock cobbles and medium to coarse gravel. Rec. 30%				
20		Coarse gravel. Rec. 20.8%				
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 17

PROJECT: Dos Rios Sector, Flood Control Works

PROJECT LOCATION: Ciales, P.R.
BORING NO: 17
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 20.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 3/01/05
ELEV: UNKNOWN
PROJECT NO: 3898
CASED TO: 18.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	4/6 5/6 6/6	Brown clayey silt sand.	11	1.00		19.2
	3/6 3/6 3/6	(silty sand, little clay).	6			16.8
5	5/6 13/6 30/6	Fine to coarse gravel with some silty sand, trace clay.	43			7.0
		Coarse gravel, rock cobbles and boulder fragments. Rec. 16.7%				
10						
		Medium to coarse gravel and rock cobbles. Rec. 30%				
15		Do. Rec. 36.1%				
20						
25						
30						
35						

Page No.1

Geotec

DSGN:					VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:					AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

BORING LOGS

SHEET: 9
DWG: SS-07
DATE:
PROJ:

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LOG OF TEST BORING
BORING 1A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 1A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 15.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/27/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 13.0'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	26/6 58/6 38/6	At top ASPHALT fragments, At bottom LIMESTONE fragments, some fine to medium sand, little silt, very dense, pale brown (10yr6/3) (P. Fill).	94			7.02
	15/6 10/6 4/6		14		4.25	23.85
5	3/6 2/6 2/6	SILT, some clay, trace fine sand, occ. limestone fragments, stiff, dark yellowish brown (10yr3/4).	4		1.25	29.64
	2/6 3/6 3/6	Sandy SILT, medium, dark yellowish brown (10yr3/4).	6		1.5	32.62
		SILT, some clay, medium, dark yellowish brown (10yr3/4).				
10	2/6 3/6 4/6	Do, little fine sand.	7		1.75	34.46
15	3/6 4/6 4/6	Sandy SILT, stiff, dark yellowish brown (10yr3/4).	8			25.16
20						
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 2A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 2A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 15.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/27/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 13.0'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	4/6 1/6 5/6	Sandy SILT, trace clay, occ. limestone fragments, very stiff, dark yellowish brown (10yr3/4).	22			23.99
	3/6 3/6 3/6	Clayey SILT, trace very fine sand, stiff.	10		1.0	37.28
5	2/6 3/6 3/6	SILT, some clay, soft, dark yellowish brown (10yr3/4).	3	1.50		31.47
	2/6 2/6 2/6	SILT, some clay & very fine sand, medium, dark brown (10yr3/3).	4		.75	34.5
10	3/6 3/6 3/6	Do, little very fine sand.	6		1.0	31.76
15	3/6 3/6 3/6	Do.	5		.75	38.21
20						
25						
30						
35						

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Geotec

LOG OF TEST BORING
BORING 3A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 3A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 18.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/28/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 16.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	3/6 2/6 6/6	Sandy CLAY, some silt, occ. limestone fragments, stiff, yellowish brown (10yr5/4).	10		4.5	19.95
5	5/6 5/6 11/6	LIMESTONE fragments, some fine to medium sand, little clay & silt, medium, very pale brown (10yr7/3), light olive brown (2.5y5/4).	22			15.17
10	2/6 4/6 4/6	CLAY, some silt, stiff, dark brown (10yr3/3).	8	1.80		34.0
15	1/6 2/6 3/6	Silty CLAY, medium, dark brown (10yr3/3).	5	1.10	1.5	38.13
	2/6 2/6 3/6	Do, little very fine sand.	5	0.99	.75	40.83
20						
25						
30						
35						

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Geotec

DSGN:						
DR:						
CHK:						
APVD:	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE
AS SHOWN

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

BORING LOGS

SHEET: 10
DWG: SS-08
DATE:
PROJ:

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LOG OF TEST BORING
BORING 4A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 4A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 15.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/28/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 13.0'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	15/6 35/6 35/6	SILT, some clay, little fine sand, stiff, brown (7.5yr4/4).	8	2.10	3.5	22.36
5	10/6 30/6 31/6	CLAY, some silt, hard, brown (7.5yr4/4).	51	13.70	4.5+	14.32
10	15/6 25/6 41/6	Cemented SILT, some clay, hard, dark brown (7.5yr3/4), gray mott.	68	12.10		14.1
15	15/6 33/6 33/6	Cemented sandy SILT, hard, reddish brown (5yr5/4).	62	3.00	4.5+	13.1
20						
25						
30						
35						

Page No.1

Geotec

LOG OF TEST BORING
BORING 5A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 5A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 15.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/27/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 13.0'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	16/6 4/6 6/6	Sandy CLAY, some silt, occ. rock fragments, stiff, dark olive gray (5y3/2).	9		3.5	26.24
	3/6 2/6 2/6	Sandy silty CLAY, medium, brown (10yr4/3).	4			37.34
5	3/6 4/6 5/6	CLAY, some silt, stiff, dark brown (10yr3/3).	9	2.70	2.5	30.2
	6/6 7/6 8/6	Do, little fine sand, very stiff, dark brown (10yr3/3).	15	2.99	3.5	29.19
10	5/6 5/6 5/6	Sandy SILT, little clay, stiff, yellowish brown (10yr5/6).	10	1.40	1.5	27.44
15	6/6 8/6 8/6	Sandy SILT, some clay, very stiff, dark yellowish brown (10yr4/6).	18			28.97
20						
25						
30						
35						

Page No.1

Geotec

LOG OF TEST BORING
BORING 6A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 6A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 15.5'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/27/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 13.0'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	3/6 10/6 3/6	At top CONCRETE fragments, At bottom CLAY, some silt, little fine sand, very stiff, dark brown (10yr3/3).	19		1.5	15.97
	3/6 3/6 5/6	CLAY, some silt, little fine sand, stiff, dark yellowish brown (10yr3/6).	10		2.25	30.53
5	2/6 2/6 3/6	Silty CLAY, some fine sand, occ. limestone fragments, medium, strong brown (7.5yr4/4).	5			26.8
	3/6 3/6 3/6	CLAY, some silt, medium, brown (7.5yr4/4).	6	1.70	1.5	38.38
10	2/6 3/6 5/6	Do.	8		2.0	43.19
15	4/6 4/6 6/6	Clayey SILT, stiff, dark yellowish brown 10yr4/6).	10		2.0	45.44
20						
25						
30						
35						

Page No.1

Geotec

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO
CHK:								
APVD:	NO.	DATE	REVISION	BY	APVD			

BORING LOGS

SHEET: 11
DWG: SS-09
DATE:
PROJ:

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LOG OF TEST BORING
BORING 7A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 7A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 13.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/28/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 11.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	6/6 4/6 4/6	CLAY, some silt, occ. rock fragments, stiff, strong brown (7.5yr4/6).	8		1.5	31.27
5	10/6 6/6 3/6	Clayey SILT, stiff, dark yellowish brown (10yr4/6), oxidized joints.	9		1.25	42.62
10	3/6 4/6 4/6	Do. little fine sand, stiff, dark yellowish brown (10yr3/6).	8		.75	34.27
	14/6 13/6 9/6	CLAY, some silt, occ. cemented silt fragments, very stiff, brown (10yr4/3).	22	2.40	2.25	30.5
15						
20						
25						
30						
35						

Page No.1

Geotec

LOG OF TEST BORING
BORING 8A

PROJECT: PLUVIAL SECTOR DOS RIOS

PROJECT LOCATION: CIALES, P.R.
BORING NO: 8A
DRILL METHOD USED: HOLLOW STEM AUGER
DEPTH TO CAVING: 11.0'
WATER DURING DRILLING: AFTERWARDS:

DATE: 8/28/07
ELEV: UNKNOWN
PROJECT NO: 4132

CASED TO: 9.5'
DATE CHECKED:

ELEV/ DEPTH	SOIL SYMBOLS SAMPLER SYMBOLS AND FIELD TEST DATA	Description	N-VALUE BPF	Qu T.S.F.	PEN T.S.F.	W %
0	2/6 4/6 4/6	CLAY, some silt, stiff, strong brown (7.5yr4/6).	8	2.40	2.5	38.05
5	4/6 6/6 6/6	Sandy SILT, some clay, stiff, dark yellowish brown (10yr4/6).	12	2.10		31.5
10	4/6 5/6 6/6	CLAY & SILT, occ. faint clast, stiff, dark yellowish brown (10yr4/6).	11		2.0	34.31
15						
20						
25						
30						
35						

Page No.1

Geotec

DSGN:					VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:					AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

BORING LOGS

SHEET: 12
DWG: SS-10
DATE:
PROJ:

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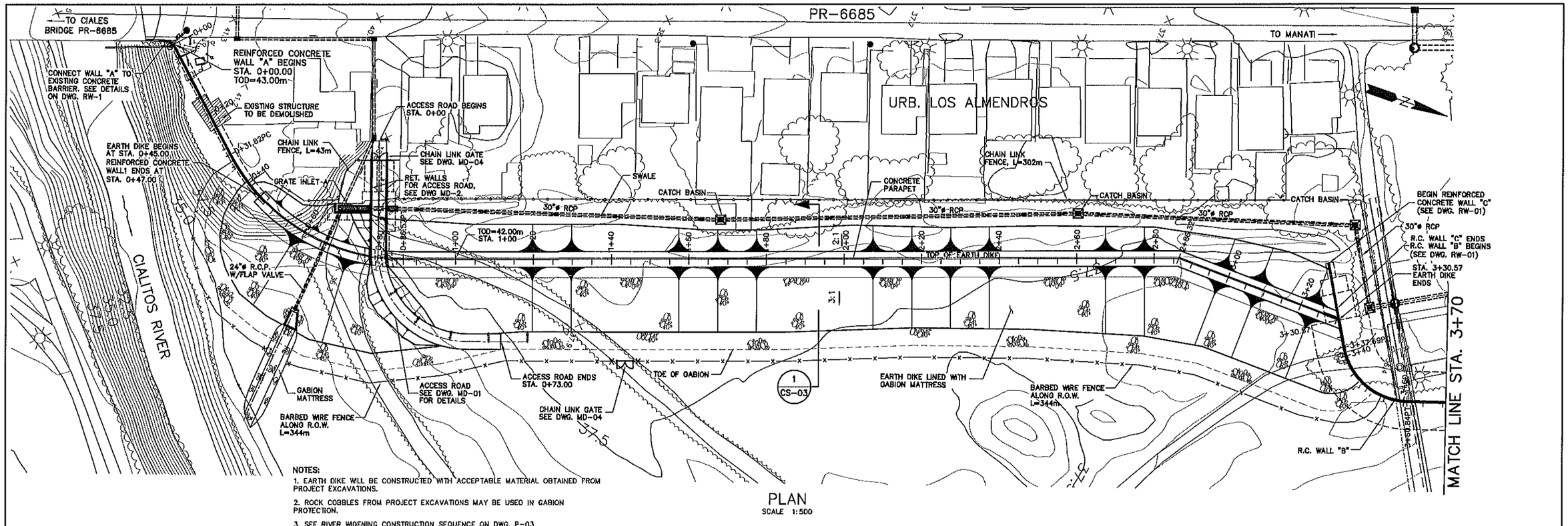
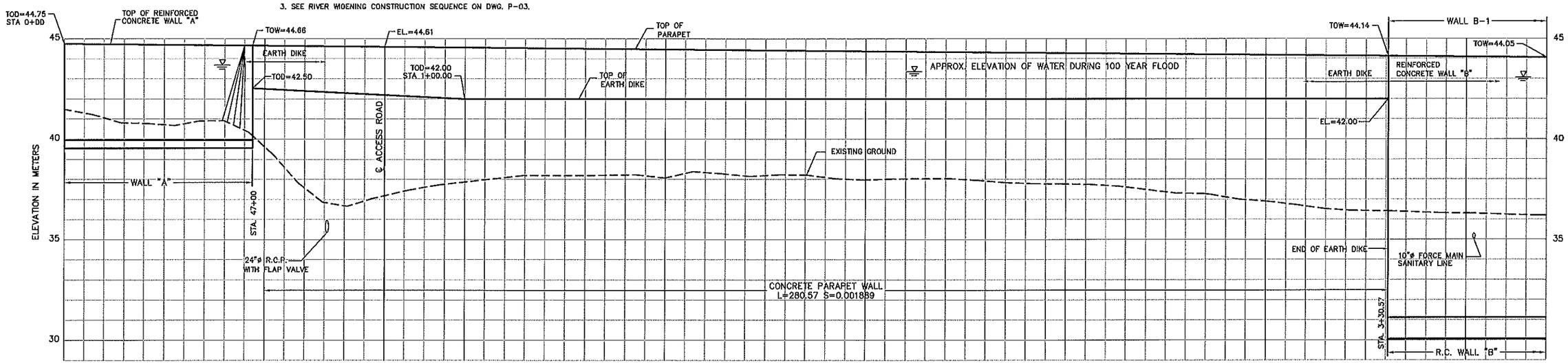


NOTES:

1. EARTH DIKE WILL BE CONSTRUCTED WITH ACCEPTABLE MATERIAL OBTAINED FROM PROJECT EXCAVATIONS.
2. ROCK COBBLES FROM PROJECT EXCAVATIONS MAY BE USED IN GABION PROTECTION.
3. SEE RIVER WIDENING CONSTRUCTION SEQUENCE ON DWG. P-03.

PLAN
SCALE 1:500



EXISTING GROUND ELEVATION	41.49	40.72	39.62	38.93	37.20	37.87	38.19	38.08	38.19	37.97	37.99	37.77	37.37	36.91	36.43	36.31	36.19
STATION	0+00		0+50	0+75	0+80	1+00		1+50		2+00		2+50		3+00		3+50	3+70

DISTANCE IN METERS

PROFILE
SCALE H = 1:500
V = 1:100

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

DIKE PLAN AND PROFILE
STA. 0+00 TO STA. 3+70

SHEET: 13
DWG: PP-01
DATE:
PROJ:

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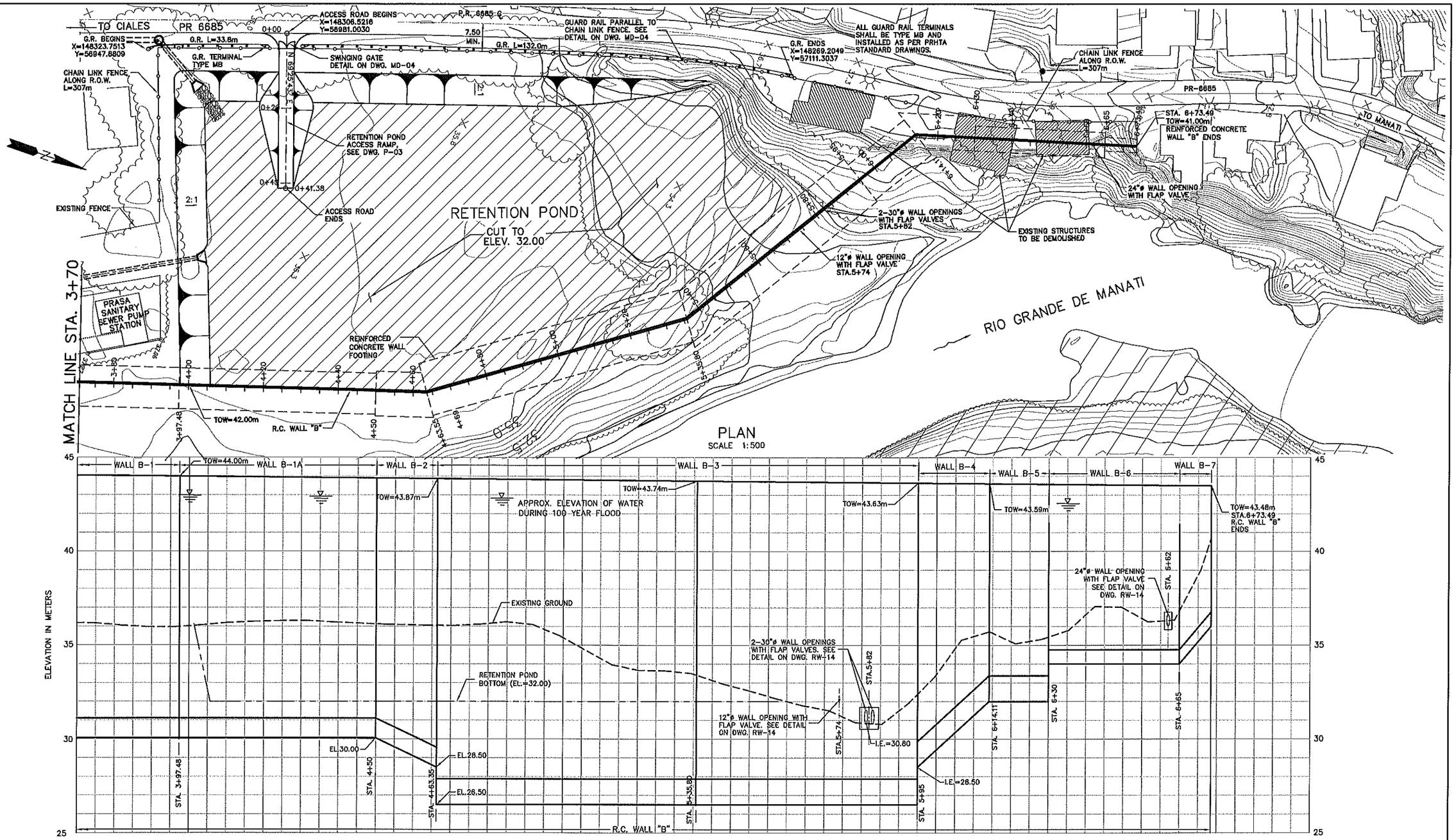

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE

AS SHOWN

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES

FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:

QUIÑONES, DIEZ, SILVA Y ASOCIADOS

SAN JUAN, PUERTO RICO

QDSA

DIKE PLAN AND PROFILE

STA. 3+70 TO STA. 6+80

SHEET: 14

DWG: PP-02

DATE:

PROJ:

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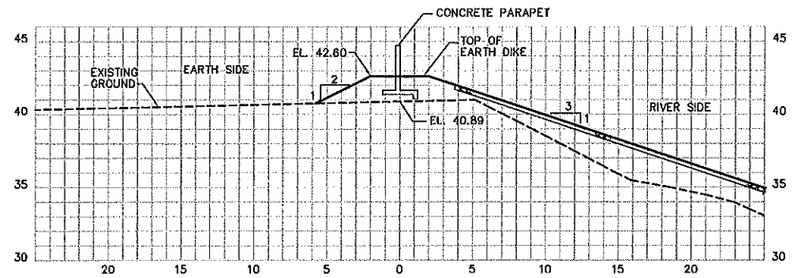
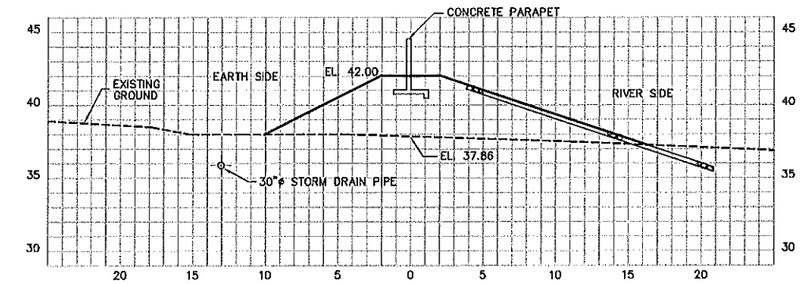
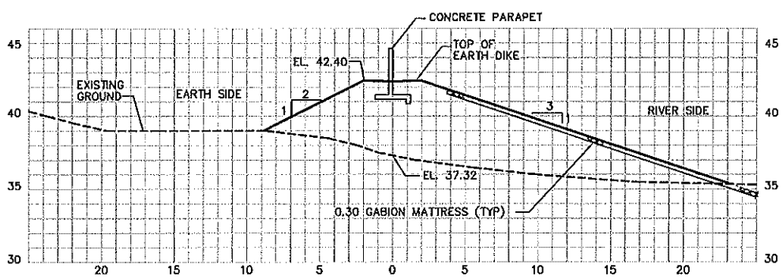


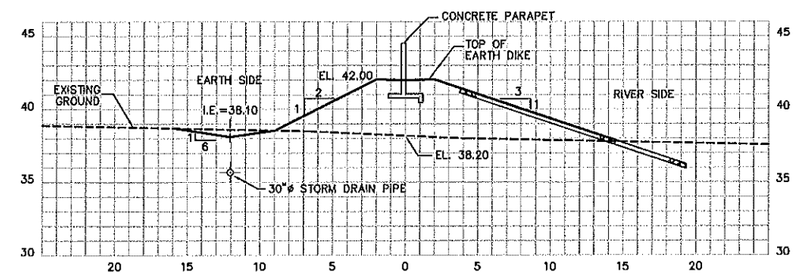
STA. 0+45



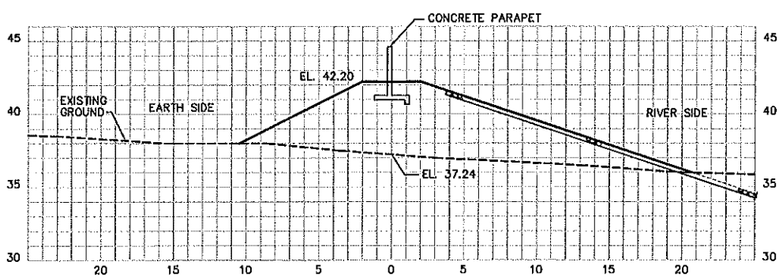
STA. 1+00



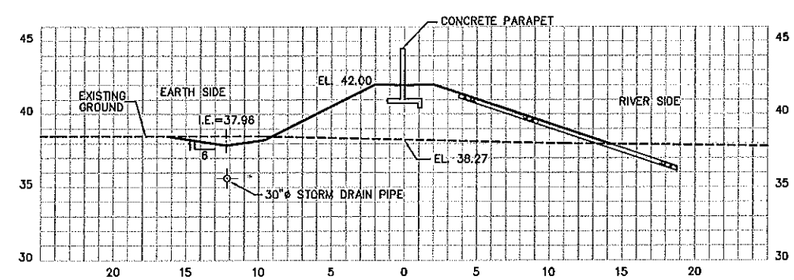
STA. 0+60



STA. 1+20



STA. 0+80



STA. 1+40

SCALE 1:200

0 5 10 15

NOTE:
CROSS SECTIONS ARE LOOKING DOWNSTREAM

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	EARTH DIKE CROSS SECTIONS STA. 0+45 TO STA. 1+40	SHEET: 15
DR:						1:200	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: CS-01
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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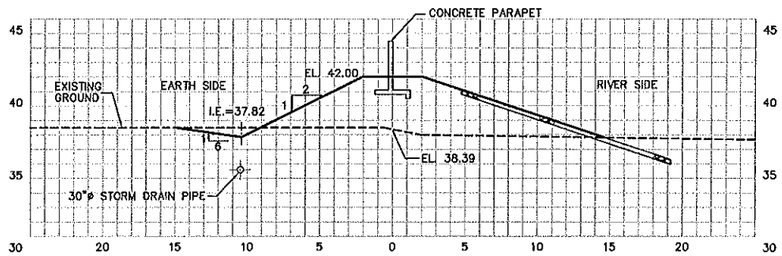
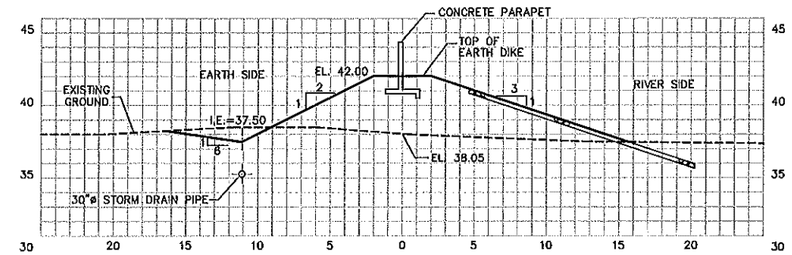
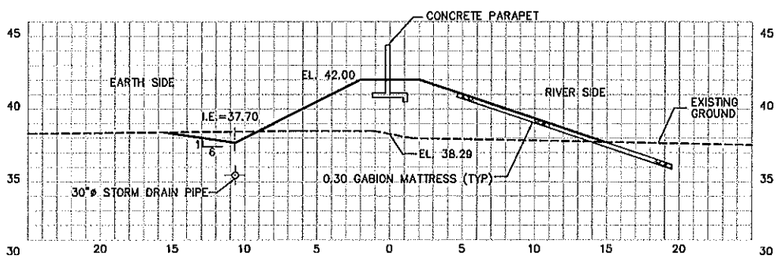


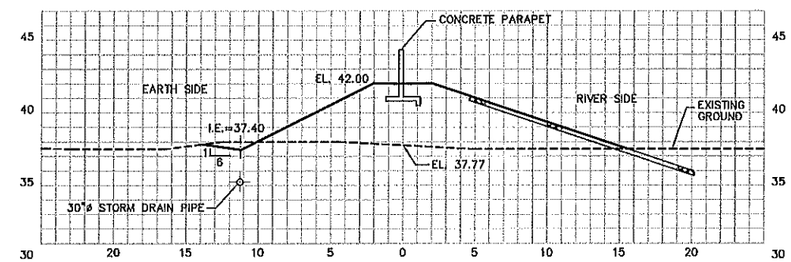
STA. 1+60



STA. 2+20



STA. 1+80



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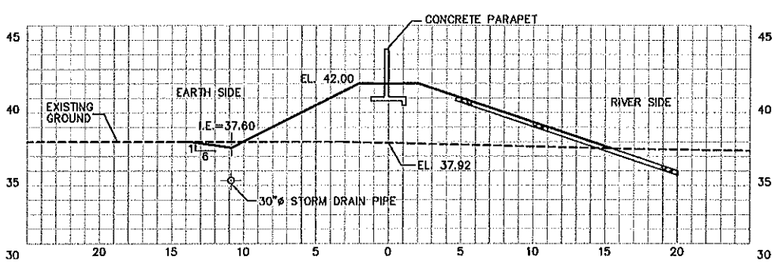
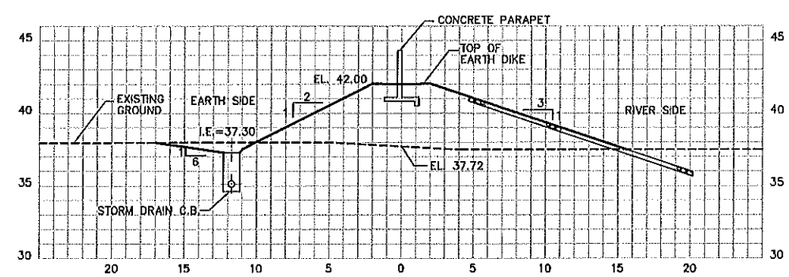


STA. 2+00



STA. 2+60

SCALE 1:200

0 5 10 15

NOTE:
CROSS SECTIONS ARE LOOKING DOWNSTREAM

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						1:200	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

EARTH DIKE
CROSS SECTIONS
STA. 1+60 TO STA. 2+60

SHEET: 18
DWG: CS-02
DATE:
PROJ:

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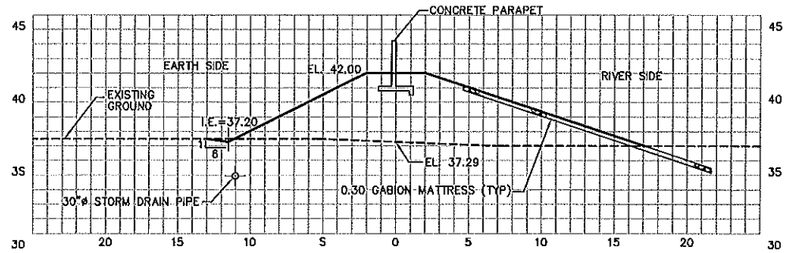
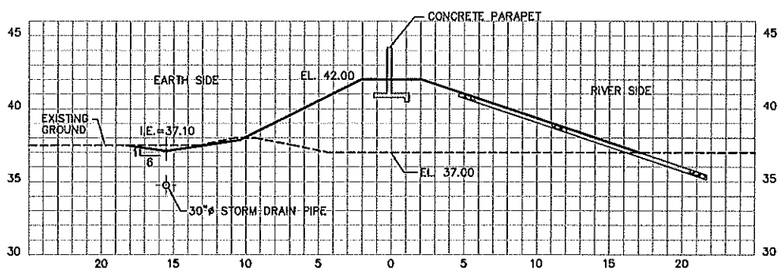
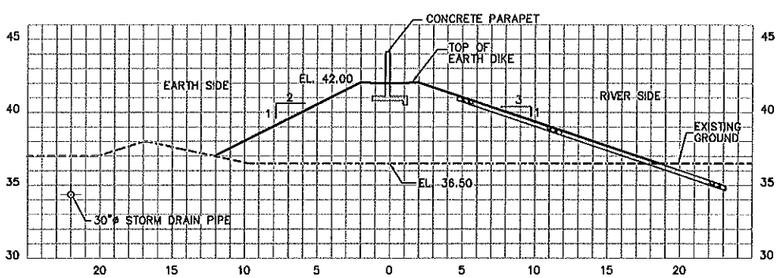


STA. 2+80



STA. 3+00

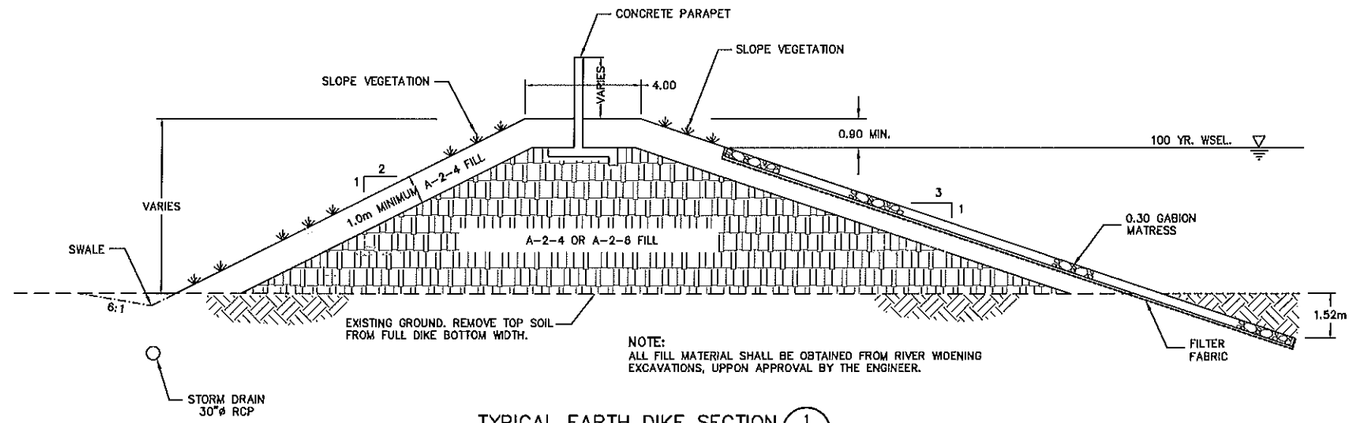


STA. 3+20

SCALE 1:200

0 5 10 15

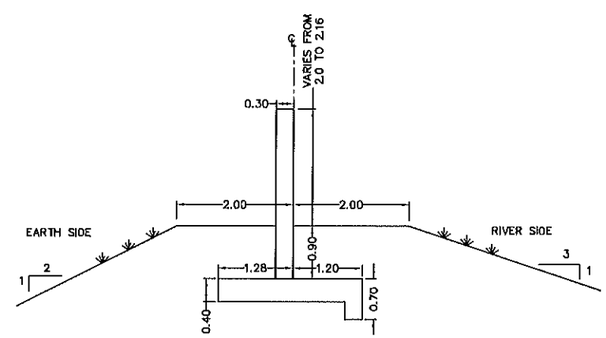
NOTE:
CROSS SECTIONS ARE LOOKING DOWNSTREAM



NOTE:
ALL FILL MATERIAL SHALL BE OBTAINED FROM RIVER WIDENING EXCAVATIONS, UPPON APPROVAL BY THE ENGINEER.

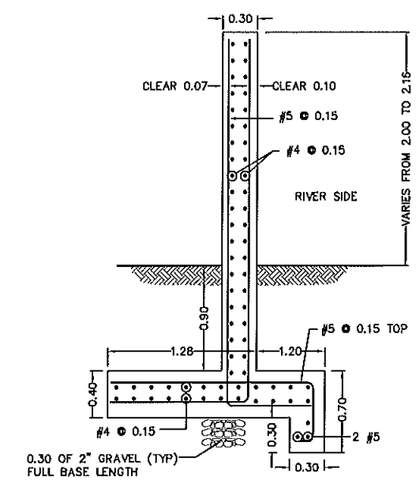
TYPICAL EARTH DIKE SECTION (1 / PP-1)

SCALE 1:100



CONCRETE PARAPET WALL DETAIL

SCALE 1:50



STRUCTURAL PARAPET WALL DETAIL

SCALE 1:25

NOTE:
USE THIS WALL SECTION FOR RETAIN SOIL IN ACCESS ROAD SECTION WITHOUT SHEAR KEY SEE DWG. MD-01

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	EARTH DIKE CROSS SECTIONS STA. 2+40 TO STA. 3+20	SHEET: 17
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: CS-03
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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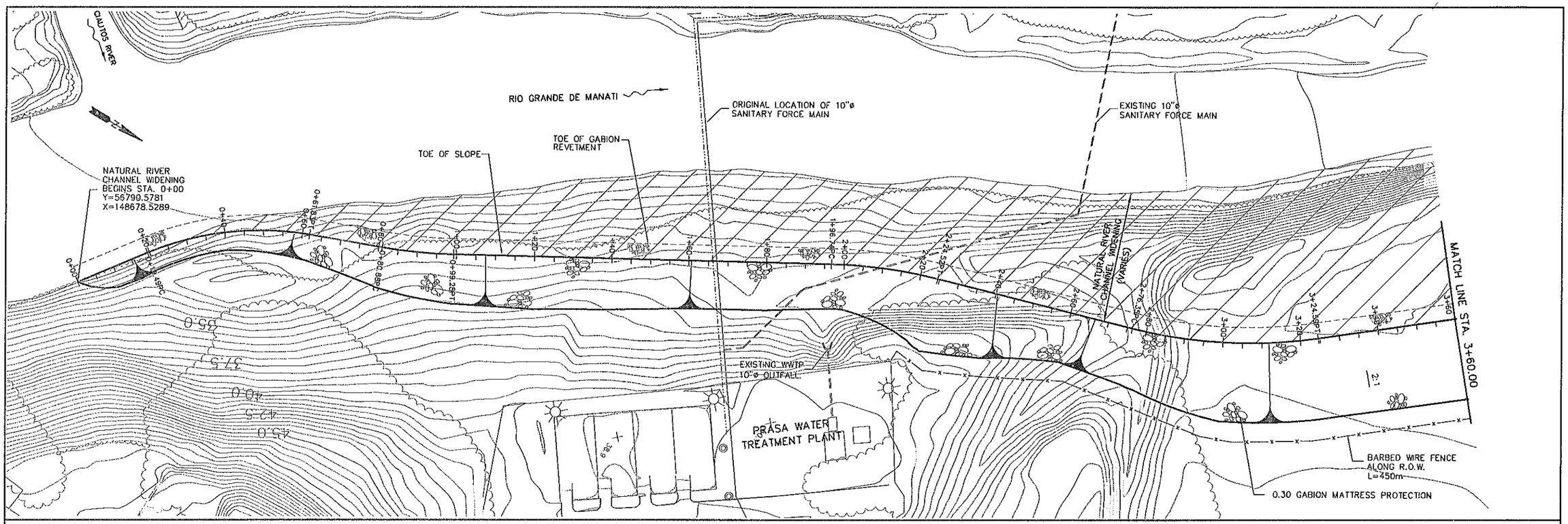
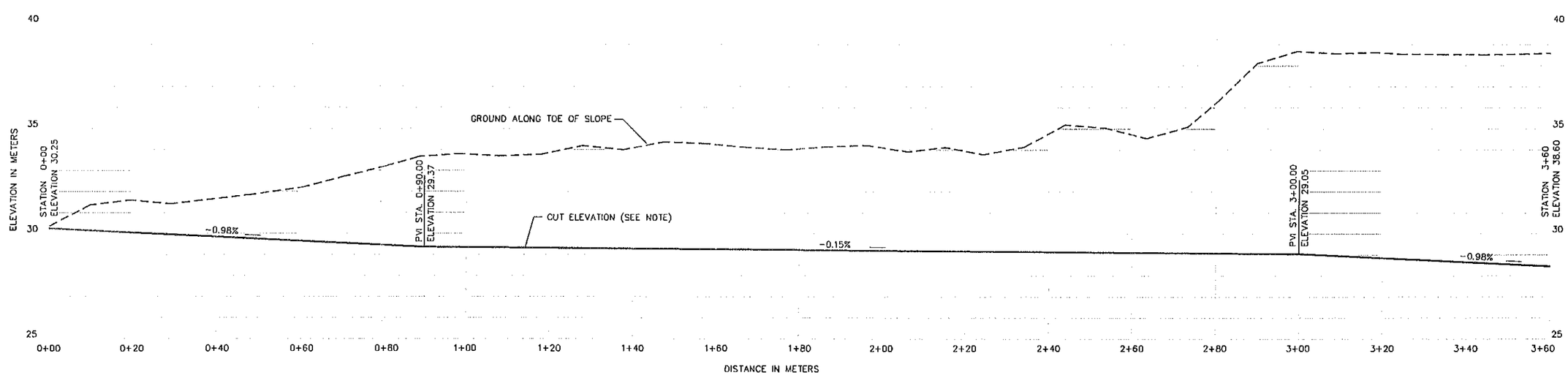


PLAN

SCALE 1:500



NOTE:

ELEVATIONS AND SLOPE ALONG TOE OF SLOPE ARE APPROXIMATE, ACTUAL CUT ELEVATIONS SHALL MATCH THE BOTTOM OF THE NATURAL RIVER CHANNEL. SEE TYPICAL SECTION ON SHEET No. P-03.

PROFILE ALONG TOE OF SLOPE

SCALE H = 1:500
V = 1:100

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	RIVER WIDENING PLAN AND PROFILE STA. 0+00 TO STA. 3+60	SHEET: 18
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: P-01
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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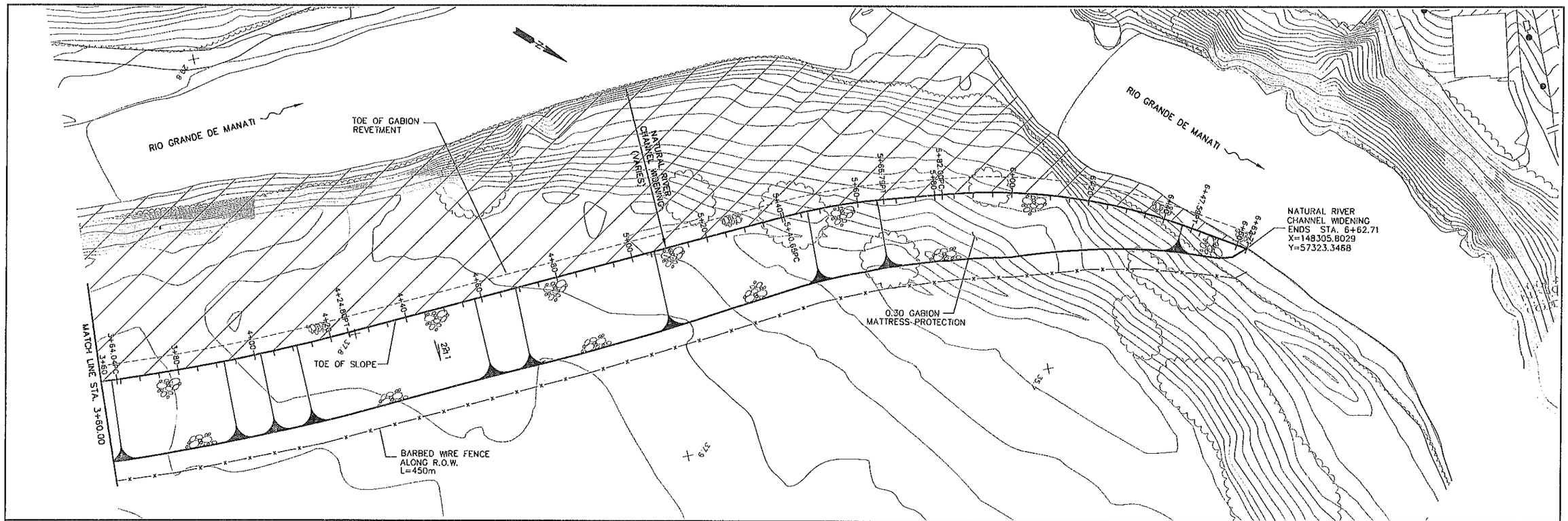
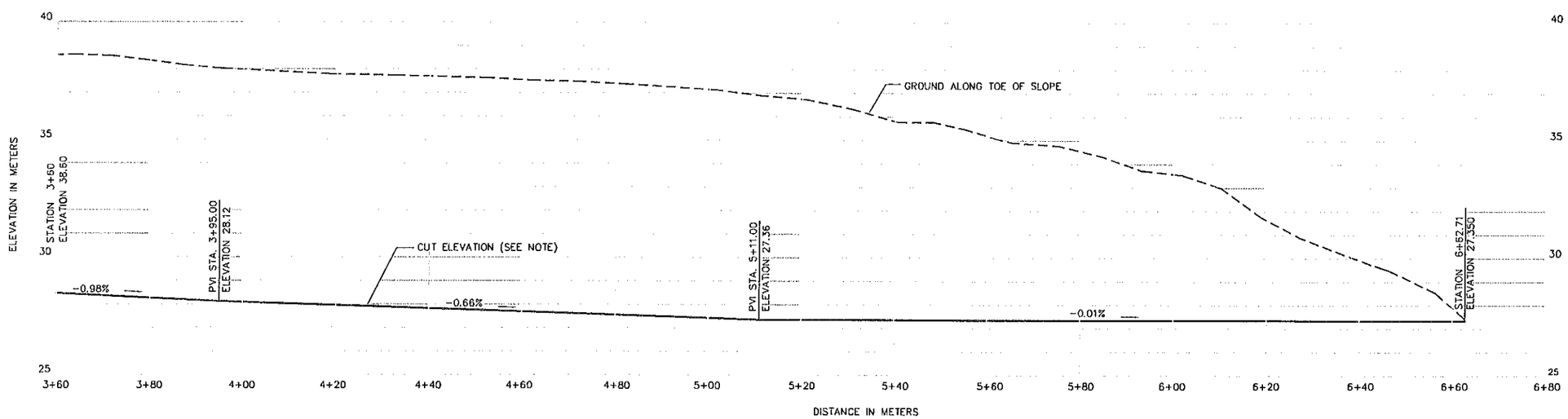


PLAN

SCALE 1:500



NOTE:

ELEVATIONS AND SLOPE ALONG TOE OF SLOPE ARE APPROXIMATE, ACTUAL CUT ELEVATIONS SHALL MATCH THE BOTTOM OF THE NATURAL RIVER CHANNEL. SEE TYPICAL SECTION ON SHEET No. P-03.

PROFILE ALONG TOE OF SLOPE

SCALE H = 1:500
V = 1:100

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

RIVER WIDENING
PLAN AND PROFILE
STA. 3+60 TO SAT. 6+62.71

SHEET: 19
DWG: P-02
DATE:
PROJ:

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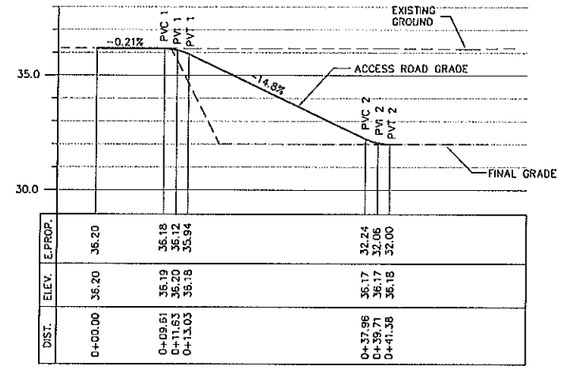
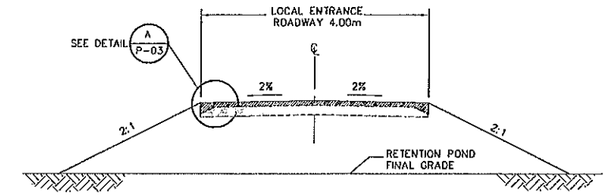
TABLE 1 RIVER WIDENING DATA TABLE

Station	Northing	Easting	Bearing	Distance
0+00.000	56790.578	148678.529		
			N 55°17'09" W	19.487
0+19.487	56801.676	148662.511	PC	
RADIUS: 75.000 N: 56863.326 E: 148705.222				
TANGENT: 21.751 PI: 0+41.238 N: 56814.062 E: 148644.631				
DELTA: 32°20'45" ARC LEN: 42.341				
CHORD LEN: 41.780 CHORD BRG: N 39°06'46" W				
0+61.827	56834.093	148636.153	PT	
			N 22°56'24" W	19.055
0+80.883	56851.641	148628.726	PC	
RADIUS: 125.000 N: 56802.920 E: 148513.612				
TANGENT: 9.215 PI: 0+90.097 N: 56860.127 E: 148625.135				
DELTA: -8°25'55" ARC LEN: 18.396				
CHORD LEN: 18.379 CHORD BRG: N 27°09'22" W				
0+99.278	56867.995	148620.338	PT	
			N 31°22'20" W	97.459
1+96.737	56951.205	148569.601	PC	
RADIUS: 125.000 N: 57016.280 E: 148676.327				
TANGENT: 13.947 PI: 2+10.684 N: 56963.113 E: 148562.340				
DELTA: 12°43'59" ARC LEN: 27.779				
CHORD LEN: 27.722 CHORD BRG: N 25°00'20" W				
2+24.516	56976.329	148557.883	PT	
			N 18°38'21" W	51.829
2+76.345	57025.439	148541.318	PC	
RADIUS: 125.000 N: 56985.489 E: 148422.874				
TANGENT: 24.426 PI: 3+00.771 N: 57048.584 E: 148533.512				
DELTA: -22°06'47" ARC LEN: 48.243				
CHORD LEN: 47.945 CHORD BRG: N 29°41'44" W				
3+24.589	57067.087	148517.567	PT	
			N 40°45'08" W	39.449
3+64.038	57096.971	148491.815	PC	
RADIUS: 500.000 N: 56770.577 E: 148113.045				
TANGENT: 30.421 PI: 3+94.458 N: 57120.016 E: 148471.957				
DELTA: -6°57'48" ARC LEN: 60.766				
CHORD LEN: 60.729 CHORD BRG: N 44°14'02" W				
4+24.804	57140.484	148449.451	PT	
			N 47°42'56" W	115.845
5+40.649	57218.425	148363.747	PC	
RADIUS: 150.000 N: 57329.397 E: 148464.669				
TANGENT: 13.105 PI: 5+53.754 N: 57227.243 E: 148354.052				
DELTA: 9°59'11" ARC LEN: 26.144				
CHORD LEN: 26.111 CHORD BRG: N 42°43'20" W				
5+66.793	57237.608	148346.032	PT	
			N 37°43'45" W	15.205
5+81.998	57249.634	148336.728	PC	
RADIUS: 150.000 N: 57341.423 E: 148455.365				
TANGENT: 33.330 PI: 6+15.328 N: 57275.995 E: 148316.332				
DELTA: 25°03'19" ARC LEN: 65.594				
CHORD LEN: 65.073 CHORD BRG: N 25°12'05" W				
6+47.592	57308.513	148309.020	PT	
			N 12°40'26" W	15.117
6+62.709	57323.261	148305.703		



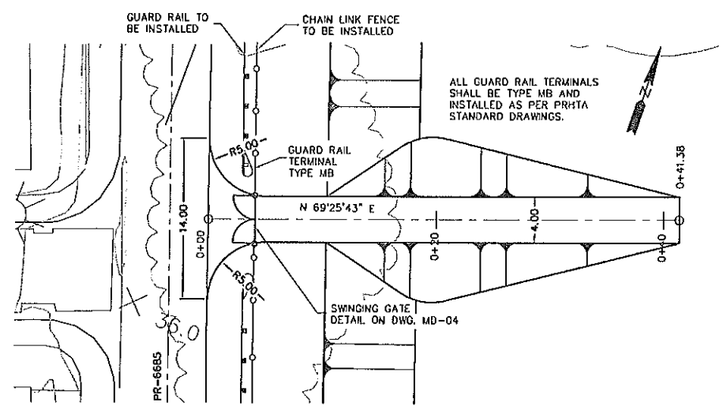
RETENTION POND ACCESS RAMP PROFILE

SCALE: HS=1:400 VS=1:100



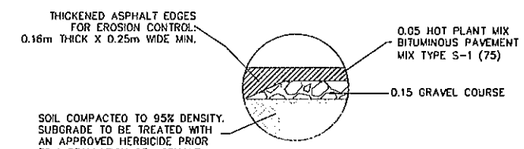
RETENTION POND ACCESS RAMP SECTION

SCALE: 1:50



RETENTION POND ACCESS RAMP PLAN

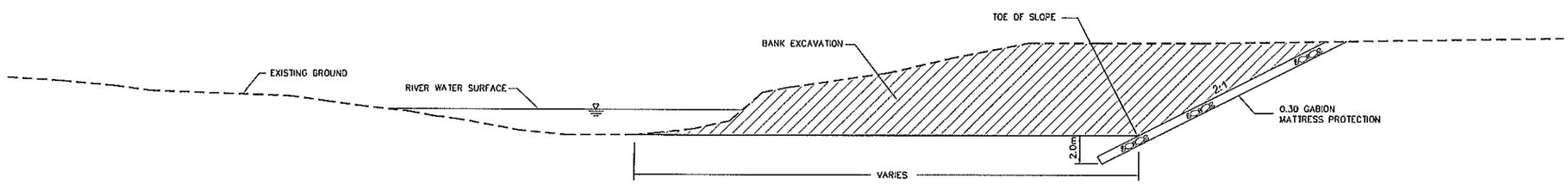
SCALE 1:250



DETAIL A P-03
N.T.S.

RIVER WIDENING CONSTRUCTION SEQUENCE:

1. EXCAVATE WIDENING SLOPE AND INSTALL GABION PROTECTION IN THE DRY.
2. COMPLETE WIDENING BY EXCAVATING TOWARDS THE NATURAL RIVER CHANNEL.



RIVER WIDENING TYPICAL SECTION

NOT TO SCALE

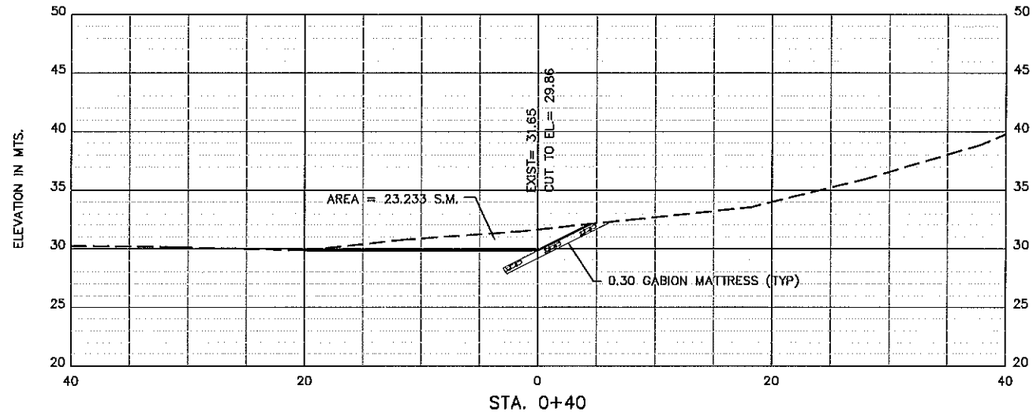
NOTE: SECTION LOOKING DOWNSTREAM

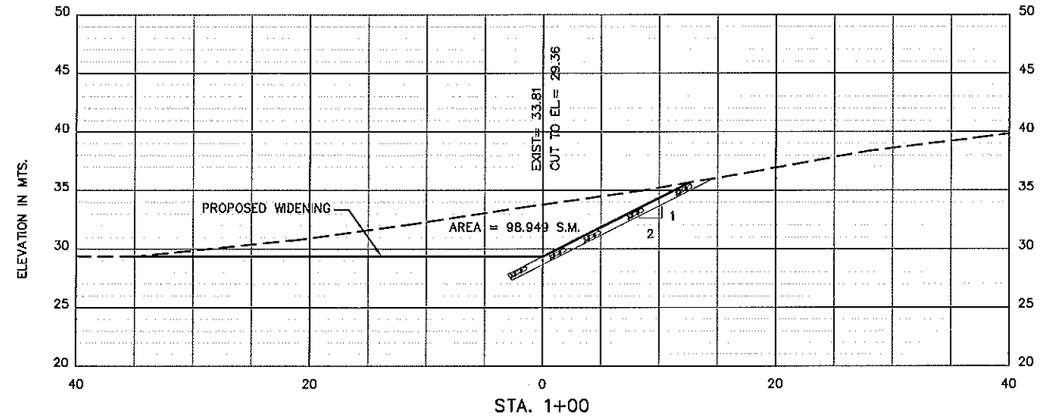
DSGN:					VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:					AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS
CHK:							SAN JUAN, PUERTO RICO
APVD:	NO.	DATE	REVISION	BY	APVD		

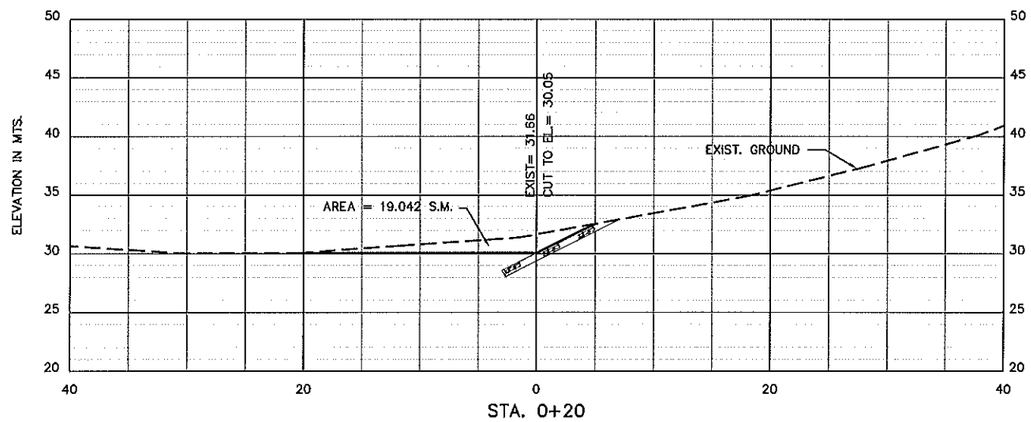
RIVER WIDENING DATA TABLE, TYPICAL SECTION AND RETENTION POND ACCESS RAMP DETAILS

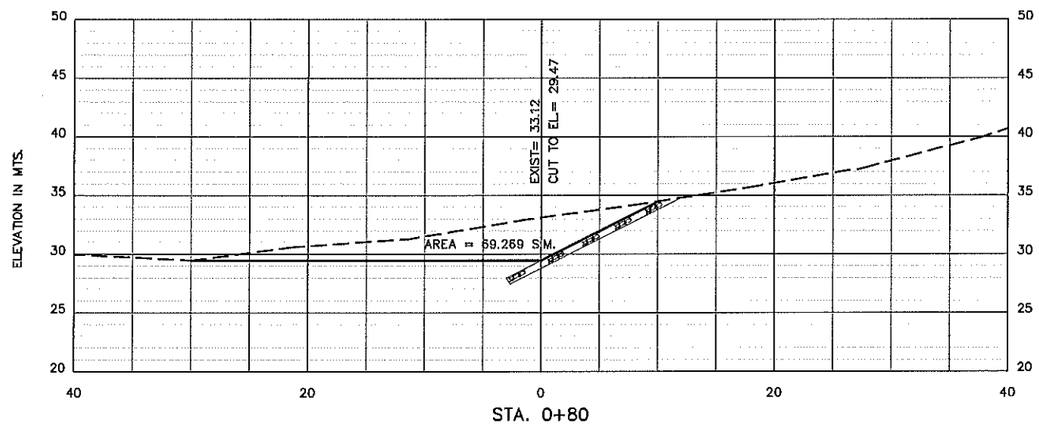
SHEET: 20
DWG: P-03
DATE:
PROJ.:

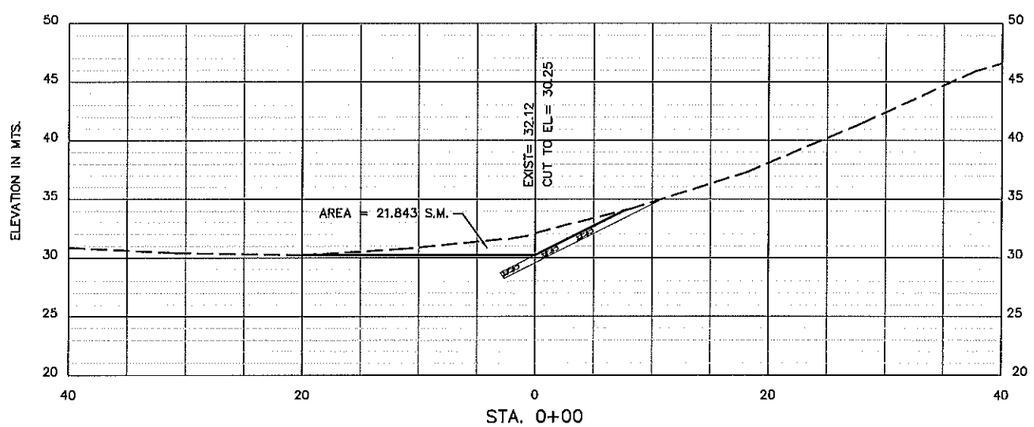
Y:\ciales\Final Plans-Phase 2\P-03.dwg, 7/8/2008 8:31:37 AM

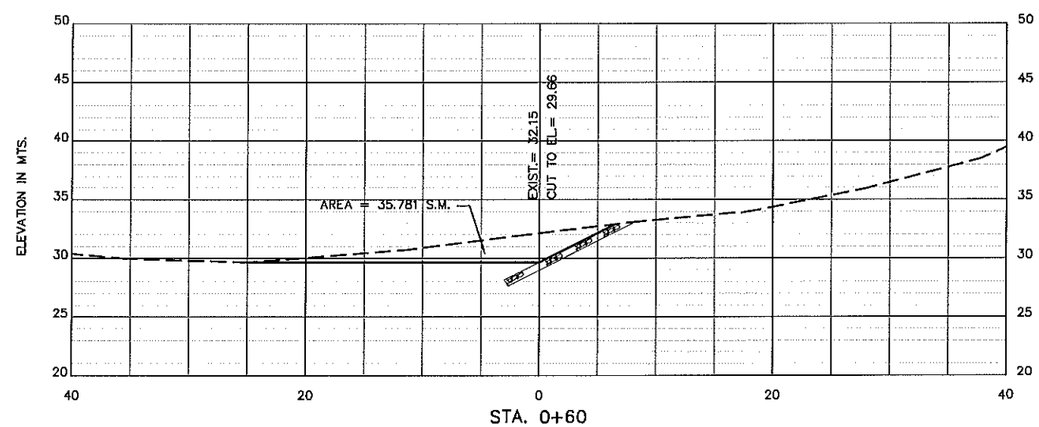












NOTE: ALL CROSS SECTIONS ARE LOOKING DOWNSTREAM.

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE

H = 1:250
V = 1:250

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES

FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

QDSA

CHANNEL WIDENING
CROSS SECTIONS

SHEET: 21
DWG: CW-1
DATE:
PROJ.:

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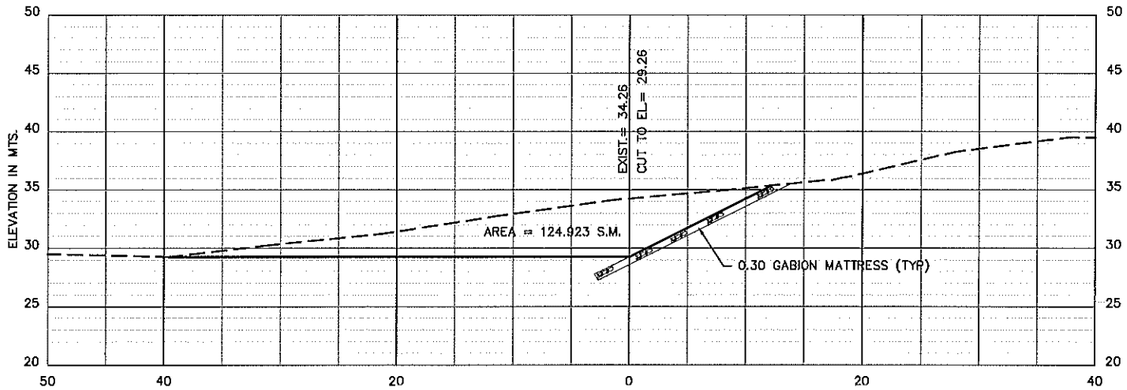

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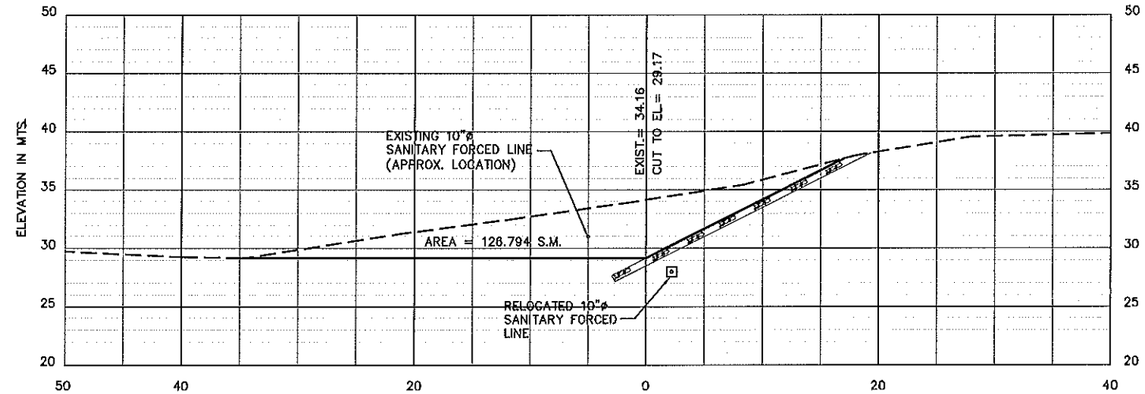

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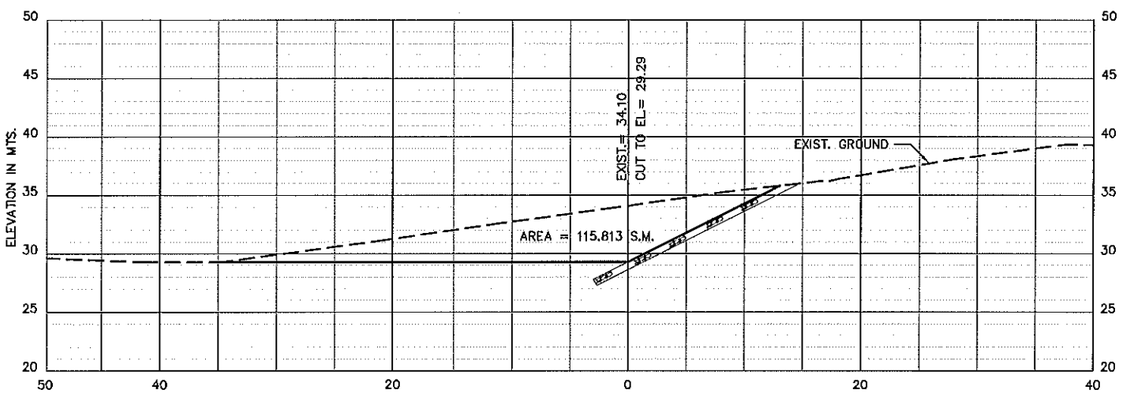

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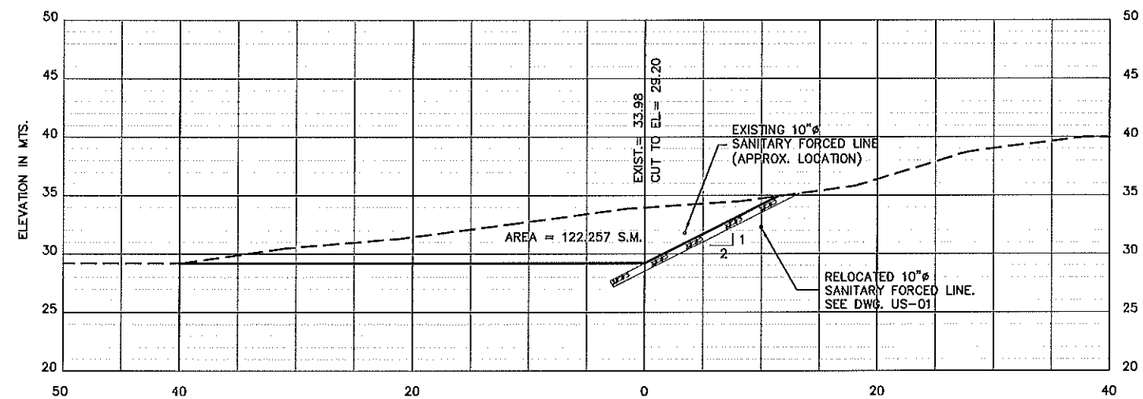

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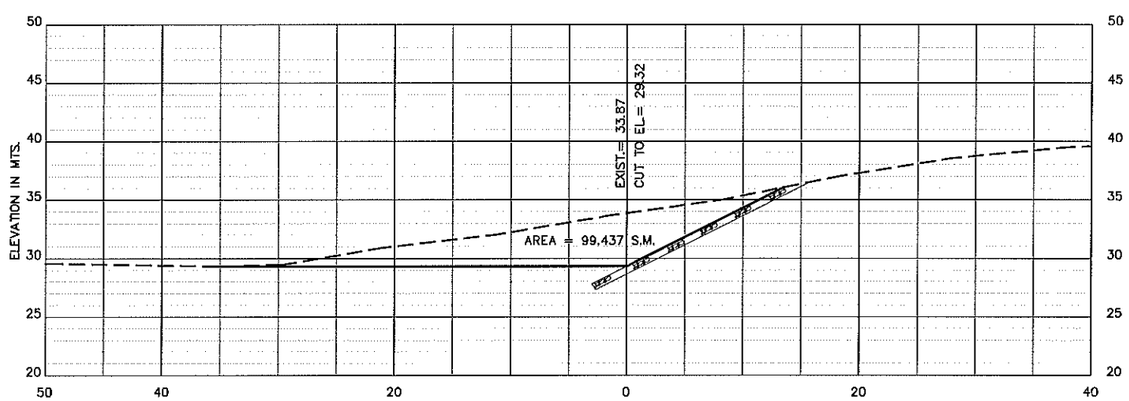
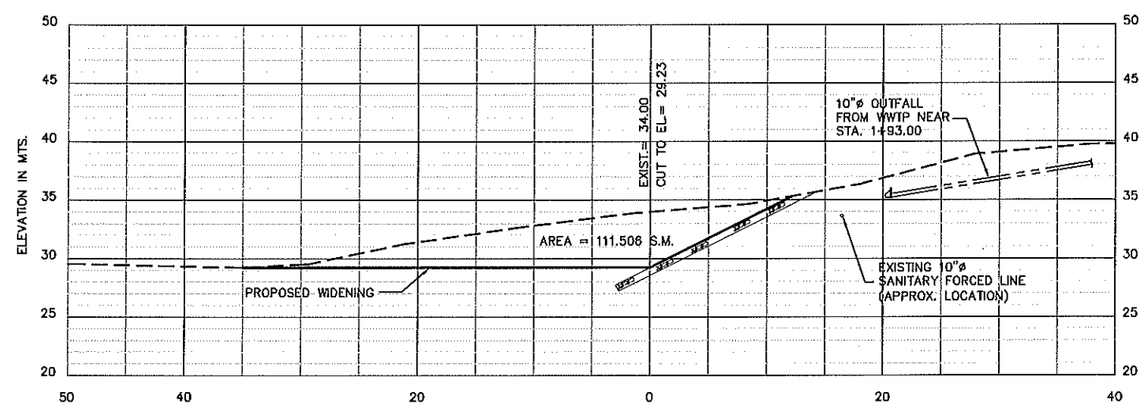


STA. 1+20



STA. 1+80

NOTE: ALL CROSS SECTIONS ARE LOOKING DOWNSTREAM.

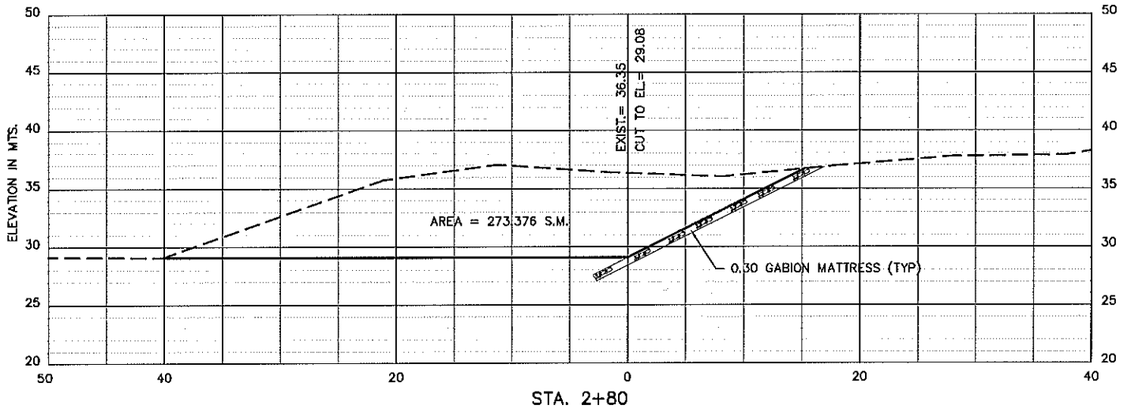
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
DR:						H = 1:250 V = 1:250	
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

CHANNEL WIDENING
CROSS SECTIONS

SHEET: 22
DWG: CW-2
DATE:
PROJ:

Y:\Ciales\Phase Completo (Aug 2012)\CW 02.dwg, 9/7/2012 1:49:44 PM, 1:12.5782



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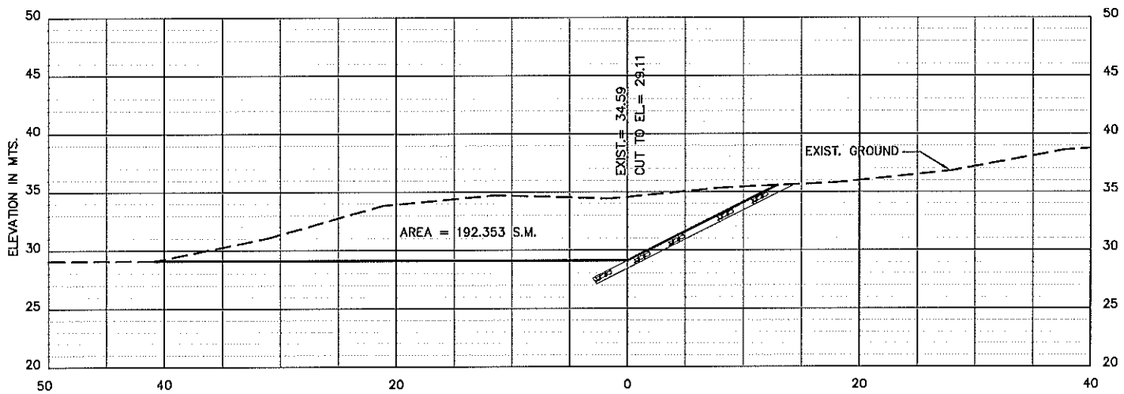

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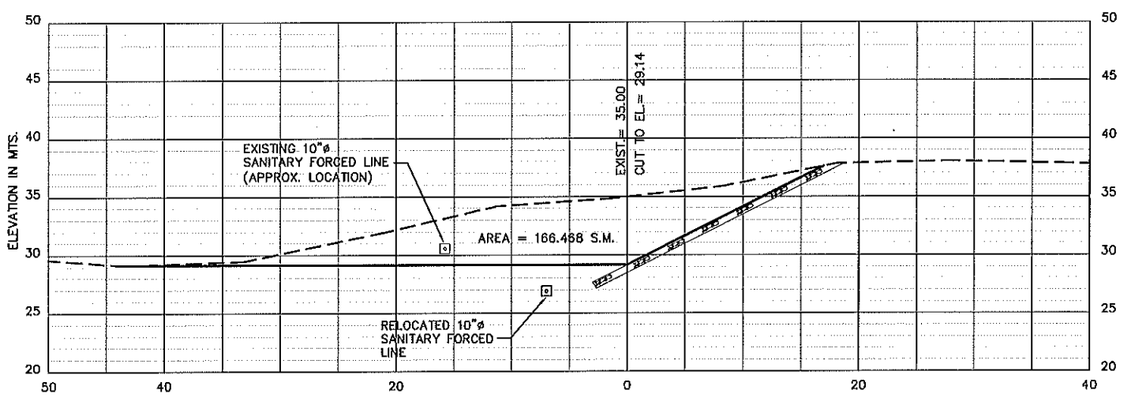

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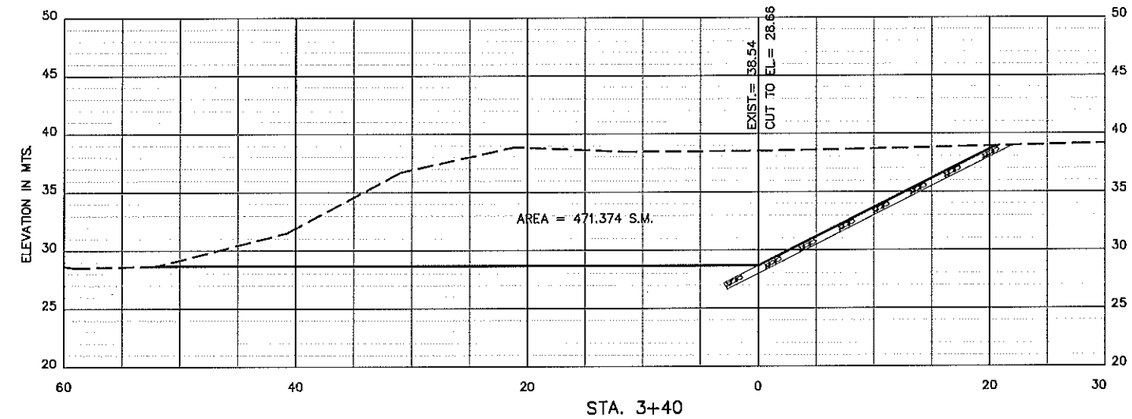

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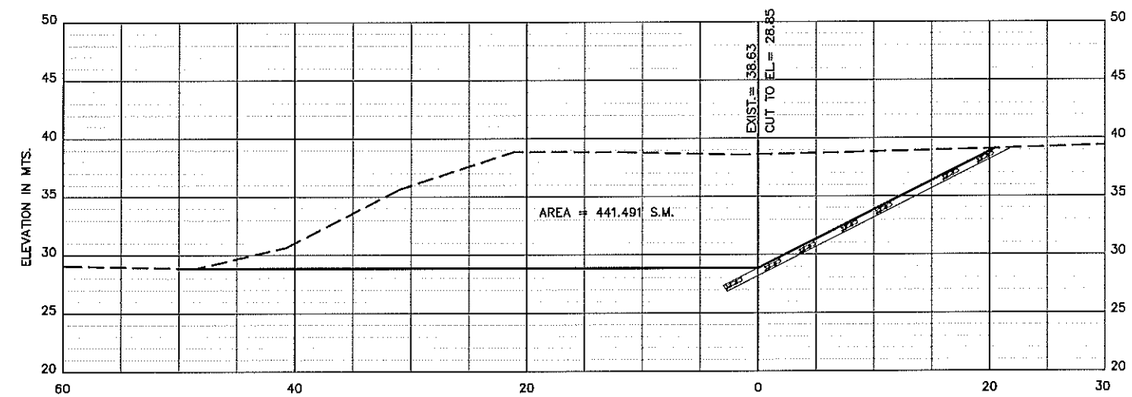
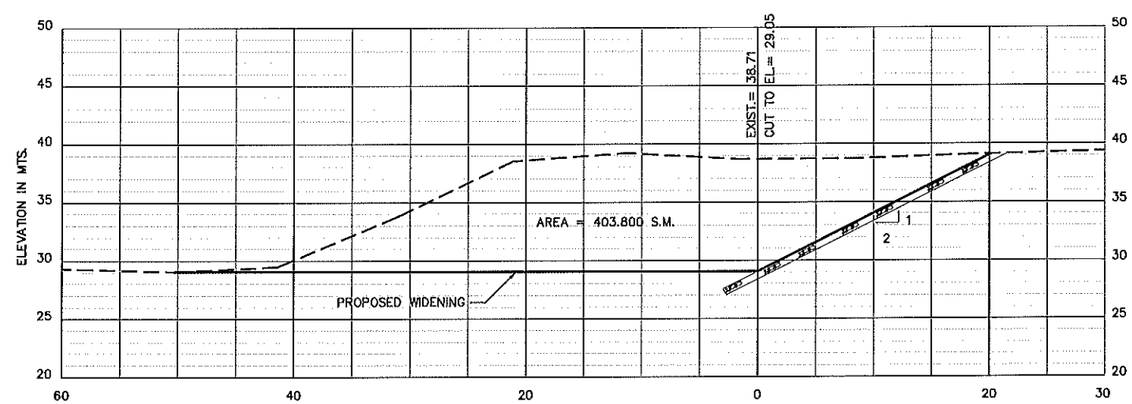


STA. 3+20



STA. 3+00

NOTE: ALL CROSS SECTIONS ARE LOOKING DOWNSTREAM.

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE

H = 1:250
V = 1:250

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES

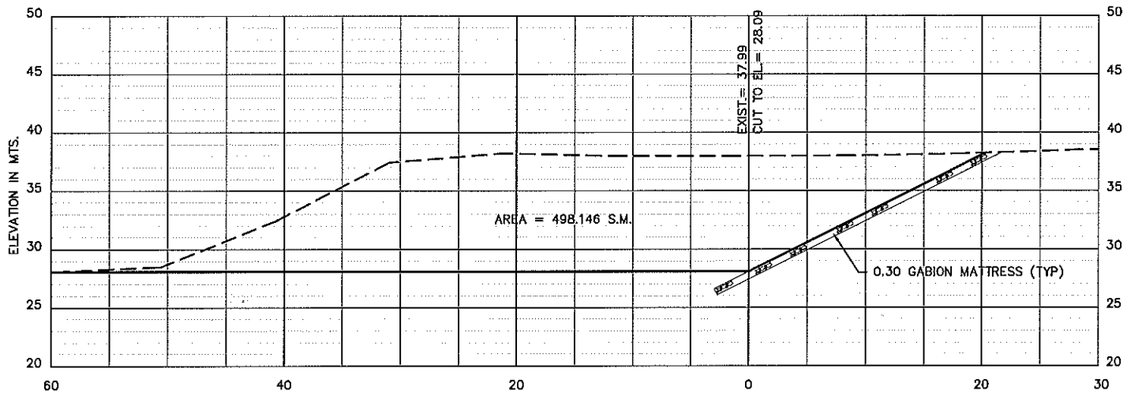
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA
Y ASOCIADOS
SAN JUAN, PUERTO RICO

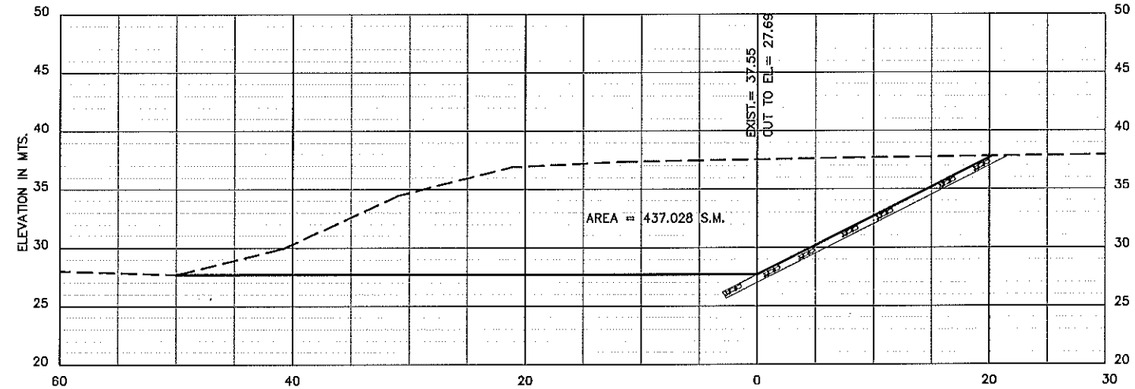
CHANNEL WIDENING
CROSS SECTIONS

SHEET: 23
DWG: CW-3
DATE:
PROJ:

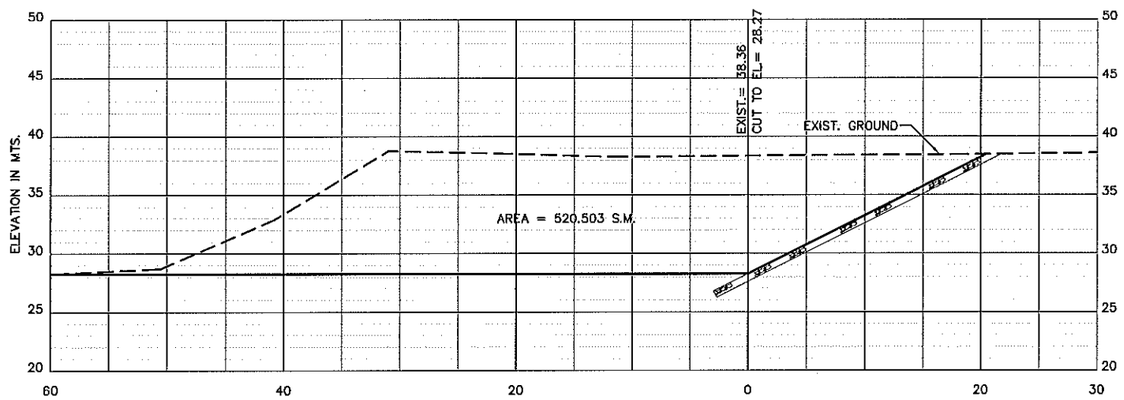
Y:\ciales\Phase Complete (Aug. 2012)\CW 03.dwg, 9/7/2012 1:50:25 PM, 1:13.0343



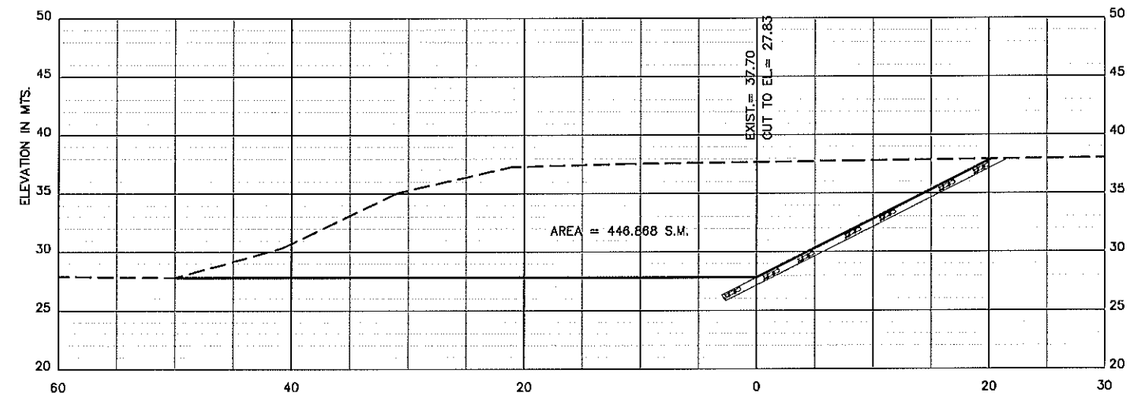
STA. 4+00



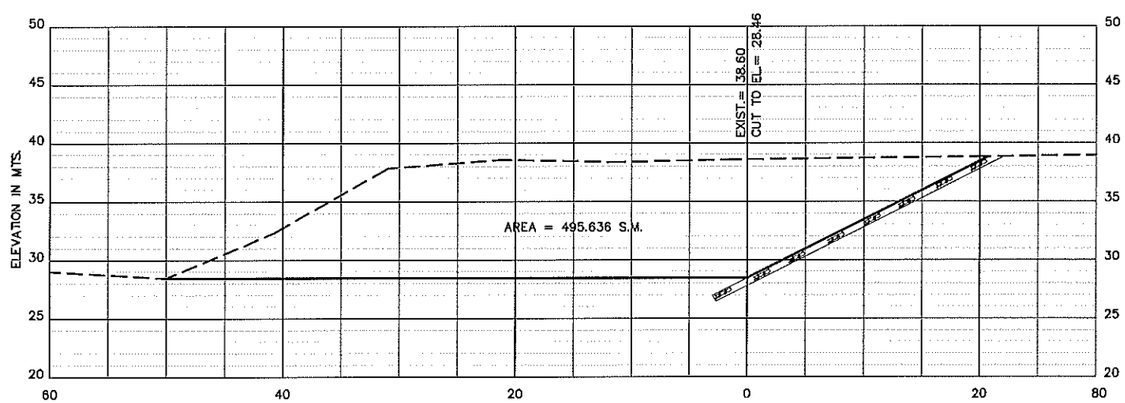
STA. 4+60



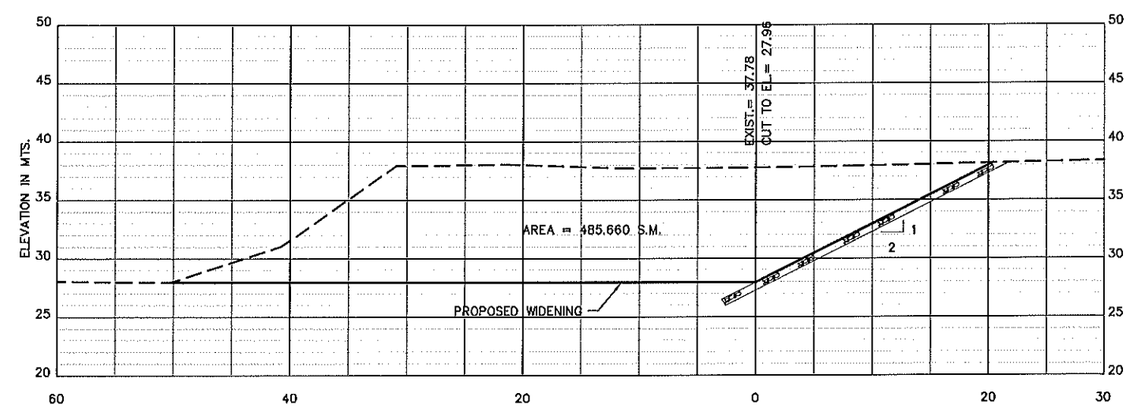
STA. 3+80



STA. 4+40



STA. 3+60



STA. 4+20

NOTE: ALL CROSS SECTIONS ARE LOOKING DOWNSTREAM.

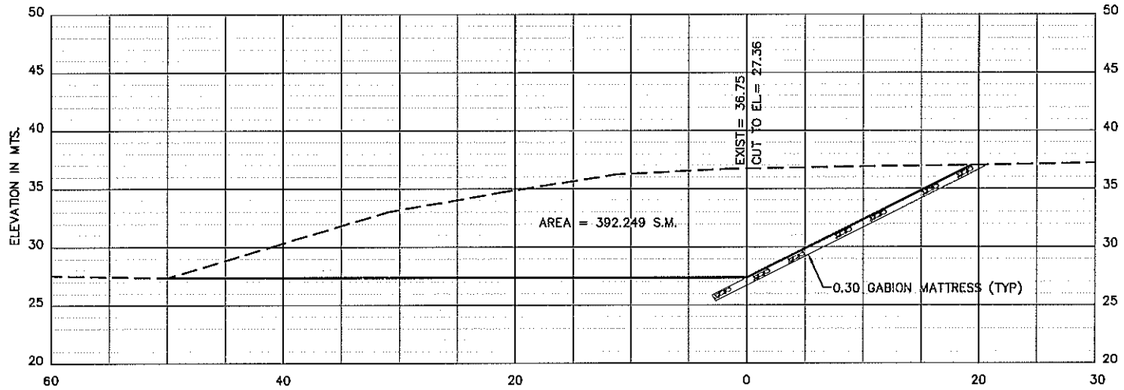
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						H = 1:250 V = 1:250	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

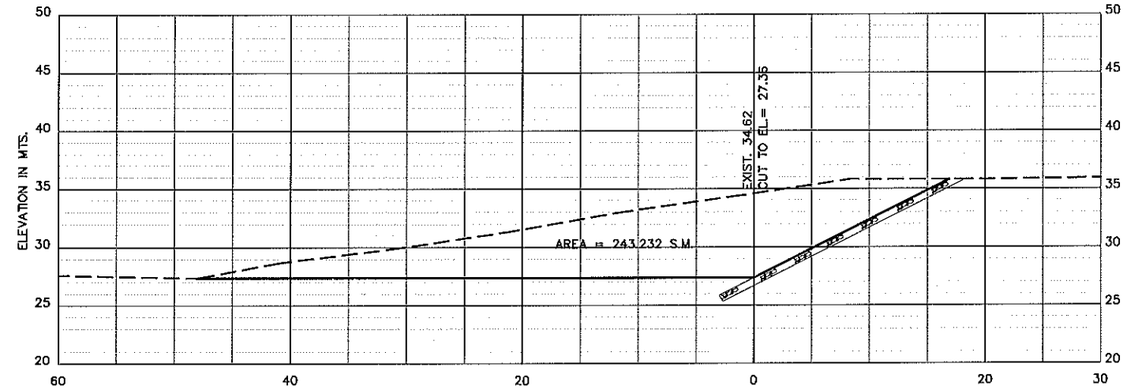
CHANNEL WIDENING
CROSS SECTIONS

SHEET: 24
DWG: CW-4
DATE:
PROJ.:

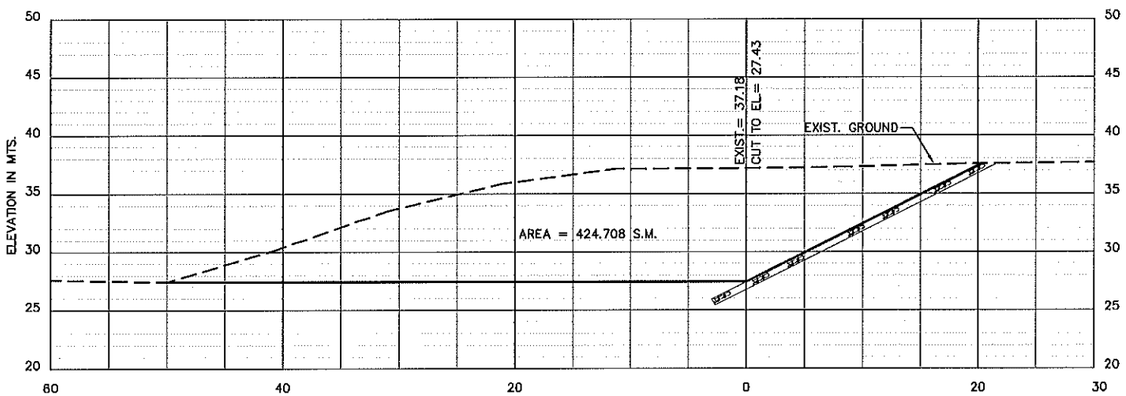
Y:\Ciales\Phase Complete (Aug 2012)\CW 04.dwg, 9/7/2012 1:51:07 PM, 1:12.9826



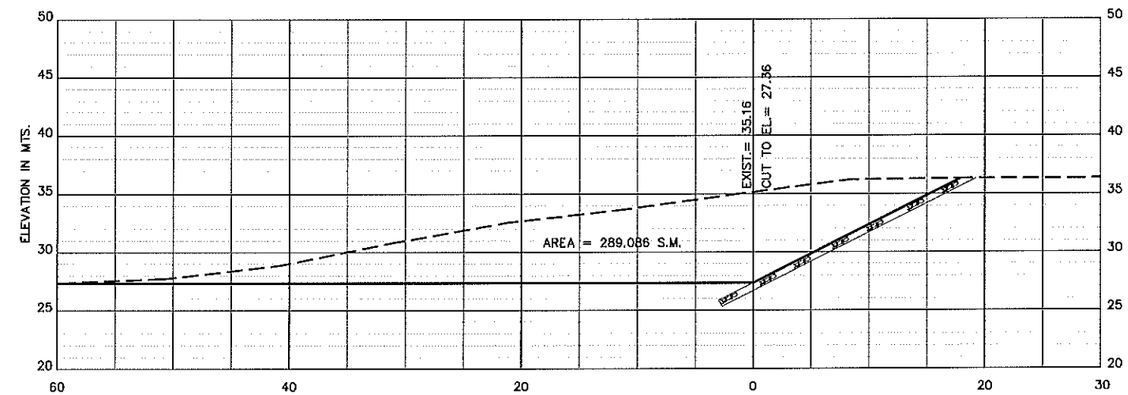
STA. 5+20



STA. 5+80



STA. 5+00



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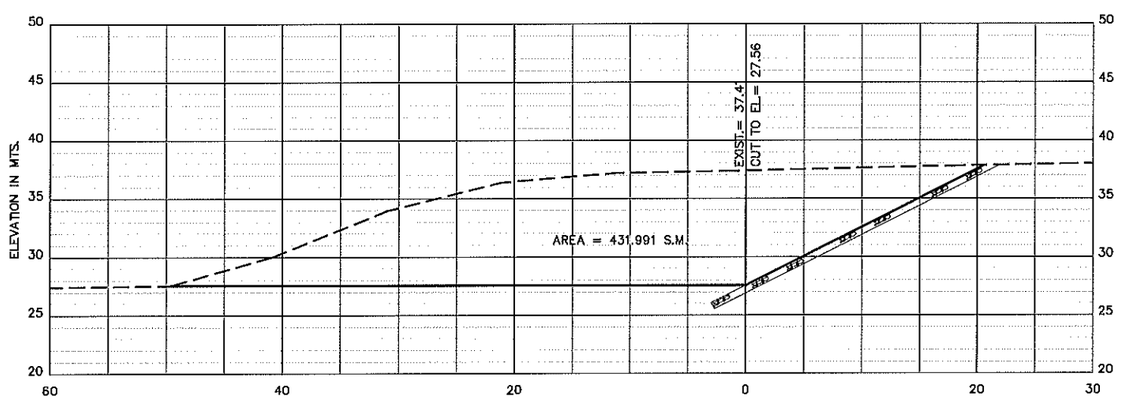
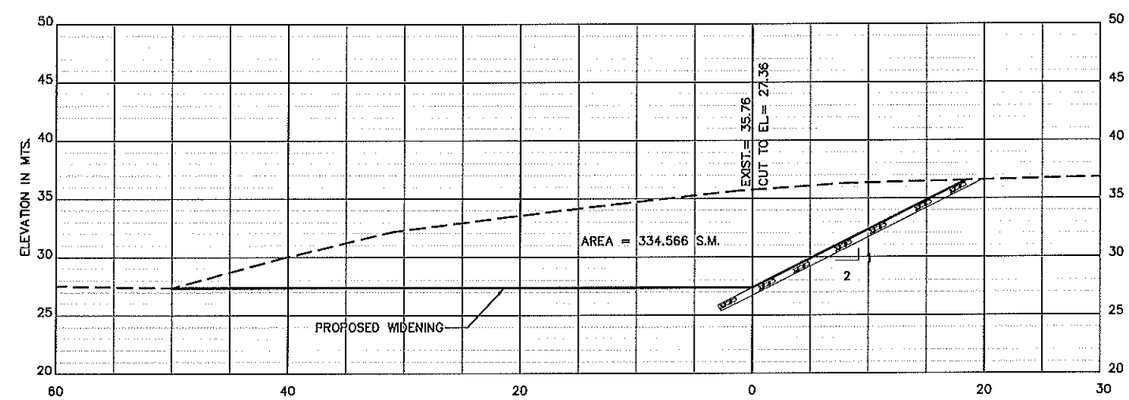


STA. 4+80



STA. 5+40

NOTE: ALL CROSS SECTIONS ARE LOOKING DOWNSTREAM.

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
H = 1:250
V = 1:250

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES

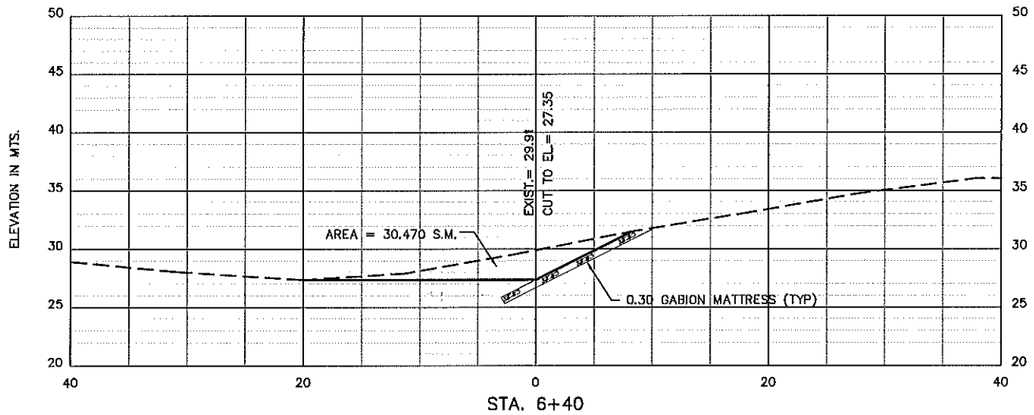
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

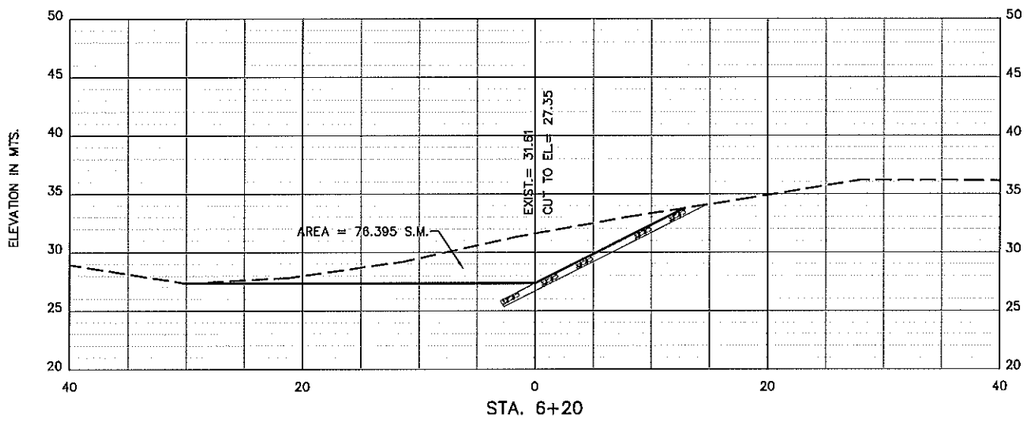
CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

CHANNEL WIDENING
CROSS SECTIONS

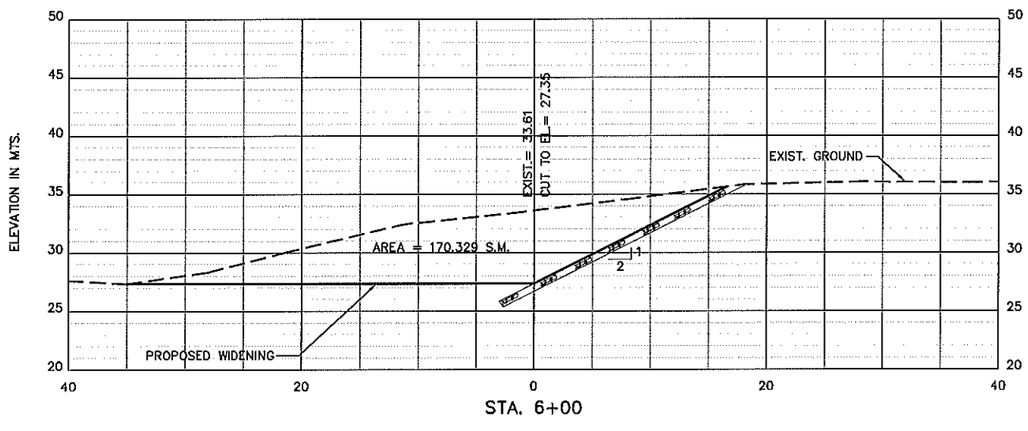
SHEET: 25
DWG: CW-5
DATE:
PROJ:

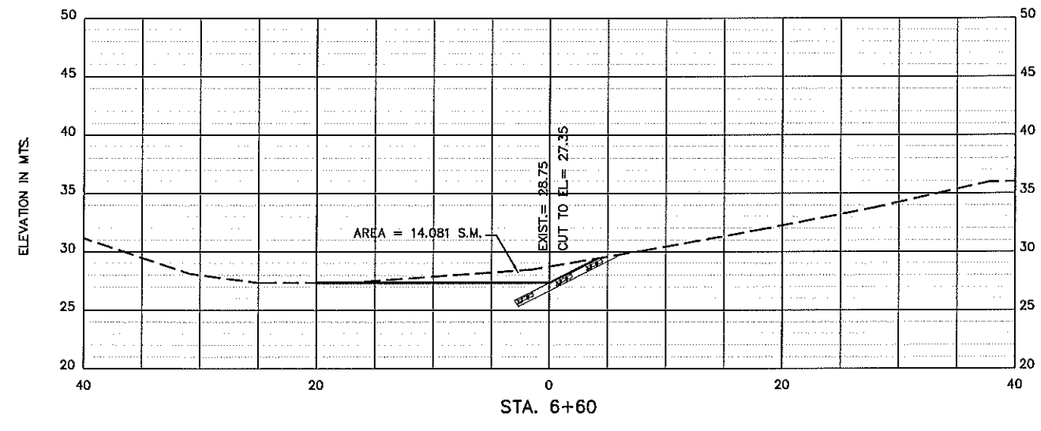
Y:\ciales\Phase Completo (Aug 2012)\CW 05.dwg, 9/7/2012 1:51:48 PM, 1:13.0235





NOTE: ALL CROSS SECTIONS ARE LOOKING DOWNSTREAM.





DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
H = 1:250
V = 1:250

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES

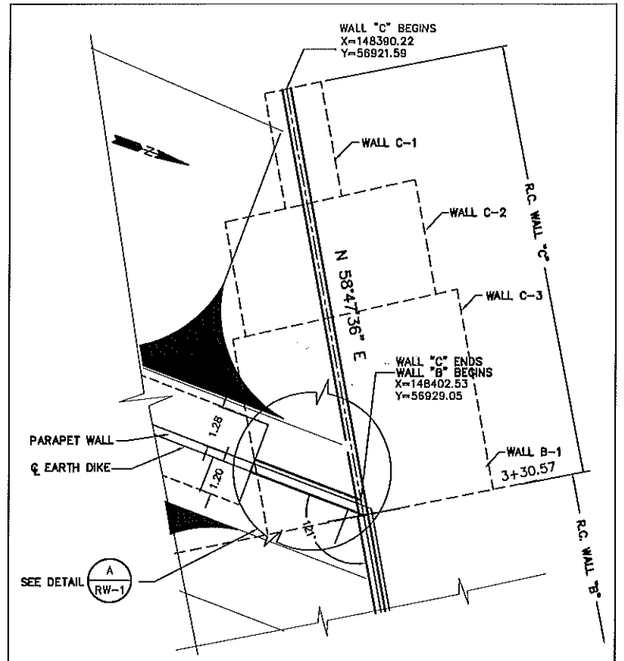
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

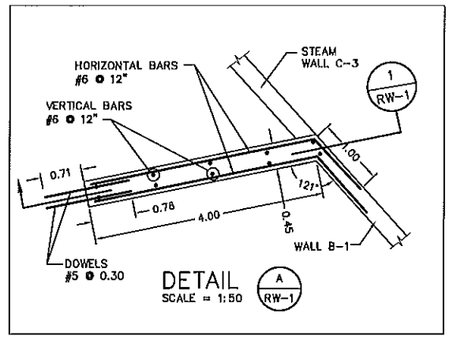
CHANNEL WIDENING
CROSS SECTIONS

SHEET: 26
DWG: CW-6
DATE:
PROJ:

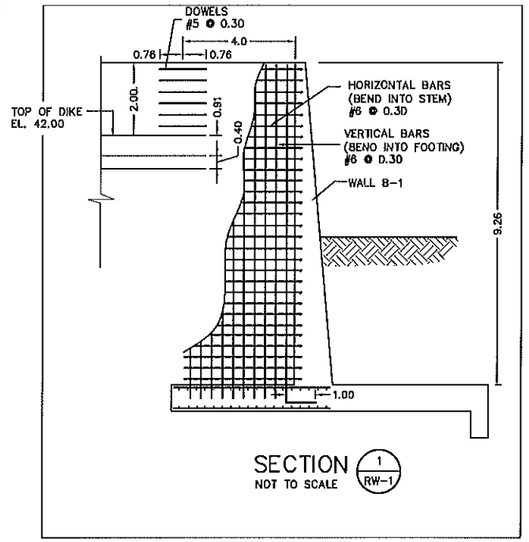
Y:\Ciales\Phase Completo (Aug 2012)\CW 06.dwg, 9/7/2012 1:52:27 PM, 1:12.585



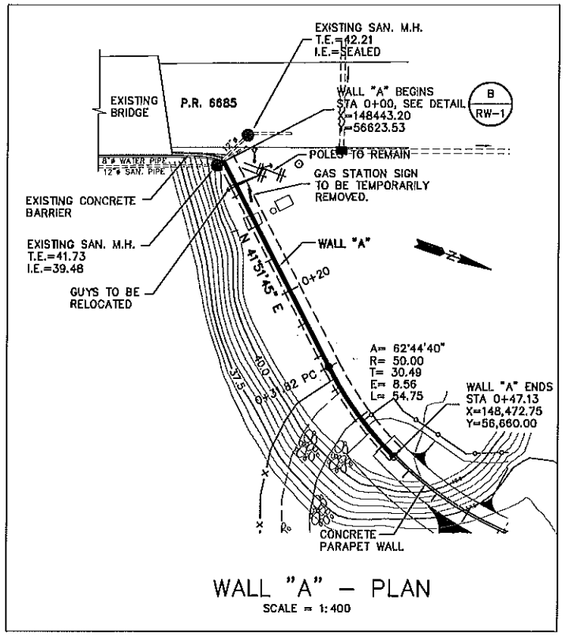
R.C. WALL "C"
WALL SECTIONS C-1 THROUGH C-3 – PLAN
SCALE = 1:100



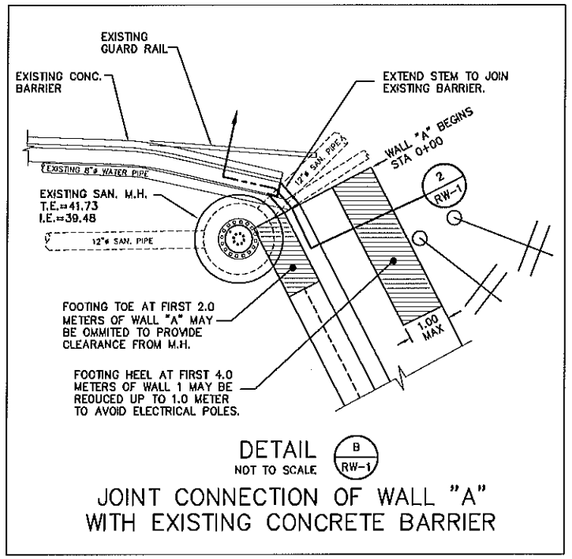
DETAIL A RW-1
SCALE = 1:50



SECTION 1 RW-1
NOT TO SCALE

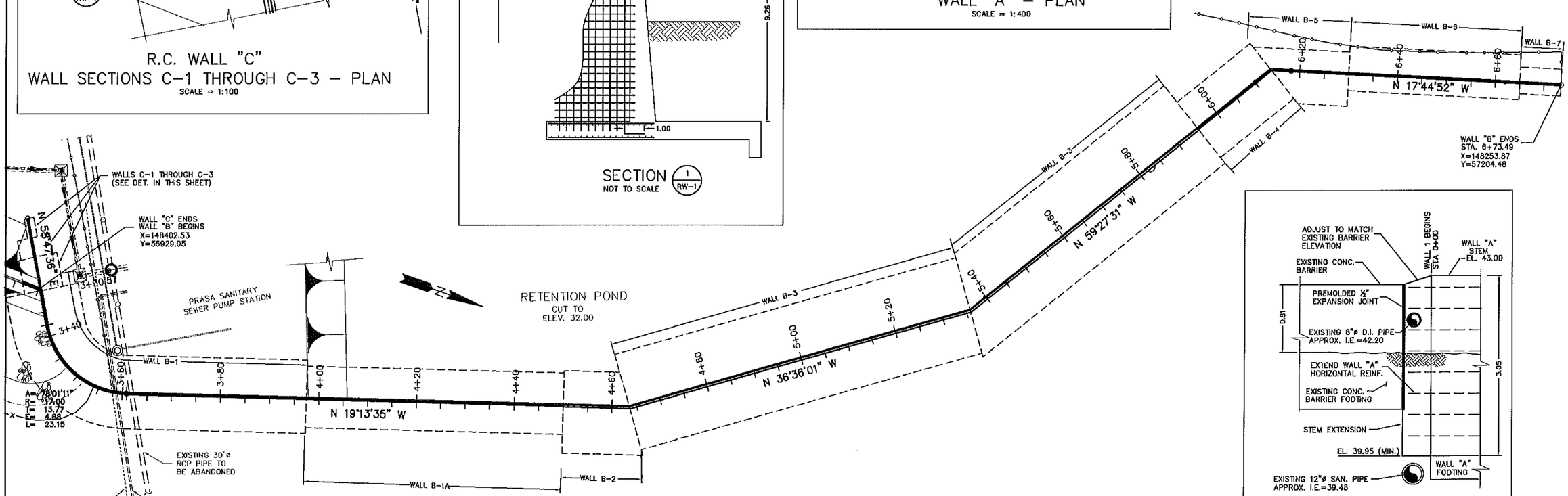


WALL "A" – PLAN
SCALE = 1:400

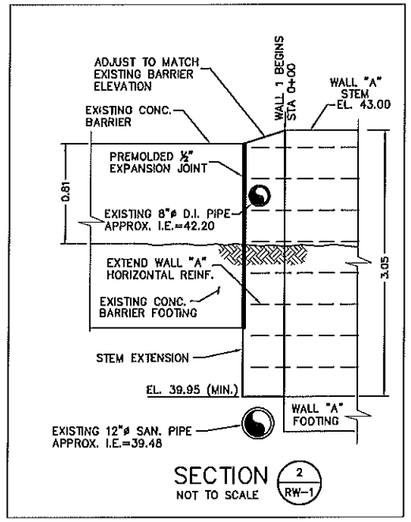


DETAIL B RW-1
NOT TO SCALE

JOINT CONNECTION OF WALL "A"
WITH EXISTING CONCRETE BARRIER



R.C. WALL "B"
WALL SECTIONS B-1 THROUGH B-8 – PLAN
SCALE = 1:400



SECTION 2 RW-1
NOT TO SCALE

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA
Y ASOCIADOS
SAN JUAN, PUERTO RICO

R.C. RETAINING WALLS FOUNDATION
LAYOUT AND MISCELLANEOUS DETAILS

SHEET: 27
DWG: RW-01
DATE:
PROJ:

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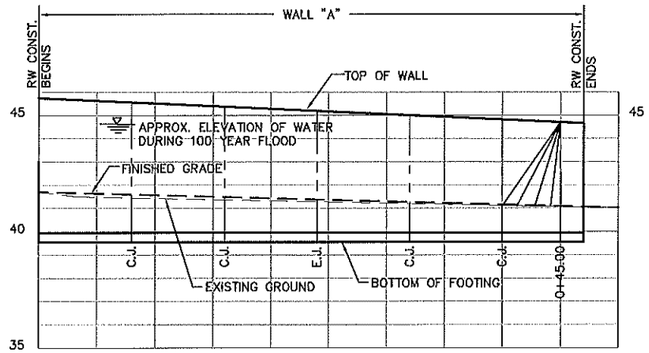
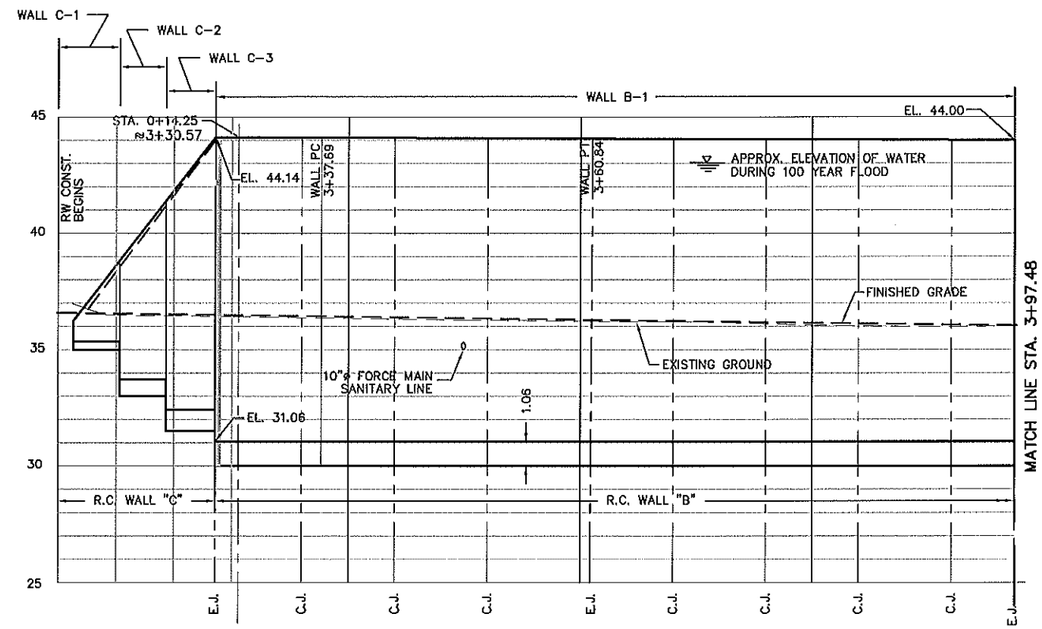


	STATION	0+00.00	0+08.00	0+16.00	0+24.00	0+32.00	0+40.00	0+47.13
ELEVATIONS	TOP OF WALL	44.75						44.66
	BOTTOM OF FOOTING	39.55	39.55	39.55	39.55	39.55	39.55	39.55
	EXISTING GROUND	41.71	41.55	41.43	41.32	41.23	39.55	41.02
	FINISHED GRADE	41.75	41.63	41.51	41.39	41.27	41.71	42.52

WALL "A" PROFILE

FROM STA. 0+00 TO STA. 0+47.13



	STATION	0+00	0+04	0+08	0+12.25	0+14.25 ≈3+30.57	3+60.84	3+97.48
ELEVATIONS	TOP OF WALL	36.50	38.82	41.39	44.14	42.13	44.07	44.00
	BOTTOM OF FOOTING	35.00	33.00	31.50	30.00	30.00	30.00	30.00
	EXISTING GROUND	37.00	36.48	36.48	36.45	36.44	36.27	36.01
	FINISHED GRADE	37.00	36.48	36.48	36.45	36.44	36.29	36.05

WALL "C" PROFILE

FROM STA. 0+00 TO STA. 0+14.25

WALL "B" PROFILE

FROM STA. 3+30.57 TO STA. 3+97.48

LEGEND:

C.J. = CONTRACTION JOINT
E.J. = EXPANSION JOINT
≈ = STATION EQUATION

NOTES:

1. ALL JOINTS AS SHOWN IN DETAIL ON DWG. RW-12.
2. ALL ELEVATIONS AND DISTANCES ARE IN METERS, UNLESS OTHERWISE SPECIFIED.
3. REINFORCED CONCRETE WALL "B" INCLUDES STRUCTURAL SECTIONS B-1 TROUGH B-7.
4. REINFORCED CONCRETE WALL "C" INCLUDES STRUCTURAL SECTIONS C-1, C-2 AND C-3.

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
H = 1:250
V = 1:125

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

RETAINING WALLS "A", "B" AND "C" PROFILES

SHEET: 28
DWG: RW-02
DATE:
PROJ:

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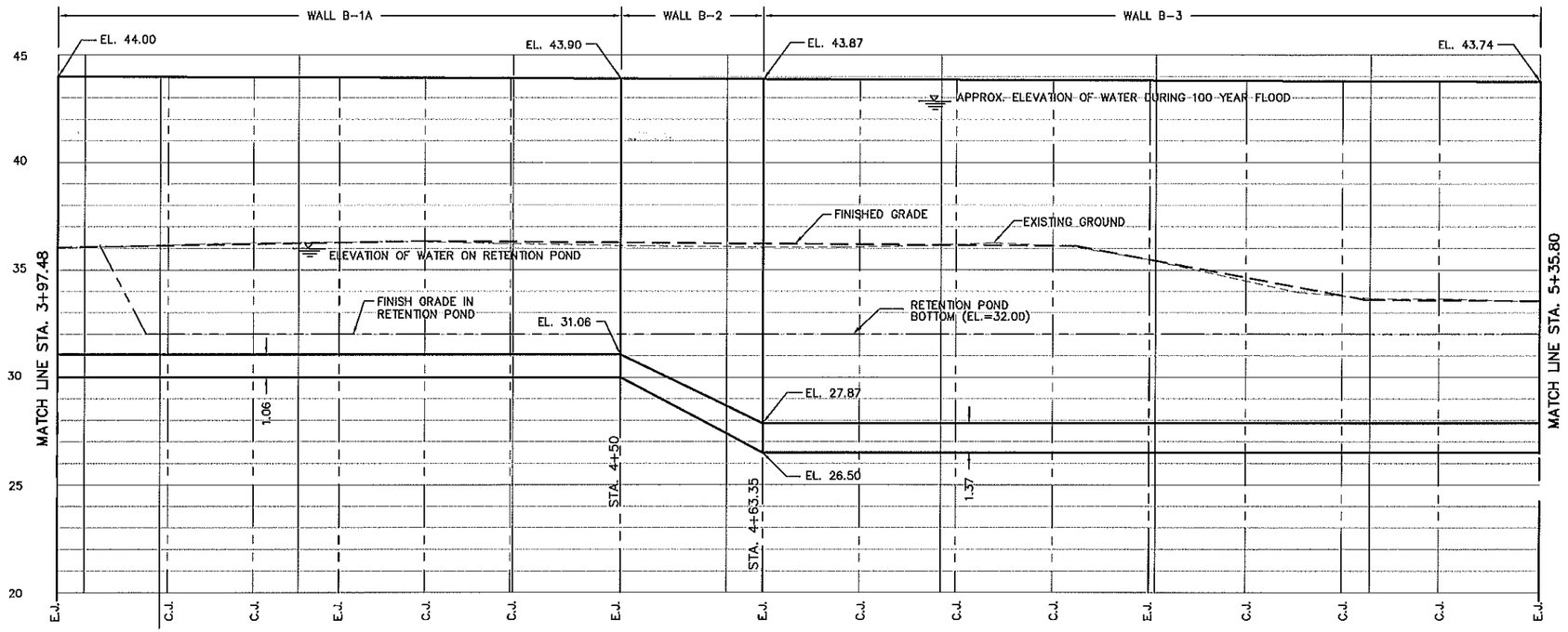

	STATION	3+97.48	4+07.05	4+23.78	4+50.00	4+63.35	499.40	5+35.80
ELEVATIONS	TOP OF WALL	44.00	43.98	43.95	43.90	43.87	43.81	43.74
	BOTTOM OF FOOTING	30.00	30.00	30.00	28.50	26.50	26.50	26.50
	EXISTING GROUND	36.01	36.14	36.30 35.27	36.13	36.05	35.47	36.50
	FINISHED GRADE	36.05	36.15	32.00 36.30	32.00 36.25	36.20	35.50	36.50

WALL "B" PROFILE

FROM STA. 3+97.48 TO STA. 5+35.80

NOTES:

1. ALL JOINTS AS SHOWN IN DETAIL ON DWG. RW-12.
2. ALL ELEVATIONS AND DISTANCES ARE IN METERS, UNLESS OTHERWISE SPECIFIED.
3. REINFORCED CONCRETE WALL "B" INCLUDES STRUCTURAL SECTIONS B-1 TROUGH B-8.
4. REINFORCED CONCRETE WALL "C" INCLUDES STRUCTURAL SECTIONS C-1, C-2 AND C-3.

LEGEND:

C.J. = CONTRACTION JOINT
E.J. = EXPANSION JOINT

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
H = 1:250
V = 1:125

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

RETAINING WALL "B" PROFILE

SHEET: 29
DWG: RW-03
DATE:
PROJ:

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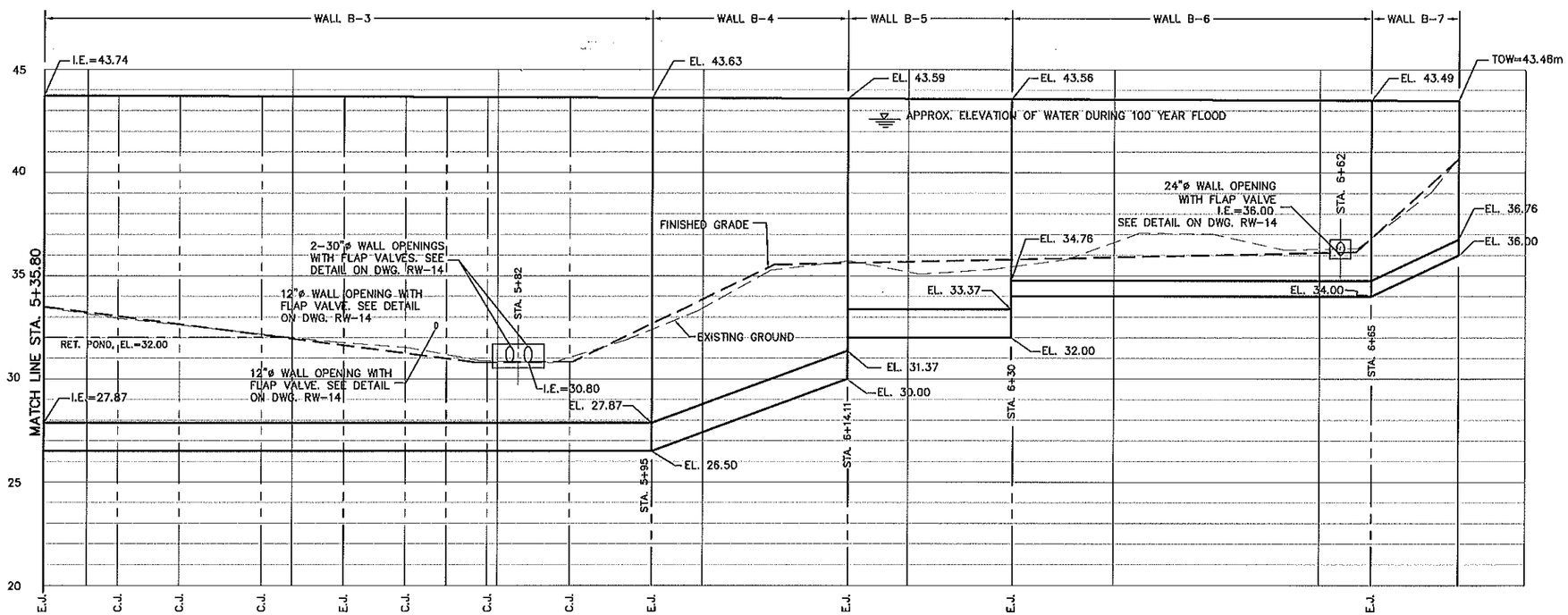
LEGEND:

C.J. = CONTRACTION JOINT
E.J. = EXPANSION JOINT

NOTES:

1. ALL JOINTS AS SHOWN IN DETAIL ON DWG. RW-12.
2. ALL ELEVATIONS AND DISTANCES ARE IN METERS, UNLESS OTHERWISE SPECIFIED.
3. REINFORCED CONCRETE WALL "B" INCLUDES STRUCTURAL SECTIONS B-1 TROUGH B-8.
4. REINFORCED CONCRETE WALL "C" INCLUDES STRUCTURAL SECTIONS C-1, C-2 AND C-3.



	STATION	5+35.80	5+65.00	5+95.00	6+07.00	6+14.11	6+30.00	6+65.00	6+73.49
ELEVATIONS	TOP OF WALL	43.74	43.68	43.63	43.61	43.59	43.56	43.49	43.48
	BOTTOM OF FOOTING	26.50	26.50	26.50	30.00	32.00	34.00	34.00	36.00
	EXISTING GROUND	36.50	31.76	32.40	35.29	35.73	35.43	36.82	40.70
	FINISHED GRADE	32.00 36.50	31.63	32.68	35.54	35.62	35.79	36.82	40.70

WALL "B" PROFILE

FROM STA. 5+35.80 TO STA. 6+73.49

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	RETAINING WALL "B" PROFILE	SHEET: 30
DR:						H = 1:250 V = 1:125	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: RW-04
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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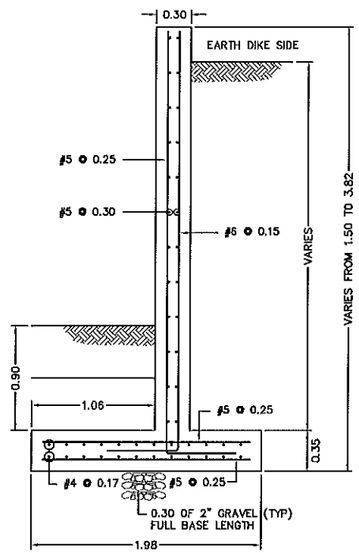
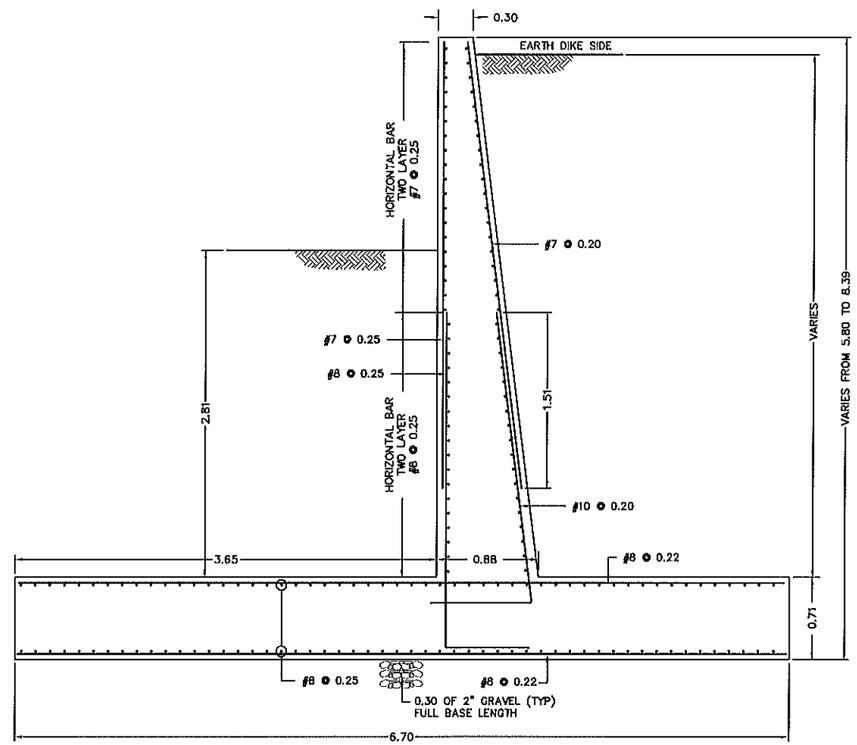
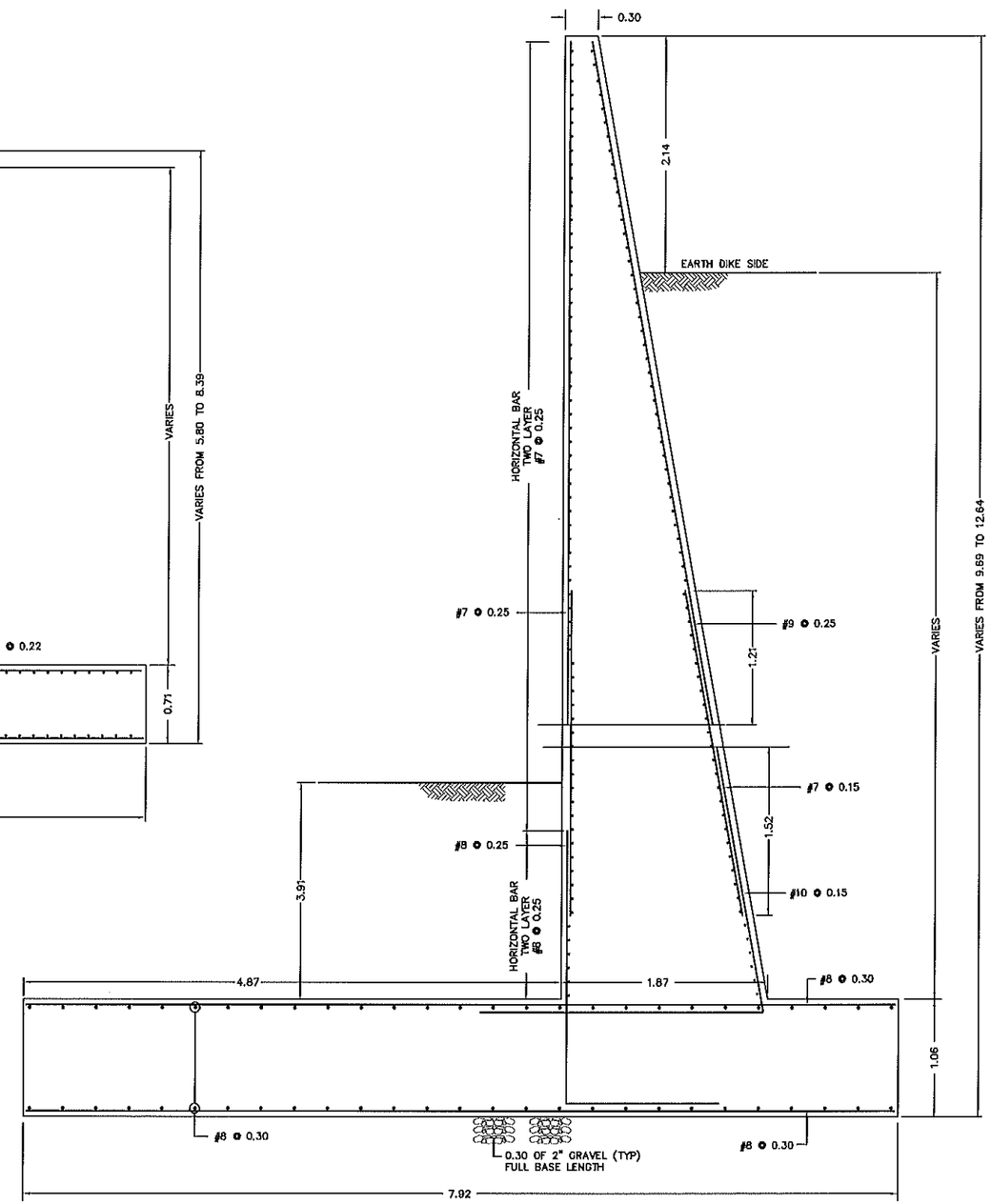


WALL SECTION C-1
SCALE 1:25



WALL SECTION C-2
SCALE 1:25



WALL SECTION C-3
SCALE 1:25

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

REINF. CONCRETE WALL "C"
STRUCTURAL DETAILS

SHEET: 31
DWG: RW-05
DATE:
PROJ:

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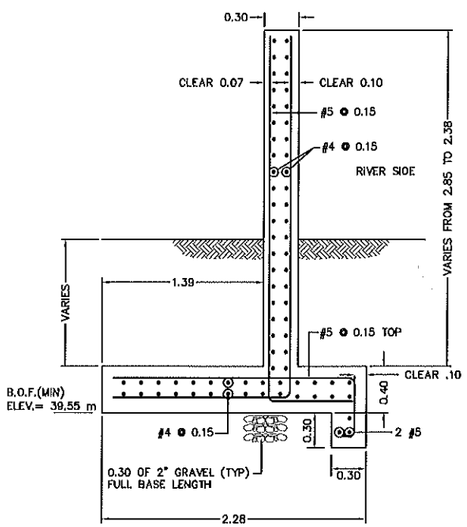
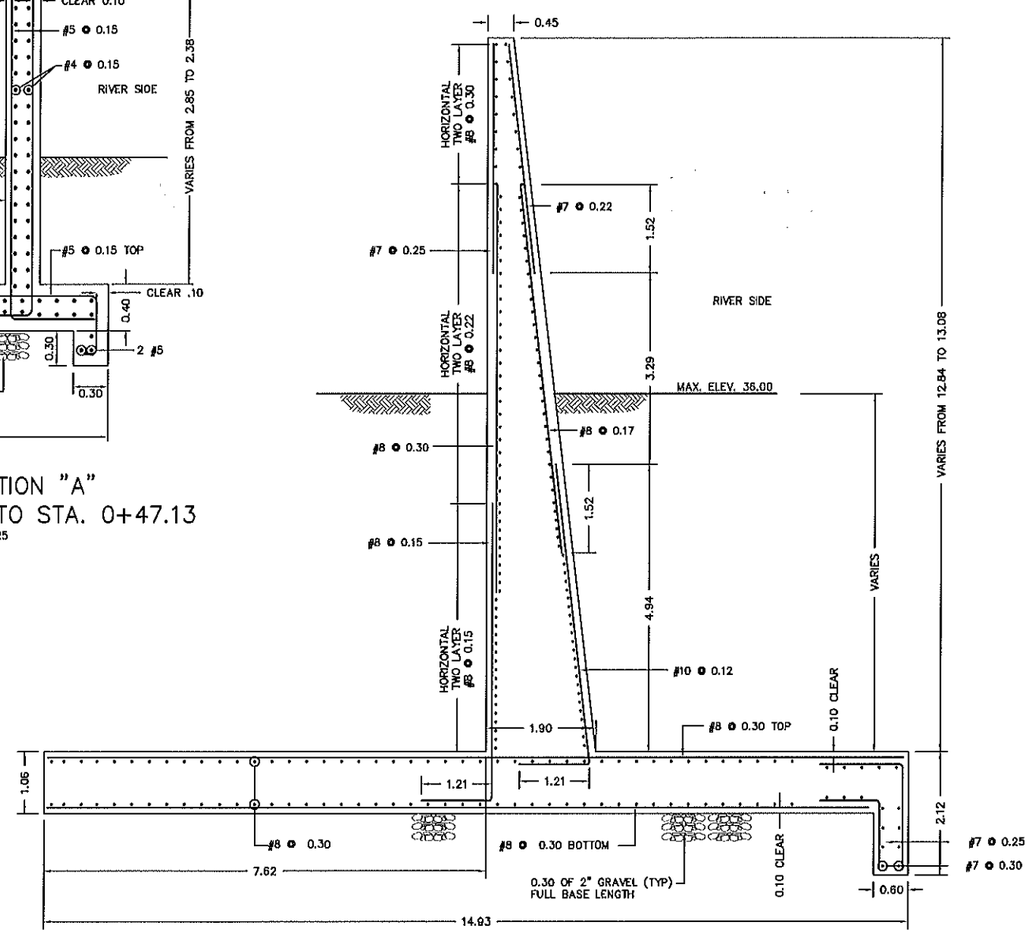
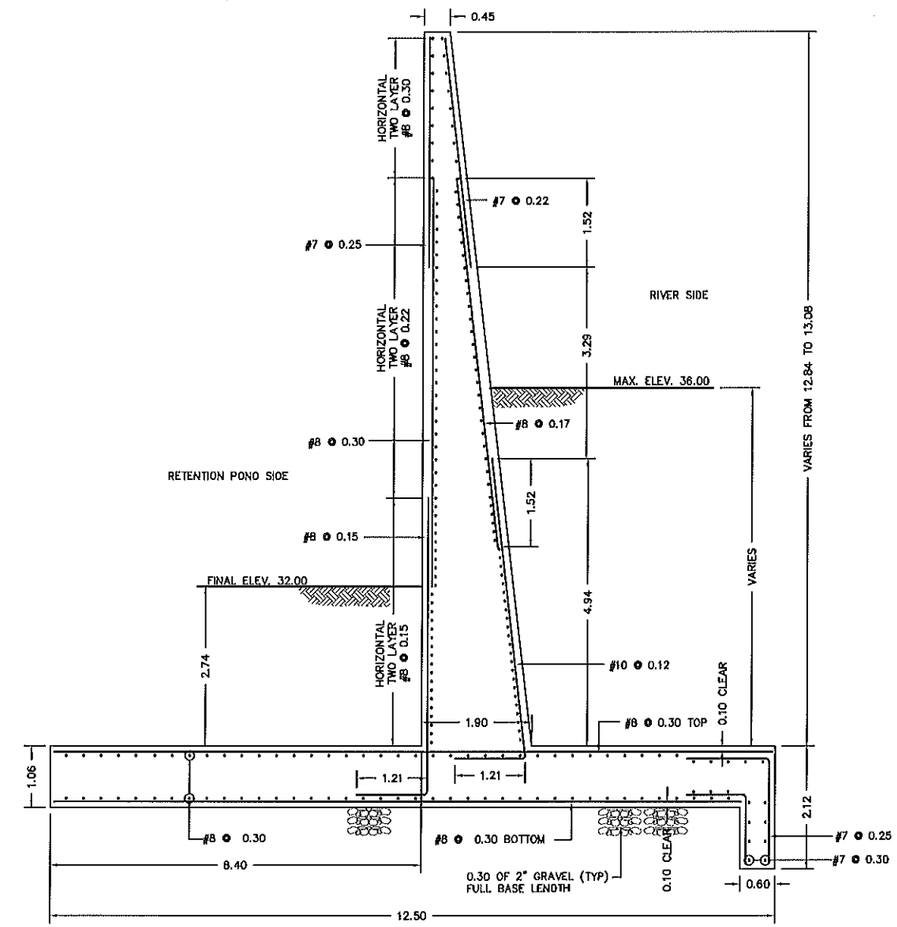


WALL SECTION "A"
FROM STA. 0+00 TO STA. 0+47.13
SCALE 1:25



WALL SECTION B-1
SCALE 1:50



WALL SECTION B-1A
SCALE 1:50

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO
QDSA

R. C. WALLS "A" AND "B"
STRUCTURAL DETAILS

SHEET: 32
DWG: RW-06
DATE:
PROJ:

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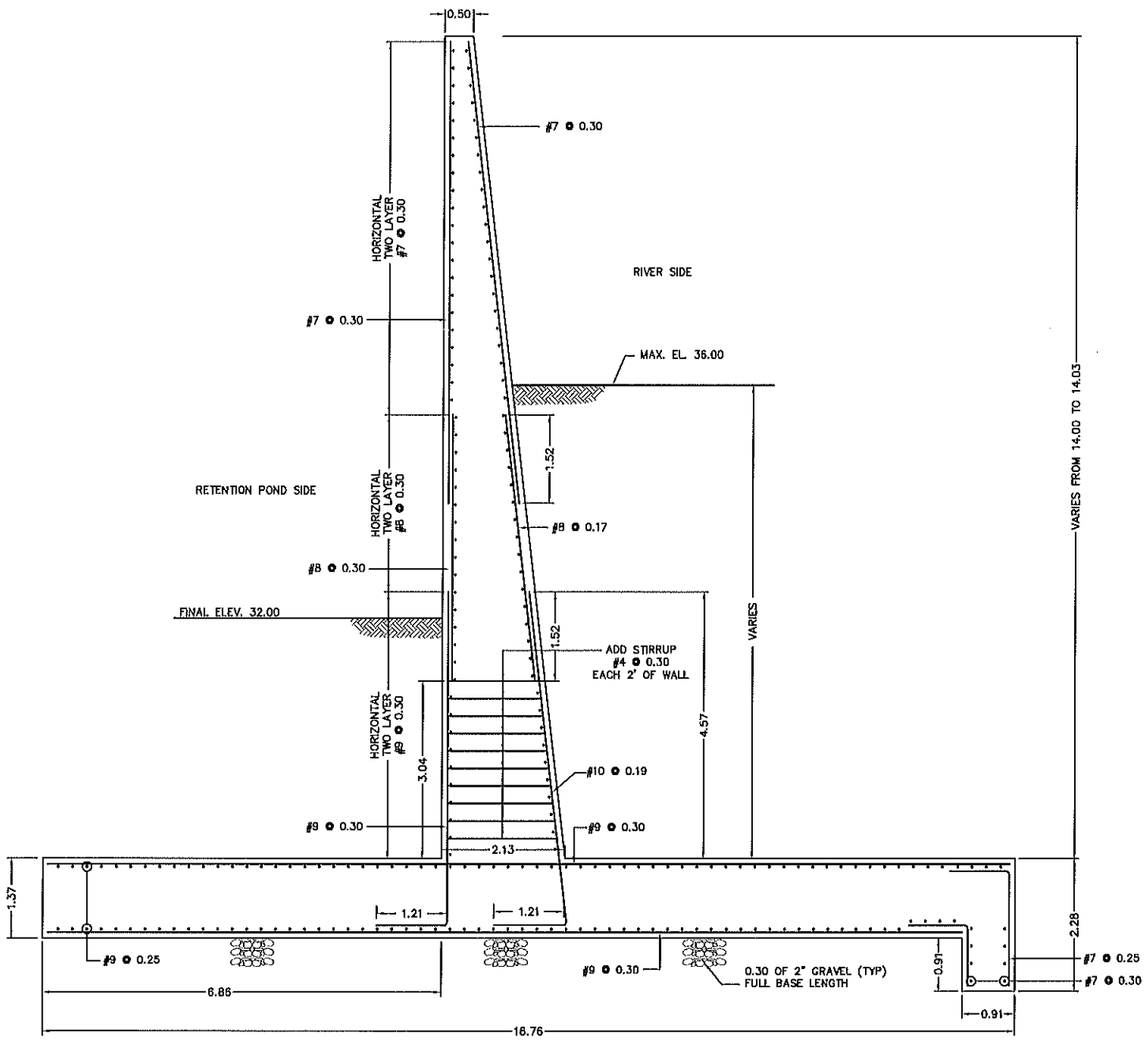
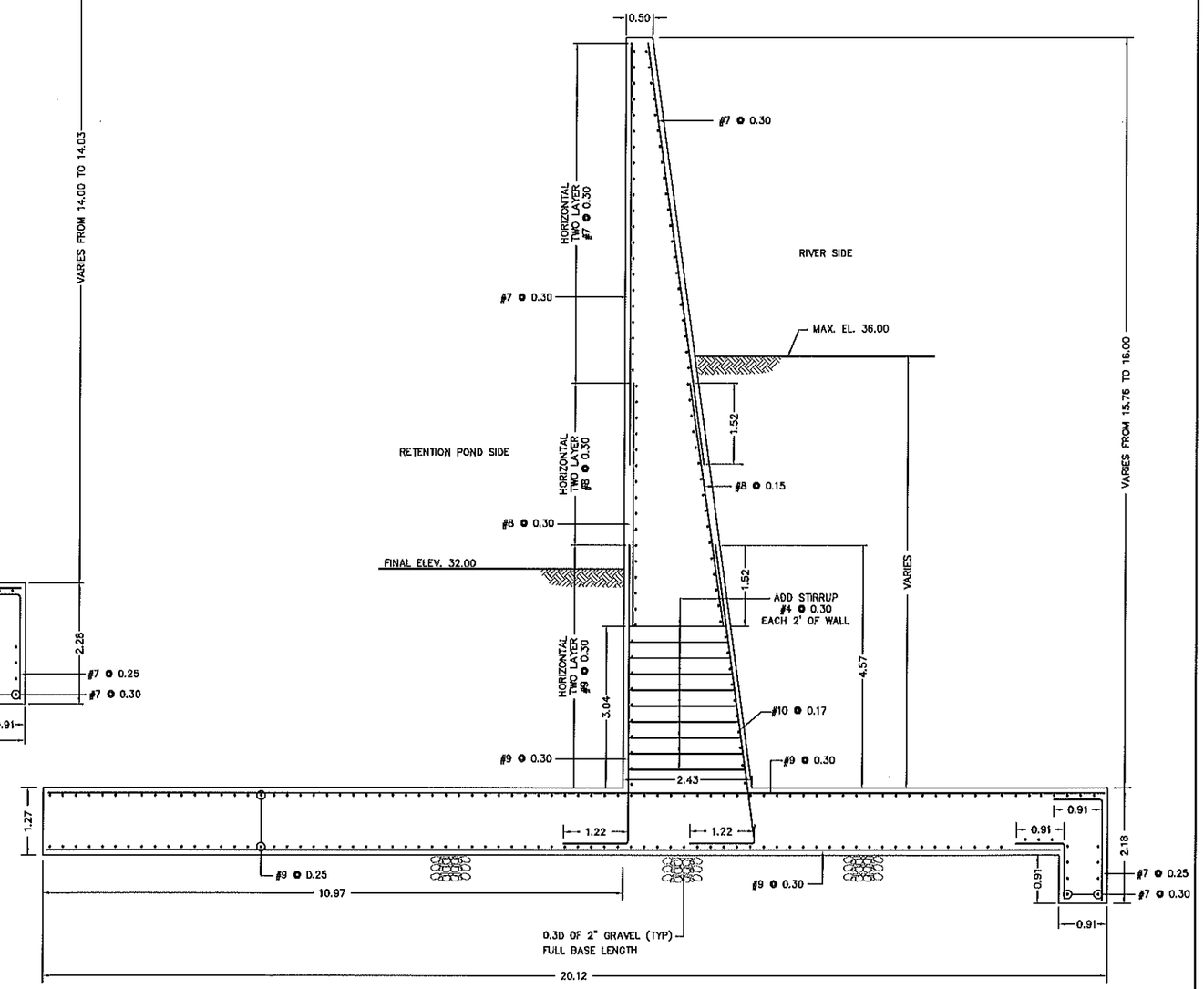


WALL SECTION B-2
SCALE 1:50



WALL SECTION B-3
SCALE 1:50

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	REINF. CONCRETE WALL "B"	SHEET: 33
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO	STRUCTURAL DETAILS	DWG: RW-07
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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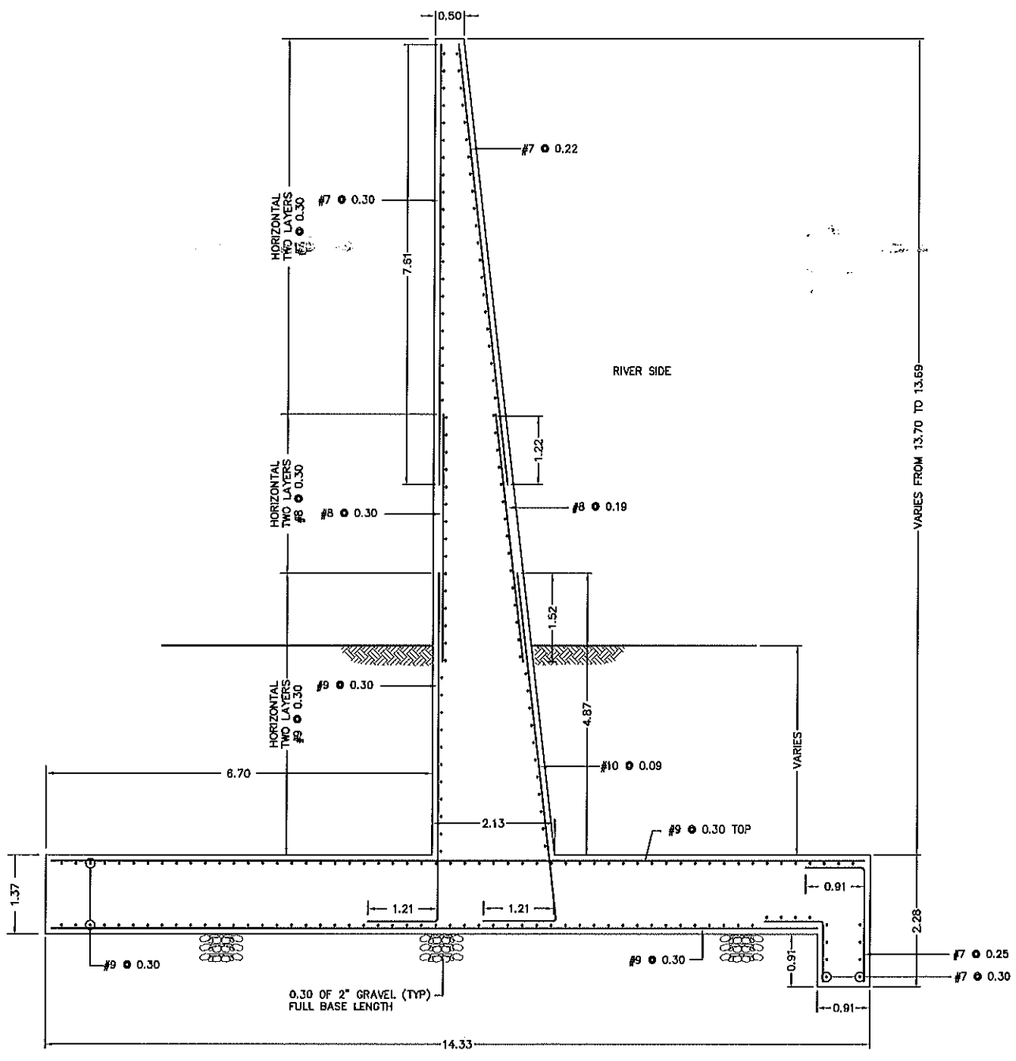
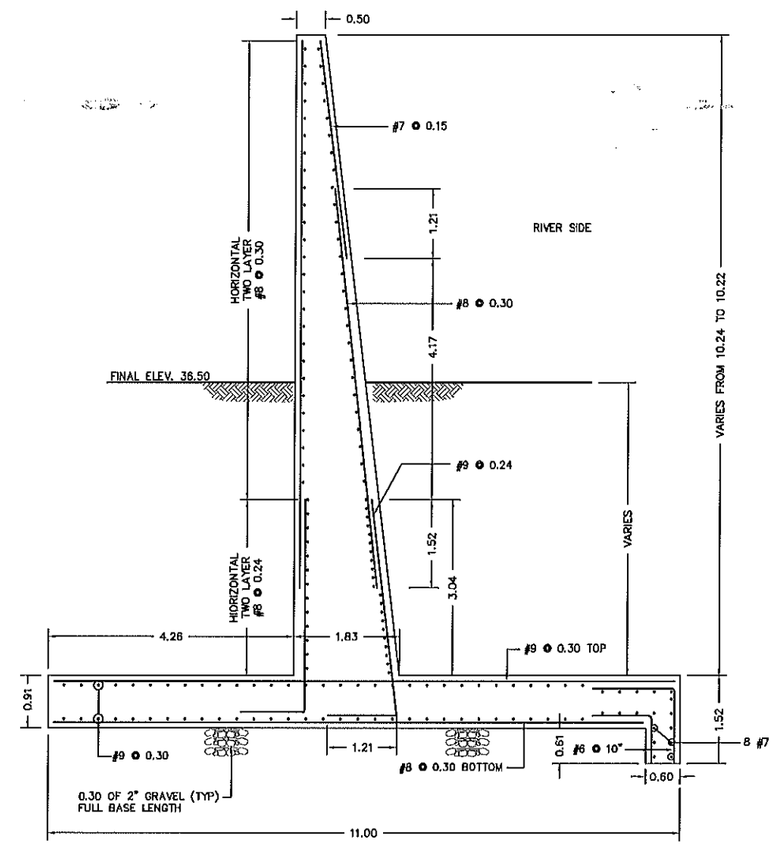


WALL SECTION B-4
SCALE 1:50



WALL SECTION B-5
SCALE 1:50

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

REINF. CONCRETE WALL "B"
STRUCTURAL DETAILS

SHEET: 34
DWG: RW-08
DATE:
PROJ:

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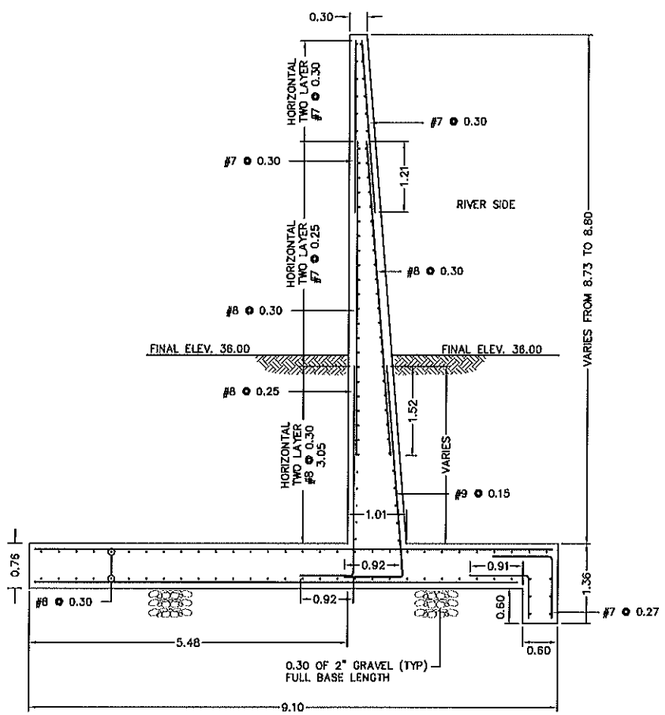
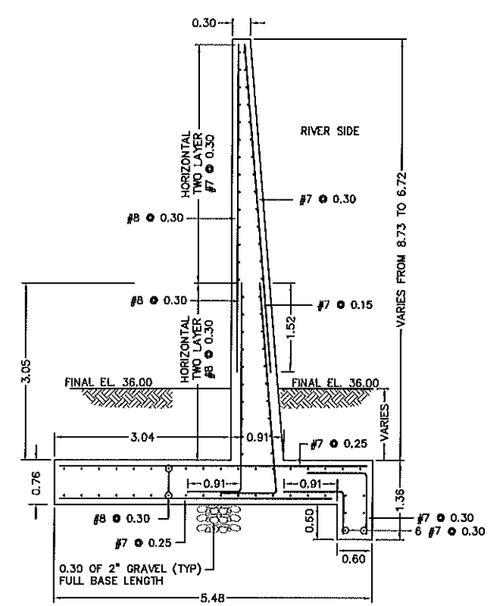


WALL SECTION B-6
SCALE 1:50



WALL SECTION B-7
SCALE 1:50

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	REINF. CONCRETE WALL "B"	SHEET: 35
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO	STRUCTURAL DETAILS	DWG: RW-09
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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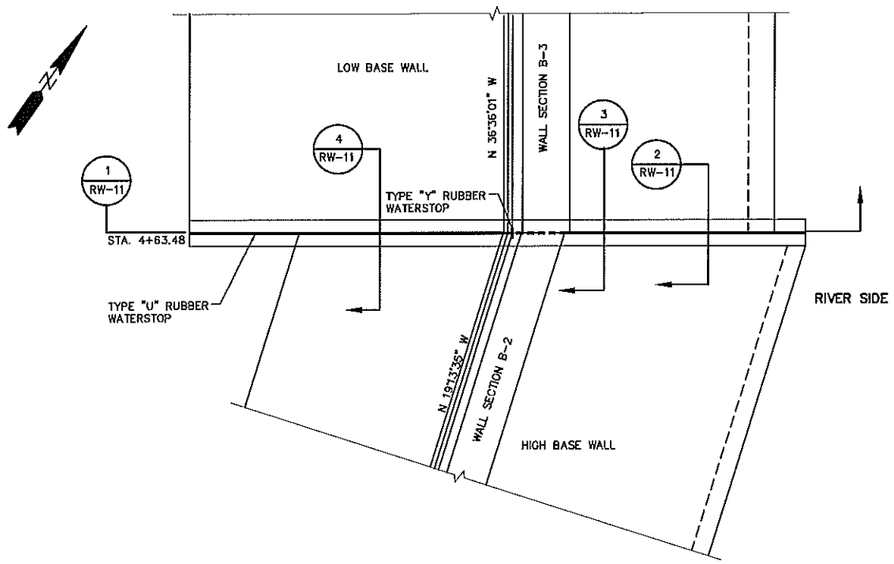
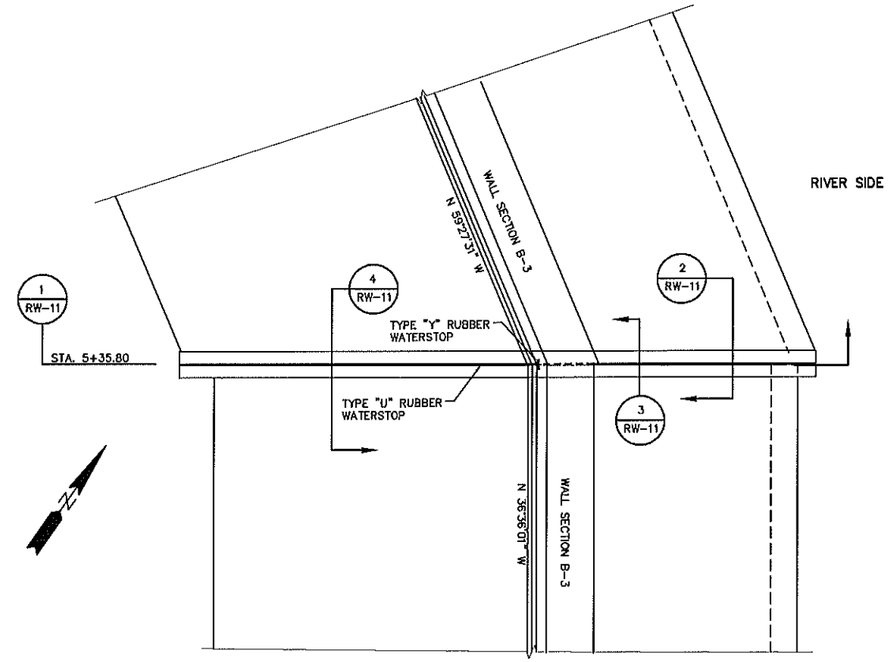
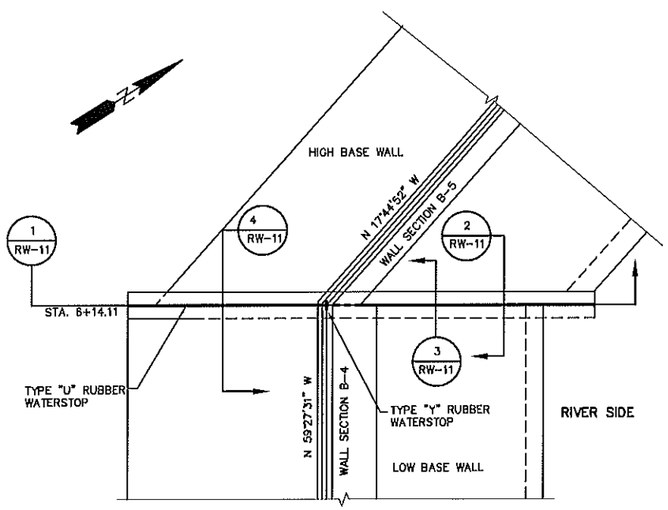


TRANSITION FROM WALL SECTION B-2 TO B-3
PLAN
SCALE = 1:100



TRANSITION FROM WALL SECTION B-3 TO B-3
PLAN
SCALE = 1:100



TRANSITION FROM WALL SECTION B-4 TO B-5
PLAN
SCALE = 1:100

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	RETAINING WALL HORIZONTAL TRANSITIONS	SHEET: 36
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: RW-10
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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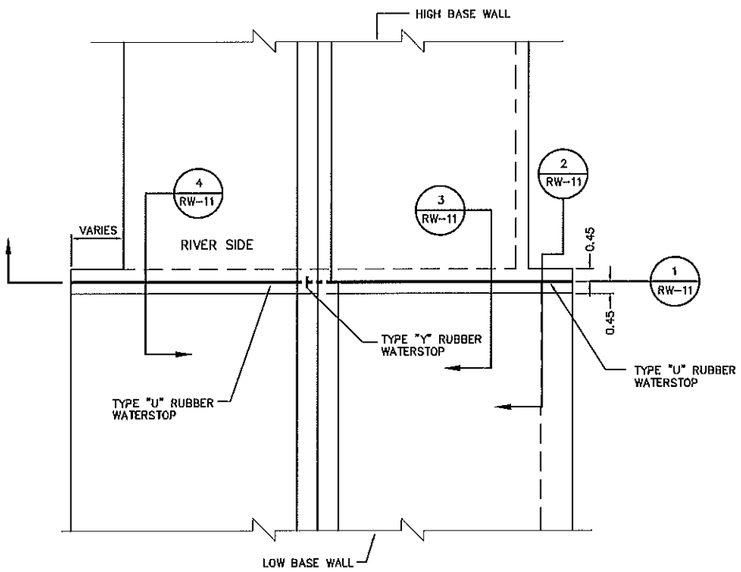
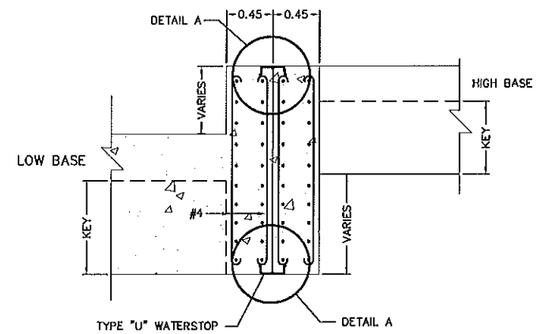
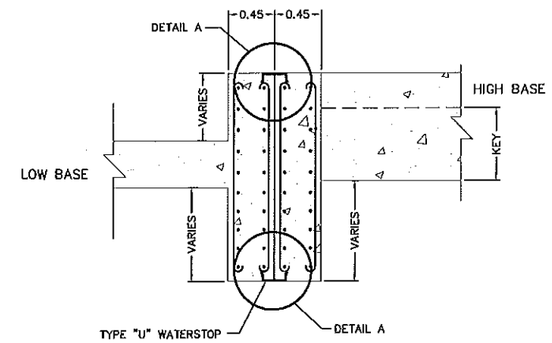


PLAN
NTS

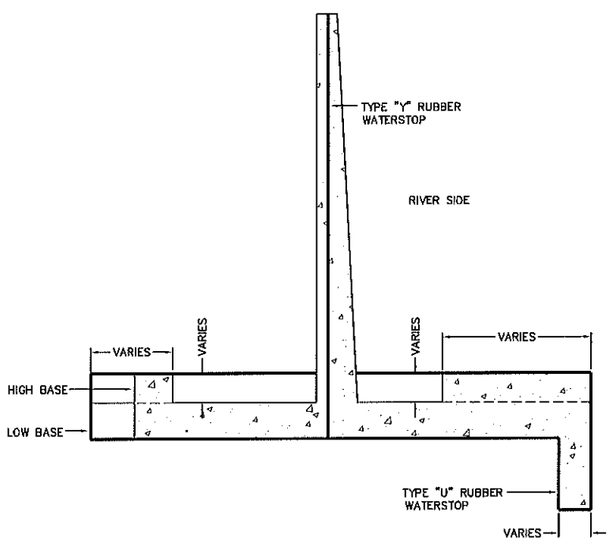
TRANSITIONS AT CHANGES IN WALL HEIGHT



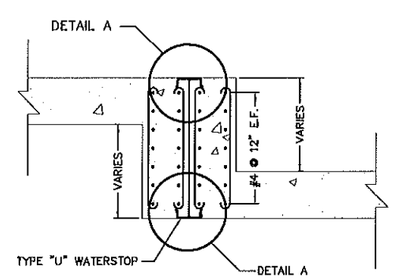
SECTION 2 RW-10 2 RW-11
NOT TO SCALE



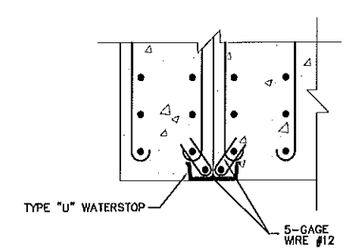
SECTION 3 RW-10 3 RW-11
NOT TO SCALE



SECTION 1 RW-10 1 RW-11
NOT TO SCALE



SECTION 4 RW-10 4 RW-11
NOT TO SCALE



DETAIL A 1 RW-11
NOT TO SCALE

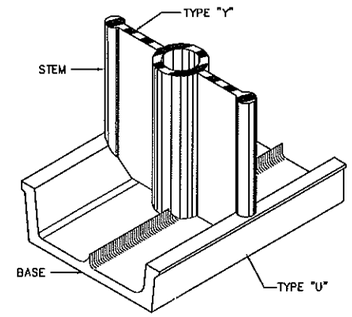
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

REINFORCED CONCRETE WALL WATER PROOFING DETAILS

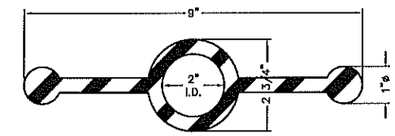
SHEET: 37
DWG: RW-11
DATE:
PROJ:

Y:\cciales\Phase Completa (Aug 2012)\RW 11.dwg, 9/4/2012 3:37:54 PM, 1:5.18342

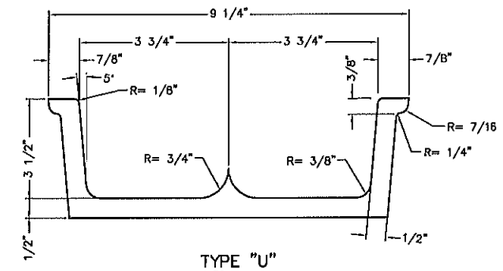


TRANSITION BETWEEN STEM AND BASE
ISOMETRIC SKETCH
NTS

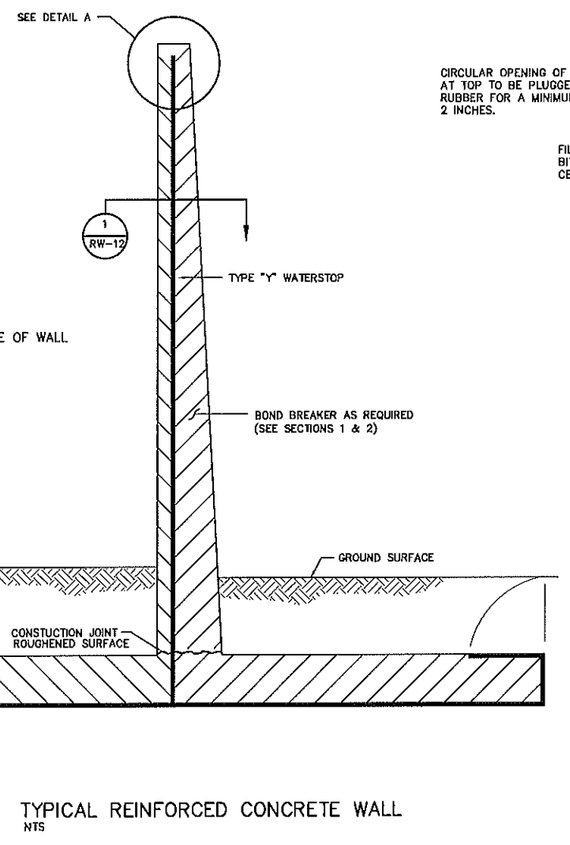
THE TYPE "Y" AND TYPE "U" WATERSTOPS SHALL BE JOINED BY VULCANIZING IF RUBBER WATERSTOPS ARE USED; OR BY HEAT SEALING THE JOINT IF PVC WATERSTOPS ARE USED.



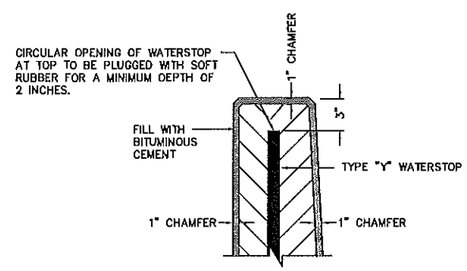
TYPE "Y"
NTS



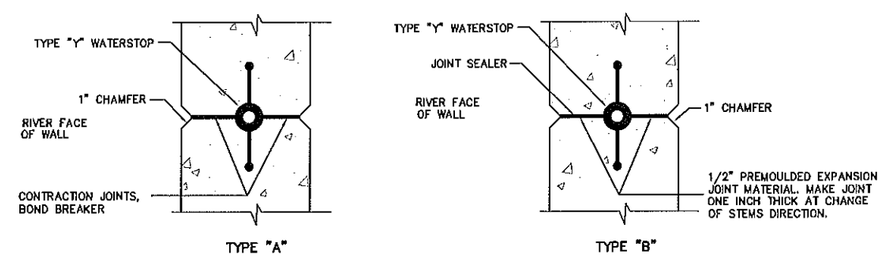
TYPE "U"
NTS



TYPICAL REINFORCED CONCRETE WALL
NTS



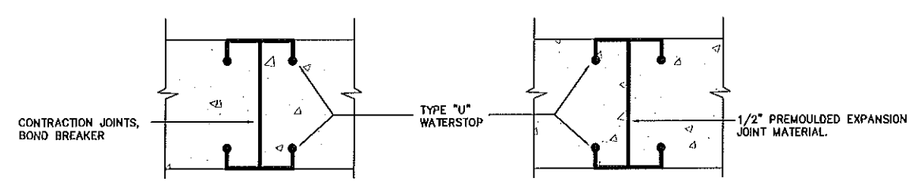
DETAIL A RW-12
NTS



TYPE "A" TYPE "B"

MONOLITH JOINT DETAIL

SECTION 1 RW-12
NOT TO SCALE



TYPE "A" TYPE "B"

MONOLITH JOINT DETAIL

SECTION 2 RW-12
NOT TO SCALE

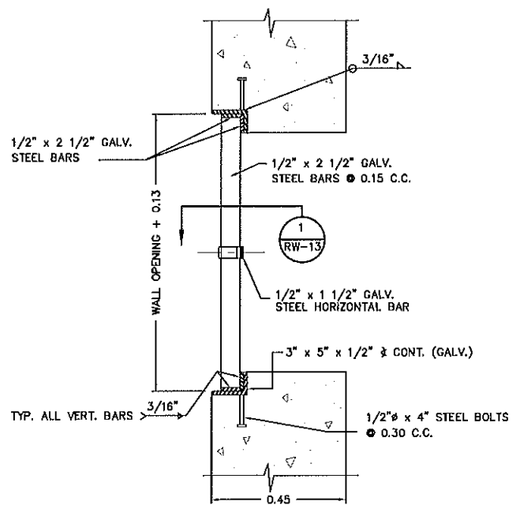
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

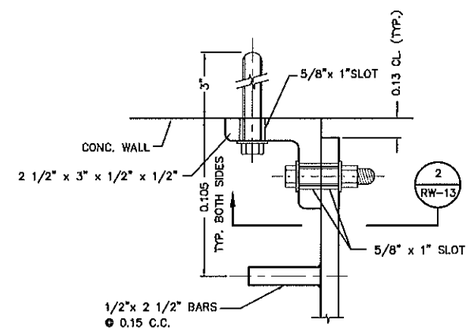
REINFORCED CONCRETE WALL
WATERSTOP DETAIL

SHEET: 38
DWG: RW-12
DATE:
PROJ:

Y:\cciales\Phase Complete (Aug 2012)\RW 12.dwg, 9/4/2012 3:43:02 PM, 1:5.22189

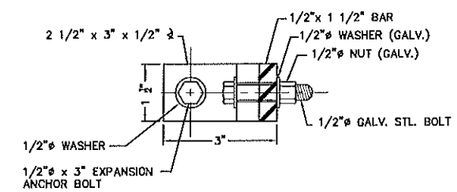


STEEL TRASH RACK
SCALE 1:10



SECTION 1 / RW-13
SCALE 1:2

(TYPICAL AT ENDS OF HORIZONTAL BARS)



SECTION 2 / RW-13
SCALE 1:2

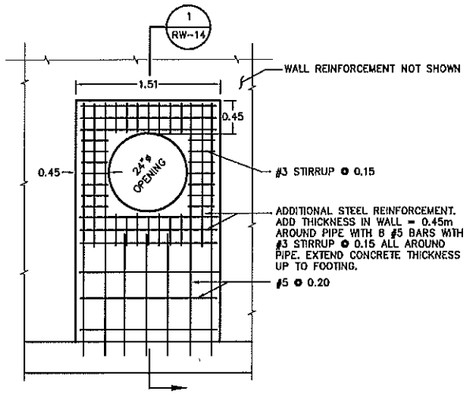
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

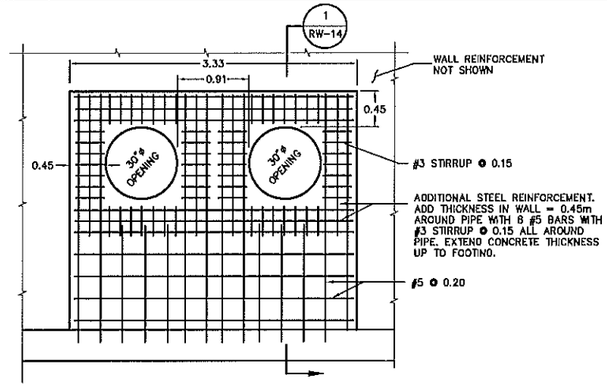
REINFORCED CONCRETE WALL
TRASH RACK DETAILS

SHEET: 39
DWG: RW-13
DATE:
PROJ:

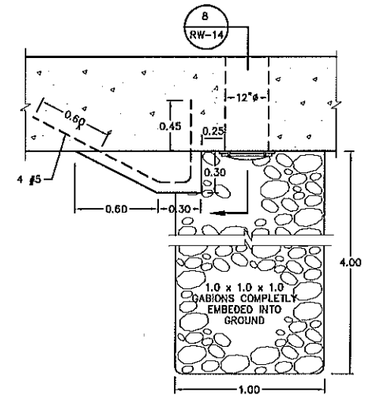
Y:\cciales\Phase Completo (Aug. 2012)\RW 13.dwg, 9/4/2012 3:45:08 PM, 1:5.25069



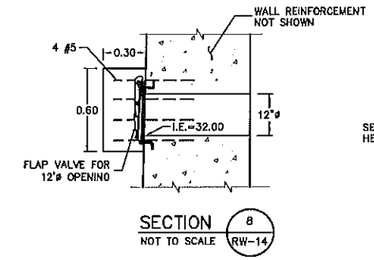
24"ø OPENING ADDITIONAL REINFORCEMENT DETAIL (EARTH SIDE)
NOT TO SCALE



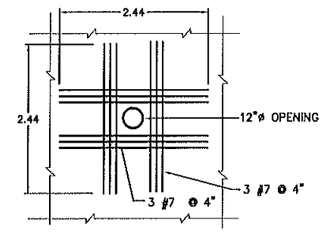
2-30"ø OPENING ADDITIONAL REINFORCEMENT DETAIL (EARTH SIDE)
NOT TO SCALE



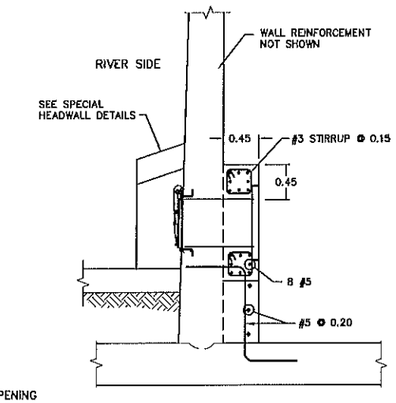
12"ø WALL OPENING PLAN
NOT TO SCALE



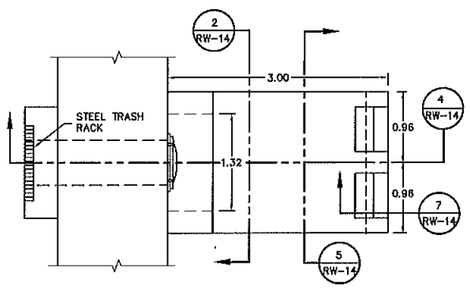
SECTION 8 RW-14
NOT TO SCALE



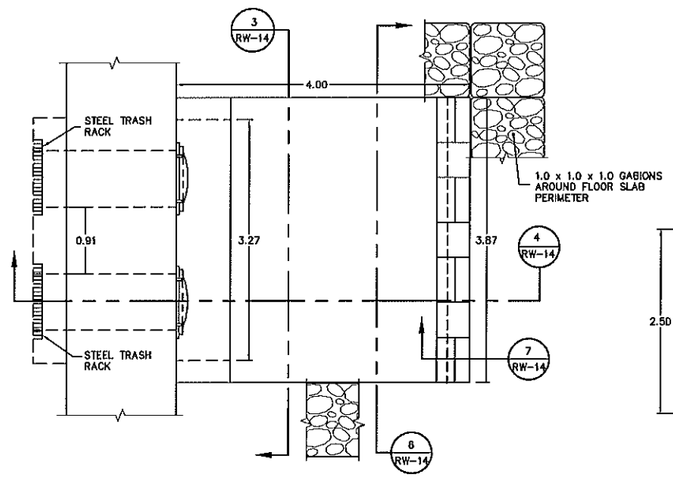
12"ø OPENING ADDITIONAL REINFORCEMENT AT EACH FACE OF WALL
NOT TO SCALE



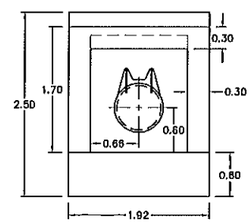
SECTION 1 RW-14
NOT TO SCALE



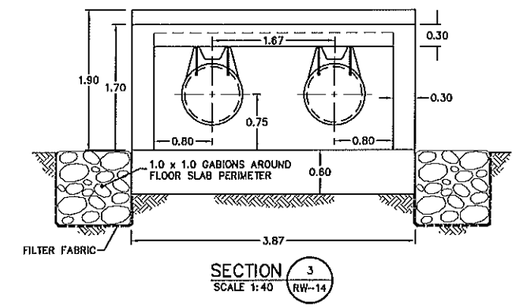
24"ø OPENING SPECIAL HEADWALL - PLAN
SCALE 1:40



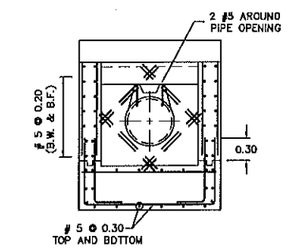
2-30"ø OPENINGS SPECIAL HEADWALL PLAN
SCALE 1:40



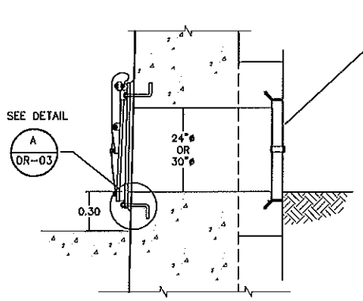
SECTION 2 RW-14
SCALE 1:40



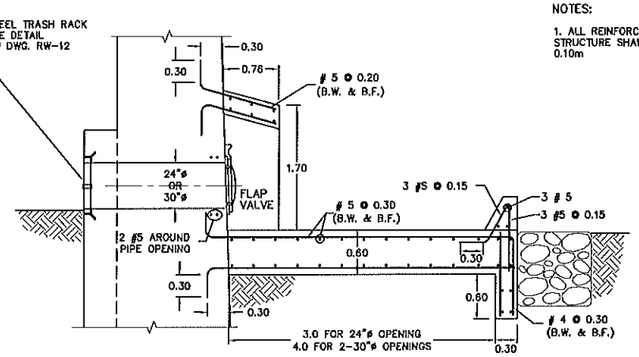
SECTION 3 RW-14
SCALE 1:40



REINFORCEMENT AT WINGWALLS AND BOTTOM SLAB
SCALE 1:40



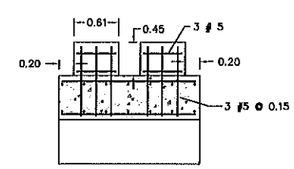
24"ø & 30"ø FLAP VALVE INSTALLATION DETAIL
NOT TO SCALE



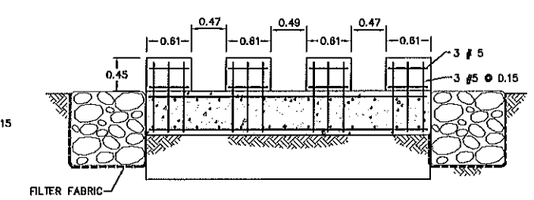
SECTION 4 RW-14
SCALE 1:40

NOTES:

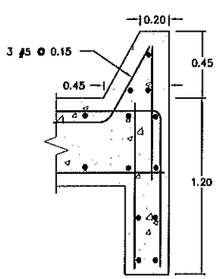
1. ALL REINFORCEMENT IN SPECIAL HEADWALL STRUCTURE SHALL HAVE A MINIMUN COVER OF 0.10m



SECTION 5 RW-14
SCALE 1:40



SECTION 6 RW-14
SCALE 1:40



SECTION 7 RW-14
SCALE 1:20

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

WALL OPENINGS DETAILS

SHEET:	40
DWG:	RW-14
DATE:	
PROJ:	

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G E N E R A L

G 1 SCOPE

THE NOTES AND DETAILS ON THIS SHEET ARE GENERAL AND APPLY TO THE ENTIRE PROJECT EXCEPT WHERE THERE ARE SPECIFIC INDICATIONS TO THE CONTRARY.

G 2 APPLICABLE SPECIFICATIONS AND CODES

CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE PUERTO RICO BUILDING CODE. THE ABOVE SHALL GOVERN EXCEPT WHERE OTHER APPLICABLE CODES OR THE FOLLOWING NOTES ARE MORE RESTRICTIVE.

G 3 ALTERNATIVE DESIGNS

THE STRUCTURAL SYSTEMS AND DETAILS ON THESE PLANS ARE THE PRIORITY DESIGN. ALTERNATIVE SYSTEMS AND DETAILS MAY BE USED IF THE CONTRACTOR SUBMITS PLANS WITH SUBSTANTIATING CALCULATIONS AND TEST DATA AND IF THE ALTERNATIVE PLANS ARE ACCEPTED BY THE ENGINEER.

G 4 DIMENSIONS

STRUCTURAL DIMENSIONS CONTROLLED BY OR RELATED TO MECHANICAL OR ELECTRICAL EQUIPMENT SHALL BE VERIFIED BY THE CONTRACTOR PRIOR TO CONSTRUCTION.

G 5 PROVISIONS FOR EQUIPMENT

MECHANICAL AND ELECTRICAL EQUIPMENT SUPPORTS, ANCHORAGES, OPENINGS, RECESSES, AND EMBEDMENTS NOT SHOWN ON THE STRUCTURAL DRAWINGS, BUT REQUIRED BY OTHER CONTRACT DRAWINGS SHALL BE PROVIDED PRIOR TO CASTING CONCRETE.

G 6 CONSTRUCTION LOAD

STRUCTURES HAVE BEEN DESIGNED FOR OPERATIONAL LOADS ON COMPLETED STRUCTURES; DURING CONSTRUCTION, STRUCTURES SHALL BE PROTECTED BY BRACING AND BALANCIND WHEREVER EXCESSIVE LOADS MAY OCCUR.

G 7 DESIGN LIVE LOADS

A. RETAININD WALL – STATIC AND DYNAMIC LOAD OF FLOOD WATERS DURIND A 100YR. STORM FLOOD. UNDERGROUND PORTION SUBJECT TO "LATERAL" LOAD OF SATURATED SOIL, AS SPECIFIED BY THE GEOTECHNICAL REPORT.

B. STAIRS – 100 PSF.

C. WIND LOAD AS PER PUERTO RICO BUILDING CODE.

D. SEISMIC LOADING AS PER PUERTO RICO BUILDING CODE.

G 8 DRAINAGE SURFACES

SLOPE DRAINAGE SURFACES UNIFORMLY TO DRAIN. SLOPE SHALL BE 2 PER CENT EXCEPT WHERE NOTED OTHERWISE ON THE PLANS.

G9 OPENINGS

OPENINGS FOR ELECT. AND MECH. CONDUITS IN WALLS AND SLABS WHERE NOT SPECIFICALLY SHOWN IN THESE DWGS. SHALL BE COORDINATED WITH THE ENGINEER.

C O N C R E T E

C 1 APPLICABLE CODE

CONCRETE CONSTRUCTION SHALL CONFORM TO THE LATEST EDITION OF THE ACI BUILDING CODE (ACI–318).

C 2 REINFORCING STEEL DETAILS

ALL DETAILING, FABRICATION, AND ERECTION OF REINFORCING BARS UNLESS OTHERWISE NOTED SHALL BE IN ACCORDANCE WITH MANUAL OF STANDARD PRACTICE FOR DETAILING REINFORCED CONCRETE STRUCTURES (ACI–315). LATEST EDITION.

C 3 DESIGN STRESSES

A. CONCRETE F'C=3,000 PSI ULTIMATE COMPRESSIVE STRENGTH 28 DAYS (FC=1,350 PSI.), AND AS OTHERWISE SPECIFIED.

B. REINFORCING STEEL

1. ALL BARS SHALL BE GRADE 80.
2. TENSION DUE TO FLEXURE
   GRADE 60 (Fs=24,000 PSI)
   GRADE 40 (Fs=20,000 PSI)
3. COLUMN REINFORCING
   GRADE 60 (Fs=24,000 PSI)
   GRADE 40 (Fs=18,000 PSI)

C 4 CONCRETE COVER

CONCRETE COVER FOR REINFORCING BARS SHALL BE AS FOLLOWS WITH MINIMUM COVER OF ONE BAR DIAMETER.

A. CONCRETE CAST AGAINST EARTH – 3".

B. CONCRETE TO BE IN CONTACT WITH LIQUID – 4"

C. CONCRETE TO BE IN CONTACT WITH EARTH OR WEATHER.

1. BARS GREATER THAN #5 – 2".
2. BARS #5 OR LESS – 1 1/2".

D. CONCRETE NOT TO BE EXPOSED TO GROUND, WEATHER, OR LIQUID.

1. BEAMS AND COLUMNS – 1 1/2"
2. SLABS, WALLS, AND JOISTS – 3/4"

C 5 MINIMUM REINFORCEMENT

CONCRETE CONSTRUCTION SHALL BE REINFORCED CONCRETE EXCEPT WHERE PLAIN CONCRETE IS INDICATED ON THE DRAWINGS. UNLESS OTHERWISE NOTED MINIMUM REINFORCING STEEL SHALL BE PROVIDED IN ACCORDANCE WITH THE FOLLOWING SCHEDULES:

SLAB THICKNESS	SIZE	SPACING (EITHER DIRECTION)
4"	#3	13"
5"	#3	10"
6"	#4	14"
8"	#4	12"
9"	#5	17"
10"	#4	18" T & B
12"	#4	16" T & B

SLABS 8" TO 9" THICK – PLACE ALTERNATE BARS TOP AND BOTTOM.

WALL THICKNESS	REINF. EACH WAY	POSITION
6"	#3 @ 7"	ON C
8"	#4 @ 10"	ON C
10"	#3 @ 9"	EF
12"	#4 @ 13"	EF
14"	#4 @ 11"	EF
16"	#5 @ 15"	EF
18"	#5 @ 14"	EF

MASS CONCRETE SHALL BE REINFORCED WITH #5 @ 12" EW MINIMUM IN ALL FACES.

C 6 ADDED TOP STEEL IN SLABS (UNLESS OTHERWISE SHOWN)

WHERE BEAMS OR WALLS ARE PARALLEL TO MAIN REINFORCING IN SLAB PROVIDE #4 @ 18" IN TOP OF SLAB NORMAL TO BEAM OR WALL. EXTEND BARS 24" BEYOND FACE OF BEAM OR WALL. WHEN SLAB IS ON ONE SIDE ONLY, TERMINATE BARS WITH STANDARD HOOK ON OTHER SIDE OF BEAM OR WALL.

C 7 EXTRA ACCESSORY BARS

IN ADDITION TO NORMAL ACCESSORIES USED TO HOLD REINFORCING STEEL FIRMLY IN POSITION, EXTRA ACCESSORY BARS SHALL BE USED AS FOLLOWS.

A. IN SLABS #5 RAISER BARS AT 36" O C MAXIMUM TO SUPPORT TOP REINFORCING STEEL.

B. IN WALLS WITH TWO CURTAINS #3 U OR Z SHAPE SPACERS AT 72" C. E. W.

C 8 BAR LAP SPLICES

THE LENGTH OF LAP SPLICES SHALL CONFORM TO SPECIFICATION ACI–318–95 FOR TENSION LAP SPLICES CONDITION AND MADE WITH THE DETAILS FOR REINFORCING STEEL SPLICE SHOWN ON THIS DWG. USE SPLICE CLASS B.

C 9 RESTRICTED BAR ANCHORAGE

IN CASES WHERE REINFORCING BARS CANNOT BE EXTENDED AS FAR AS REQUIRED DUE TO THE LIMITED EXTENT OF THE ADJACENT CONCRETE STRUCTURE, THE BARS SHALL EXTEND AS FAR AS POSSIBLE AND END IN STANDARD HOOKS.

C10 STANDARD HOOKS

BARS ENDING IN RIGHT ANGLE BENDS OR HOOKS SHALL CONFORM TO THE REQUIREMENTS OF ACI–318–95.

C11 SLOPING SLABS

MONOLITHIC SLABS WITH TOPS THAT ARE SLOPED SHALL HAVE BOTTOMS SLOPED THE SAME AMOUNT MAINTAINING A UNIFORM SLAB THICKNESS, UNLESS OTHERWISE SHOWN.

C12 GROUND SUPPORTED SLABS

CONCRETE SLAB SUPPORTED BY GROUND UNLESS OTHERWISE NOTED SHALL BE 4" THICK REINFORCED WITH 4 X 4–W35 X W3.5 WWF AT MIDDEPTH OF SLAB AND DOWELED ALONG THE EDGE OF SLAB TO ALL ADJACENT WALLS, COLUMN AND FOUNDATIONS WITH #3 @ 15" THAT LAP 12" WITH WWF AND EXTEND INTO WALLS, COLUMNS AND FOUNDATIONS AT LEAST 9". IF SLAB IS DESIGNATED AS "ISOLATED SLAB" ON DRAWINGS, OMIT DOWELS AND SUBSTITUTE 3/8" THICK PREMOLDED JOINT FILLER TO ISOLATE THE SLAB FROM CONTACT WITH THE STRUCTURE ALONG ITS PERIMETER.

C13 CHAMFERS

EXCEPT AS OTHERWISE REQUIRED, EXPOSED CONCRETE CORNERS AND EDGES SHALL HAVE 3/4" CHAMFERS. RE–ENTRANT CORNERS SHALL NOT HAVE FILLETS.

C14 ANCHOR BOLTS

USE OF ANCHOR BOLT SHALL BE GOVERNED BY THE FOLLOWING TABLE:

BOLT DIAMETER	1/2"	5/8"	3/4"	7/8"	1"	1–1/8"	1–1/4"
MIN. EMBEDMENT IN STRUCTURAL CONCRETE	4"	4"	5"	6"	7"	8"	9"
ALLOWABLE SHEAR	1000#	1500#	1780#	2075#	2075#	2250#	2650#

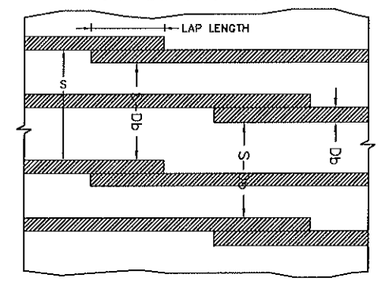
ALL BOLTS SHALL BE HOT–DIPPED GALVANIZED UNLESS OTHERWISE NOTED. EMBEDMENT LENGTH FOR BOLTS IN TENSION SHALL BE DETERMINED BY THE ENGINEER.

C15 MONOLITHIC CONSTRUCTION

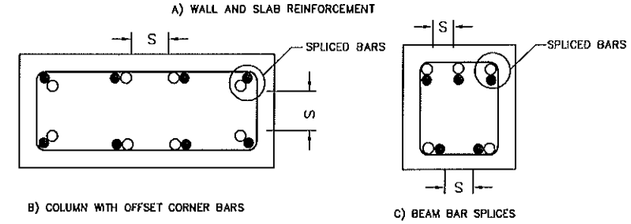
ALL BEAMS AND SLABS SHALL BE CAST MONOLITHICALLY.

C16 SHORING OF WALLS

ALL BASEMENT WALLS SHALL BE KEPT SHORED UNTIL FLOOR ABOVE THEM HAVE BEEN CAST.



A) WALL AND SLAB REINFORCEMENT



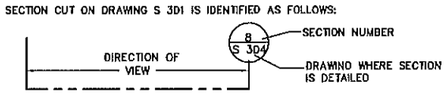
B) COLUMN WITH OFFSET CORNER BARS

C) BEAM BAR SPLICES

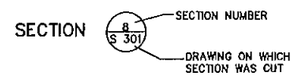
SPACING OF SPLICE BARS

CROSS REFERENCING SYSTEM

1. A SECTION CUT ON DRAWING S 301 IS IDENTIFIED AS FOLLOWS:



2. ON DRAWINGS S 304 THE SECTION IS IDENTIFIED AS FOLLOWS:



3. DETAILS ARE CROSS REFERENCED IN A MANNER SIMILAR TO THAT OF SECTIONS EXCEPT DETAILS ARE ASSIGNED LETTERS RATHER THAN NUMBERS.

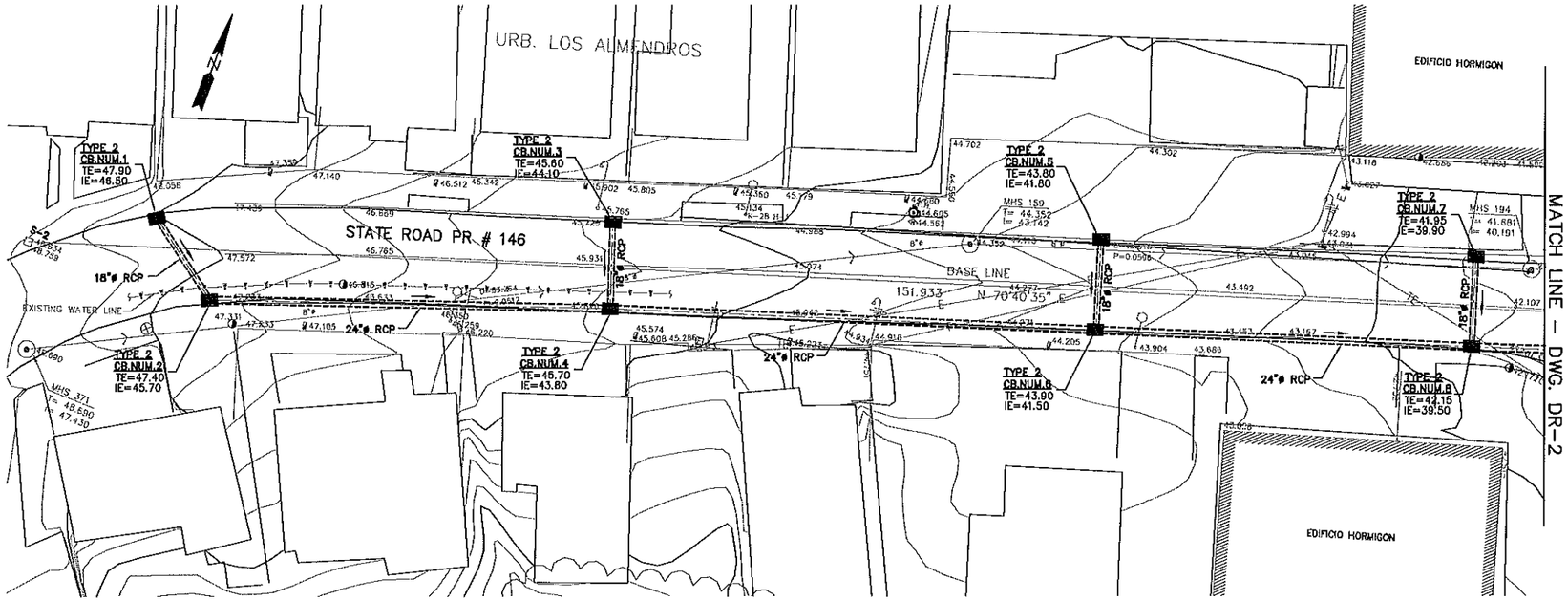
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

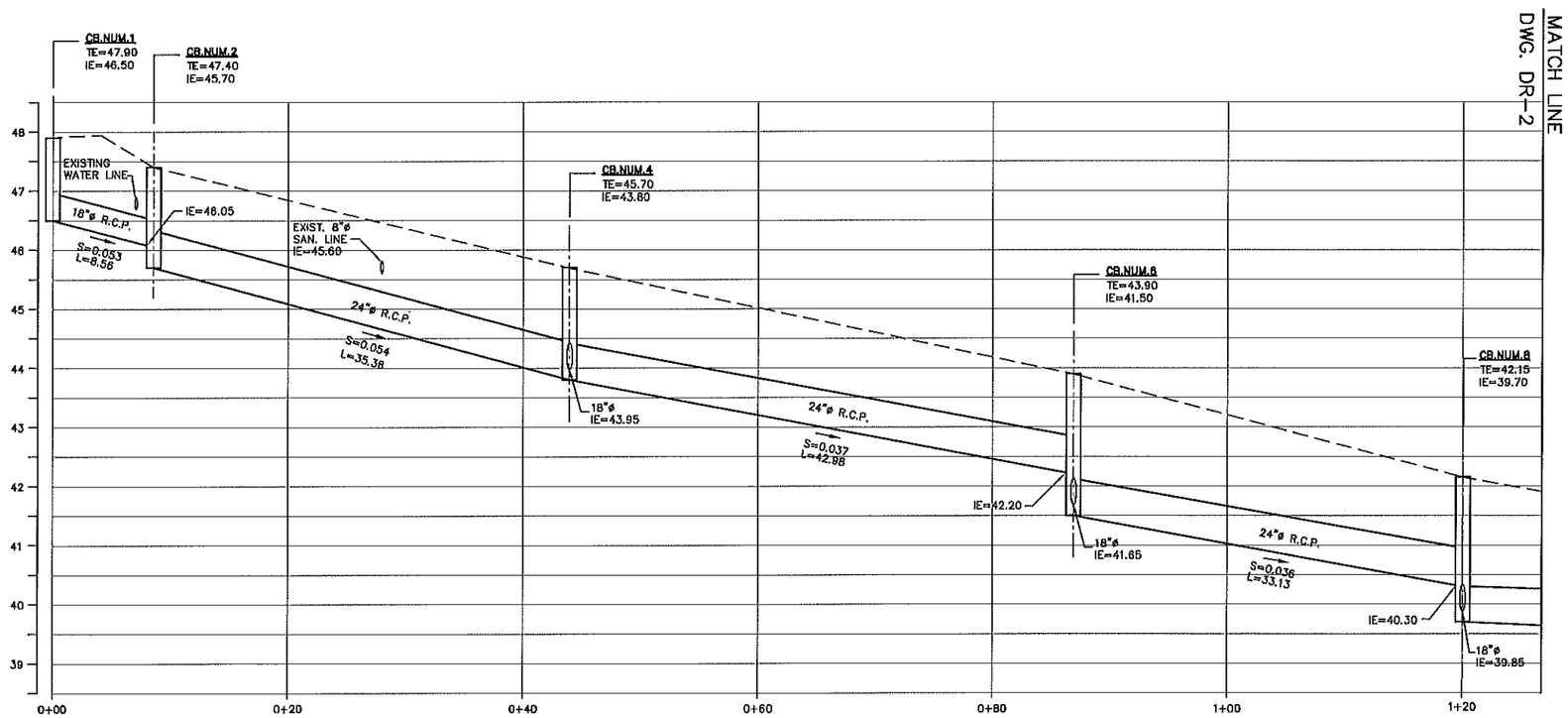
REINF. CONCRETE WALLS
STRUCTURAL NOTES

SHEET: 41
DWG: RW–15
DATE:
PROJ:

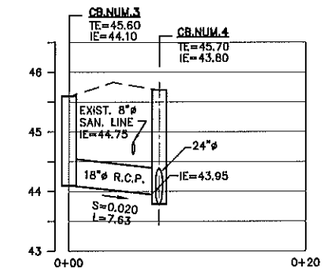
Y:\cales\Phase Complete (Aug 2012)\RW 15.dwg, 9/4/2012 3:53:08 PM, 1:2.61266



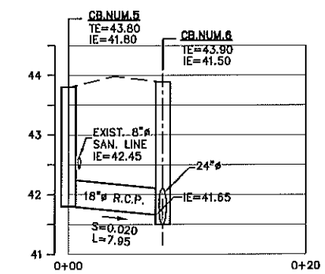
PLAN



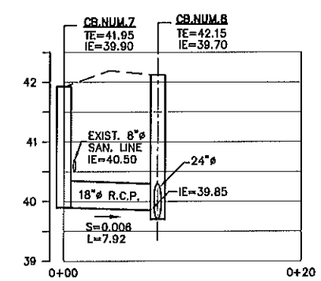
PROFILE FROM CB.#1 TO CB.#8



PROFILE
FROM CB.#3 TO CB.#4



PROFILE
FROM CB.#5 TO CB.#6



PROFILE
FROM CB.#7 TO CB.#8

NOTES:
1. SEE DRAWING DR-2 FOR CATCH BASIN DETAILS, TRENCH EXCAVATION AND BACKFILL DETAILS ARE SHOWN ON DWG. DR-05.
2. ALL REINFORCED CONCRETE PIPES SHALL BE CLASS III.

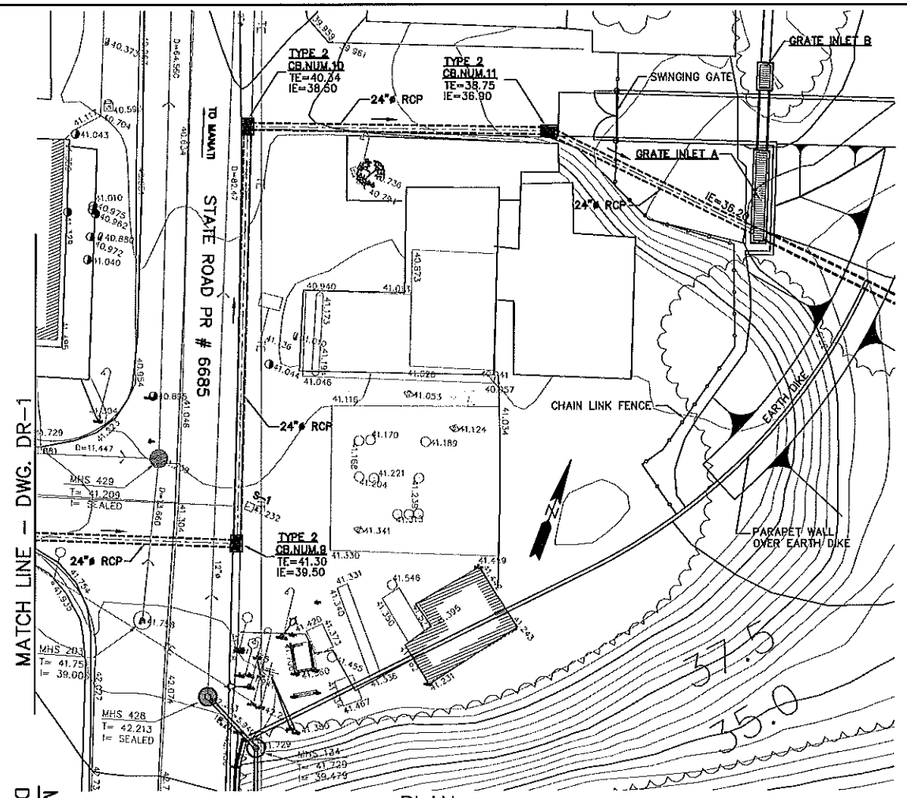
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						H=1:250 V=1:50	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

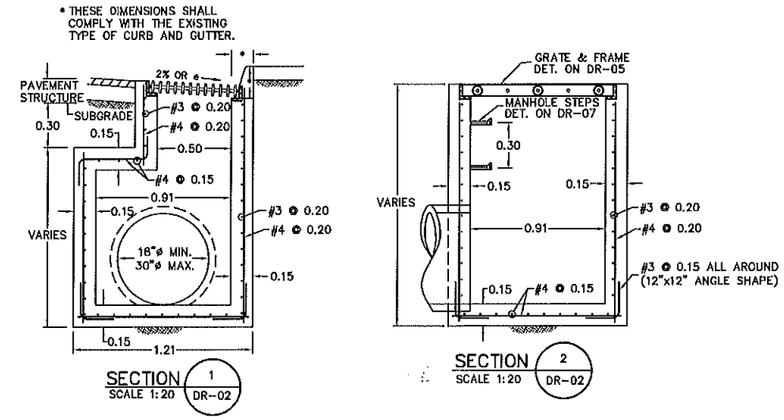
PLAN AND PROFILE
STORM SEWER SYSTEM
AT ROAD PR-146

SHEET: 42
DWG: DR-01
DATE:
PROJ:

Y:\Cciales\Phase Completo (Aug 2012)\DR 01 to DR 02.dwg, 9/7/2012 1:35:31 PM, 1:25.4546

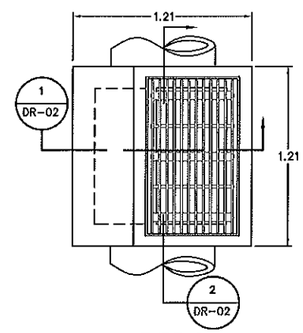


PLAN

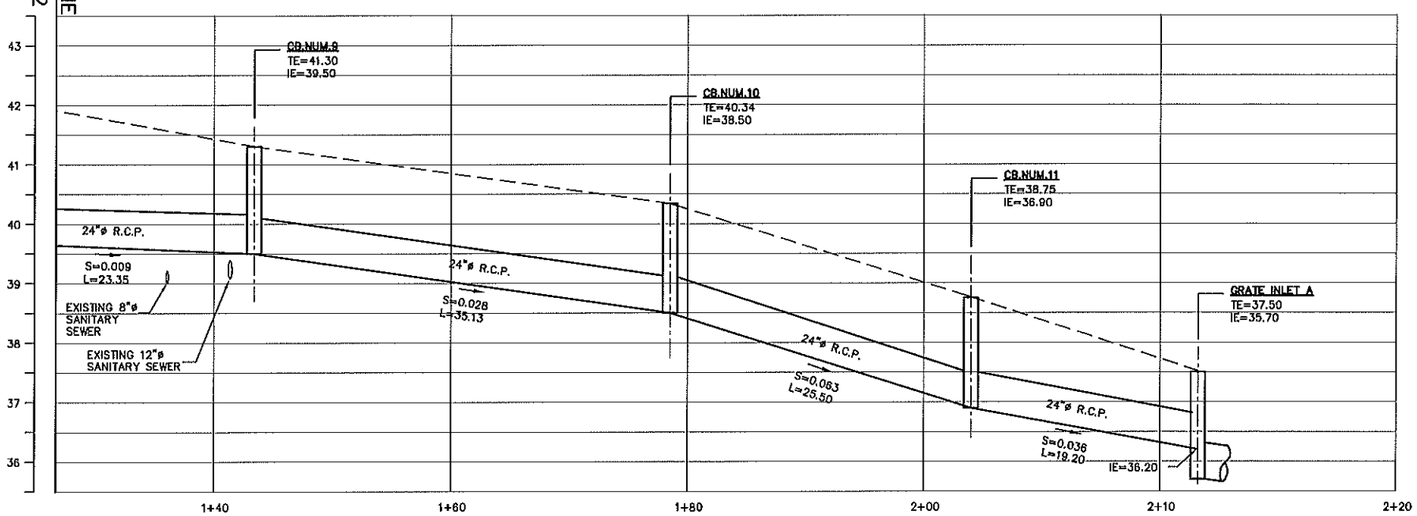


SECTION 1 / DR-02
SCALE 1:20

SECTION 2 / DR-02
SCALE 1:20



TYPE 2
CATCH BASIN PLAN
SCALE 1:20



PROFILE FROM CB.#9 TO GRATE INLET

STRUCTURE	NORTHING	EASTING	BEARING	DISTANCE
CB.NUM.1	56597.33	148302.24	S 55°00'11" E	8.56
CB.NUM.2	56592.42	148309.25	N 69°16'16" E	35.38
CB.NUM.4	56604.92	148342.35	N 70°32'51" E	42.98
CB.NUM.6	56619.24	148382.88	N 70°34'27" E	33.13
CB.NUM.8	56630.26	148414.12	N 70°05'35" E	23.35
CB.NUM.9	56638.21	148436.08	N 20°41'05" W	35.13
CB.NUM.10	56671.07	148423.67	N 68°54'33" E	25.50
CB.NUM.11	56680.25	148447.46	S 85°04'59" E	19.20
GRATE INLET	56678.94	148466.62		
CB.NUM.3	56612.07	148339.67	S 20°35'13" E	7.63
CB.NUM.4	56604.92	148342.35		
CB.NUM.5	56626.77	148380.30	S 18°54'08" E	7.96
CB.NUM.6	56619.24	148382.88		
CB.NUM.7	56637.73	148411.49	S 19°23'34" E	7.92
CB.NUM.8	56630.26	148414.12		

DRAINAGE STRUCTURES
HORIZONTAL CONTROL

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
H=1:250
V=1:50

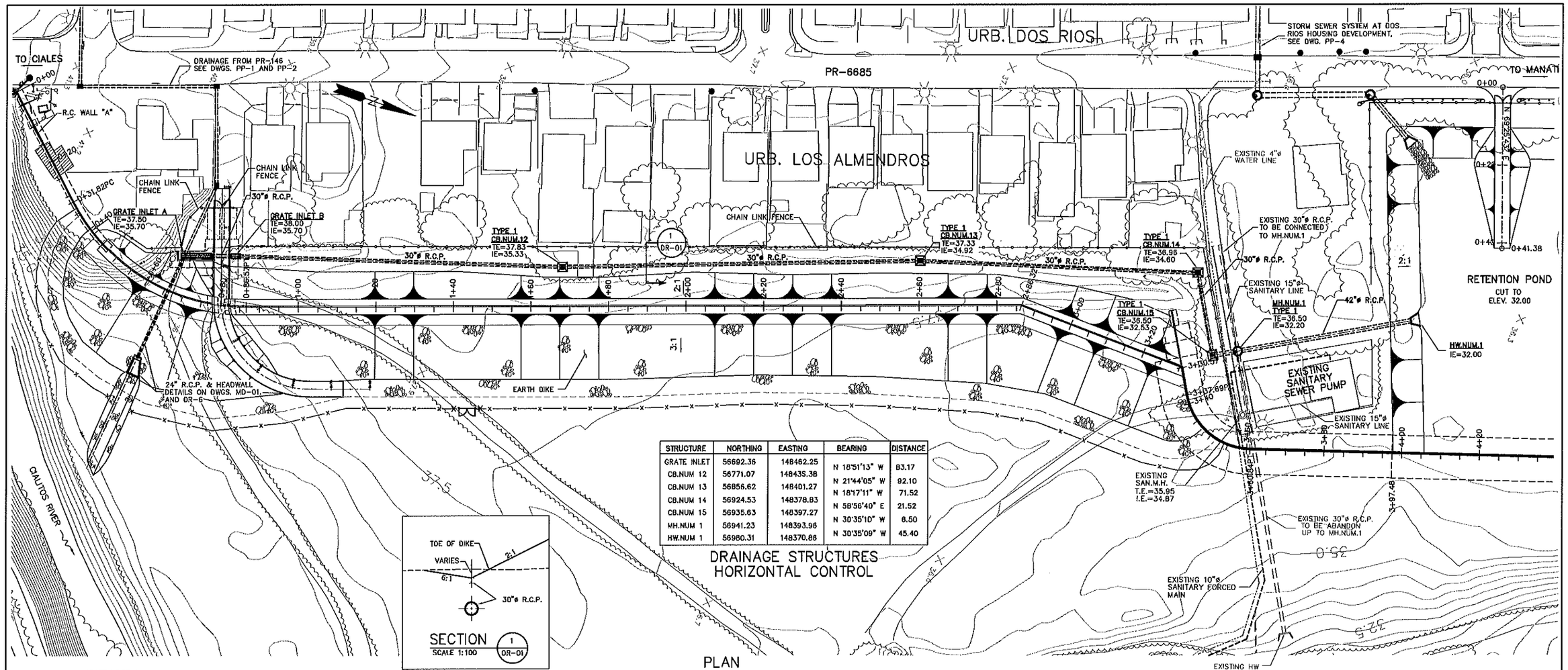
DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

PLAN AND PROFILE
STORM SEWER SYSTEM
AT ROAD PR-6685

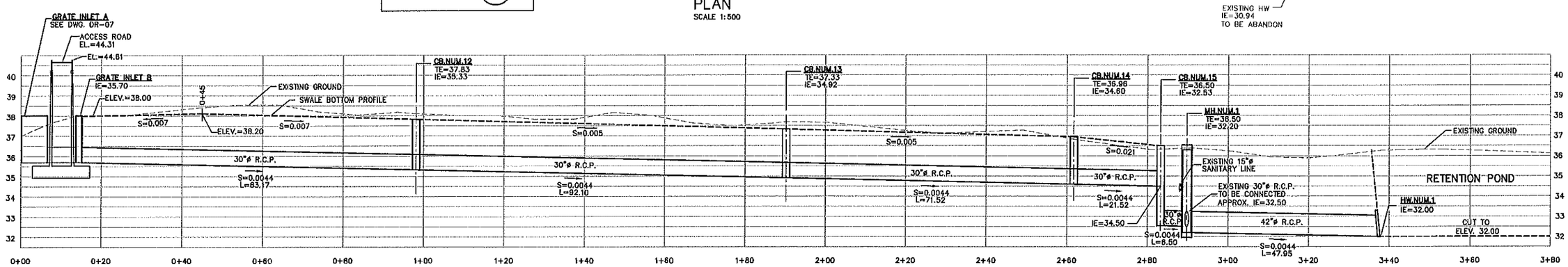
SHEET: 43
DWG: DR-02
DATE:
PROJ:

Y:\clients\Phase Completa (Aug 2012)\DR 01 to DR 02.dwg, 9/5/2012 3:46:25 PM, 1:25.5145



STRUCTURE	NORTHING	EASTING	BEARING	DISTANCE
GRATE INLET	56692.36	148462.25	N 18°51'13" W	83.17
CB.NUM 12	56771.07	148435.38	N 21°44'05" W	92.10
CB.NUM 13	56856.62	148401.27	N 18°17'11" W	71.52
CB.NUM 14	56924.53	148378.83	N 58°56'40" E	21.52
CB.NUM 15	56935.63	148397.27	N 30°35'10" W	6.50
MH.NUM 1	56941.23	148393.96	N 30°35'09" W	45.40
HW.NUM 1	56980.31	148370.66		

DRAINAGE STRUCTURES HORIZONTAL CONTROL



PROFILE
SCALE: H=1:500
V=1:100

NOTES:

1. SEE DRAWING DR-05 FOR CATCH BASIN TYPE 1, TRENCH EXCAVATION AND BACKFILL DETAILS.
2. ALL REINFORCED CONCRETE PIPES SHALL BE CLASS III.

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE

AS SHOWN

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES

FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

QDSA

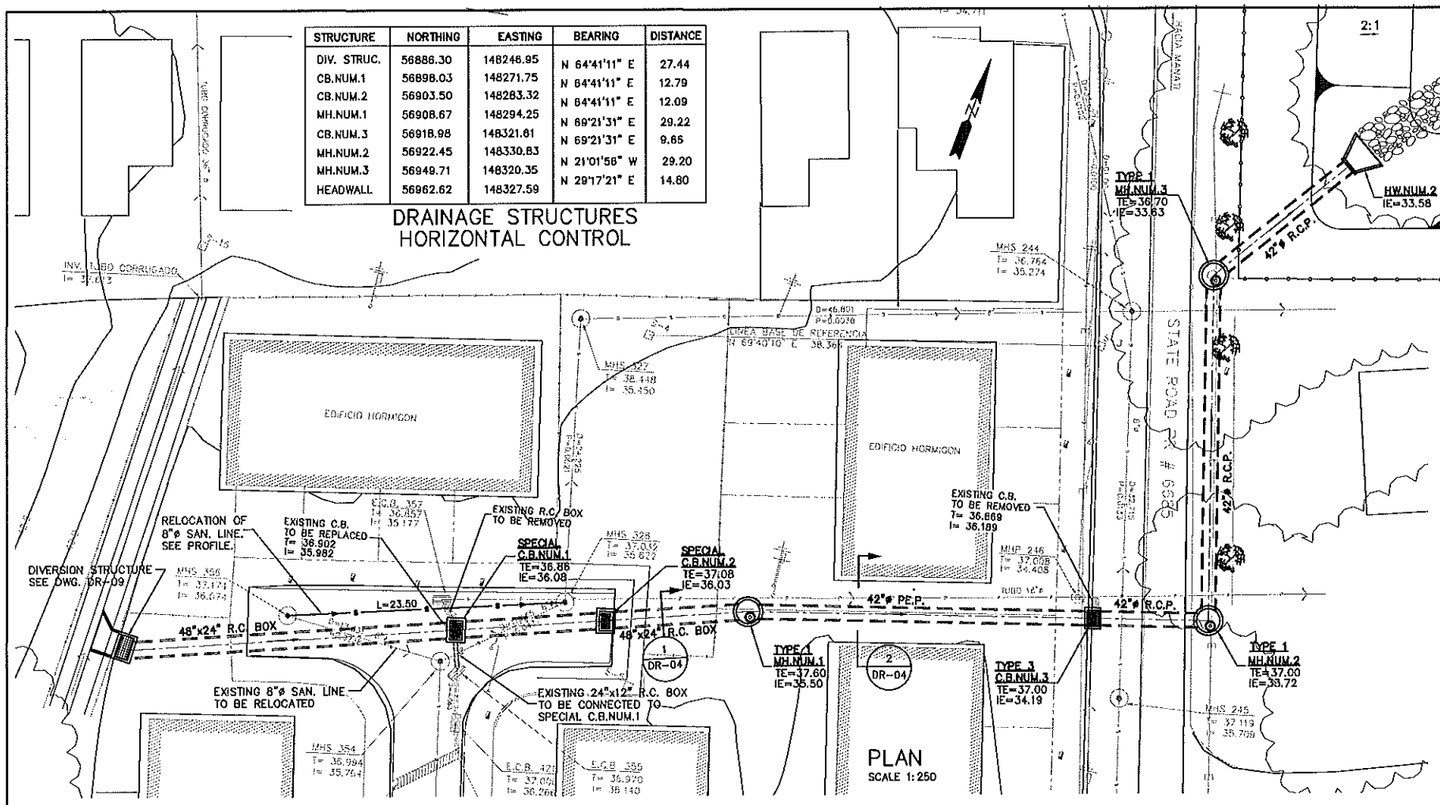
PLAN AND PROFILE
STORM SEWER SYSTEM
ALONG WEST SIDE OF DIKE

SHEET: 44
DWG: DR-03
DATE:
PROJ:

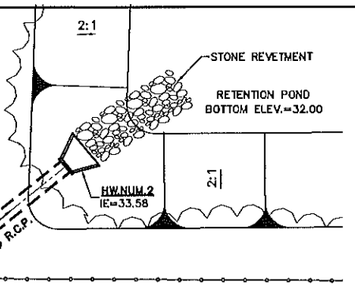
Y:\cciales\Phase Complete (Aug 2012)\DR 03.dwg, 9/5/2012 3:45:29 PM, 1:26.1117

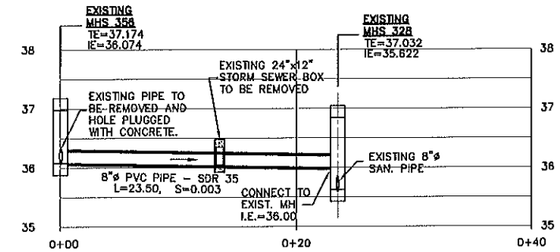
STRUCTURE	NORTHING	EASTING	BEARING	DISTANCE
DIV. STRUC.	56888.30	148246.95	N 64°41'11" E	27.44
CB.NUM.1	56898.03	148271.75	N 64°41'11" E	12.79
CB.NUM.2	56903.50	148283.32	N 64°41'11" E	12.09
MH.NUM.1	56908.67	148294.25	N 69°21'31" E	29.22
CB.NUM.3	56918.98	148321.61	N 69°21'31" E	9.65
MH.NUM.2	56922.45	148330.83	N 21°01'56" W	29.20
MH.NUM.3	56949.71	148320.35	N 29°17'21" E	14.80
HEADWALL	56962.62	148327.59		

DRAINAGE STRUCTURES
HORIZONTAL CONTROL



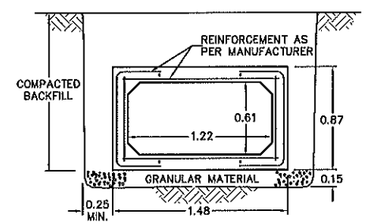
PLAN
SCALE 1:250



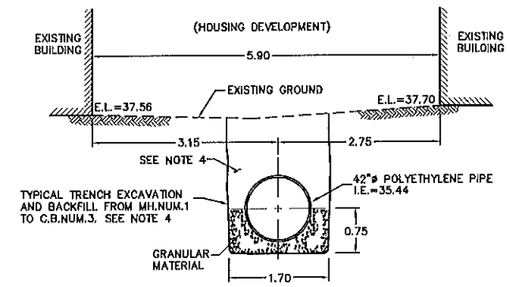


SANITARY PIPE PROFILE
SCALE: H=1:250
V=1:50

NOTE: EXISTING SANITARY SEWER CONNECTIONS IN THE REMOVED PIPE SHALL BE REINSTALLED IN THE RELOCATED PIPE. SEE SANITARY CONNECTION ON DETAIL (A/DR-04).



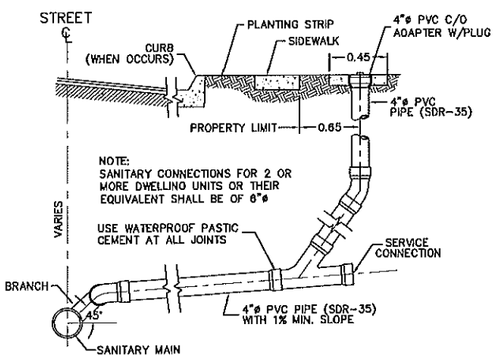
PRECAST BOX CULVERT
SECTION 1 DR-04
SCALE 1:50



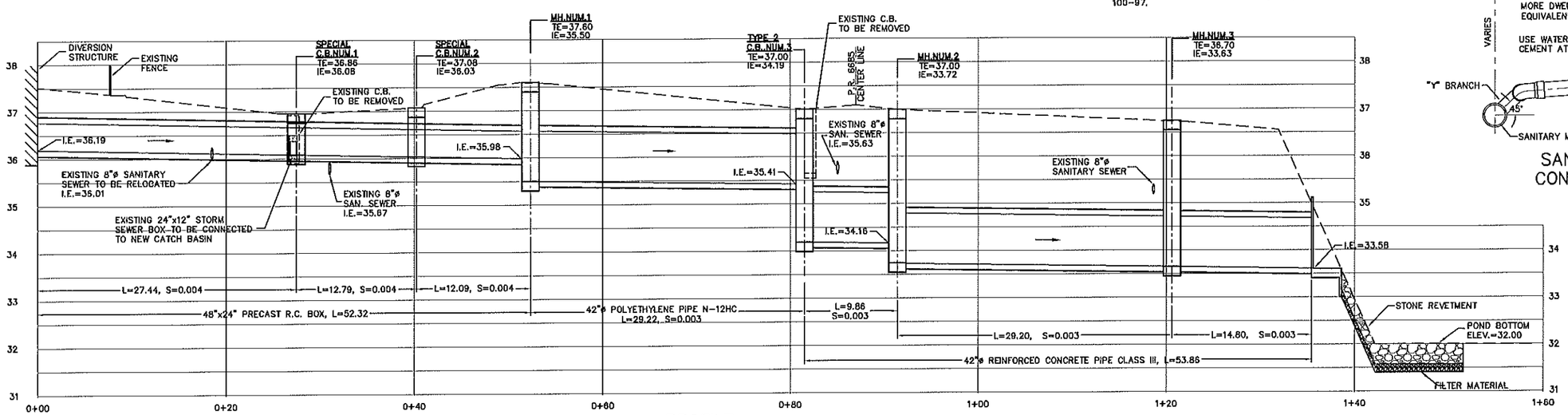
SECTION 2 DR-04
SCALE 1:100

NOTES:

1. SEE DRAWING DR-5 FOR CATCH BASINS TYPE 3, TRENCH EXCAVATION AND BACKFILL DETAILS. MANHOLES DETAILS ARE SHOWN ON DWG. DR-8.
2. DETAILS FOR SPECIAL CATCH BASINS ARE SHOWN ON DWG. DR-9.
3. ALL REINFORCED CONCRETE PIPES SHALL BE CLASS III.
4. REFER TO TYPICAL PIPE TRENCH DETAIL, GENERAL EXCAVATION AND BEDDING NOTES ON DWG. DR-05.
5. POLYETHYLENE PIPE SHALL COMPLY WITH THE CORRUGATED POLYETHYLENE PIPE ASSOCIATION (CPPA) STANDARD SPECIFICATION 100-97.



SANITARY SERVICE CONNECTION DETAIL A DR-04
NOT TO SCALE



PROFILE
SCALE: H=1:250
V=1:50

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

PLAN AND PROFILE
STORM SEWER SYSTEM
AT DOS RIOS HOUSING DEVELOPMENT

SHEET: 45
DWG: DR-04
DATE:
PROJ:

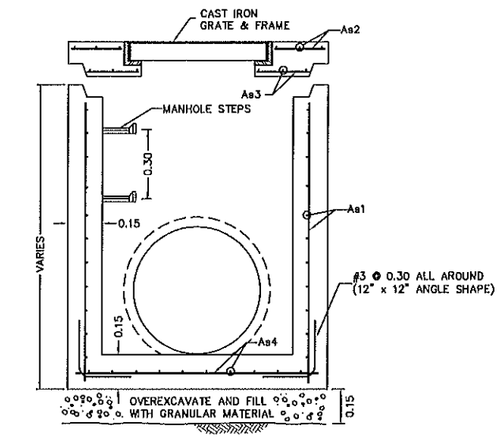
Y:\cIales\Phase Complete (Aug 2012)\DR 04.dwg, 8/4/2012 4:15:34 PM, 1:25.6375

GENERAL NOTES FOR "TYPE 1" PRECAST CATCH BASIN

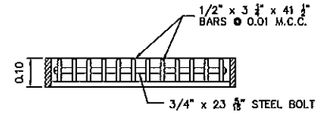
1. STANDARD SIZES REFER TO INTERNAL DIMENSIONS.
2. ALL TOP SLABS 6" THICK.
3. WALL THICKNESS AND BOTTOM SLABS FOR ALL SIZES SHALL BE SIX INCHES.
4. MAXIMUM ALLOWABLE TOTAL DEPTH = 12 FEET.

TABLE "A"

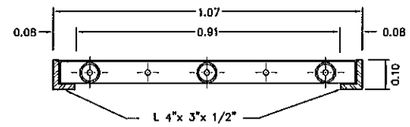
STANDARD SIZES	As1	As2	As3	As4	CONCRETE F'c @ 28 DAYS	MAX. PIPE DIAM.
3'x4'	0.15	0.12	0.30	0.30	4,000 psi	24"
4'x5'	0.18	0.12	0.36	0.36	4,500 psi	36"



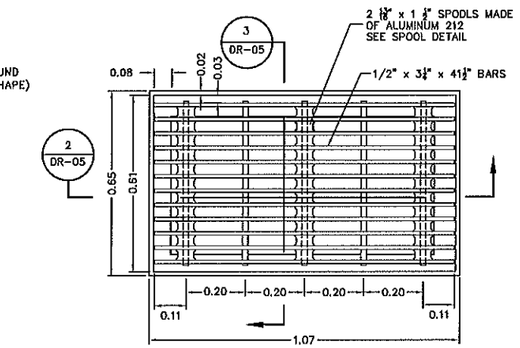
SECTION 1 / DR-05
NOT TO SCALE



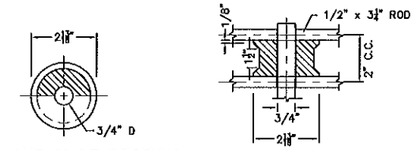
SECTION 3 / DR-05
SCALE 1:10



SECTION 2 / DR-05
SCALE 1:10

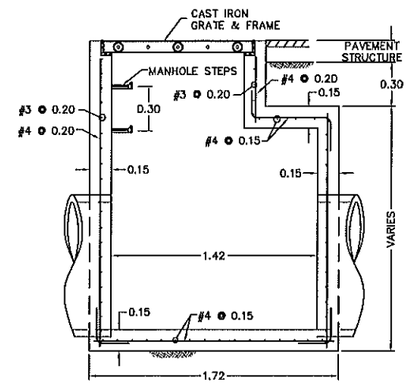


CAST IRON GRATING & FRAME
SCALE 1:10

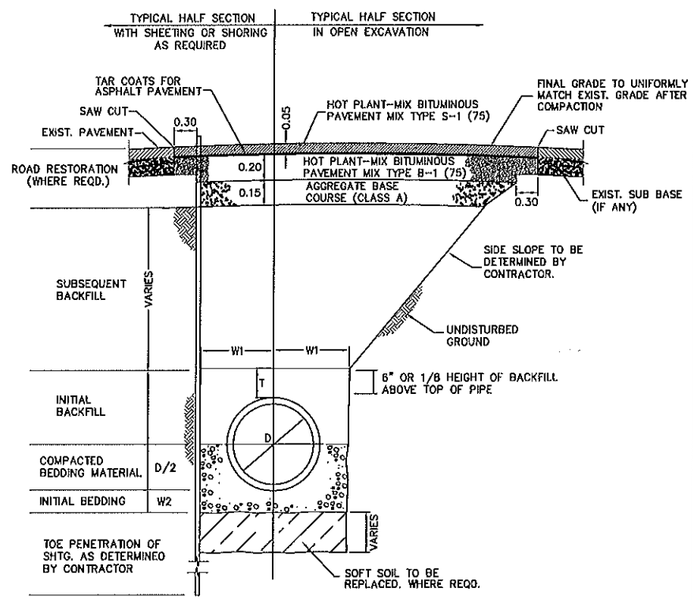


HALF AND HALF SECTION SPOOLS SECTION

SPOOL DETAIL
NOT TO SCALE



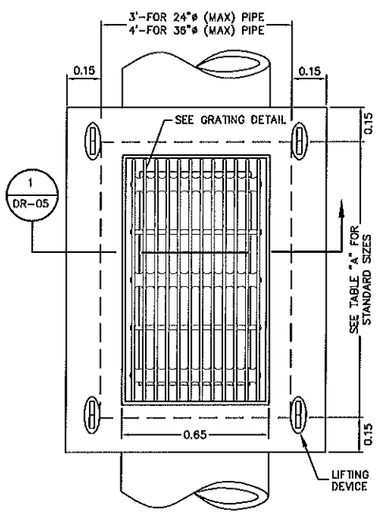
SECTION 4 / DR-05
SCALE 1:20



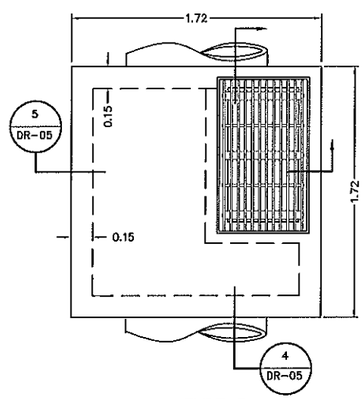
NOTES :
1. MINIMUN W1 DIMENSION 0.70 D + 4"
2. MAXIMUM W1 DIMENSION 18" + D/2
3. MINIMUM W2 DIMENSION 6" FOR CLASS B BEDDING.
4. MINIMUM T = 8"

T= HEIGHT OF COMPACTED BACKFILL ABOVE TOP OF PIPE. MATERIAL MAY BE THE SAME EXCAVATED MATERIAL EXCEPT VERY SOFT ORGANIC CLAYS AND PEAT. USE TAMPER, VERIFY WITH PIPE MANUFACTURER.

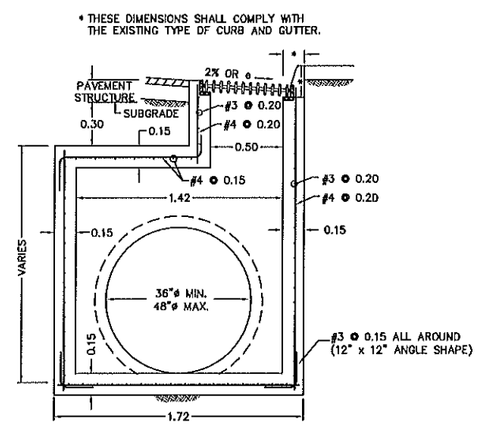
TYPICAL PIPE TRENCH DETAIL
NOT TO SCALE



TYPE 1
PRECAST CATCH BASIN PLAN
NOT TO SCALE



TYPE 3
CATCH BASIN PLAN
SCALE 1:20



SECTION 5 / DR-05
SCALE 1:20

GENERAL EXCAVATION NOTES

1 – THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SAFETY, INTEGRITY, AND STABILITY OF PEOPLE, BUILDINGS, EMBANKMENTS, EXISTING PIPE LINES, OR ANY OTHER STRUCTURES IN THE VICINITY OF EXCAVATIONS OR ANY OTHER CONSTRUCTION OPERATION. WHERE NECESSARY SHEET PILING, FENCING, OR ANY OTHER DEVICE TO INSURE THE PROTECTION OF SUCH PEOPLE OR STRUCTURES SHALL BE INSTALLED.

2 – OPEN TRENCH: SLOPE TO BE DETERMINED BY CONTRACTOR.

3 – TRENCH PROTECTION: TO BE DETERMINED BY CONTRACTOR TO ENSURE PROTECTION OF ADJACENT STRUCTURES, TRENCH WALLS, AND WORKING CREWS INSIDE AND OUTSIDE OF TRENCH.

4 – EXISTING FENCES AND GATES TO REMAIN SHALL BE LEFT IN A CONDITION EQUAL TO OR BETTER THAN FOUND.

5 – ALL EXCAVATION SHALL BE OPEN CUT FROM THE SURFACE. NO TUNNELING SHALL BE ALLOWED EXCEPT WHERE SPECIFICALLY SHOWN, OR PERMITTED IN WRITTING BY THE ENGINEER.

BEDDING NOTES:

1 – INITIAL BEDDING MATERIAL SHALL BE OF GRANULAR MATERIAL THAT IS FREE FLOWING, SUCH AS SAND OR HYDRAULICALLY GRADED CRUSHED STONE FINES, OR MIXED SAND AND GRAVEL, OR SANDY LOAM. MATERIAL SHALL BE FREE FROM LUMPS, STONES OVER TWO INCHES IN DIAMETER, CLAY, AND ORGANIC MATTER.

2 – COMPACTED BEDDING SHALL BE OF SELECT FILL MATERIALS SUCH AS GRAVEL, FINE ROCK CUTTINGS, SAND, SANDY LOAM, OR LOAM FREE FROM EXCESSIVE CLAY. ROCK CUTTINGS SHALL HAVE NO DIMENSION GREATER THAN TWO INCHES. SELECT FILL MATERIAL SHALL CLASSIFY AS A1 OR A3 AND HAVE A PLASTIC LIMIT RANGE FROM 4 TO 12.

3 – INITIAL BACKFILL SHALL BE NATURAL SAND, MEETING ASTM C33. PLACE SAND AROUND PIPE IN 0.15M LAYERS AND THOROUGHLY HAND TAMP. ASSURE THAT ALL VOIDS ARE FILLED BY "WALKING IN" AND SLICING WITH A SHOVEL TO PIPE SPRING-LINE.

4 – SUBSEQUENT BACKFILL SHALL CLASSIFY AS A-2-4 OR BETTER. THESE MATERIALS SHOULD NOT CONTAIN VEGETATIVE OR ORGANIC MATER OR ROCKS LARGER THAN 3 INCHES. BACKFILL SHOULD BE PLACED IN LOOSE LIFTS NO GREATER THAN 8 INCHES.

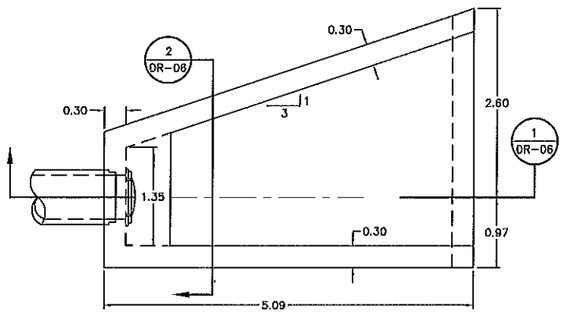
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

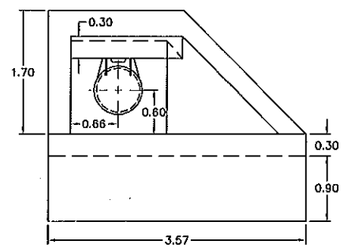
CATCH BASIN AND PIPE TRENCH DETAILS

SHEET: 46
DWG: DR-05
DATE:
PROJ:

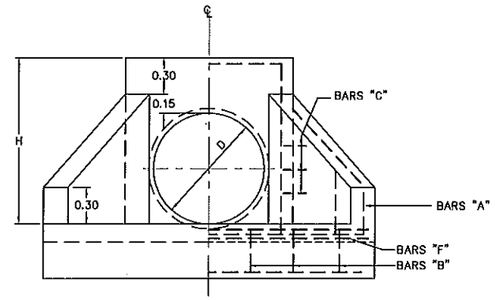
Y:\Cieles\Phase Completo (Aug 2012)\DR 05.dwg, 9/4/2012 4:16:49 PM, 1:0.65017:



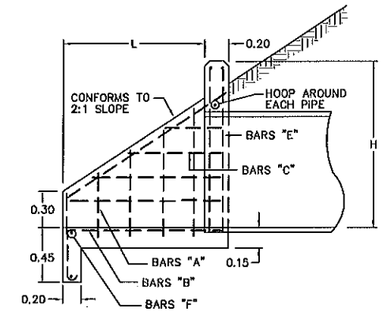
PLAN
SCALE 1:40



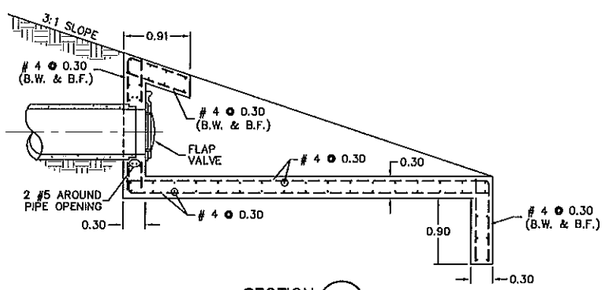
ELEVATION
SCALE 1:40



ELEVATION

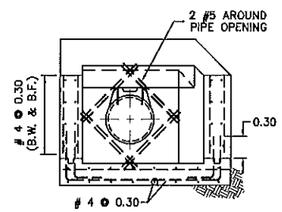


TYPICAL WING ELEVATION
NOT TO SCALE

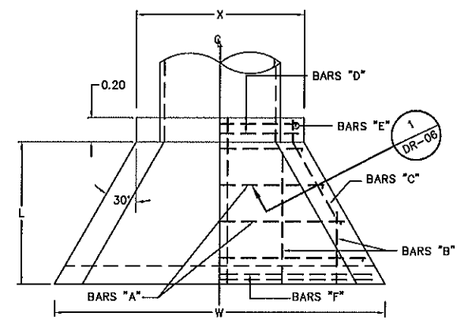


SECTION 1 DR-06
SCALE 1:40

24"ø RC PIPE AT STATION 0+65.69
HEADWALL DETAILS

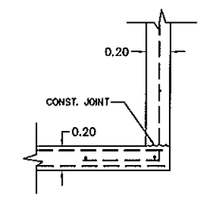


SECTION 2 DR-06
SCALE 1:40

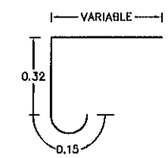


PLAN

HEADWALL DETAILS
NOT TO SCALE

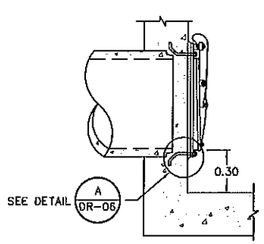


SECTION 1 DR-06
NOT TO SCALE

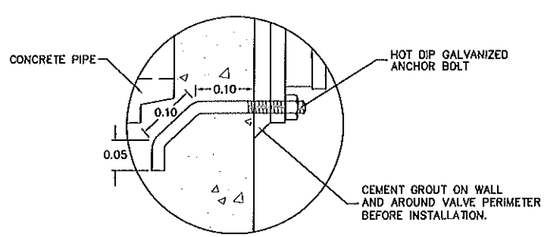


BAR "B" DETAIL

STANDARD HEADWALL DETAILS



FLAP VALVE
INSTALLATION DETAIL
SCALE 1:20



DETAIL A DR-06
SCALE 1:5

PIPE DIA.	TABLE OF DIMENSIONS					REINFORCING STEEL					
	W	X	H	L	G	BARS "A"	BARS "B"	BARS "C"	BARS "D"	BARS "E"	BARS "F"
42"	3.18	1.54	1.52	1.83	–	3/8" DIA. @ 0.30 M. O.C.	5/8" DIA. @ 0.45 M. O.C.	3/8" DIA. @ 0.30 M. O.C.	3/8" DIA.	5/8" DIA.	3/8" DIA.

NOTES:

1. STRUCTURE DIMENTIONS TO BE ADJUSTED IN THE FIELD IF NECESARY.
2. THE CONTRACTOR SHALL ADJUST THE GRADING WHEN SLOPES ARE DIFFERENT TO THE SLOPES SHOWN IN THIS PLAN.
3. PROVIDE 0.075mm COVER FOR ALL REINFORCEMENT.
4. UNLESS OTHERWISE INDICATED ALL DIMENSIONS ARE IN METERS.

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
AS SHOWN

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

HEADWALL DETAILS

SHEET: 47
DWG: DR-06
DATE:
PROJ:

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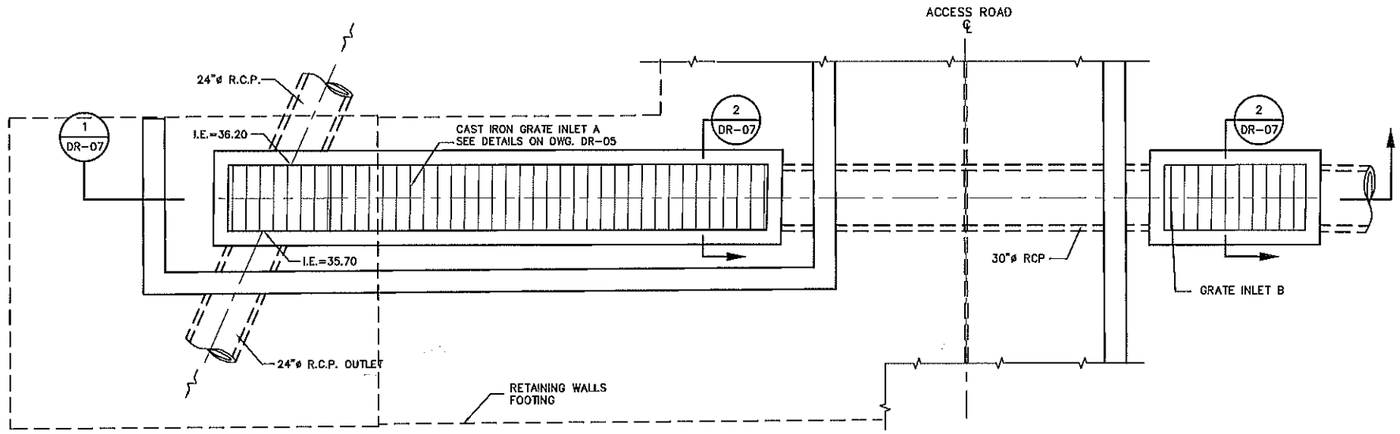
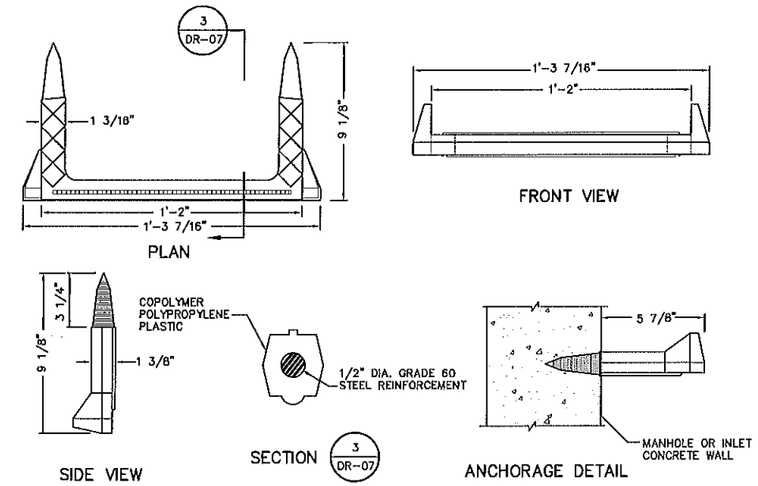
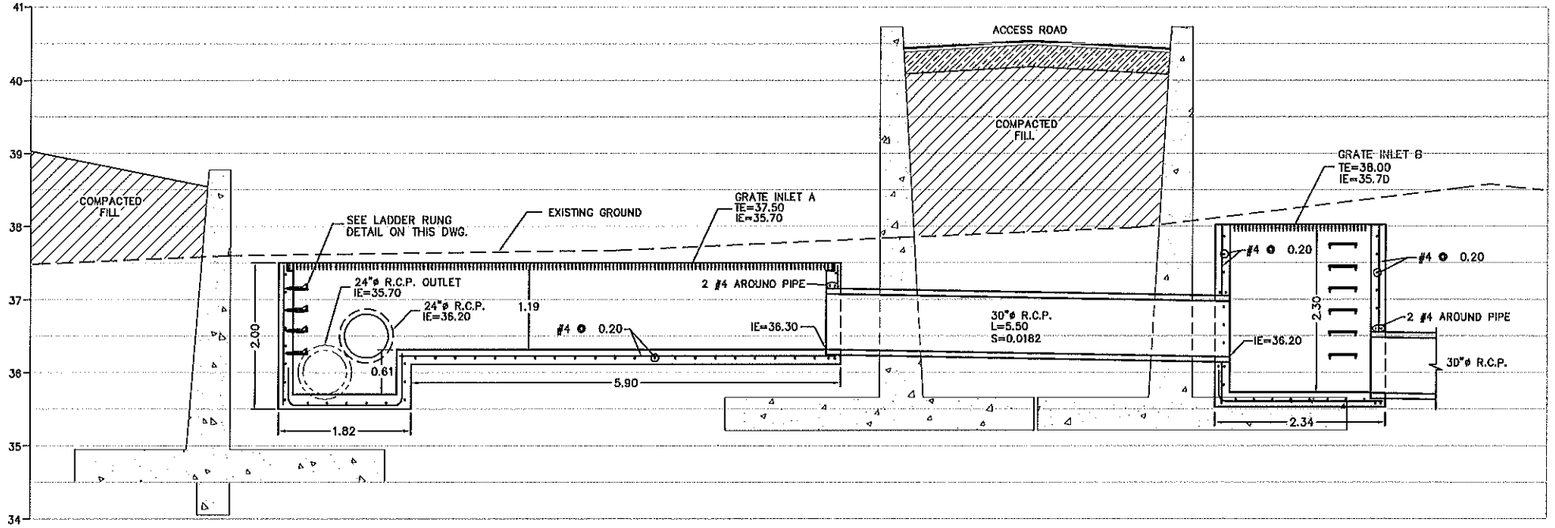


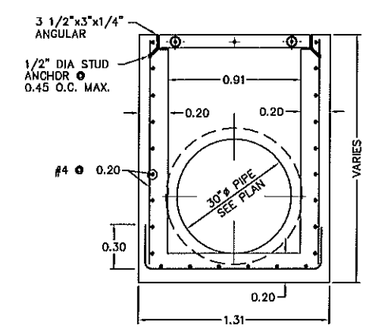
CROSS GRATE PLAN
SCALE 1:40



DETAIL OF LADDER RUNG
AND ANCHORAGE SYSTEM
NOT TO SCALE



SECTION 1 DR-07
SCALE 1:40



SECTION 2 DR-07
SCALE 1:20

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

CROSS GRATE DETAILS
PLAN AND PROFILE

SHEET: 48
DWG: DR-07
DATE:
PROJ:

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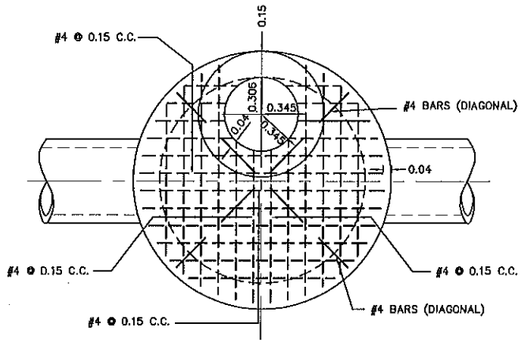
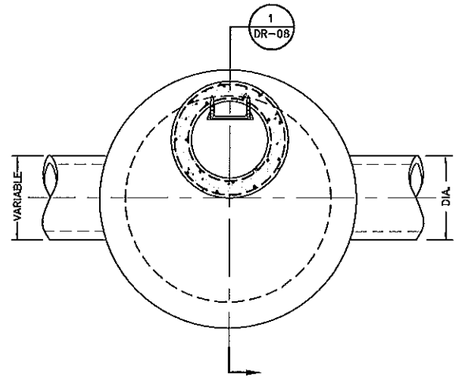
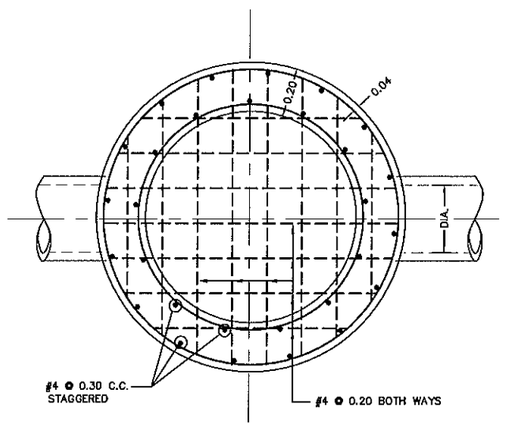


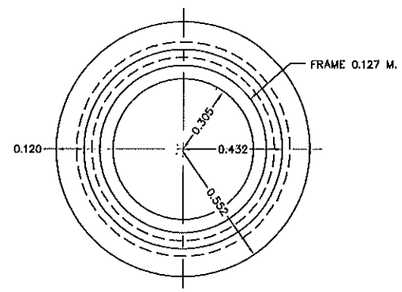
REINFORCEMENT FOR TOP SLAB
NOT TO SCALE



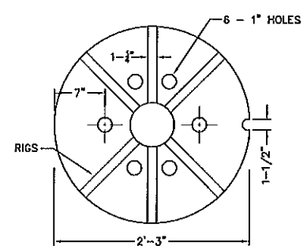
PLAN SHOWING REINFORCEMENT FOR SHAFT
NOT TO SCALE



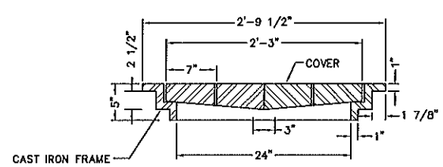
REINFORCEMENT FOR BOTTOM SLAB
NOT TO SCALE



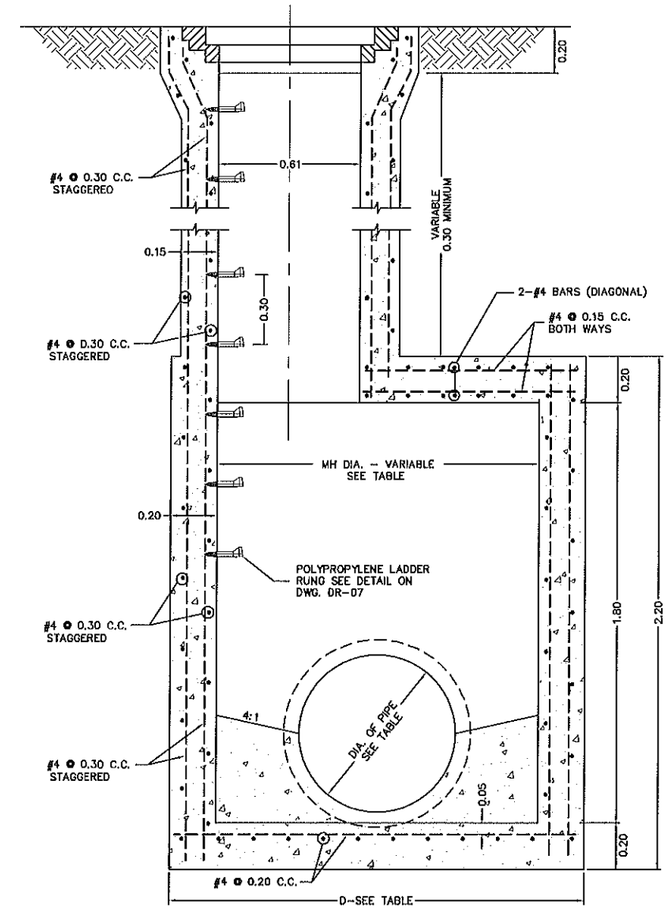
MANHOLE COVER
NOT TO SCALE



PLAN OF MANHOLE COVER
NOT TO SCALE



SECTION OF MANHOLE COVER & FRAME
NOT TO SCALE



SECTION 1 DR-08
NOT TO SCALE

NOTE:

MANHOLE TYPE INDICATED IN PLANS INDICATES MANHOLE DIAMETER TO BE USED REGARDLESS OF PIPE SIZE, BUT SHALL NOT BE LESS THAN THAT INDICATED IN TABLE FOR CORRESPONDING PIPE DIAM.

MAXIMUM SEWERS FOR MANHOLES		
TYPE	MANHOLE DIAM. (METERS)	MAX. PIPE DIAM. (INCHES)
1	2.00	48"

DSGN:					VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:					AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

STORM SEWER MANHOLE DETAILS

SHEET: 49
DWG: DR-08
DATE:
PROJ:

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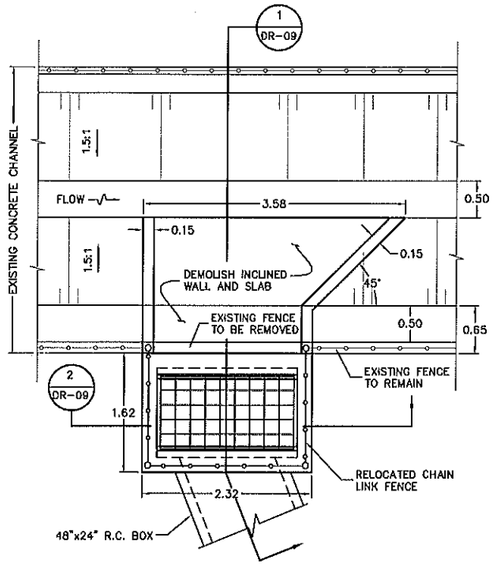
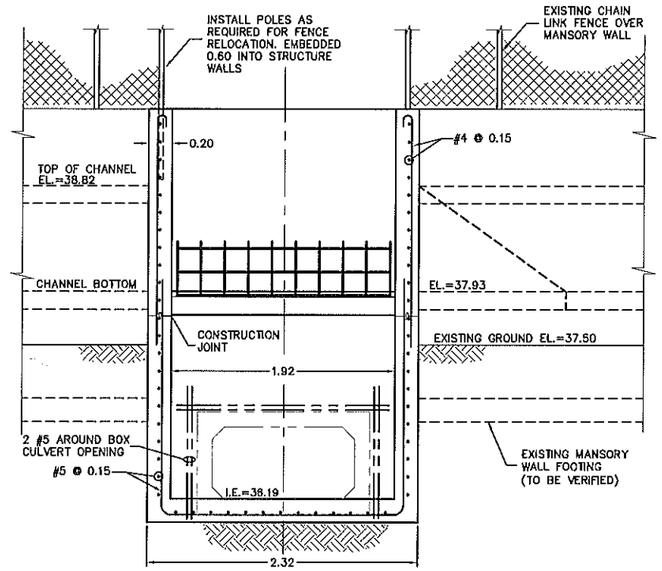
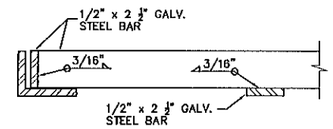


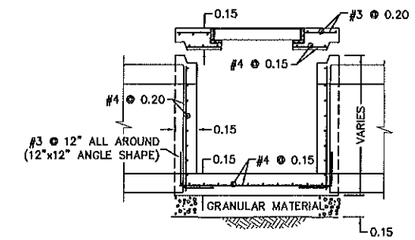
DIVERSION STRUCTURE PLAN
SCALE 1:40



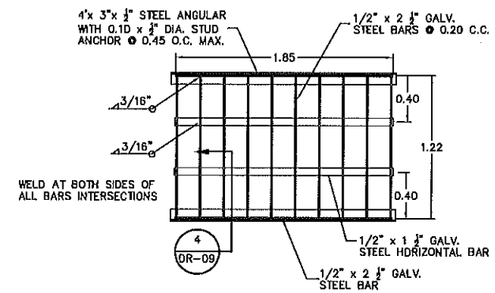
SECTION 2 DR-09
SCALE 1:25



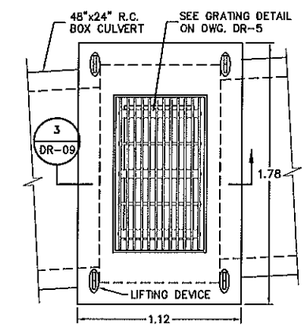
SECTION 4 DR-09
SCALE 1:5



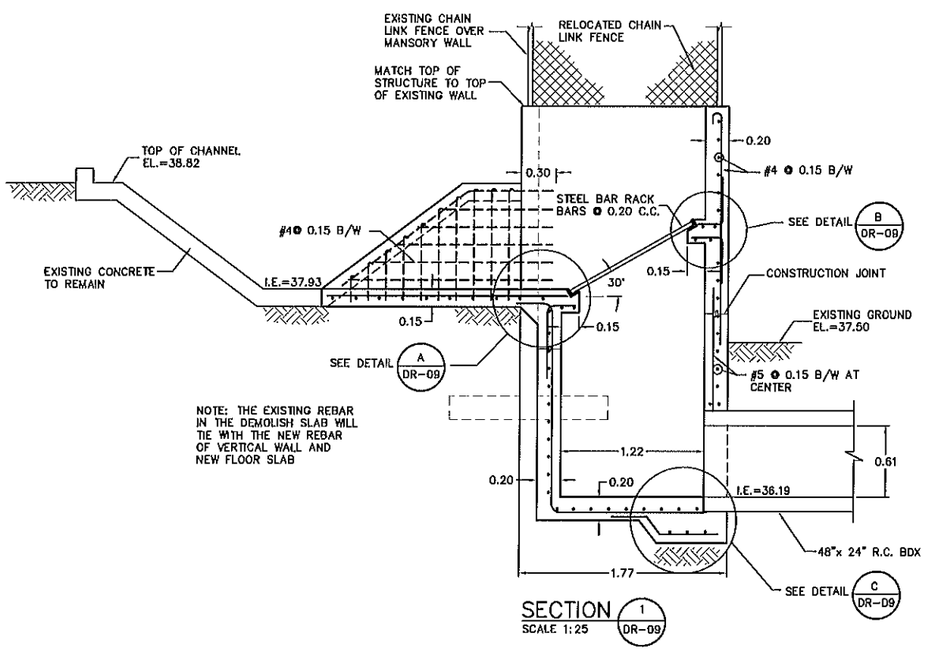
SECTION 3 DR-09
SCALE 1:20



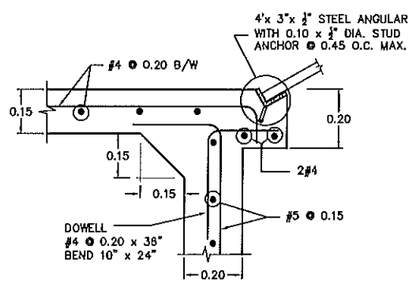
STEEL BAR RACK
SCALE 1:25



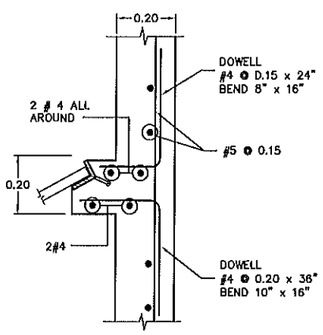
SPECIAL CATCH BASIN PLAN
SCALE 1:20



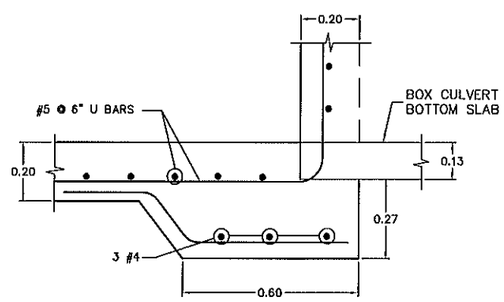
SECTION 1 DR-09
SCALE 1:25



DETAIL A DR-09
SCALE 1:10



DETAIL B DR-09
SCALE 1:10



DETAIL C DR-09
SCALE 1:10

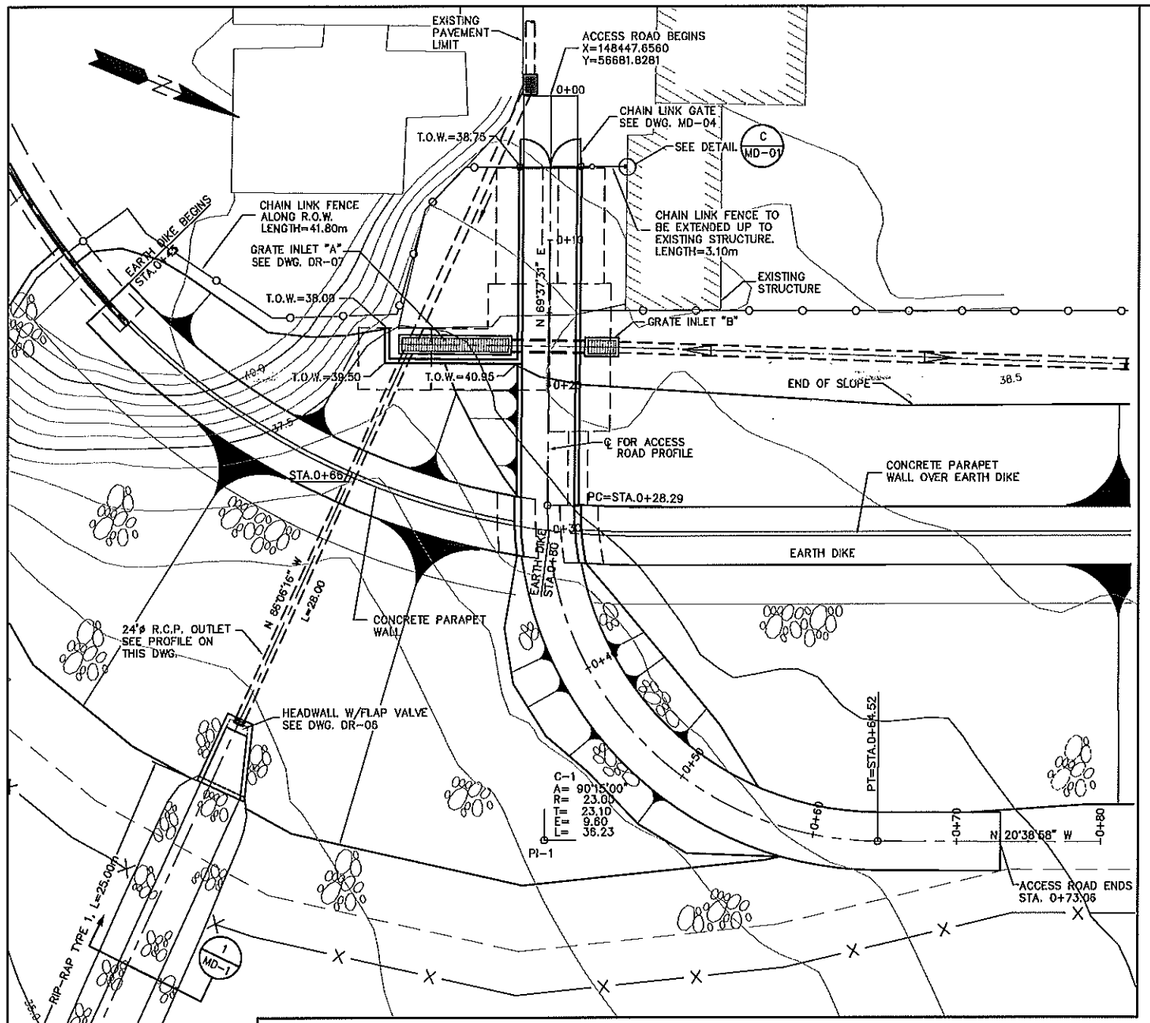
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

STORM SEWER SYSTEM
DIVERSION STRUCTURE DETAILS

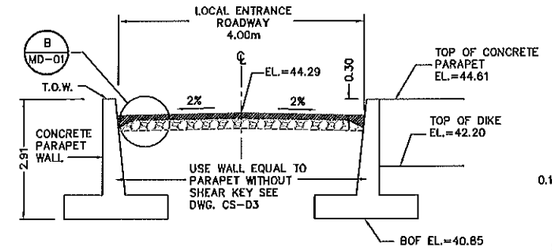
SHEET: 50
DWG: DR-09
DATE:
PROJ:

Y:\Cciales\Phase Complete (Aug 2012)\DR 09.dwg, 9/4/2012 4:23:38 PM, 1:2.06449



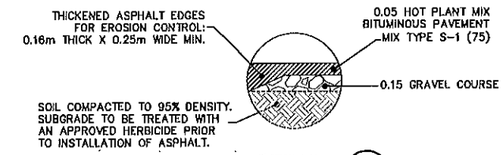
DETAIL A G-02
SCALE 1:200

ACCESS ROAD AND RELATED WORK PLAN

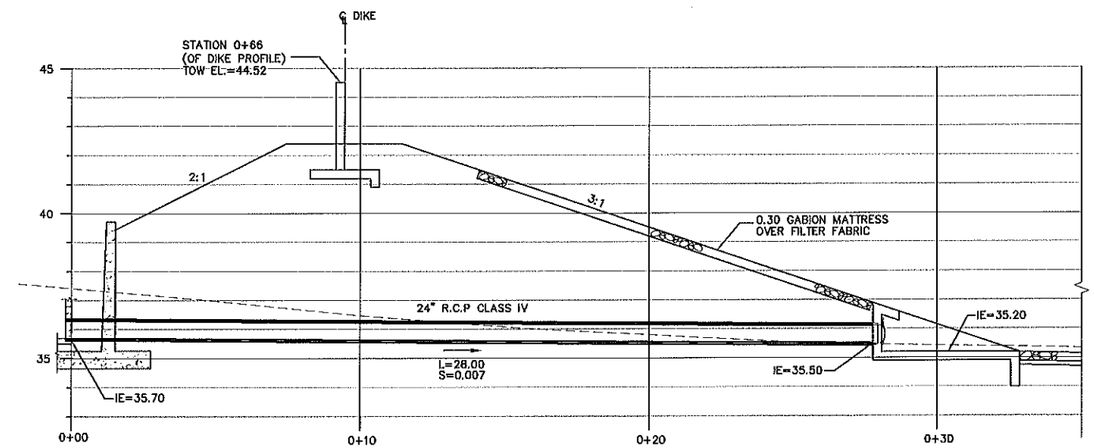


ACCESS ROAD SECTION

NOT TO SCALE

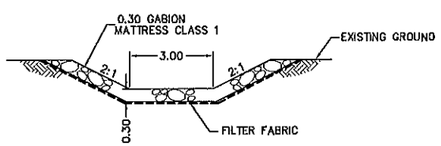


DETAIL B MD-01
NOT TO SCALE

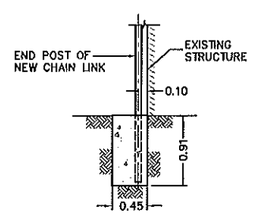


24"ø R.C. PIPE OUTLET PROFILE

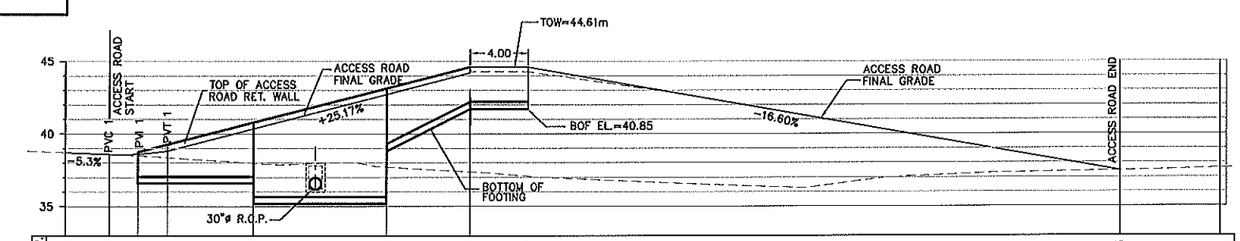
SCALE: 1:100



SECTION 1 MD-1
SCALE 1:100



DETAIL C MD-01
NOT TO SCALE



DIST.	ELEV.**	E.PROF.*								
0+00.00	38.71	38.71	38.58	38.65	39.27	40.78	43.13	44.29	44.29	37.45	37.56
0+03.03	38.58	38.58								37.45	37.56
0+05.00	38.50	38.50									
0+07.03	38.50	38.50									
0+13.00	38.00	38.00									
0+22.20	37.71	37.71									
0+28.00	37.32	37.32									
0+32.00											
0+73.06	37.45	37.45									
0+80.00	37.56	37.56									

VS=1:200
HS=1:200

*ACCESS ROAD GRADE ELEVATION
**EXISTING GROUND ELEVATION

ACCESS ROAD PROFILE

SCALE: 1:200

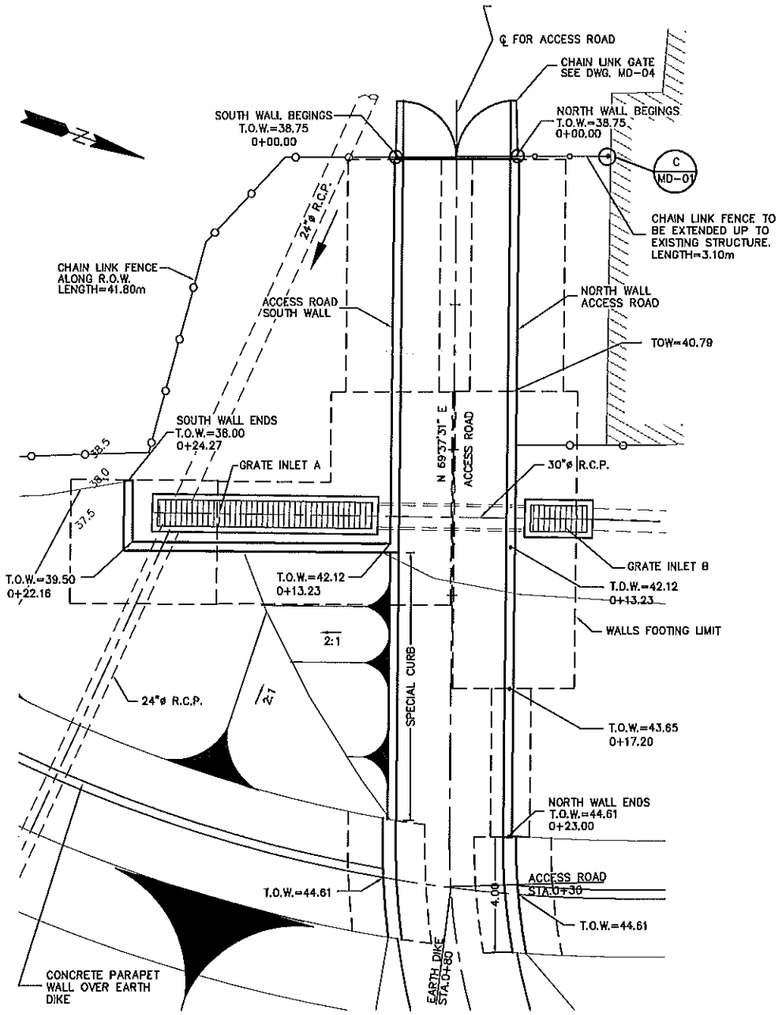
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

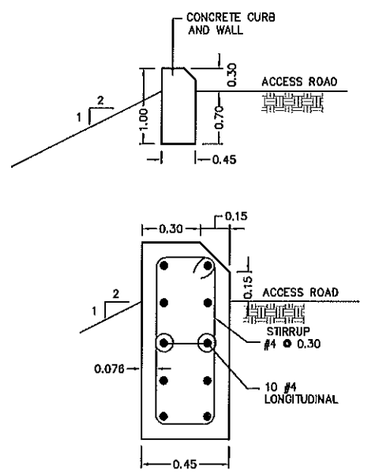
MISCELANEOUS DETAILS
ACCESS ROAD AND RELATED WORK

SHEET: 51
DWG: MD-01
DATE:
PROJ:

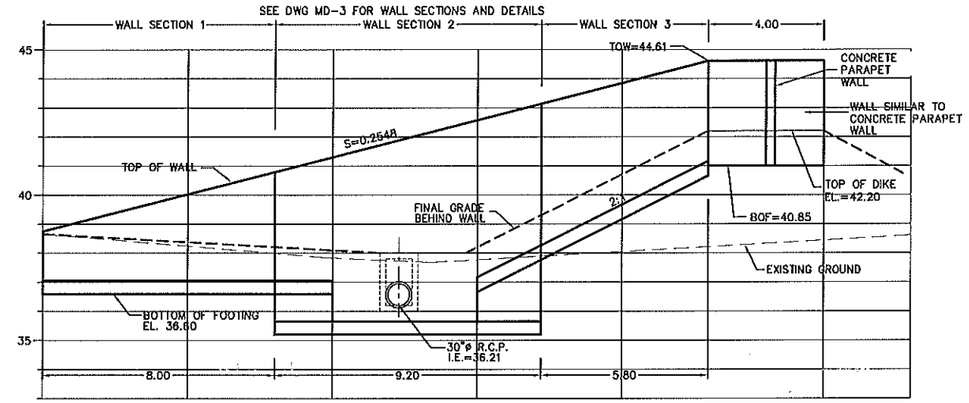
Y:\Ciales\Fase Completa (Aug 2012)\MD 01.dwg, 9/6/2012 2:46:01 PM, 1:10.4803



PLAN
SCALE 1:100

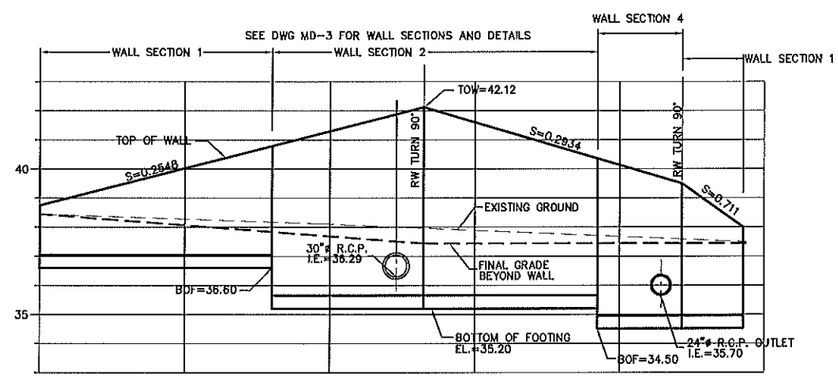


SPECIAL CURB DETAIL
NOT TO SCALE



	STATION	0+00.00	0+08.00	0+12.30	0+17.20	0+23.00	0+27.00
ELEVATIONS	TOP OF WALL	38.75	40.79	41.88	43.65	44.61	44.61
	BOTTOM OF FOOTING	36.60	35.20	35.20	35.20 37.77	40.66	40.85
	EXISTING GROUND	38.65	38.00	37.72	37.89	38.22	38.40
	FINISHED GRADE	38.65	38.10	38.00	39.31	42.20	44.29

ACCESS ROAD NORTH WALL PROFILE
SCALE H = 1:100
V = 1:100



	STATION	0+00.00	0+08.00	0+12.30	0+13.23	0+19.23	0+22.16	0+24.27
ELEVATIONS	TOP OF WALL	38.75	40.79	41.88	42.12	40.36	39.50	38.00
	BOTTOM OF FOOTING	36.60	36.60	35.20	35.20	35.20 34.50	34.50	34.50
	EXISTING GROUND	38.45	38.17	38.00	37.95	37.71	37.55	37.50
	FINISHED GRADE	38.60	38.10	37.50	37.50	37.50	37.50	37.50

ACCESS ROAD SOUTH WALL PROFILE (OPENING PROFILE ALONG WALL)
SCALE H = 1:100
V = 1:100

NOTES:

1. ALL ELEVATIONS AND DISTANCES ARE IN METERS, UNLESS OTHERWISE SPECIFIED.

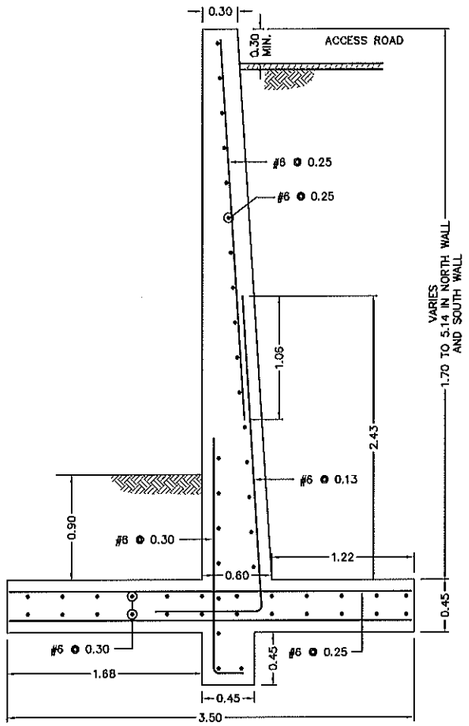
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

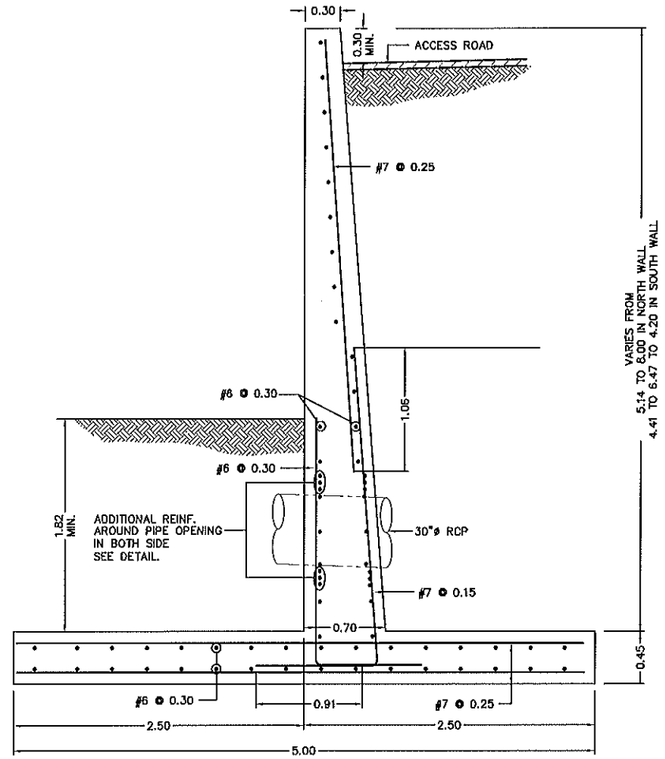
MISCELANEOUS DETAILS
ACCESS ROAD WALLS
PLAN AND PROFILE

SHEET: 52
DWG: MD-02
DATE:
PROJ:

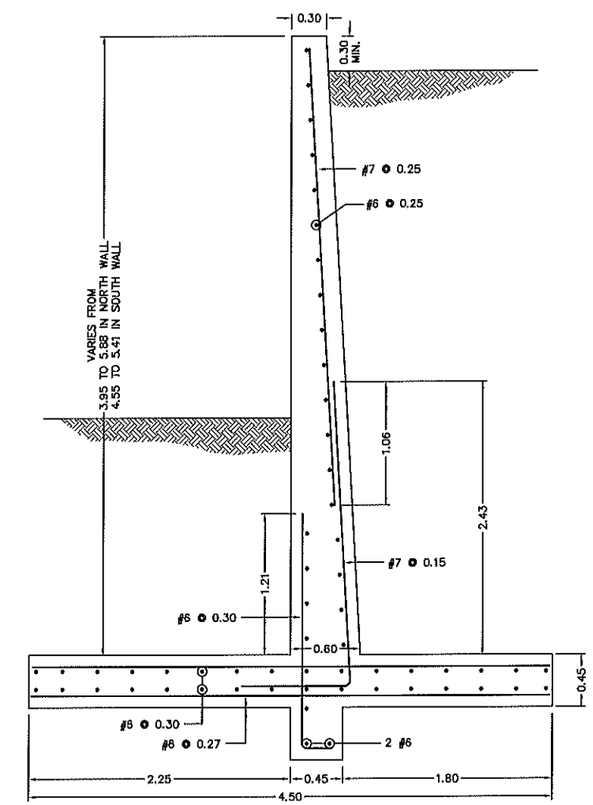
Y:\ciales\Phase Complete (Aug 2012)\MD 02.dwg, 9/6/2012 3:09:18 PM, 1:5.21027



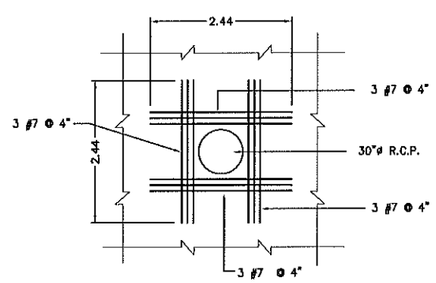
WALL SECTION 1
SCALE 1:25



WALL SECTION 2
SCALE 1:25



WALL SECTION 3
SCALE 1:25



ADDITIONAL REINFORCEMENT
AT EACH FACE OF WALL
AT PIPE CROSSING.
SCALE 1:25

NOTES:

1. ALL WALL SECTIONS REINFORCEMENT SHALL HAVE A MINIMUM COVER OF 0.10m
2. ALL DOWELS OF VERTICAL REINFORCEMENT WILL BEND INTO THE FOOTING 0.91.

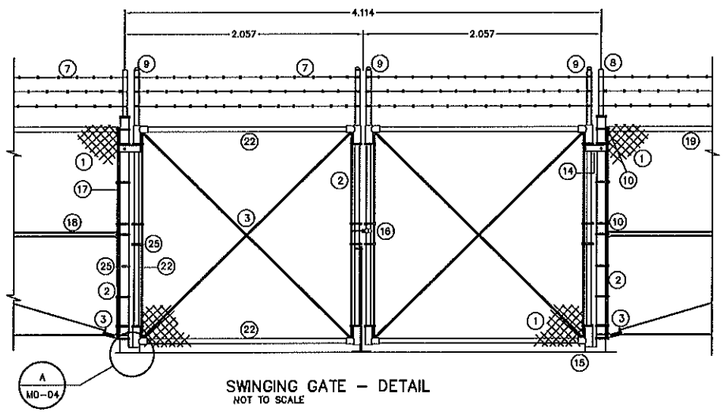
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA
Y ASOCIADOS
SAN JUAN, PUERTO RICO

MISCELANEOUS DETAILS
ACCESS ROAD WALLS
STRUCTURAL DETAILS

SHEET: 53
DWG: MD-03
DATE:
PROJ:

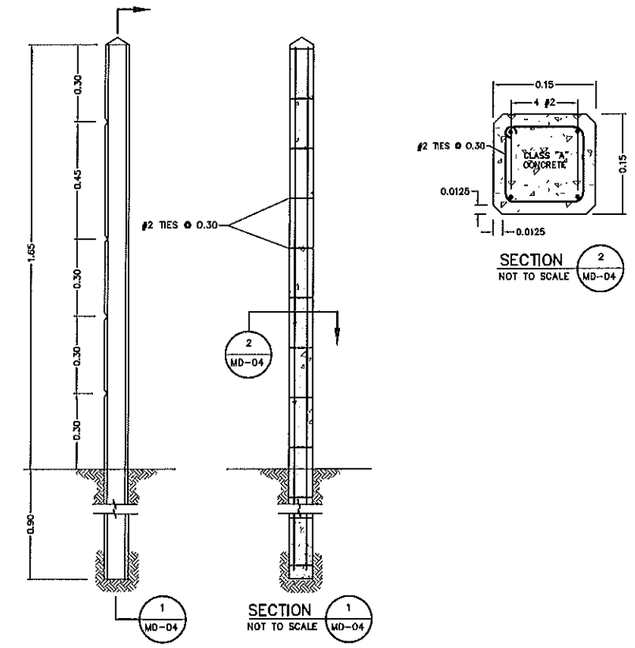
Y:\Ciales\Phase Complete (Aug 2012)\MD 03.dwg, 8/5/2012 3:48:16 PM, 1:1.29899



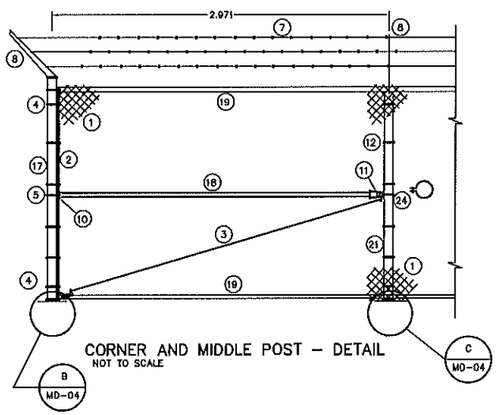
SWINGING GATE – DETAIL
NOT TO SCALE

NEW FENCE FITTINGS DESCRIPTION:

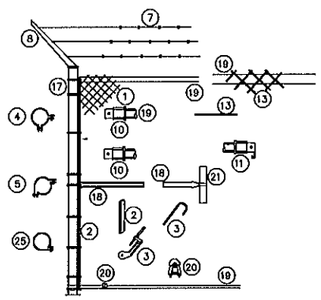
1. WIRE MESH 2" x 2" SQ. x 6'--0" H. GAUGE No.9
2. GALVANIZED TENSION BAR 1/2" D.
3. GALVANIZED REINF. BAR WITH ADJUSTMENT TURN BUCKLE.
4. GALVANIZED TENSION SHORT STRAP (CORNER POST 3")
5. GALVANIZED BRACE LONG 90° (CORNER POST 3").
6. GALVANIZED BRACE SHORT STRAP FOR BARBED WIRE (CORNER POST 3") (GATE POST 3")
7. BARBED WIRE STRANDS #10 (3 LINE).
8. SINGLE ARM FOR CORNER AND MIDDLE POST 3" (3 MOORING HOOKS).
9. TOP CONICAL CAP (2" ON GATE).
10. GALVANIZED BRACE END 5/8".
11. GALVANIZED BRACE END 5/8" WITH HOOK.
12. GALVANIZED STRAP AND LINE WITH LOOKING WASHER 2".
13. ALUMINUM RAIL TIE STRAPLES.
14. TOP HINGE (3" TO 2") ON GATE.
15. BOTTOM HINGE (3" TO 2") ON GATE.
16. SINGLE BOLT LOCK WITH PADLOCK.
17. GALVANIZED END POST -- 3" O.D. -- 5.81 #/FT.
18. GALVANIZED MIDDLE CORNER REINF. 1--5/8" O.C.
19. GALVANIZED TOP REINF. 1--5/8" O.D. (STRAIGTH WITH EXPANSION SLEEVE COUPLING).
20. GALVANIZED 2/8 WIRE ROPE CLIP – 3/8".
21. GALVANIZED MIDDLE POST 2" O.D.
22. GALVANIZED GATE FRAME 2" O.D.
23. GALVANIZED ELBOW GATE 2".
24. GALVANIZED TENSION SHORT STRAP (MIDDLE POST 2").
25. GALVANIZED BRACE STRAP (GATE POST 3").
26. STANDARD GATE STOP.



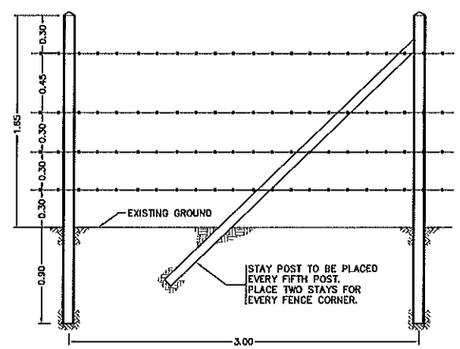
FENCE POST DETAIL
NOT TO SCALE



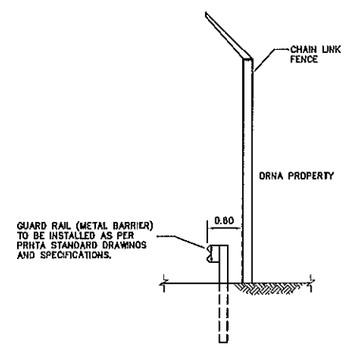
CORNER AND MIDDLE POST – DETAIL
NOT TO SCALE



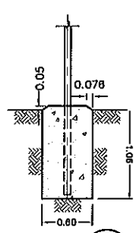
CORNER AND END POST ASSEMBLY – DETAIL
NOT TO SCALE



BARBED WIRE FENCE DETAIL
NOT TO SCALE

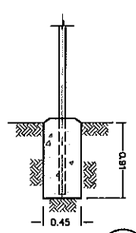


GUARD RAIL LOCATION DETAIL
NOT TO SCALE



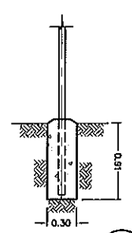
DETAIL A
NOT TO SCALE MD-04

GATE POST



DETAIL B
NOT TO SCALE MD-04

CORNER OR END POST



DETAIL C
NOT TO SCALE MD-04

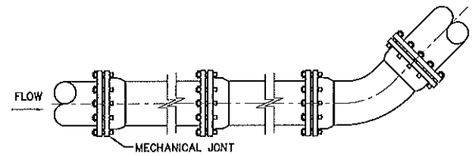
MIDDLE POST

DSGN:					VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:
DR:					AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS
CHK:							SAN JUAN, PUERTO RICO
APVD:	NO.	DATE	REVISION	BY	APVD		

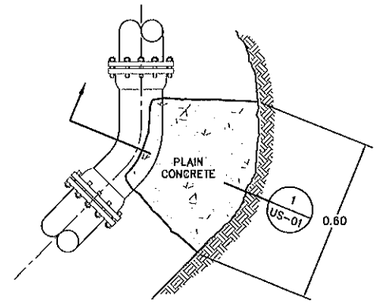
MISCELANEOUS DETAILS
FENCES DETAILS

SHEET: 54
DWG: MD-04
DATE:
PROJ:

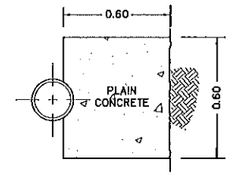
Y:\ciales\Phase Complete (Aug 2012)\MD 04.dwg, 9/4/2012 4:31:24 PM, 1:1.3012



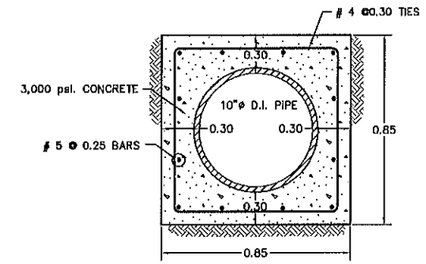
MECHANICAL JOINT DETAIL
NOT TO SCALE



TYPICAL THRUST BLOCK DETAIL
NOT TO SCALE



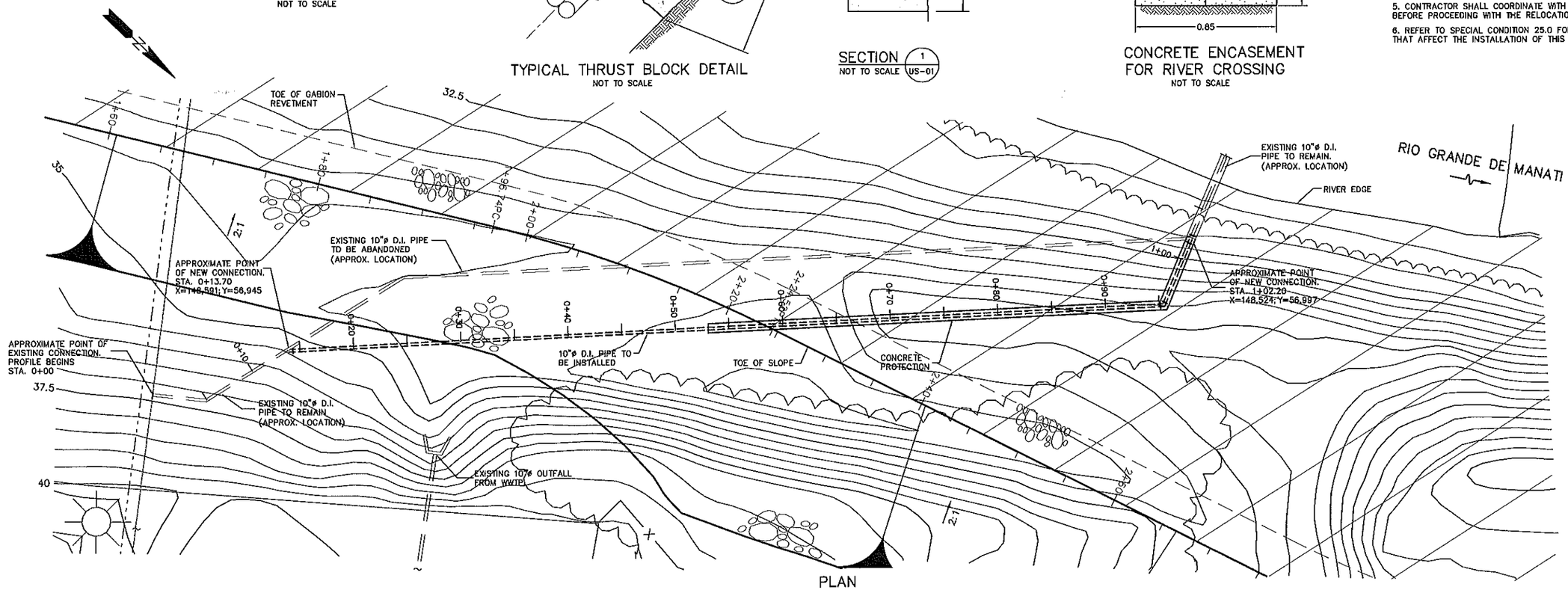
SECTION 1 / US-01
NOT TO SCALE



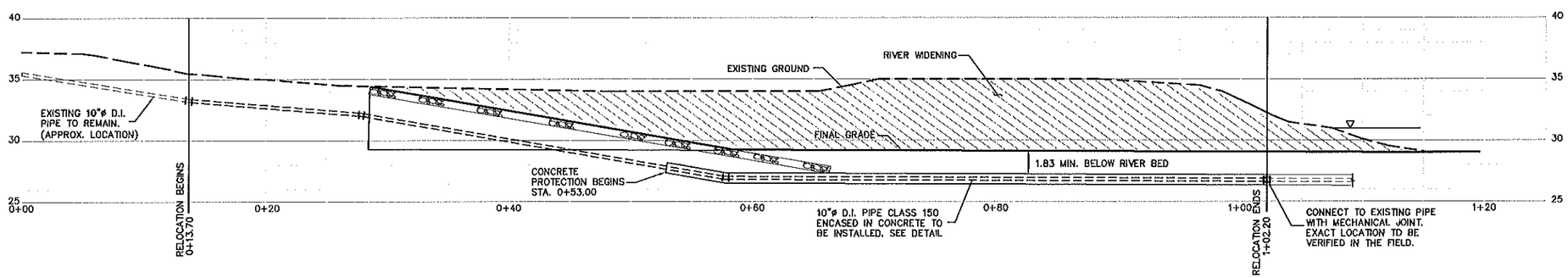
CONCRETE ENCASEMENT
FOR RIVER CROSSING
NOT TO SCALE

NOTES:

1. ALL JOINTS OUTSIDE THE CONCRETE ENCASEMENT SHALL BE MADE WITH MECHANICAL JOINTS. SEE DETAIL. JOINTS INSIDE THE CONCRETE ENCASEMENT SHALL BE PUSH-ON TYPE JOINTS.
2. ALL BENDS OUTSIDE THE CONCRETE ENCASEMENT SHALL BE RESTRAINED WITH THRUST BLOCKS. SEE THRUST BLOCK DETAIL.
3. CONTRACTOR SHALL VERIFY EXACT LOCATION OF THE EXISTING LINE CONNECTION POINTS AND ADJUST ALL REQUIRED FITTINGS AND BENDS BEFORE THE INSTALLATION OF THE NEW PIPE.
4. CONNECTIONS AT BOTH ENDS SHALL BE MADE SIMULTANEOUSLY.
5. CONTRACTOR SHALL COORDINATE WITH P.R.A.S.A. PERSONNEL BEFORE PROCEEDING WITH THE RELOCATION WORKS.
6. REFER TO SPECIAL CONDITION 25.0 FOR USACE'S REQUIREMENTS THAT AFFECT THE INSTALLATION OF THIS PIPELINE.



PLAN



PROFILE
SCALE H = 1:200
V = 1:200

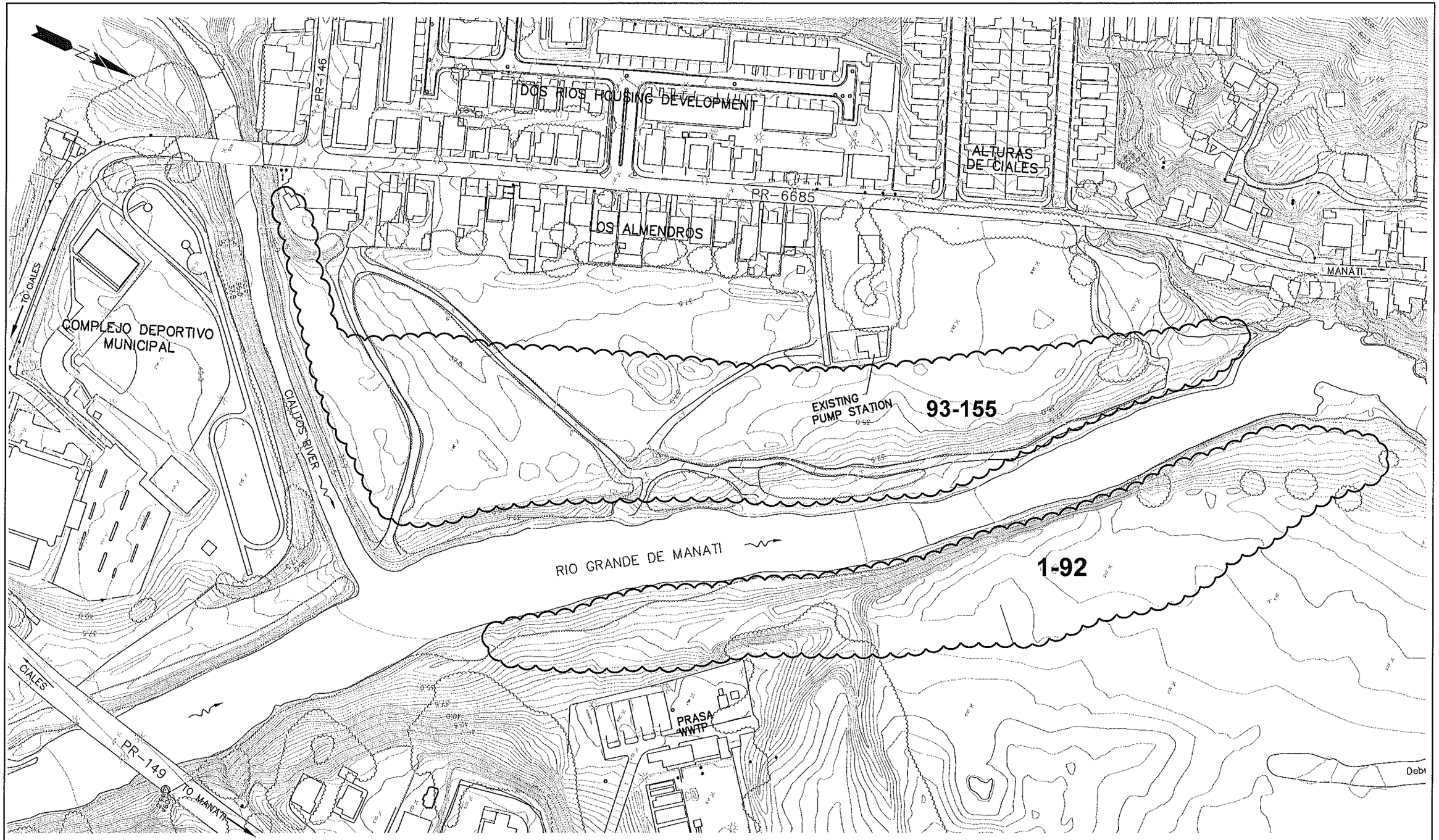
DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO
QDSA

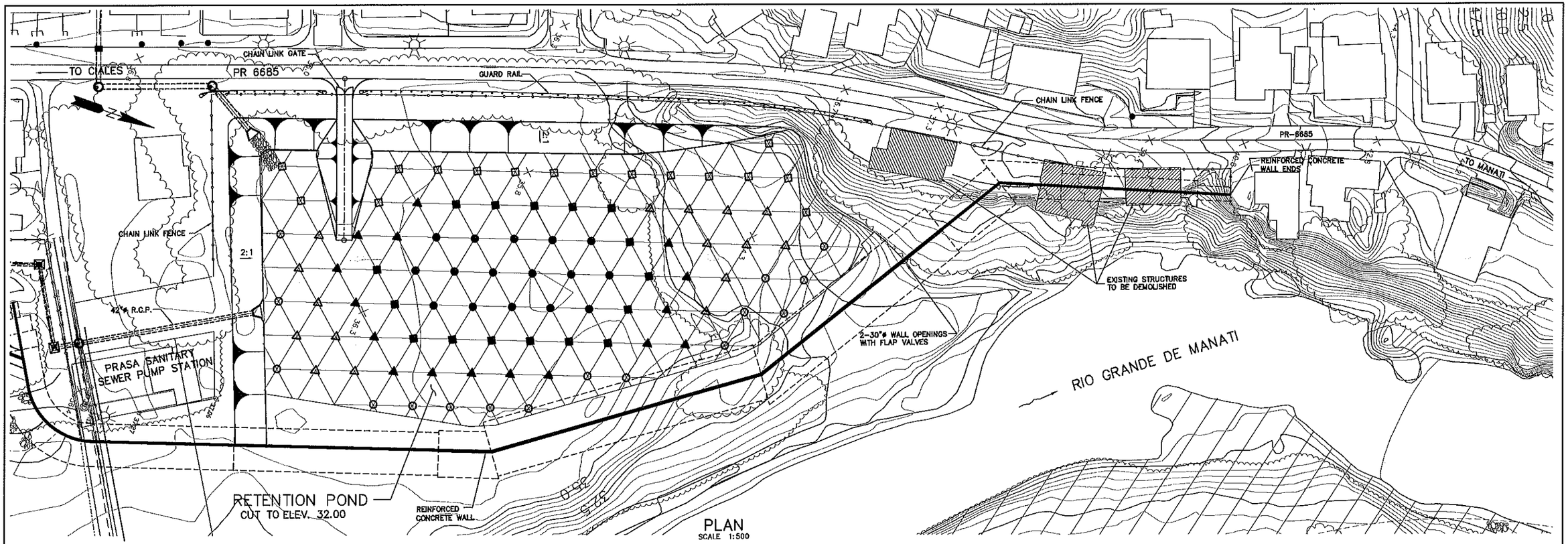
10"ø SANITARY FORCE LINE RELOCATION
PLAN, PROFILE & DETAILS

SHEET: 55
DWG: US-01
DATE:
PROJ:

Y:\Ciales\Phase Completa (Aug 2012)\US Ciales, 9/4/2012 4:32:44 PM, 1:10.49(5)



DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	TREE INVENTORY	SHEET: 56
DR:						SCALE= 1:1000	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: RD-01
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:



PLAN
SCALE 1:500

SPECIFICATIONS FOR CUTTING AND REMOVING TREES AND TREE PLANTING FOR THOSE REPLACED

THE CONTRACTOR SHALL:

1. PROVIDE ALL LABOR, PLANTING MATERIAL, SOIL PREPARATON, PLANTING MIXES AND NECESSARY EQUIPMENT TO COMPLETE THE LANDSCAPE WORK.
2. USE TREE SPECIES, LOCATION AND DETAILS AS SHOWN ON THE PLANS AND IN ACCORDANCE TO THE PLANTING PLAN APPROVED BY THE DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AND THESE SPECIIFICATIONS.
3. PRESENT A MAINTENANCE SCHEDULE FOR THOSE TREES TO BE PLANTED, SPECIFYING A MINIMUM PERIOD OF SIX (6) MONTHS THAT SHALL INCLUDE: WATERING, FERTILIZING, WEED AND DESEASE CONTROL, STAKING REVISIONS AND ANY OTHER RECCOMENDED AND NECESSARY MEASURES.
4. MAKE SURE THAT ALL WORK DESCRIBED BELOW IS PERFORMED AND SUPERVISED BY A CAPABLE TREE PLANTING AND FORESTRY PROFESSIONAL; SUCH AS A LANDSCAPING ARQUITECT, AGRONOMIST, ALBORICULTURIST, FORESTER, HORTICULTURIST OR OTHERS WITH SPECIALIZED EDUCATION ON THIS FIELD, AS DESCRIBE ON PLANNING REGULATION NUMBER 25, "PLANTING, CUTTING AND FORESTATION FOR PUERTO RICO".
   - 4.1 TAKE PROTECTION MEASURES FOR THOSE TREES LOCATED NEAR THE CONSTRUCITON SITE. THESE INCLUDE:
     - A. LOCATE AND MARK WITH FLAGGING OR SIGNS ALL ACCESS ROADS FOR CONSTRUCION EQUIPMENT, PARKING AREAS, MATERIALS, GRAVEL AND SAND STORAGE AREAS SO THAT THESE OPERATIONS ARE KEPT OUTSIDE OF THE DRIPPING ZONE OF THOSE TREES THAT WILL NOT BE IMPACTED BY THE CONSTRUCTION SO AS TO AVOID SOIL COMPACTION AND ANY DAMAGE TO THE ROOT SYSTEM TO THESE TREES.
     - B. ESTABLISH PHYSICAL BARRIERS AROUND TREES AND GROUP OF TREES TO REMAIN, THAT MAY BE AFFECTED BY CONSTRUCTION ACTIVITIES. BARRIERS SHALL CONSIST OF A FOUR (4) FEET HIGH FENCE AROUND THE OUTSIDE LIMIT OF THE TREES DRIPPING ZONE.
     - C. LIMIT ALL CONSTRUCTION ACTIVITIES NEAR THE TREES TO A MINIMUM DISTANCE FROM THE DRIPPING ZONE (MAXIMUM HORIZONTAL EXTENSION OF BRANCHES). ANY CONSTRUCTION ACTIVITY PERFORMED WITHIN THIS ZONE WOULD AFFECT TREE HEALTH , STABILITY AND ITS GENERAL CONDITION.
     - D. WILL NOT THROW TRASH, CONSTRUCTION DEBRIS, FILL MATERIAL OR ANY OTHER MATERIAL RESULTING FROM THE CONSTRUCTION IN THE DRIPPING ZONE THE TREES.
   - 4.2 IMPLEMENT MANAGEMENT MEASURES FOR THOSE TREES RETAINED AND NOT IMPACTED DIRECTLY BY THE CONSTRUCTION. AFTER ALL WORK IS COMPLETED, THE CONTRACTOR SHALL:
     - A. REMOVE ALL SIONS AND PROTECTION FENCES INSTALLED ON THE PROJECT.
     - B. PERFORM ALL TRIMMING WORK TO AFECTED TREES DUE TO TRAFFIC IN THE AREA. THE TRIMMING REFERS TO ALL BROKEN, DAMAGE OR DRY BRANCHES. THIS TRIMMING SHOULD BE PERFORMED BY A TRAINED CREW AND ALL WORK SUPERVISED BY A CAPABLE PROFESSIONAL.
     - C. WATER AND FERTILIZE IF NECESSARY.
     - D. REGULARLY INSPECT TO IDENTIFY POSSIBLE FUTURE PROBLEMS DETECTED ON TREES.
   - 4.3 SUBMIT A MAINTENANCE SCHEDULE FOR THOSE TREES PLANTED AS PART OF THE PLANTING PLAN. THIS SHALL INCLUDE:
     - A. PREPARATION OF A SCHEDULE OF AT LEAST THREE (3) YEARS SPECIFYING ALL TASKS TO BE PERFORMED AND THE FREQUENCY TO WHICH THEY HAVE TO BE DONE. IT IS RECCOMENDED THAT:

       WATERING:

       LONG AND DEEP WATERING DAILY FOR A MINIMUM PERIOD OF SIX (6) MONTHS. AFTER THAT THE FREQUENCY WILL BE ALTERED SPACING THE WATERING PERIODS: EVERY OTHER DAY FOR SIX (6) TO NINE (9) MONTHS, EVERY FOURTH DAY FOR NINE (9) TO TWELVE (12) MONTHS, ETC.

       FERTILIZING:

       AT THE TIME OF PLANTING, IF NECESSARY, A DILUTED FERTILIZING SOLUTION 12-12-12, 4# 12-12-12 PER CUBIC YARD SHOULD BE APPLIED. AFTER THIS, ONE OR TWO APPLICATIONS OF FERTILIZER A YEAR IS RECCOMENDED.

       WEED AND DESEASE CONTROL:

       MAINTAIN ALL TREES IN OBSERVATION TO DETECT ANY WEED CONTAMINATION OR SIGNS OF DISEASE. IF ANYTHING ABNORMAL IS NOTED, IT SHOULD BE NOTIFIED TO THE "SERVICIO DE EXTENSION AGRICOLA, PROGRAMA DE PROTECCION DE CULTIVOS".

       STAKING REVISIONS:

       CHECK ALL STAKES EVERY MONTH, TO MAKE SURE THAT THEY ARE FIRMLY IN POSITION AND IN GOOD CONDITIONS.
5. CONSTRUCT TREE PRESERVATION AND PROTECTION STRUCTURES AROUND ALL TREES WHICH ROOT SYSTEM HAS BEEN AFFECTED VERY NEAR ITS TRUNK.
   - 5.1 ESTABLISH PROTECTED OR ROCK LINED TERRACES THAT WILL ALLOW PERCOLATION AROUND THOSE TREES WHERE THE SOIL WAS CUT AND WHERE THERE WERE VARIATIONS IN SOIL LEVEL NEAR THE TRUNK, WITHIN ITS DRIPPING ZONE.
   - 5.2 CONSTRUCT A SOIL RETENTION WALL WITH RESISTENT MATERIAL THAT PERMITS WATER PERCOLATION.
   - 5.3 MAINTAIN THE ORIGINAL SOIL LEVEL, DO NOT ALTER ITS HEIGHT IN THE ROOT CROWN OR ITS SURROUNDINGS.
6. OBTAIN PREVIOUS AUTHORIZATION FROM THE DRNA FOR ANY VARIATION TO ANY OF THE ACTIVITIES PREVIOUSLY DESCRIBED.
7. ASSUME ALL RESPONSIBILITY FOR DAMAGES TO PERSONS, PUBLIC OR PRIVATE PROPERTY, OR FOR ANY OTHER DAMAGE RESULTING FROM WORK HEREIN AUTHORIZED.
8. MAINTAIN EVIDENCE OF THE APPROVED PERMIT GRANTED BY THE DRNA TO PERFORM THESE WORKS. THE PERMIT DOES NOT EXEMPT THE CONTRACTOR FROM HIS RESPONSIBILITY TO OBTAIN ANY OTHER CLAUSES OF THE DRNA PERMIT, THE FORREST LAW OF PUERTO RICO, THE SPECIAL FORESTAL PERMIT REGULATION OR ANY OTHER LAW OF THE COMMONWEALTH OF PUERTO RICO, WILL REQUIRE A RENEWAL OF PERMIT THAT MAY BE REQUIRED BY ANY OTHER FEDERAL OR STATE AGENCY. ANY VIOLATION TO THE THE DRNA PERMIT.

LEGEND:

SYMBOLS	COMMON NAME	SCIENTIFIC NAME	
○	CAYUR	ANNONA GLABRA	16
▲	EMAJAGUA	HIBISCUS PERNAMBUCENCIS	16
■	PALMA DE SIERRA	PRESTOEA MONTANA	16
□	EMAJAGUILLA	THESPESIA POPULNEA	16
△	MARIA	CALOPHYLLIM CALABA	16
●	MAMEY	MAMMEA AMERICANA	16
		TOTALS	96

(TREE SPACING 10.0m x 10.0m)

DSGN:					
DR:					
CHK:					
APVD:	NO.	DATE	REVISION	BY	APVD

VERIFY SCALE
AS SHOWN

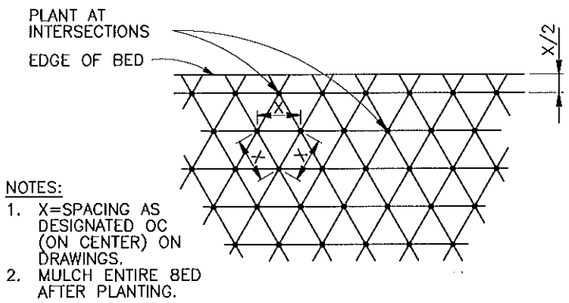
DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES
AREA OF WATER AND MINERAL RESOURCES
FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

TREE PLANTING PLAN

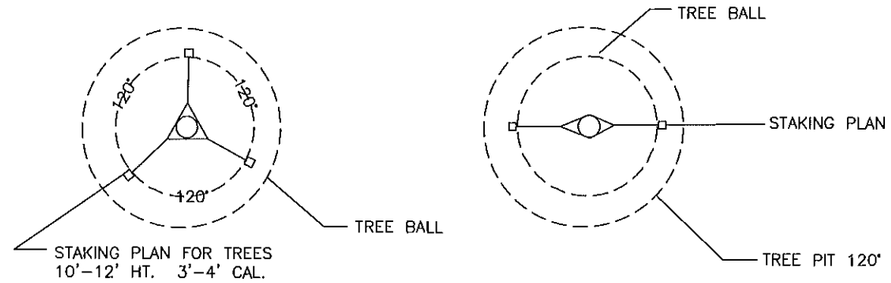
SHEET: 57
DWG: RD-02
DATE:
PROJ:

Y:\ciales\Phase Completo (Aug 2012)\RD 02.dwg, 9/6/2012 3:29:42 PM, 1:25.9943

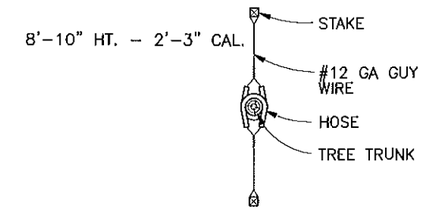


NOTES:
1. X=SPACING AS DESIGNATED OC (ON CENTER) ON DRAWINGS.
2. MULCH ENTIRE BED AFTER PLANTING.

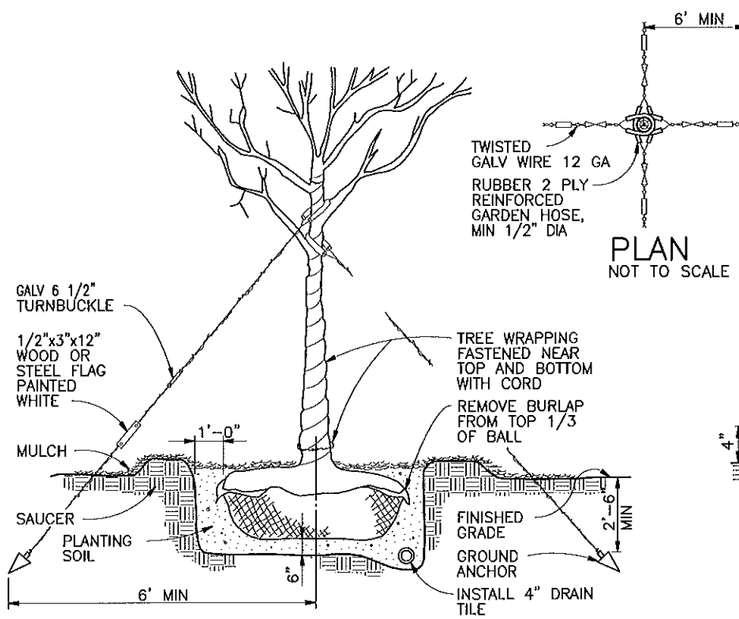
PLANT SPACING
NOT TO SCALE



STAKING PLAN
NOT TO SCALE



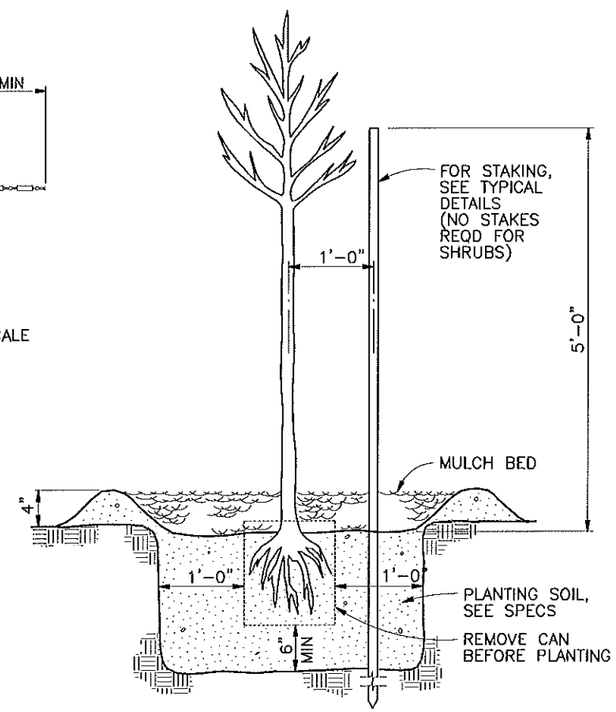
TREE FASTENING
NOT TO SCALE



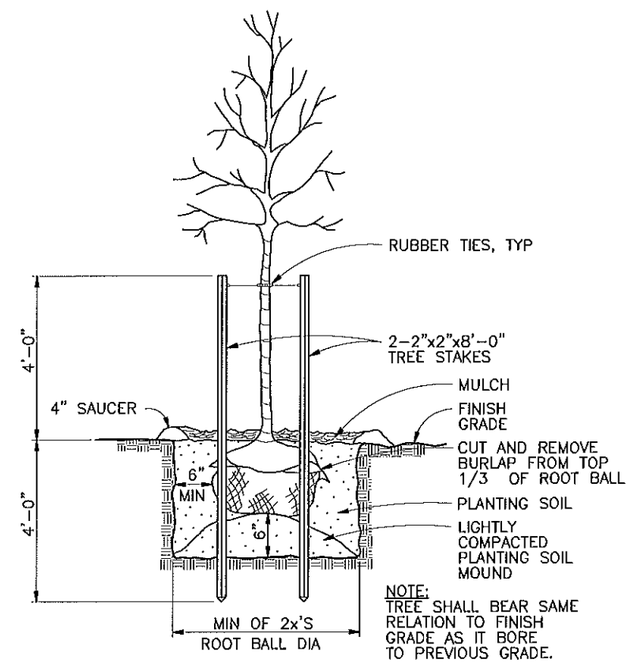
TYPICAL SECTION

PLAN
NOT TO SCALE

PLANTING TREES 4" CALIPER OR LARGER
NOT TO SCALE



PLANTING TREES (SHRUBS)
NOT TO SCALE



NOTE:
TREE SHALL BEAR SAME RELATION TO FINISH GRADE AS IT BORE TO PREVIOUS GRADE.

TREE PLANTING AND STAKING
NOT TO SCALE

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

TREE PLANTING DETAILS

SHEET: 58
DWG: RD-03
DATE:
PROJ:

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GENERAL NOTES FOR TRAFFIC MAINTENANCE:

FOR THE CONSTRUCTION A STORM SEWER SYSTEM IN THE MUNICIPALITY OF CIALES, THE FOLLOWING CONSTRUCTION SCHEDULE AND SPECIAL INSTRUCTIONS SHALL BE FOLLOWED, IN ORDER TO MAINTAIN TRAFFIC FLOW WITH THE LEAST POSSIBLE INTERFERENCE FROM CONSTRUCTION OPERATIONS. ANY ALTERATIONS TO THIS SCHEDULE, SHALL BE SUBMITTED IN WRITING FOR APPROVAL, PREVIOUS TO ITS APPLICATION, TO THE PRHTA EXECUTIVE DIRECTOR.

1. PROVISIONAL SIGNING AND CONTROL OF TRAFFIC FOR THE DIFFERENT CONSTRUCTION PHASES SHALL BE AS PROVIDED IN THE MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES, M.U.T.C.D. 2003 EDITIONAND PRHTA STANDARD DRAWINGS.

2. THE CONTRACTOR SHALL PROVIDE ACCESS TO ALL BUSINESS AND HOME ENTRANCES AT ALL TIMES. NO BUSINESS OR HOUSE SHALL BE LEFT WITHOUT AN ACCESS. ADDITIONAL FLAGGERS SHALL BE USED IN ORDER TO AID TRAFFIC WHEN CROSSING NEAR THE CLOSED WORK AREA. PROPERTY OWNER(S) WITH PRIMARY ACCESS ALONG AFFECTED AREAS SHALL BE NOTIFIED IN A TIMELY MANNER OF CONSTRUCTION.

3. FLAGGERS SHALL BE MAINTAINED IN AREAS WHERE TRAFFIC COULD ENCOUNTER PROBLEMS WITH TRUCKS AND HEAVY MACHINERY.

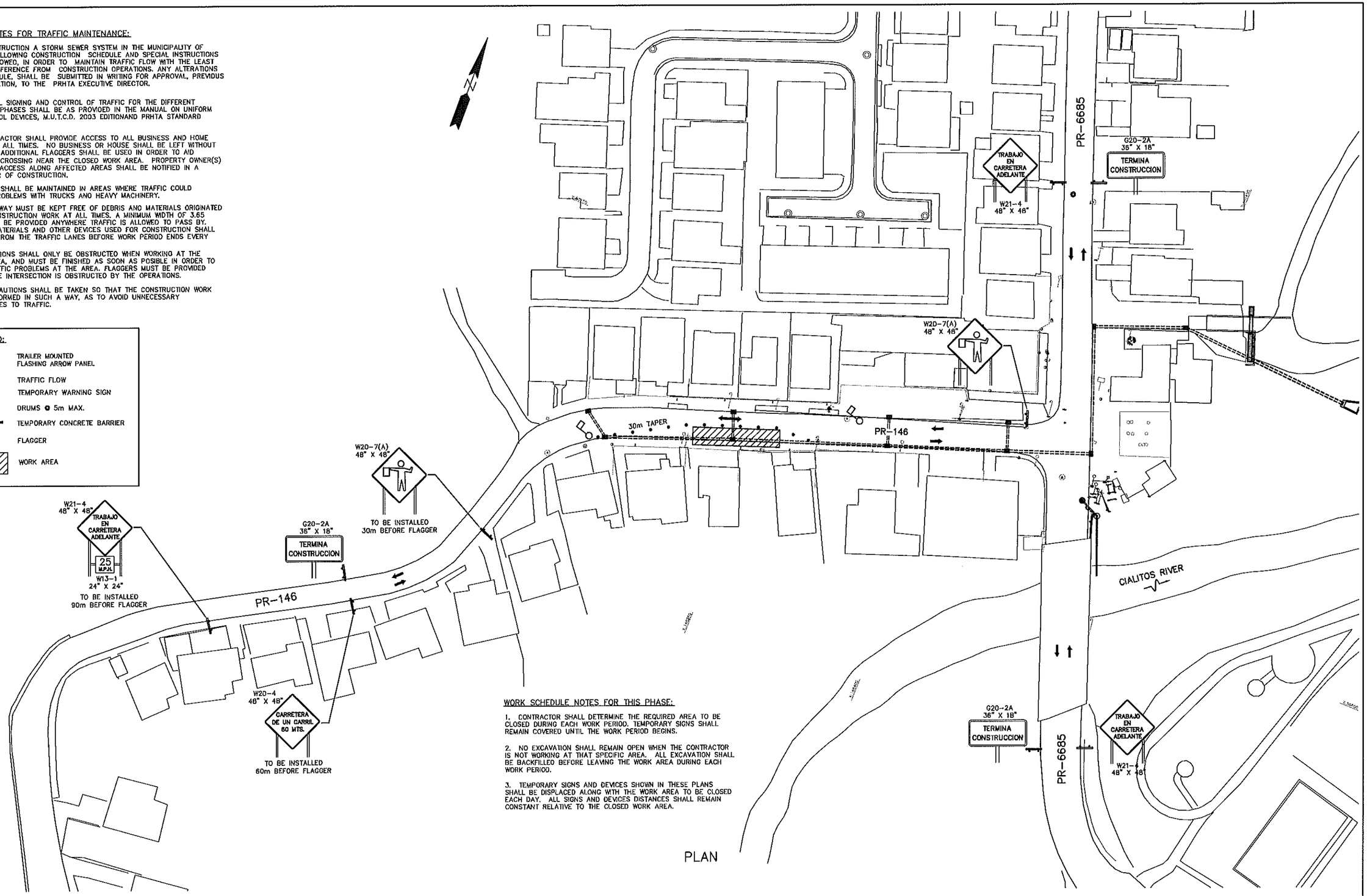
4. THE ROADWAY MUST BE KEPT FREE OF DEBRIS AND MATERIALS ORIGINATED FROM THE CONSTRUCTION WORK AT ALL TIMES. A MINIMUM WIDTH OF 3.65 METERS SHALL BE PROVIDED ANYWHERE TRAFFIC IS ALLOWED TO PASS BY. EQUIPMENT, MATERIALS AND OTHER DEVICES USED FOR CONSTRUCTION SHALL BE REMOVED FROM THE TRAFFIC LANES BEFORE WORK PERIOD ENDS EVERY DAY.

5. INTERSECTIONS SHALL ONLY BE OBSTRUCTED WHEN WORKING AT THE SPECIFIED AREA, AND MUST BE FINISHED AS SOON AS POSIBLE IN ORDER TO PREVENT TRAFFIC PROBLEMS AT THE AREA. FLAGGERS MUST BE PROVIDED WHENEVER THE INTERSECTION IS OBSTRUCTED BY THE OPERATIONS.

6. ALL PRECAUTIONS SHALL BE TAKEN SO THAT THE CONSTRUCTION WORK MAY BE PERFORMED IN SUCH A WAY, AS TO AVOID UNNECESSARY INCONVENIENCES TO TRAFFIC.

LEGEND:

- TRAILER MOUNTED FLASHING ARROW PANEL
- TRAFFIC FLOW
- TEMPORARY WARNING SIGN
- DRUMS @ 5m MAX.
- TEMPORARY CONCRETE BARRIER
- FLAGGER
- WORK AREA



WORK SCHEDULE NOTES FOR THIS PHASE:

1. CONTRACTOR SHALL DETERMINE THE REQUIRED AREA TO BE CLOSED DURING EACH WORK PERIOD. TEMPORARY SIGNS SHALL REMAIN COVERED UNTIL THE WORK PERIOD BEGINS.

2. NO EXCAVATION SHALL REMAIN OPEN WHEN THE CONTRACTOR IS NOT WORKING AT THAT SPECIFIC AREA. ALL EXCAVATION SHALL BE BACKFILLED BEFORE LEAVING THE WORK AREA DURING EACH WORK PERIOD.

3. TEMPORARY SIGNS AND DEVICES SHOWN IN THESE PLANS SHALL BE DISPLACED ALONG WITH THE WORK AREA TO BE CLOSED EACH DAY. ALL SIGNS AND DEVICES DISTANCES SHALL REMAIN CONSTANT RELATIVE TO THE CLOSED WORK AREA.

PLAN

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						1:500	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

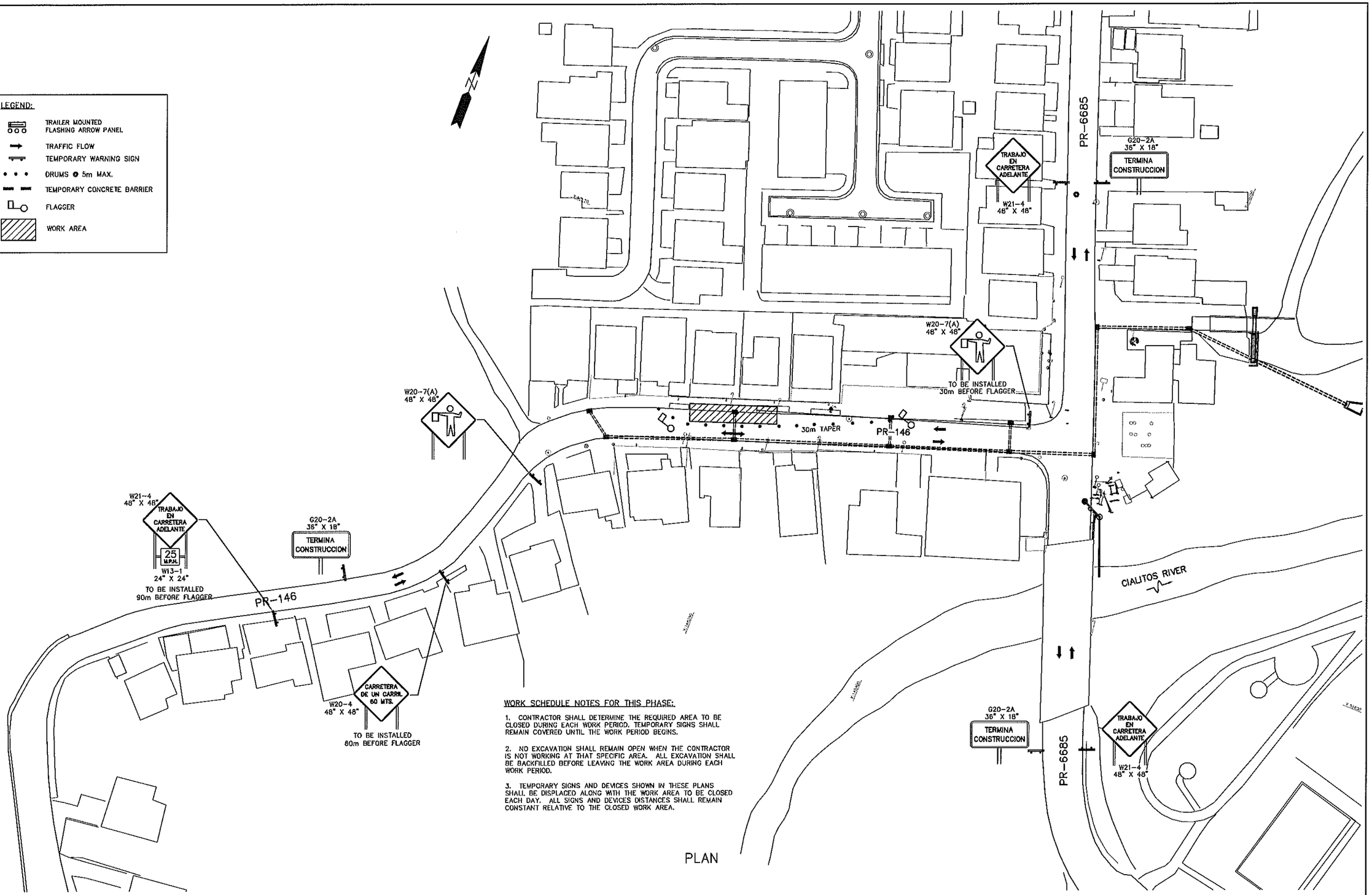
MANAGEMENT OF TRAFFIC
ROAD PR-146
PHASE 1 – STAGE 1

SHEET: 59
DWG: MOT-01
DATE:
PROJ:

Y:\cciales\Phase Completo (Aug 2012)\MOT 01 to MOT 06.dwg, 9/4/2012 4:44:06 PM, 1:25.5758

LEGEND:

- TRAILER MOUNTED FLASHING ARROW PANEL
- TRAFFIC FLOW
- TEMPORARY WARNING SIGN
- DRUMS @ 5m MAX.
- TEMPORARY CONCRETE BARRIER
- FLAGGER
- WORK AREA



WORK SCHEDULE NOTES FOR THIS PHASE:

1. CONTRACTOR SHALL DETERMINE THE REQUIRED AREA TO BE CLOSED DURING EACH WORK PERIOD. TEMPORARY SIGNS SHALL REMAIN COVERED UNTIL THE WORK PERIOD BEGINS.

2. NO EXCAVATION SHALL REMAIN OPEN WHEN THE CONTRACTOR IS NOT WORKING AT THAT SPECIFIC AREA. ALL EXCAVATION SHALL BE BACKFILLED BEFORE LEAVING THE WORK AREA DURING EACH WORK PERIOD.

3. TEMPORARY SIGNS AND DEVICES SHOWN IN THESE PLANS SHALL BE DISPLACED ALONG WITH THE WORK AREA TO BE CLOSED EACH DAY. ALL SIGNS AND DEVICES DISTANCES SHALL REMAIN CONSTANT RELATIVE TO THE CLOSED WORK AREA.

PLAN

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	MANAGEMENT OF TRAFFIC	SHEET: 60
DR:						1:500	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO	ROAD PR-146	DWG: MOT-02
CHK:									PHASE 1 - STAGE 2	DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

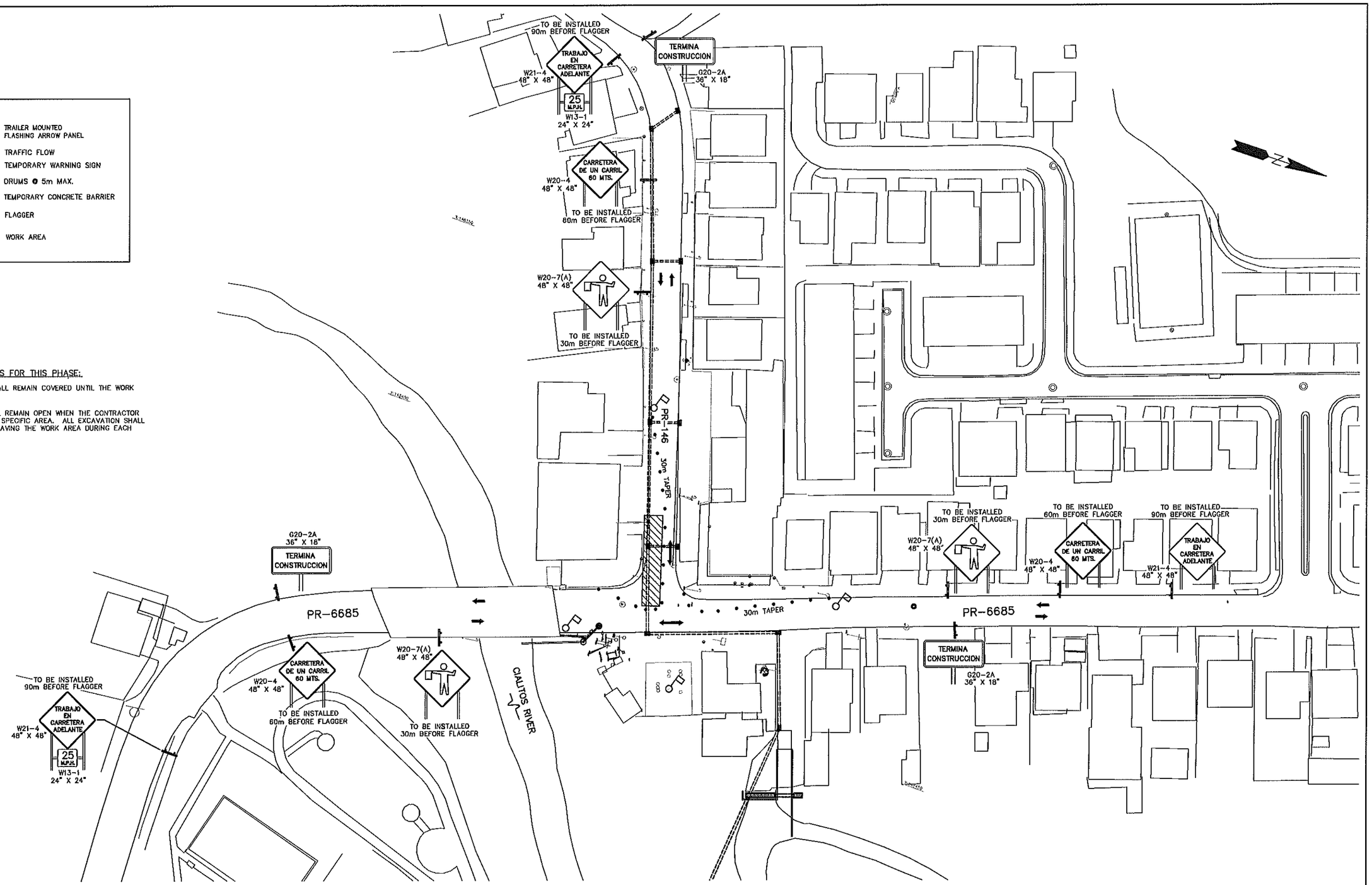
LEGEND:

- TRAILER MOUNTED FLASHING ARROW PANEL
- TRAFFIC FLOW
- TEMPORARY WARNING SIGN
- DRUMS @ 5m MAX.
- TEMPORARY CONCRETE BARRIER
- FLAGGER
- WORK AREA

WORK SCHEDULE NOTES FOR THIS PHASE:

1. TEMPORARY SIGNS SHALL REMAIN COVERED UNTIL THE WORK PERIOD BEGINS.

2. NO EXCAVATION SHALL REMAIN OPEN WHEN THE CONTRACTOR IS NOT WORKING AT THAT SPECIFIC AREA. ALL EXCAVATION SHALL BE BACKFILLED BEFORE LEAVING THE WORK AREA DURING EACH WORK PERIOD.



PLAN

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	MANAGEMENT OF TRAFFIC	SHEET: 61
DR:						1:500	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO	ROAD PR-146 & PR-6685	DWG: MOT-03
CHK:									PHASE 2 - STAGE 1	DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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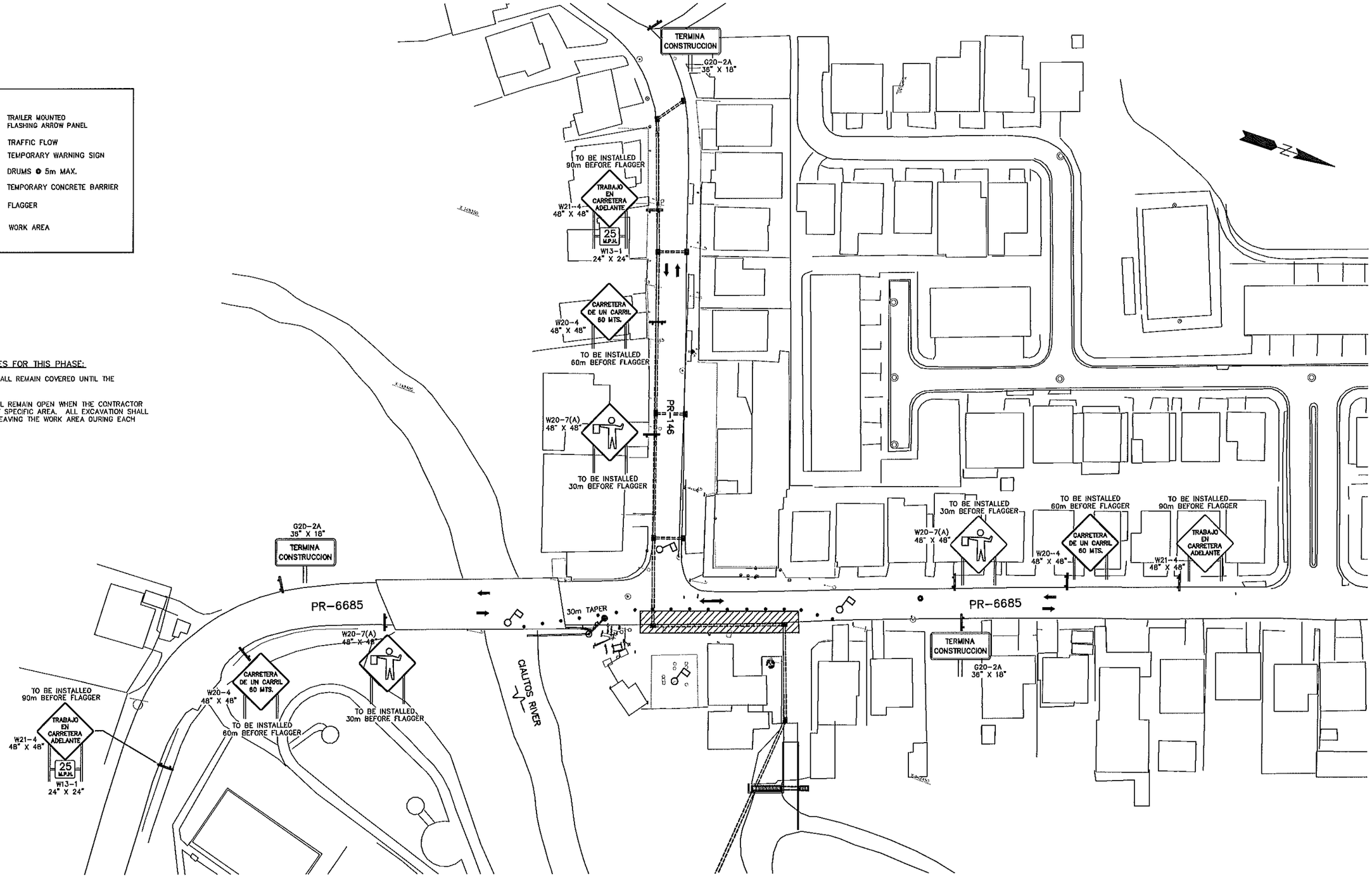
LEGEND:

- TRAILER MOUNTED FLASHING ARROW PANEL
- TRAFFIC FLOW
- TEMPORARY WARNING SIGN
- DRUMS @ 5m MAX.
- TEMPORARY CONCRETE BARRIER
- FLAGGER
- WORK AREA

WORK SCHEDULE NOTES FOR THIS PHASE:

1. TEMPORARY SIGNS SHALL REMAIN COVERED UNTIL THE WORK PERIOD BEGINS.

2. NO EXCAVATION SHALL REMAIN OPEN WHEN THE CONTRACTOR IS NOT WORKING AT THAT SPECIFIC AREA. ALL EXCAVATION SHALL BE BACKFILLED BEFORE LEAVING THE WORK AREA DURING EACH WORK PERIOD.



PLAN

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						1:500	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

MANAGEMENT OF TRAFFIC
ROAD PR-146 & PR-6685
PHASE 2 - STAGE 2

SHEET: 62
DWG: MOT-04
DATE:
PROJ:

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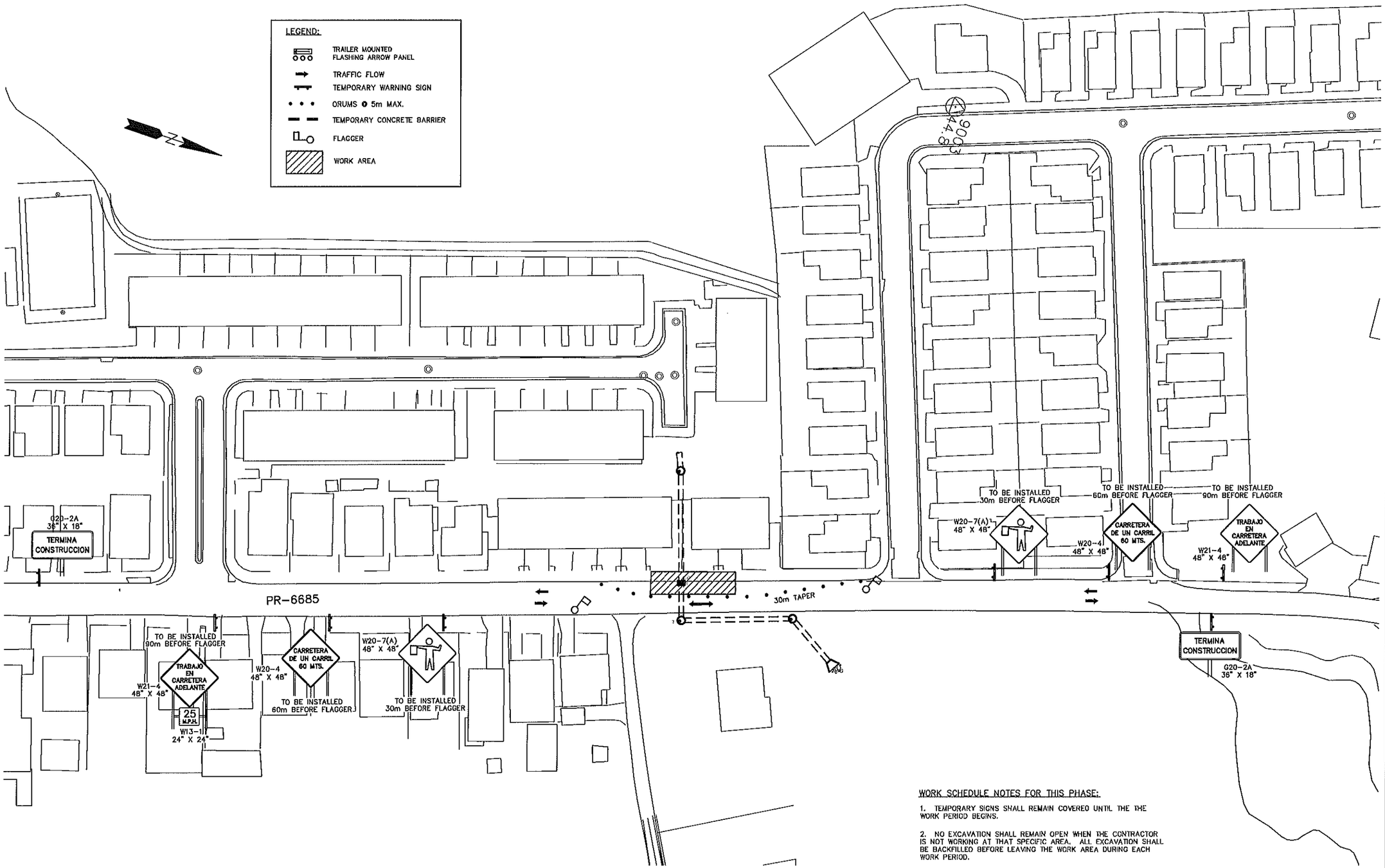

PLAN

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	MANAGEMENT OF TRAFFIC	SHEET: 63
DR:						1:500	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO	ROAD PR-6685	DWG: MOT-05
CHK:									PHASE 3 – STAGE 1	DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

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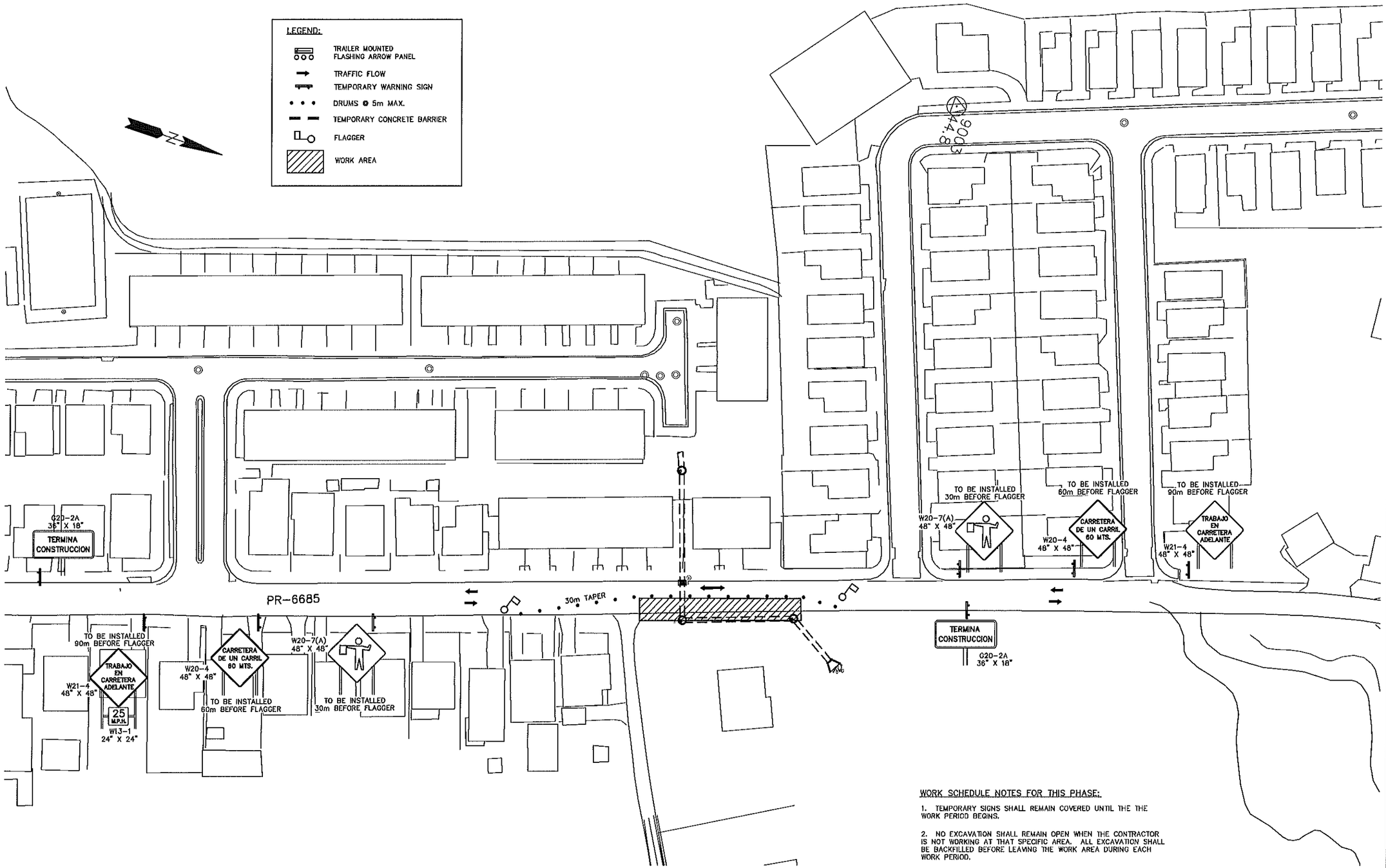

PLAN

WORK SCHEDULE NOTES FOR THIS PHASE:

1. TEMPORARY SIGNS SHALL REMAIN COVERED UNTIL THE THE WORK PERIOD BEGINS.

2. NO EXCAVATION SHALL REMAIN OPEN WHEN THE CONTRACTOR IS NOT WORKING AT THAT SPECIFIC AREA. ALL EXCAVATION SHALL BE BACKFILLED BEFORE LEAVING THE WORK AREA DURING EACH WORK PERIOD.

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						1:500	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

MANAGEMENT OF TRAFFIC
ROAD PR-6685
PHASE 3 – STAGE 2

SHEET: 64
DWG: MOT-06
DATE:
PROJ:

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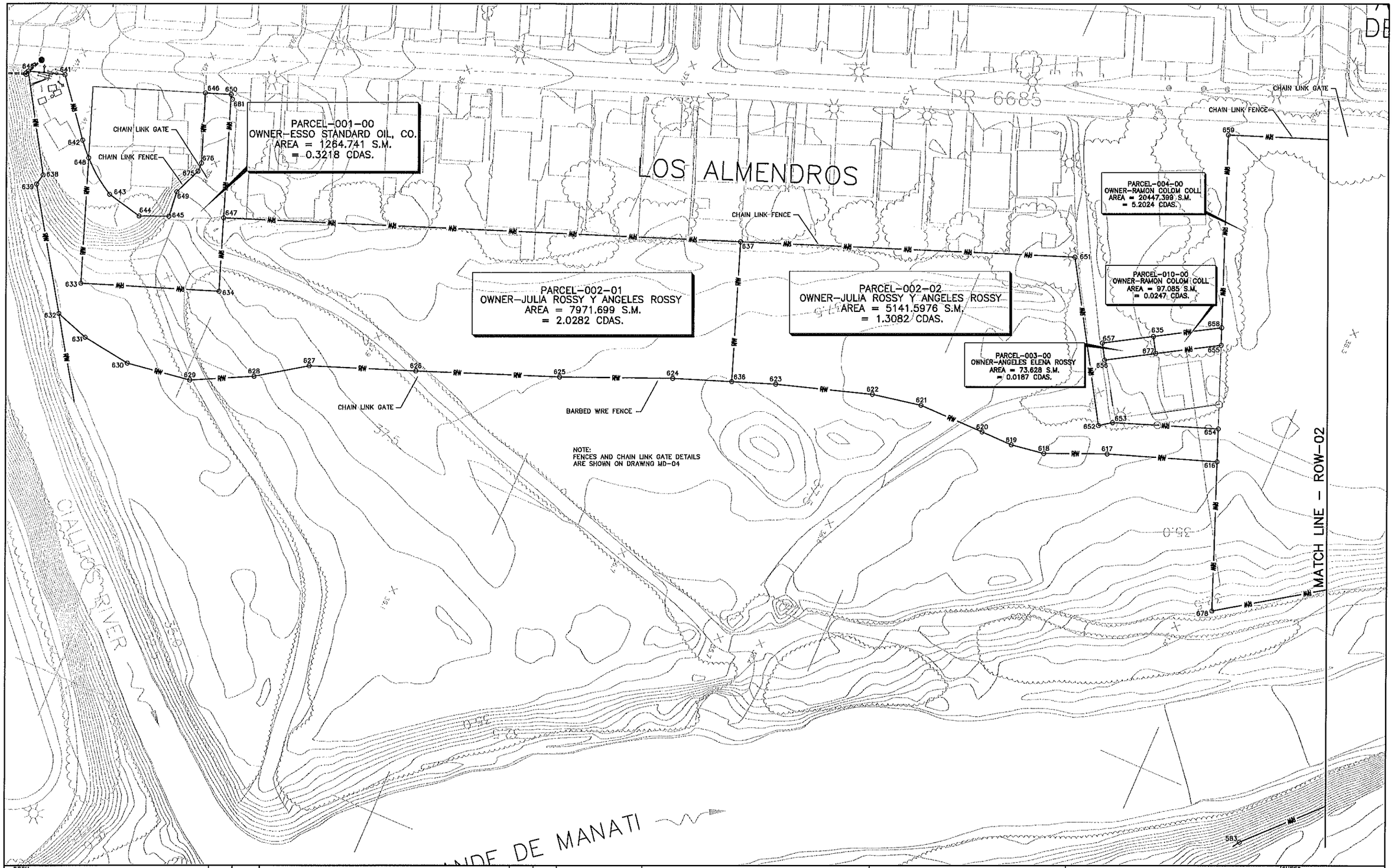
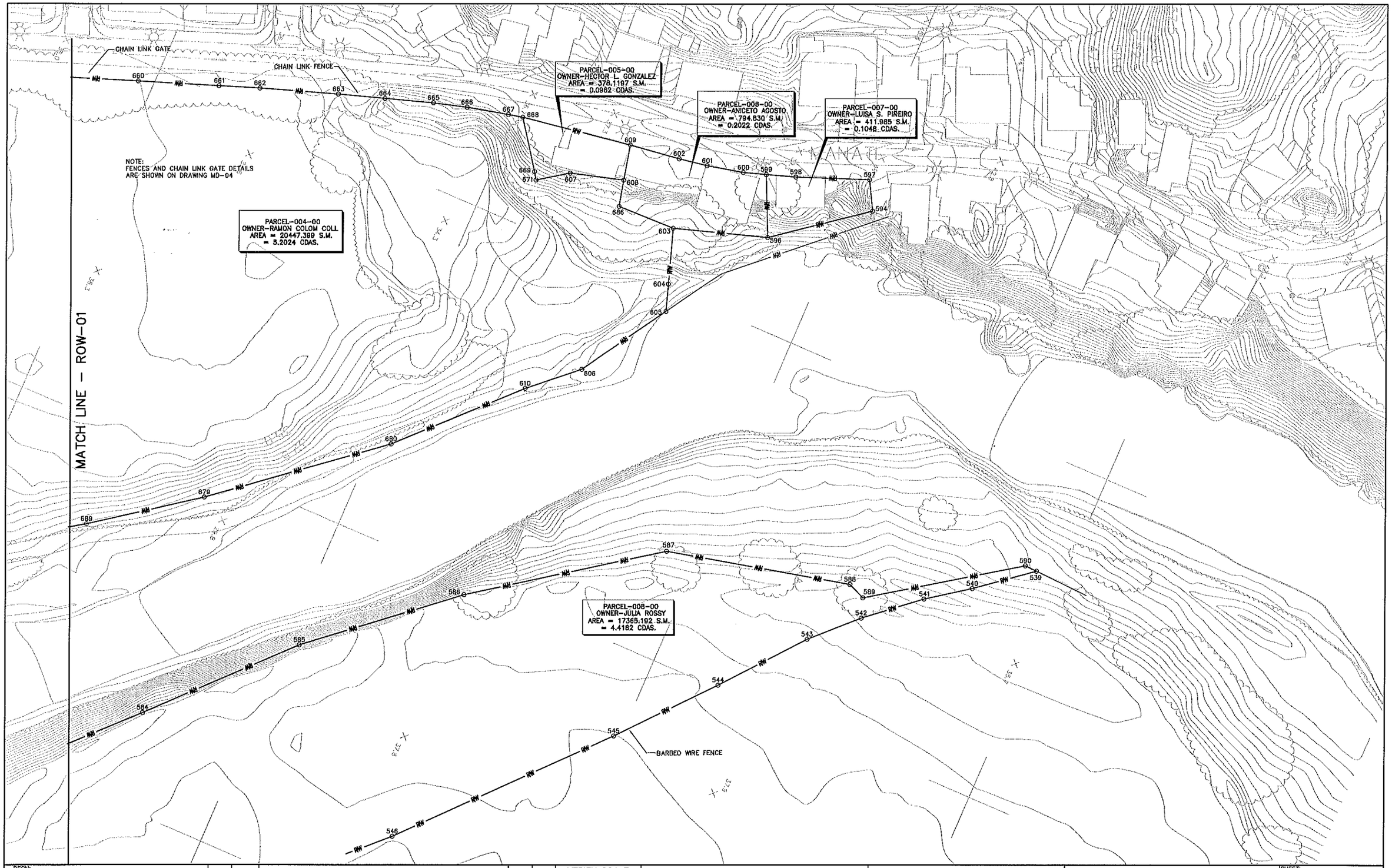


DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	LAND ACQUISITION PLANS	SHEET: 65
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: ROW-01
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:



DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES	CONSULTING ENGINEER:	LAND ACQUISITION PLANS	SHEET: 66
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.	QUIÑONES, DIEZ, SILVA Y ASOCIADOS SAN JUAN, PUERTO RICO		DWG: ROW-02
CHK:										DATE:
APVD:	NO.	DATE	REVISION	BY	APVD					PROJ:

Y:\ciales\Phase Complete (Aug 2012)\ROW 02.dwg, 8/4/2012 4:47:18 PM, 1:25.8054

RIO GRANDE DE MANATI

PRASA WWTP

PARCEL-008-00
OWNER-JULIA ROSSY
AREA = 13365.193 S.M.
= 4.4182 CDAS

BARBED WIRE FENCE

MATCH LINE - ROW-02

DSGN:						VERIFY SCALE	DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESOURCES AREA OF WATER AND MINERAL RESOURCES
DR:						AS SHOWN	FLOOD PROTECTION WORKS DOS RIOS, CIALES, P.R.
CHK:							
APVD:	NO.	DATE	REVISION	BY	APVD		

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

LAND ACQUISITION PLANS

SHEET: 67
DWG: ROW-03
DATE:
PROJ:

Y:\ciales\Phase Complete (Aug 2012)\ROW 03.dwg, 9/4/2012 4:49:41 PM, 1:26.1354

PARCEL-001-00
OWNER-ESSO STANDARD OIL, CO.
AREA = 1284.741 S.M. = 0.3218 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			640	56649.2002	148459.1901	TO BE ESTABLISH
CURVE	A=12.2127	DELTA=15°36'06"	T=8.1443	EXT=0.4189		
642-643	N 30°39'59" E	12.1750	643	56658.9661	148468.4804	TO BE ESTABLISH
RADIUS POINT		44.8500	681	56680.6175	148427.1827	TO BE ESTABLISH
643-644	N 12°59'20" E	10.5648	644	56669.2803	148468.8349	TO BE ESTABLISH
644-645	N 22°35'14" W	8.6348	645	56677.2328	148465.5184	TO BE ESTABLISH
645-649	S 84°25'19" W	7.4878	649	56676.5050	148458.0880	TO BE ESTABLISH
649-675	N 67°24'54" W	8.4988	675	56679.7690	148450.2190	TO BE ESTABLISH
675-676	S 89°39'39" W	2.5421	676	56679.7510	148447.8770	TO BE ESTABLISH
676-646	S 69°42'55" W	20.3048	646	56672.7116	148428.6314	TO BE ESTABLISH
646-650	N 19°58'16" W	7.4855	650	56679.7282	148426.0816	TO BE ESTABLISH
650-647	N 70°01'47" E	35.7619	647	56691.9421	148459.6932	TO BE ESTABLISH
647-634	N 70°01'47" E	21.2400	634	56699.1952	148479.6560	TO BE ESTABLISH
634-633	S 19°58'13" E	40.0000	633	56661.6014	148493.3173	TO BE ESTABLISH
633-648	S 70°01'47" W	36.3106	648	56649.2002	148459.1901	TO BE ESTABLISH

PARCEL-002-01
OWNER-JULIA ROSSY Y ANGELES ROSSY
AREA = 7971.699 S.M. = 2.0282 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			640	56823.1432	148443.1440	TO BE ESTABLISH
640-641	N 17°58'31" W	10.7087	641	56833.3292	148439.8393	TO BE ESTABLISH
641-642	N 51°23'29" E	19.6175	642	56845.5705	148455.1890	TO BE ESTABLISH
CURVE	A=5.4203	DELTA=96°55'28"	T=2.7135	EXT=0.0820		
642-648	N 47°55'45" E	5.4170	648	56849.2002	148459.1901	TO BE ESTABLISH
RADIUS POINT		44.8500	681	56880.6175	148427.1827	TO BE ESTABLISH
648-633	N 70°01'47" E	36.3106	633	56861.6014	148493.3173	TO BE ESTABLISH
633-634	N 19°58'13" W	40.0000	634	56899.1952	148479.6560	TO BE ESTABLISH
634-647	S 70°01'47" W	21.2400	647	56891.9421	148459.6932	TO BE ESTABLISH
647-637	N 20°40'24" W	150.3244	637	56832.5869	148406.6229	TO BE ESTABLISH
637-638	N 70°08'17" E	40.5272	638	56848.5583	148444.7393	TO BE ESTABLISH
638-624	S 20°01'52" E	17.1543	624	56830.2397	148450.6152	TO BE ESTABLISH
624-625	S 22°36'40" E	33.0058	625	56799.7709	148463.3051	TO BE ESTABLISH
625-626	S 20°53'37" E	41.7681	626	56760.7512	148478.2003	TO BE ESTABLISH
626-627	S 20°32'05" E	30.8476	627	56731.8637	148489.0209	TO BE ESTABLISH
627-628	S 34°03'06" E	16.3341	628	56718.3503	148498.1669	TO BE ESTABLISH
628-629	S 26°41'11" E	18.6598	629	56701.6494	148508.5516	TO BE ESTABLISH
629-630	S 08°08'46" E	18.7053	630	56683.1312	148509.1913	TO BE ESTABLISH
630-631	S 08°01'05" W	14.3208	631	56668.9505	148507.1037	TO BE ESTABLISH
631-632	S 18°38'22" W	10.2932	632	56659.1972	148503.9039	TO BE ESTABLISH
632-639	S 58°44'12" W	37.9834	639	56638.3638	148472.1438	TO BE ESTABLISH
639-638	N 78°08'11" W	3.2669	638	56639.0334	148468.9468	TO BE ESTABLISH
638-640	S 58°22'14" W	30.3040	640	56623.1432	148443.1440	TO BE ESTABLISH

PARCEL-002-02
OWNER-JULIA ROSSY Y ANGELES ROSSY
AREA = 5141.5976 S.M. = 1.3082 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			637	56832.5869	148406.6229	TO BE ESTABLISH
637-651	N 20°40'24" W	97.1282	651	56923.4591	148372.3336	TO BE ESTABLISH
651-652	N 58°32'23" E	49.1842	652	56949.1207	148414.2579	TO BE ESTABLISH
652-653	N 35°23'08" W	4.1683	653	56952.5270	148411.8741	TO BE ESTABLISH
653-654	N 19°52'17" W	30.6847	654	56981.3847	148401.4441	TO BE ESTABLISH
654-616	N 68°28'11" E	9.5077	616	56984.8739	148410.2884	TO BE ESTABLISH
616-617	S 19°13'35" E	31.9351	617	56954.7200	148420.8047	TO BE ESTABLISH
617-618	S 22°52'34" E	18.3128	618	56937.8478	148427.9238	TO BE ESTABLISH
618-619	S 08°32'57" E	9.7603	619	56928.1760	148429.3775	TO BE ESTABLISH
619-620	S 00°25'06" W	9.2269	620	56918.9493	148429.3101	TO BE ESTABLISH
620-621	S 00°09'19" W	19.3935	621	56899.5559	148429.2575	TO BE ESTABLISH
621-622	S 10°45'54" E	14.4233	622	56885.3864	148431.9515	TO BE ESTABLISH
622-623	S 17°17'05" E	28.2737	623	56858.3695	148438.3522	TO BE ESTABLISH
623-638	S 20°01'52" E	12.8080	638	56848.3563	148444.7393	TO BE ESTABLISH
638-637	S 70°08'17" W	40.5272	637	56832.5869	148406.6229	TO BE ESTABLISH

PARCEL-003-00
OWNER-ANGELES ELENA ROSSY
AREA = 73.828 S.M. = 0.0187 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			657	56940.6943	148391.9518	TO BE ESTABLISH
657-635	N 30°35'10" W	14.8880	635	56953.5109	148384.3763	TO BE ESTABLISH
635-677	N 59°24'41" E	4.9452	677	56956.0273	148388.6333	TO BE ESTABLISH
677-656	S 30°35'19" E	14.8880	656	56943.2111	148395.2093	TO BE ESTABLISH
656-657	S 59°24'41" W	4.9458	657	56940.6943	148391.9518	TO BE ESTABLISH

PARCEL-004-00
OWNER-RAMON COLOM COLL
AREA = 20447.399 S.M. = 5.2024 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			659	56950.1982	148322.3958	TO BE ESTABLISH
659-660	N 20°28'02" W	48.4066	660	56995.5491	148305.4692	TO BE ESTABLISH
660-661	N 19°27'08" W	23.4188	661	57017.5737	148297.8099	TO BE ESTABLISH
661-662	N 20°07'27" W	11.9068	662	57028.7536	148293.4133	TO BE ESTABLISH
662-663	N 18°52'26" W	22.8117	663	57050.3388	148288.0340	TO BE ESTABLISH
663-664	N 18°03'38" W	13.5485	664	57063.2197	148281.8338	TO BE ESTABLISH
664-665	N 18°04'52" W	14.1453	665	57076.6665	148277.4435	TO BE ESTABLISH
665-666	N 15°58'21" W	9.8847	666	57086.1696	148274.7235	TO BE ESTABLISH
666-667	N 13°15'09" W	12.1978	667	57098.0426	148271.9272	TO BE ESTABLISH
667-668	N 12°42'39" W	4.2806	668	57102.1890	148270.9919	TO BE ESTABLISH
668-669	N 54°13'50" E	16.1078	669	57111.6044	148284.0614	TO BE ESTABLISH
669-671	N 55°52'31" E	2.4980	671	57113.0058	148286.1293	TO BE ESTABLISH
671-607	N 34°52'23" W	10.1100	607	57121.3003	148280.3468	TO BE ESTABLISH
607-608	N 15°54'32" W	15.7740	608	57136.4701	148276.0250	TO BE ESTABLISH
608-686	N 76°31'54" E	7.7397	686	57138.2727	148283.5518	TO BE ESTABLISH
686-603	N 01°27'15" W	16.9999	603	57155.2671	148283.1204	TO BE ESTABLISH
603-604	N 71°27'02" E	16.2121	604	57160.4248	148298.4903	TO BE ESTABLISH
604-605	N 71°27'02" E	7.9252	605	57162.9458	148306.0038	TO BE ESTABLISH
605-606	S 57°37'54" E	29.7085	606	57147.0409	148331.0063	TO BE ESTABLISH
606-610	S 41°56'07" E	17.3599	610	57134.1338	148342.6917	TO BE ESTABLISH
610-680	S 45°43'21" E	42.0765	680	57104.7760	148372.8343	TO BE ESTABLISH
680-679	S 39°10'52" E	56.2313	679	57061.1882	148406.3598	TO BE ESTABLISH
679-689	S 36°02'06" E	34.9858	689	57032.9129	148428.9295	TO BE ESTABLISH
689-678	S 33°39'27" E	38.7096	678	57000.8924	148450.3834	TO BE ESTABLISH
678-616	S 68°28'11" W	43.1028	616	56984.8739	148410.2884	TO BE ESTABLISH
616-654	S 68°28'11" W	9.5077	654	56981.3847	148401.4441	TO BE ESTABLISH
654-655	S 68°28'11" W	24.1739	655	56972.5130	148378.0570	TO BE ESTABLISH
655-656	S 68°28'11" W	5.0668	656	56970.6535	148374.2437	TO BE ESTABLISH
656-659	S 68°28'11" W	55.7373	659	56950.1982	148322.3958	TO BE ESTABLISH

PARCEL-005-00
OWNER-HECTOR L. GONZALEZ
AREA = 378.1197 S.M. = 0.0882 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			668	57102.1890	148270.9919	TO BE ESTABLISH
668-609	N 08°54'00" W	32.3860	609	57134.1871	148265.9812	TO BE ESTABLISH
609-608	N 77°11'37" E	10.3000	608	57135.4701	148276.0250	TO BE ESTABLISH
608-607	S 15°54'32" E	15.7740	607	57121.3003	148280.3468	TO BE ESTABLISH
607-671	S 34°52'23" E	10.1100	671	57113.0058	148286.1293	TO BE ESTABLISH
671-669	S 55°52'31" W	2.4980	669	57111.6044	148284.0614	TO BE ESTABLISH
669-668	S 54°13'50" W	16.1078	668	57102.1890	148270.9919	TO BE ESTABLISH

PARCEL-006-00
OWNER-ANICETO AGOSTO
AREA = 794.830 S.M. = 0.2022 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			609	57134.1871	148265.9812	TO BE ESTABLISH
609-602	N 07°50'34" W	14.7900	602	57148.6388	148263.9831	TO BE ESTABLISH
602-601	N 09°05'34" W	8.3391	601	57157.0731	148262.6452	TO BE ESTABLISH
601-600	N 12°49'05" W	10.7300	600	57167.5357	148260.2647	TO BE ESTABLISH
600-599	N 18°25'13" W	6.7007	599	57173.8931	148258.1474	TO BE ESTABLISH
599-596	N 65°10'23" E	18.2459	596	57181.5542	148274.7069	TO BE ESTABLISH
596-603	S 17°44'52" E	27.6007	603	57155.2671	148283.1204	TO BE ESTABLISH
603-686	S 01°27'15" E	16.9999	686	57138.2727	148283.5518	TO BE ESTABLISH
686-609	S 76°54'35" W	18.0394	609	57134.1871	148265.9812	TO BE ESTABLISH

PARCEL-007-00
OWNER-LUISA S. PIÑEIRO
AREA = 411.985 S.M. = 0.1048 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			599	57173.8931	148258.1474	TO BE ESTABLISH
599-598	N 18°25'13" W	8.6598	598	57182.1092	148255.4110	TO BE ESTABLISH
598-597	N 21°12'08" W	21.4999	597	57202.1537	148247.8353	TO BE ESTABLISH
597-594	N 61°03'49" E	9.1275	594	57206.5700	148255.6233	TO BE ESTABLISH
594-596	S 37°20'19" E	31.4839	596	57181.5542	148274.7069	TO BE ESTABLISH
596-599	S 65°10'23" W	18.2459	599	57173.8931	148258.1474	TO BE ESTABLISH

PARCEL-008-00
OWNER-JULIA ROSSY
AREA = 17365.192 S.M. = 4.4182 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			590	57288.2519	148332.1512	TO BE ESTABLISH
590-539	N 02°42'03" E	3.5981	539	57291.8441	148332.3208	TO BE ESTABLISH
539-540	S 38°24'22" E	19.2938	540	57276.7250	148344.3065	TO BE ESTABLISH
540-541	S 35°31'53" E	14.3318	541	57265.0620	148352.8353	TO BE ESTABLISH
541-542	S 40°04'25" E	19.0600	542	57250.4769	148364.9056	TO BE ESTABLISH
542-543	S 44°35'52" E	16.8687	543	57238.4441	148376.7706	TO BE ESTABLISH
543-544	S 50°26'23" E	29.0189	544	57219.9623	148399.1428	TO BE ESTABLISH
544-545	S 49°12'24" E	33.6394	545	57197.9846	148424.6102	TO BE ESTABLISH
545-546	S 47°38'16" E	70.5017	546	57150.4791	148476.7036	TO BE ESTABLISH
546-547	S 44°04'37" E	38.2867	547	57122.9737	148503.3367	TO BE ESTABLISH
547-548	S 40°45'18" E	56.8094	548	57079.9402	148540.4234	TO BE ESTABLISH
548-549	S 33°35'41" E	20.3989	549	57062.9484	148551.7105	TO BE ESTABLISH
549-550	S 22°44'20" E	8.4732	550	57055.1339	148554.9858	TO BE ESTABLISH
550-551	S 11°06'48" E	38.2018	551	57017.6464	148562.3491	TO BE ESTAOLISH
551-552	S 29°50'00" E	20.8842	552	56999.7053	148572.6390	TO BE ESTABLISH
552-553	S 26°44'05" E	15.6275	553	56985.7484	148579.6692	TO BE ESTABLISH
553-554	S 04°07'12" W	11.9493	554	56973.8300	148578.8107	TO BE ESTABLISH
554-555	S 12°03'44" E	10.0425	555	56964.0093	148580.9093	TO BE ESTABLISH
555-558	S 30°49'36" E	5.2231	558	56959.5241	148583.5858	TO BE ESTABLISH
558-557	S 32°32'19" E	33.7366	557	56931.1892	148601.8988	TO BE ESTABLISH
557-558	S 33°03'44" E	37.9058	558	56899.4212	148622.5763	TO BE ESTABLISH
558-559	S 30°13'07" E	24.4606	559	56878.2845	148634.8873	TO BE ESTABLISH
559-560	S 20°28'58" E	16.5788	560	56862.7523	148640.8790	TO BE ESTABLISH
560-577	S 12°47'21" E	2.3248	577	56860.4853	148641.1036	TO BE ESTABLISH
577-578	N 39°02'56" W	18.1163	578	56874.5545	148620.7806	TO BE ESTABLISH
578-579	N 37°21'34" W	39.1749	579	56905.6924	148606.0087	TO BE ESTABLISH
579-580	N 46°08'16" W	35.1654	580	56930.0733	148580.6397	TO BE ESTABLISH
580-581	N 25°03'19" W	58.2743	581	56982.8639	148555.9810	TO BE ESTABLISH
581-582	N 34°20'59" W	48.8825	582	57021.5705	148529.5078	TO BE ESTABLISH
582-583	N 57°52'52" W	24.8465	583	57034.7809	148508.4841	TO BE ESTABLISH
583-584	N 45°51'47" W	50.0836	584	57069.6439	148472.5345	TO BE ESTABLISH
584-585	N 46°37'09" W	49.4575	585	57103.8136	148436.5885	TO BE ESTABLISH
585-586	N 40°15'13" W	48.8494	586	57141.8582	148404.3773	TO BE ESTABLISH
586-587	N 35°20'32" W	80.2085	587	57190.7695	148369.5503	TO BE ESTABLISH
587-588	N 13°04'02" W	54.2331	588	57243.5982	148357.2884	TO BE ESTABLISH
588-589	N 22°11'42" E	5.4197	589	57248.6183	148359.3358	TO BE ESTABLISH
589-590	N 34°26'41" W	48.0823	590	57288.2519	148332.1512	TO BE ESTABLISH

PARCEL-010-00
OWNER-RAMON COLOM COLL
AREA = 97.085 S.M. = 0.0247 CDAS.

COURSE	BEARING	DISTANCE	PT#	NORTHING	EASTING	DESCRIPTION
			635	56953.5109	148384.3763	TO BE ESTABLISH
635-658	N 30°35'10" W	19.9133	658	56970.6533	148374.2437	TO BE ESTABLISH
658-655	N 68°28'11" E	5.0668	655	56972.5130	148378.0570	TO BE ESTABLISH
655-677	S 30°24'39" E	19.1157	677	56956.0273	148388.6333	TO BE ESTABLISH
677-635	S 59°24'41" W	4.9452	635	56953.5109	148384.3763	TO BE ESTABLISH

DSGN:						
DR:						
CHK:						
APVD:						
	NO.	DATE	REVISION	BY	APVD	

VERIFY SCALE

AS SHOWN

DEPARTMENT OF NATURAL AND ENVIRONMENTAL RESDURCES
AREA OF WATER AND MINERAL RESOURCES

FLOOD PROTECTION WORKS
DOS RIOS, CIALES, P.R.

CONSULTING ENGINEER:
QUIÑONES, DIEZ, SILVA Y ASOCIADOS
SAN JUAN, PUERTO RICO

LAND ACQUISITION PLANS

SHEET: 88
DWG: ROW-04
DATE:
PROJ:

Y:\cadd\Phase Complete (Aug 2012)\ROW 04.dwg, 9/4/2012 4:50:30 PM, 1:26.2438

Attachment 2
Geotechnical Information

RIO GRANDE DE MANATI FLOOD RISK MANAGEMENT STUDY, CIALES, PUERTO RICO

Engineering Appendix

ATTACHMENT 2 – Geotechnical Information

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RIO GRANDE DE MANATI FLOOD RISK MANAGEMENT STUDY, CIALES, PUERTO RICO

Engineering Appendix

ATTACHMENT 2 – Geotechnical Information

1 STUDY AREA – GENERAL

The Municipality of Ciales is located on the northern slopes of the Central Mountain Range, approximately 25 miles southwest of San Juan and has a population of approximately 19,000 (Fig. 1). During an initial site visit conducted on 26 October 2018, members of the Project Delivery Team (PDT) with input from the Municipality and local Sponsor defined the limits of the study as the flood-prone area (i.e., within the 500-year floodplain) extending approximately 12,500 linear feet along the Rio Grande de Manati from the PR-145 Bridge downstream to the PR-6685 Bridge (Fig. 1). The study area encompasses several communities, including the City of Ciales, Residencial Dos Rios, Dos Rios, and Alturas De Ciales (Fig. 1).

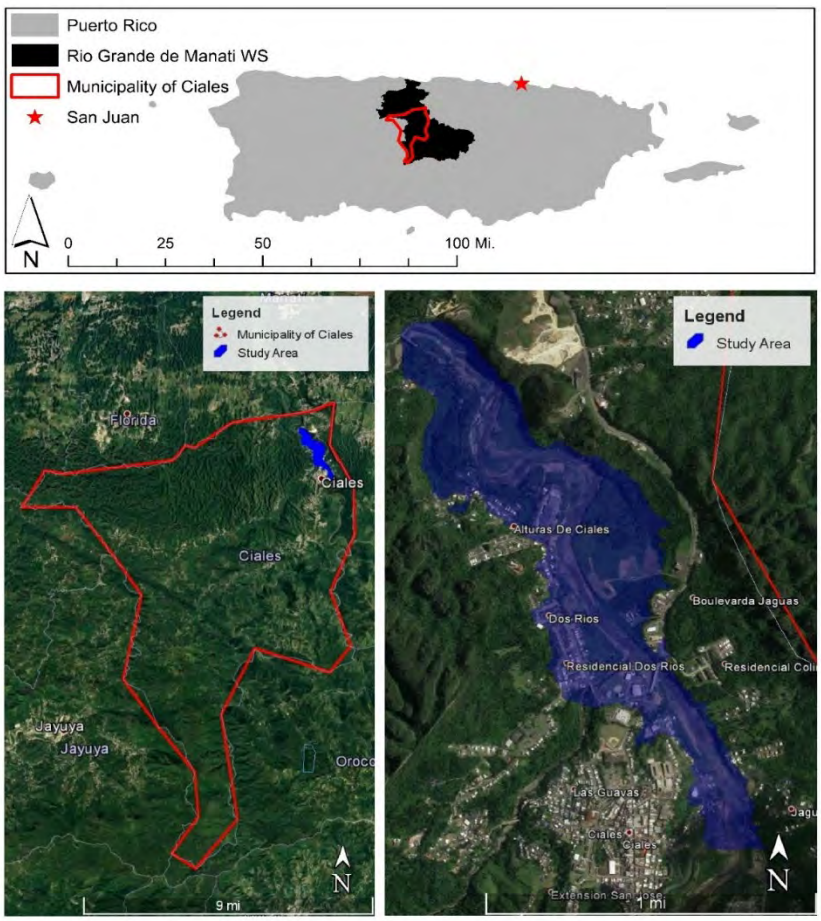

Figure 1- Location of the Rio Grande de Manati watershed.

1.1 GEOTECHNICAL INFORMATION

Available geotechnical investigation performed for bridge foundations and flood control works in and around the project area were reviewed to evaluate the type and condition of subsurface materials for this feasibility study. Area geology and seismicity, subsurface soil/ bedrock types, laboratory test results, and other pertinent geotechnical information contained in the reports is summarized below.

1.1.1 Geology and Seismicity

Puerto Rico has volcanic past. The oldest rocks exposed within the limits of the Ciales and Manati Municipalities are young from a geologic standpoint. The town of Ciales sits over Granodiorite, a Plutonic igneous rock. East and west of the Ciales-Dos Rios are large extensions of Lares Limestone. This is a massive hard crystalline pale-orange to nearly white coralline limestone where sinkholes are abundant. Quaternary alluvium and colluvium border the river and talus slopes at the interior face of the Lares Escarpment.

The island of Puerto Rico is seismically highly active. According to UBC code, Puerto Rico lies within Seismic Zone 3 and as such peak ground acceleration of 0.3g should be considered in the evaluation of civil infrastructure and flood protection works.

1.1.2 Subsurface Investigation

Five (5) borings were performed as part of subsoil investigation for the Bridge over Manati River (PR-149 Bridge) in March 1971. The investigation was conducted to gather subsurface information at the abutments and piers of the bridge in order to provide foundation recommendations for the construction of the structure. Borings B-1 and B-5 were drilled for left and right abutments, respectively. Borings B-4, B-3 and B-2 were drilled for intermediate piers P-1, P-2 and P-3, respectively. The borings were drilled to depths ranging from 28 ft. to 55 ft. In the field SPT blow counts were measured in the borings. SPT blow count is a measure of soils consistency (fine grained soils, i.e., clay and silt) and density (coarse grained soils, i.e., sand and gravel) and is often used to derive soil's parameters for design. Coring was performed in the borings after auger refusal was met. Generally used correlation of SPT N value with the soils relative density for coarse grained soil and, consistency and shear strength for fine grained soil is presented in Table 1 below.

Table 1 - SPT N-Value and its Correlation to Coarse Grained and Fine Grained Soils.

Relative Density of Coarse Grained Soils (Sand and Gravel)		Consistency of Fine-Grained Soils (Clay and Silt)		
Descriptive Term	**SPT N-Value**	**Descriptive Term**	**Unconfined Compressive Strength (psf)**	**SPT N-Value**
Very Loose	0 -.4 3	Very Soft	Less than 500	less than 2
Loose	4 – 10	Soft	500 - 1000	2 - 4
Medium Dense	10 – 30	Medium Stiff	1,000 – 2,000	4 – 8
Dense	30 – 50	Stiff	2,000 – 4,000	8 – 15
Very Dense	50 and over	Very Stiff	4,000 – 8,000	15 - 30
		Hard	greater than 8,000	> 30

As part of flood control works, subsurface investigation was performed for the design and construction of different structures in Ciales, Puerto Rico. Altogether 17 borings were drilled to depths varying from 20 to 40 feet along the banks of the Rio Grande de Manati River. Eleven borings (Boring 1 thru Boring 11), were drilled on the southern side of the river and six borings (Boring 12 thru Boring 17), were drilled on the northern side of the river. Field and laboratory tests were conducted during the investigation. Field test consist of measurement of SPT N values and pocket penetrometer tests. Laboratory test consist of moisture content, specific gravity, unit weight, plasticity and grain size analysis tests on the selected samples from the borings.

1.1.3 Subsurface Soil and Bedrock

At the boring performed for the bridge over Manati River, the soil profile described by the test borings B-1 through B-4 indicate that, the subsurface soil consist of deep flood plain and channel deposit extending deeper toward the south. These deposits consist of stratified layers of sand, sand and gravel, boulders and thin layers of medium clayey silt. The thin layers of medium clayey silt were found erratically along the site possibly on account of an old river meander during previous geologic activities. 2 to 4 feet thick sandy clay was encountered in south side borings B-1, B-2 and B-3 at the ground surface. Volcanic rock was encountered in borings B-3 and B-4 below the flood plain deposit.

At the right (north) abutment of the bridge and corresponding to Boring No. 5, the subsurface soil consists of surface clayey soil overlying clayey sandy silt derived from the heavily weathered underling volcanic rocks.

The topography of the site is level ground towards the south where the river can extend during heavy flood. Toward the north abutment where residual soil is encountered, the area consists of a hilly section where erosion of the river banks is minimum.

The subsurface conditions at the location of the 15 flood control borings consist of two main strata. The upper stratum is comprised of interbedded layers of silty and sandy clay and clayey and silty sand. The lower layer consists of sandy gravel with cobbles and boulders, with traceand layers of clay and silt. . Based on the review borings, the upper stratum of fine grained materials consisting of clayey silty soils with trace sand and gravel are present to depths ranging from 2 to 15 feet below the ground surface. Weathered rock was encountered in some of the borings below the coarse grained soils at a depth below 35 feet.

1.1.4 Field and Laboratory Test Results and Preliminary Design Parameters

SPT N-values measured in the borings (B-1 through B-5) drilled for the design of bridge over Manati River is shown in the plot below in Figure 2 Based on the N values shown in the plot, the top 10-12 feet of alluvial soils is loose to medium dense (SPT N-values between 4 - 29). Below this depth, the sand and gravel are dense to very dense.

Borings B-1 is a left abutment boring, Borings B-2, B-3 and B-4 were drilled for Piers P-3, P-2 and P-1, respectively; Boring B-5 is a right abutment boring). N-values greater than 100 is shown as N-value of 100.

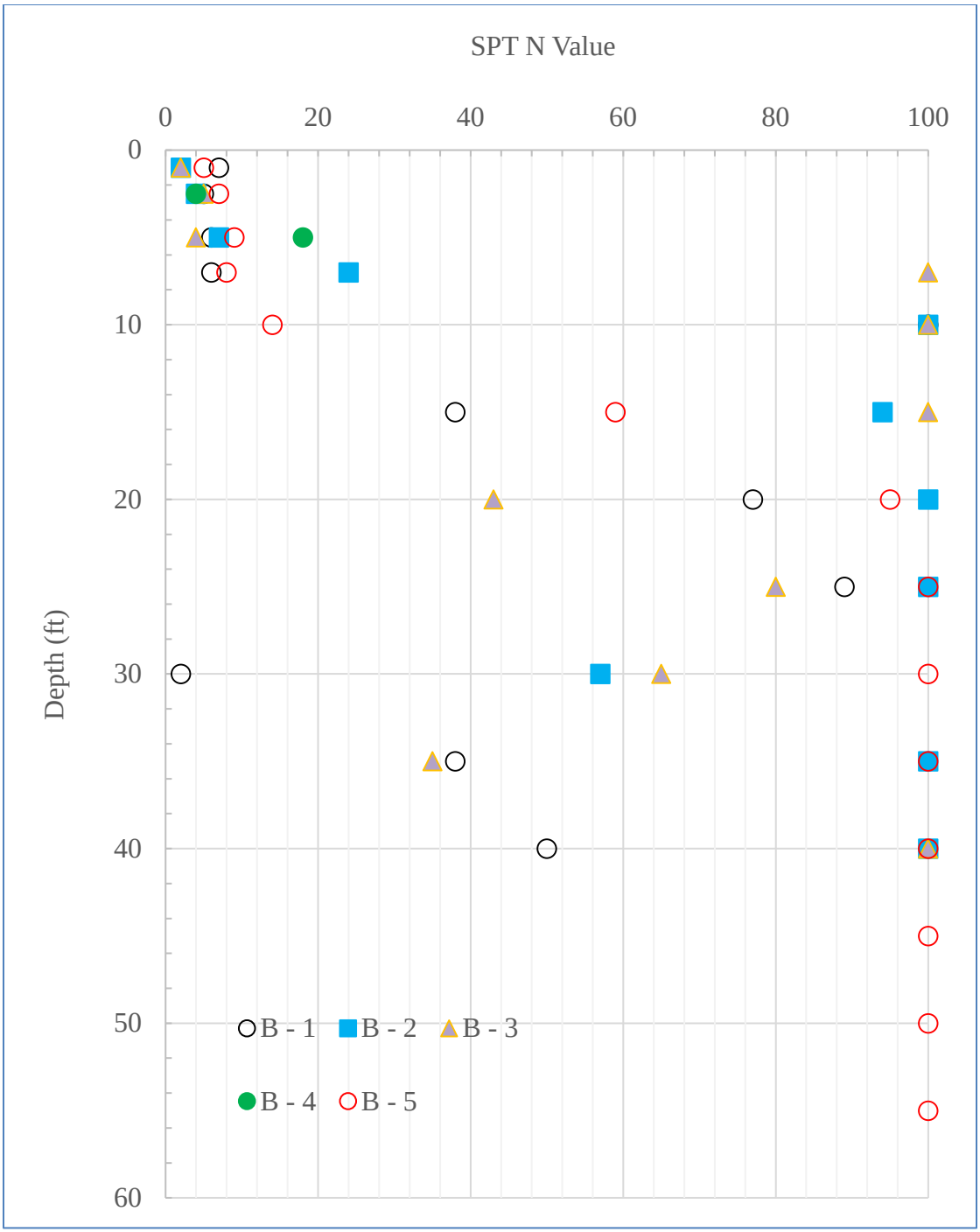

Figure 2 - SPT N-Values Measured at Borings Drilled for Bridge Foundation for Bridge 149

Table 2 below show the results of Atterberg limits (liquid limit and plasticity index) test measured in selected soil samples from the borings drilled for flood control works. Plasticity Index of 1-10, 11-30 and >30 indicate low, medium and high plastic soils, respectively. Undrained shear strength of the corresponding samples are also shown in the table. Undrained shear strength reported is half the value of unconfined compressive strength measured using pocket penetrometer. Based on the test results the near surface fine grained soils is medium plastic and of medium stiff consistency. For preliminary design calculation, an undrained shear strength of about 750 psf can be assigned to these soils.

Table 2 - Plasticity and Shear Strength Test Results of Fine Grained Soil Samples from Borings Drilled for Flood Control Works, Ciales.

S.N.	Boring No.	Sample No.	Sample Depth (feet)	USCS Classification	Water Content (%)	Liquid Limit (%)	Plasticity Index (%)	Undrained Shear Strength (psf)
1	B-3	2	2	Lean Clay	32	46	20	1,500
2	B-6	2	2	Lean Clay	31	41	18	1,000
3	B-8	4	6	Lean Clay	38	51	25	600
4	B-10	7	10	Organics	52	62	29	250
5	B-12	4	6	Lean Clay to Silty Sand	28	42	20	2,000

SPT N value measured in borings drilled for flood control works is shown in Figure 3 (borings Southside of Rio Grande de Manati River) and Figure 4 (borings Northside of Rio Grande de Manati River). Based on the measured SPT values, the relative density of soil is generally medium dense in the upper strata consisting of clayey and silty sand and grades to dense to very dense in the lower strata consisting of sand, gravel and cobble. Soils effective friction angles of 30 and 34 degrees can be assigned to upper and lower strata of coarse grained soils, respectively. N-values greater than 100 is shown as N-value of 100.

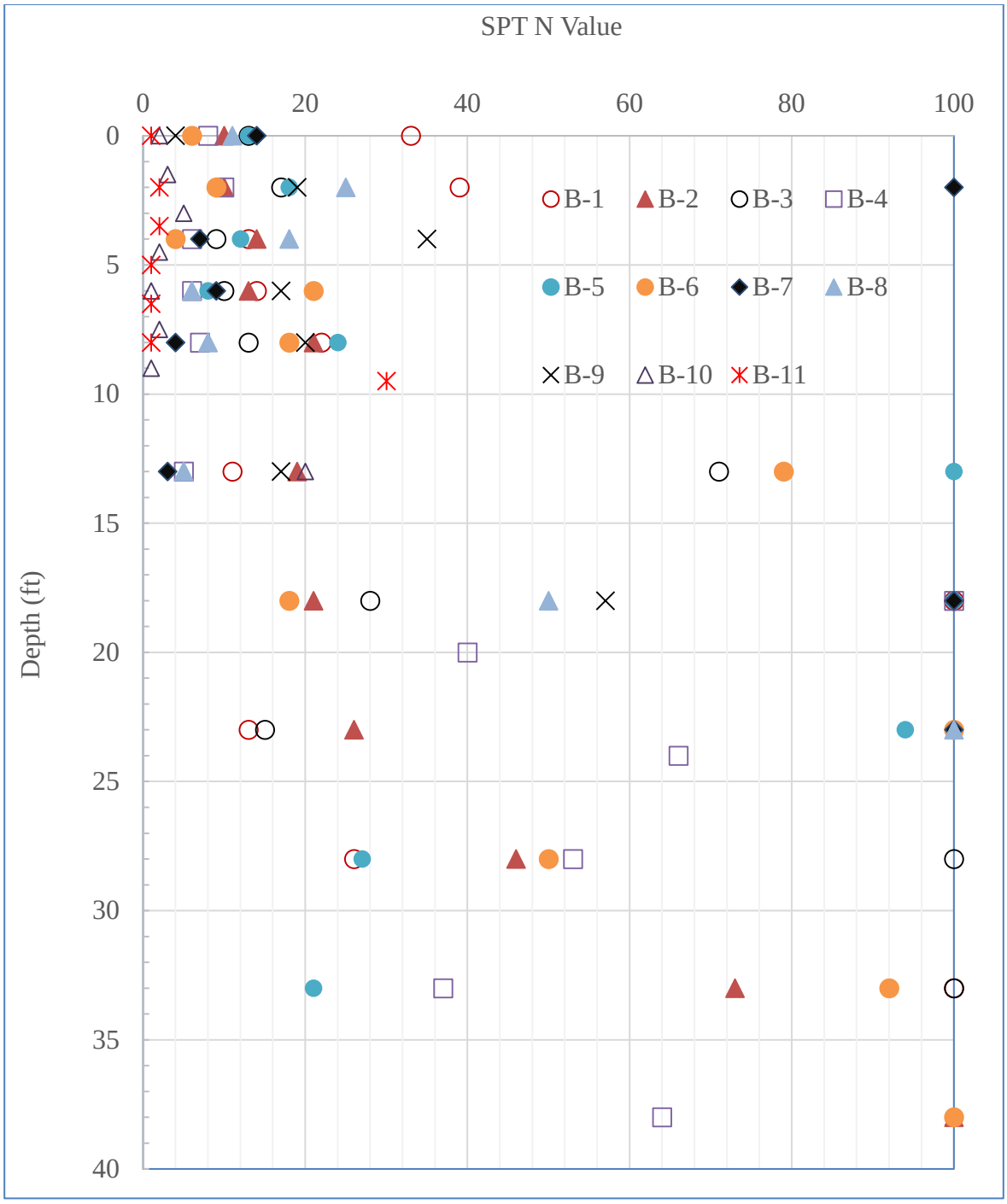

Figure 3 - SPT N-Values Measured at Borings Drilled on Southside of Rio Grande de Manati River for Flood Control Works.

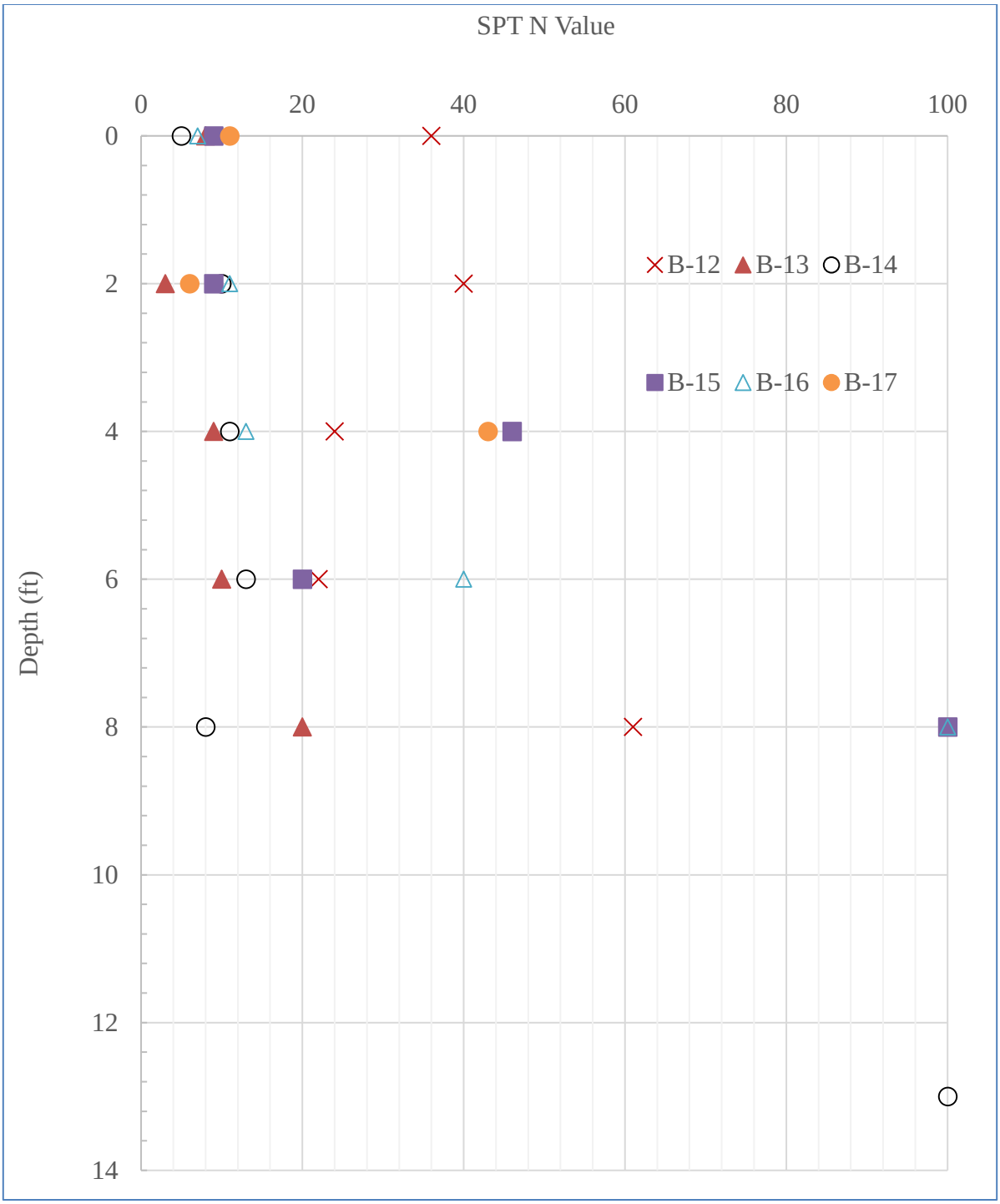

Figure 4 - SPT N-Values Measured at Borings Drilled on Northside of Rio Grande de Manati River for Flood Control Works.

Grain size distribution tests were performed on selected samples from the borings drilled for flood control project. The results of the grain size test is plotted in Figure 5. Percent of fine grained (silt size and clay size) fraction was not determined. In total, fine grained fraction ranged from 5 to 63 percent. Particle size ranges are Gravel (75 mm - 4.75 mm), Sand (4.75 mm - 0.075 mm), Silt (0.075 mm - 0.002 mm) and Clay (less than 0.002 mm).

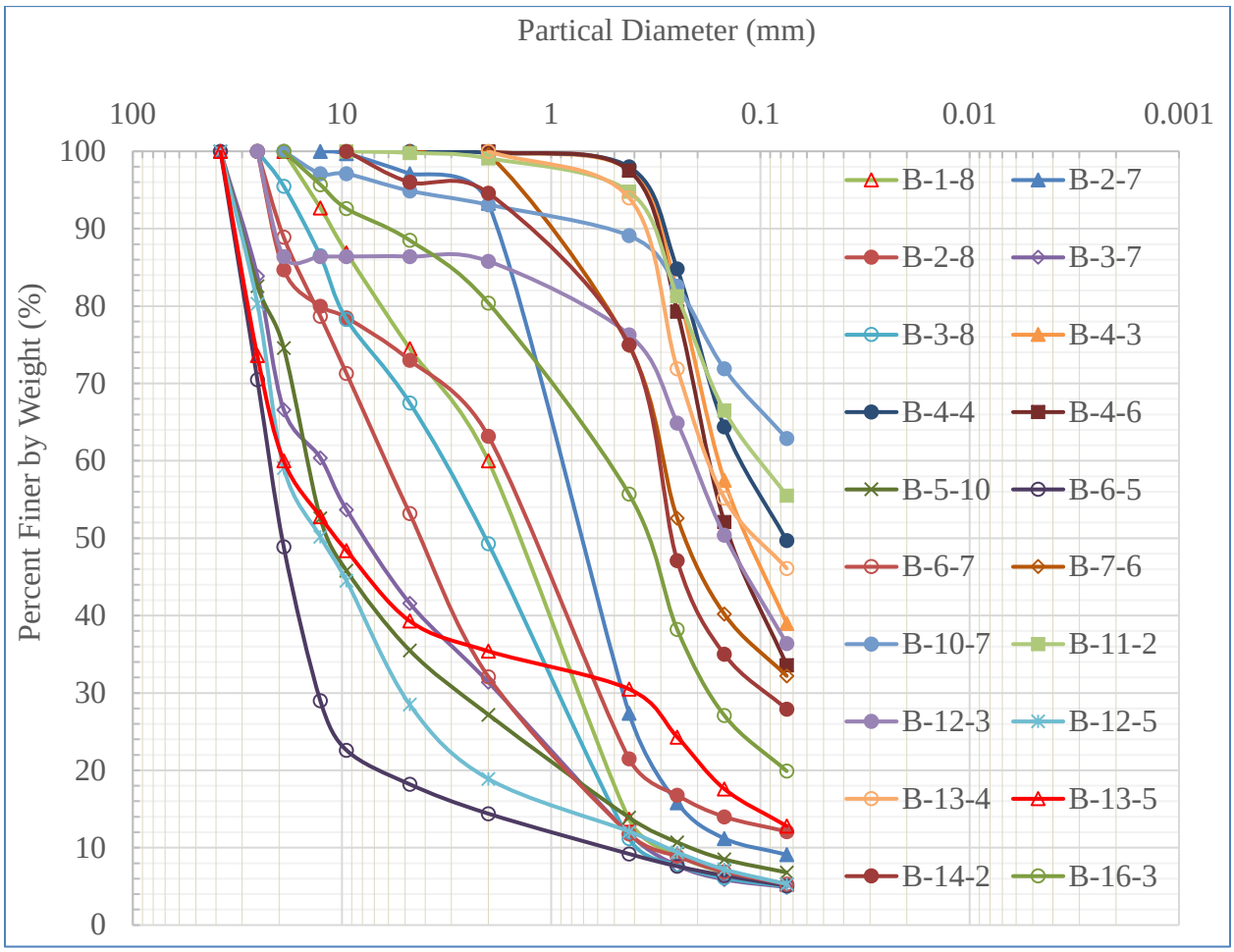

Figure 5 - Grain Size Distribution Plot of Samples from Borings Drilled for Flood Control Works, Ciales.

2 Geotechnical Considerations for the Alternatives Considered

2.1 Assumptions

Preliminary analyses performed for this Feasibility Study is based on the existing data provided by the sponsor. Available geotechnical information was used to interpret subsurface soil and rock types, and derive engineering parameters to formulate geotechnical recommendations for the planned structures related to Alternatives considered for implementation at the site.

A reference list of existing documents that were reviewed is provided with this Appendix.

2.2 Recommendation

Conceptual design recommendations of project features are described below. The recommendations are based on available geotechnical information in the vicinity of the project. Additional site specific exploration/ investigation will be needed during final design phase of any of the non-relocation based alternatives or Options that might be implemented. . Relevant USACE Engineering Design Manuals to develop the design assumptions/ recommendations are listed with this Appendix.

2.2.1 Bridge Scour

Scour susceptible materials are present in the Rio Grande de Manati River flood plain. Based on the SPT blow counts measured in PR-149 bridge borings, the top 10 to 12 feet of alluvial soil is loose to medium-dense which is likely to be highly erodible. Below this depth, the sand and gravel are dense to very dense.

The report of the subsoil investigation (1971) performed for this bridge recommended erosion protection using heavy rocks at the left (south) abutment and extending to the existing highway PR 145.

Scour Evaluation Report Phase 2 (URS 2012) indicated possible 9 to 16 feet of scour at bridge piers and abutments.

Significant erosion, transport, and deposition of sediment may occur during storm events which would otherwise not occur in normal flow conditions.

2.2.2 Streambank

The recommendation provided in the subsoil exploration report (2005) for flood control works indicate that cut slopes with an inclination of 2H:1V was proposed along the eastern bank of the Grande de Manati River for any widening of the channel. It was recommended that the existing soil at the site can withstand the proposed cut provided the face of the slope is protected by a layer of filter fabric and riprap mattress.

Based on the existing topography and flood elevation, the improvement may require maintaining and or constructing up to 20 feet high river bank in the river. Backfill required for constructing the bank slope can be either fine or coarse grained soils. Random fill, organics and highly plastic soils should not be used as a backfill. Highly compressible organic was encountered in some of the borings performed for the flood control works north of the Rio Grande de Manati River.

For a conceptual design, 2.5H : 1V bank slope is recommended based on the infinite slope analysis with soil's average friction angle of 30 degrees and slope stability factor of safety of 1.5 (Figure 6). The analysis does not consider the pore water pressure in the slope which will have an effect to reduce the factor of safety. A 3H : 1V slope should be more stable and ideal. Future slope design should include analysis of seismic stability given the higher seismic potential in the region.

Infinite Slope Analysis
(applies to material with zero cohesion)

Equation:
From EM 1110-2-1902, Equation C-27

$$F = \frac{\tan \phi'}{\tan \beta}$$

(The equation assumes no pore water pressure)

where ϕ' = effective friction angle (degree)
β = slope angle (degree)

Slope Angle:

Vertical, V =	1	
Horizontal, H =	2.5	
tan β =	0.381	radian

Soil's Property

Effective Friction, ϕ' =	30	degree
	0.577	radian
Factore of Safety, F =	1.52	

Figure 6 - 2.5H : 1V Infinite Slope Stability Calculation.

2.2.3 Flood Wall

Flood wall ranging in height from 6 to 8 feet will be constructed to protect the existing waste water treatment plant (WWTP). Subsurface investigation was performed in the vicinity of the WWTP for the flood control works (2005). Boring B-12 was performed down of the WWTP. Mixture of sandy and clayey soils were encountered in the boring to the boring termination depth of 20 feet. The top 4 feet of materials encountered in the boring may be fill consisting of sand, gravel and limestone fragments. SPT blow counts measured in the borings ranged from 22 to 61 in the medium dense and very dense soils, respectively. Pocket penetrometer tests in the clayey soils indicated undrained shear strength of at least 1,000 psf.

Based on the level of protection needed, an I-type of flood wall is recommended in the area of WWTP. I-walls are generally suitable for protection in narrow restricted areas where the exposed wall height is not more than 10 feet. I-walls consist of driven sheet piles capped by a concrete wall. The vast majority of I-walls within the USACE inventory fall into the Type II I-wall which is essentially the sheetpile wall with a concrete cap placed above ground with needed embedment for stability.

Alluvium soils consisting of sand, gravel and cobbles investigated in this area are highly permeable based on the laboratory grain size analysis results. Sheet pile may need to be extended to greater depth to provide seepage cutoff below the I-wall. In general the sheet pile cut-off should penetrate the coarse grained alluvium which may be greater than 35 feet in depth.

2.3 Conclusions

Based on the existing data, erodible soils are present in the channel and flood plain of Rio Grande de Manati River. Scour evaluation study indicated considerable scour along the PR-149 Bridge piers and abutments.

The island of Puerto Rico is seismically highly active. This should be considered in the future design of slope and other channel improvement methods.

The recommendation contained in the report is based on the review of the existing subsurface investigation and should only be considered as preliminary. Detail site specific subsurface investigation should be performed during the design phase of the project.

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EM 1110-2-2502 USACE Engineering and Design, Retaining and Flood Walls, September 1989

EM 1110-2-1601 USACE Hydraulic Designs of Flood Control Channels, June 1994

Attachment 3
Hydrologic and Hydraulic (H&H) Information

RIO GRANDE DE MANATI FLOOD RISK MANAGEMENT STUDY, CIALES, PUERTO RICO

Engineering Appendix

ATTACHMENT 3 – Hydrologic and Hydraulic (H&H) Information

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ATTACHMENT 3 – Hydrologic and Hydraulic (H&H) Information

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1 MODELING OF ALTERNATIVES

1.1 General

The Municipality of Ciales, Puerto Rico has a long history of flooding during severe storm and hurricane events. United States Geological Survey (USGS) data indicate the Rio Grande de Manati has reached flood stage 35 times within the past 50 years. A study was completed in 2007 for the Federal Emergency Management Agency (FEMA) by the URS Group, Inc. and Dewberry to develop new flood hazard information in the wake of flooding caused by Tropical Storm Jeanne in 2004. The study included updating the hydrology and creating a 1-dimensional (1D), steady state hydraulic model in HEC-RAS (URS Group, Inc., 2006; URS Group, Inc., 2007). USACE obtained the HEC-RAS model, and supporting hydrology and hydraulic files, in 2019. The HEC-RAS model covers approximately 21 miles of the Rio Grande de Manati (from Route 145 to its confluence with Atlantic Ocean). This study focuses on the upstream extent of the Rio Grande de Manati, which spans from the Route 145 bridge to the Route 6885 bridge. Input for the existing conditions hydraulic model retrieved from FEMA is summarized below. Very minimal updates to the retrieved model were made, as stated below, so previous calibration and verification runs of the existing conditions model are assumed to be relevant.

1.2 Existing Conditions - Alternative 0 (No Action)

1.2.1 Model Input

1.2.1.1 Geometry

For the existing conditions geometry data, a Triangular Irregular Network (TIN) developed from Light Detection and Ranging (LiDAR) data was used to prepare the Rio Grande de Manati hydraulic model. The hydraulic cross sections were cut from the digital terrain model for the HEC-RAS hydraulic model. Generally, the survey data were used to develop the channel portion of the cross-section geometry while the TIN was the source of overbank topography (URS Group, Inc., 2007).

This study is primarily focused on the upstream extent of the hydraulic model that was completed for FEMA in 2007. The primary area of interest for this study is between the Route 145 bridge and the Route 6885 bridge along the Rio Grande de Manati. The inclusion of two interpolated cross sections were added to the existing conditions model in order to sufficiently model the alternatives and compare with the existing conditions model. The geometry for the two interpolated cross sections were based solely on the adjacent cross sections in the existing conditions model.

Manning's roughness coefficient values were determined for each cross section using the Cowan (1956) procedure outlined in "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Floodplains". The ground photographs acquired during a field survey were used in conjunction with the 2004 aerial images to estimate Manning's roughness coefficients for the channel and overbank areas. Assigned channel Manning's n roughness coefficients ranged from 0.035 to 0.058, and overbank values ranged from 0.015 to 0.19, all of which were in a reasonable range for the terrain being evaluated (URS Group, Inc., 2007).

There are seven total bridges in the FEMA model, although only three of those are within the project area: Route 6885, Route 149, and Route 145. It was noted that the most upstream bridge crossing, Route 145, was washed out as a result of Hurricane Maria in 2017, and a temporary bridge is currently located in the same approximate location. No design information is available for the temporary and/or proposed bridge crossing at that approximate location, so Route 145 was retained in the model to be conservative.

Note that Post-Maria LiDAR was not available at the commencement of this study, and the PDT was directed by the vertical team to use available, pre-Maria LiDAR due to the condensed timeline. It is recommended that post-Maria LiDAR be incorporated into the hydraulic model, wherever available, and that new wet sections be surveyed. Based on imagery pre- and post-Maria, the overbank land cover appear to be similar, although the channel geometry is noticeably different in certain areas, particularly around bends due to sediment erosion and deposition.

The hydraulic model was retrieved from FEMA and was previously calibrated based on the available data at the time. No new data was available at the commencement of this study, so the FEMA model was assumed to be representative of existing conditions. The PDT is aware of the limitations of the FEMA model and highly recommends the incorporation of new LiDAR and survey data and re-calibration during the design phase.

1.2.1.2 Steady Flow Data

The existing conditions model included four flows profiles for Rio Grande de Manati at locations along the studied reach, the 10%, 2%, 1%, and 0.2% annual chance peak flow discharges. The discharges were based on the Log Pearson Type III statistical analysis of systematic annual peak flow data recorded at the Ciales and Highway 2 gages. The discharges at un-gaged sites along the reach were calculated using the transfer equation based on drainage area ratio to a specific power, and the power was driven from the one-variable (drainage area) regression equation defined in USGS WRI 99-4142 (URS Group, Inc., 2006).

Additional flows (50%, 20%, 4% and 0.5% annual chance peak flow discharges) were calculated for locations of interest for this study, primarily because eight flows are required for economic analysis of alternatives. In accordance with the previously calculated flow profiles, these additional flows were also calculated using the transfer equation based on drainage area ratio to a specific power. Upon closer review of the flows assigned to specific flow change locations, it was determined that some of the flow change locations, as described in the FEMA FIS, did not align with their associated descriptions and drainage areas. Therefore, in addition to inclusion of four additional flow profiles, it was also decided to correct the cross sections associated with flows based on associated descriptions and drainage areas.

Overall changes to the resulting water surface profiles in the existing conditions model was, on average, less than one foot. Specifically the differences ranged from 0.1 ft. (0.3% during the 50-yr event) to 2.7 ft. (4.4 % during the 500-yr event).

1.2.1.3 Boundary Conditions

The original existing conditions model included a downstream boundary condition at the San Juan Tidal Gage (URS Group, Inc., 2006). One boundary condition allows the hydraulic model to be run in a subcritical flow regime. In the interest of running the model in a mixed flow regime (capturing both sub- and super-critical flow regimes), an upstream boundary condition, set to critical depth, was also incorporated.

The hydraulic model was switched from subcritical to mixed flow due to potential impacts from the steep terrain. Based on comparing the water surface elevations from the runs using a subcritical flow regime and the runs using a mixed flow regime, there are no differences in the water surface elevations in the study area, that the resulting alternatives and associated analyses were not impacted.

1.2.2 Model Output

The water surface profiles, output table, and cross sections for the project extents are included in the attached H&H HEC-RAS Model Results.

1.2.3 Groundwater

Groundwater interactions with surface water are not incorporated in the hydraulic model used for this study. Typical groundwater levels within the project extents should be considered for any proposed alteration to the existing channel and adjacent banks.

1.2.4 Flood Plains

The 1% and 0.2% floodplains were delineated previously for the FEMA FIS (URS Group, Inc., 2007). Based on that study, the TIN created from the LiDAR data was converted to a 5-by-5 meter grid cell digital elevation model (DEM). This ground surface was then intersected with 5-by-5-meter grid cell water-surface representations of the 1% and 0.2% annual chance floods, respectively. Figure 1 illustrate the final 1% chance floodplain developed based on this study.

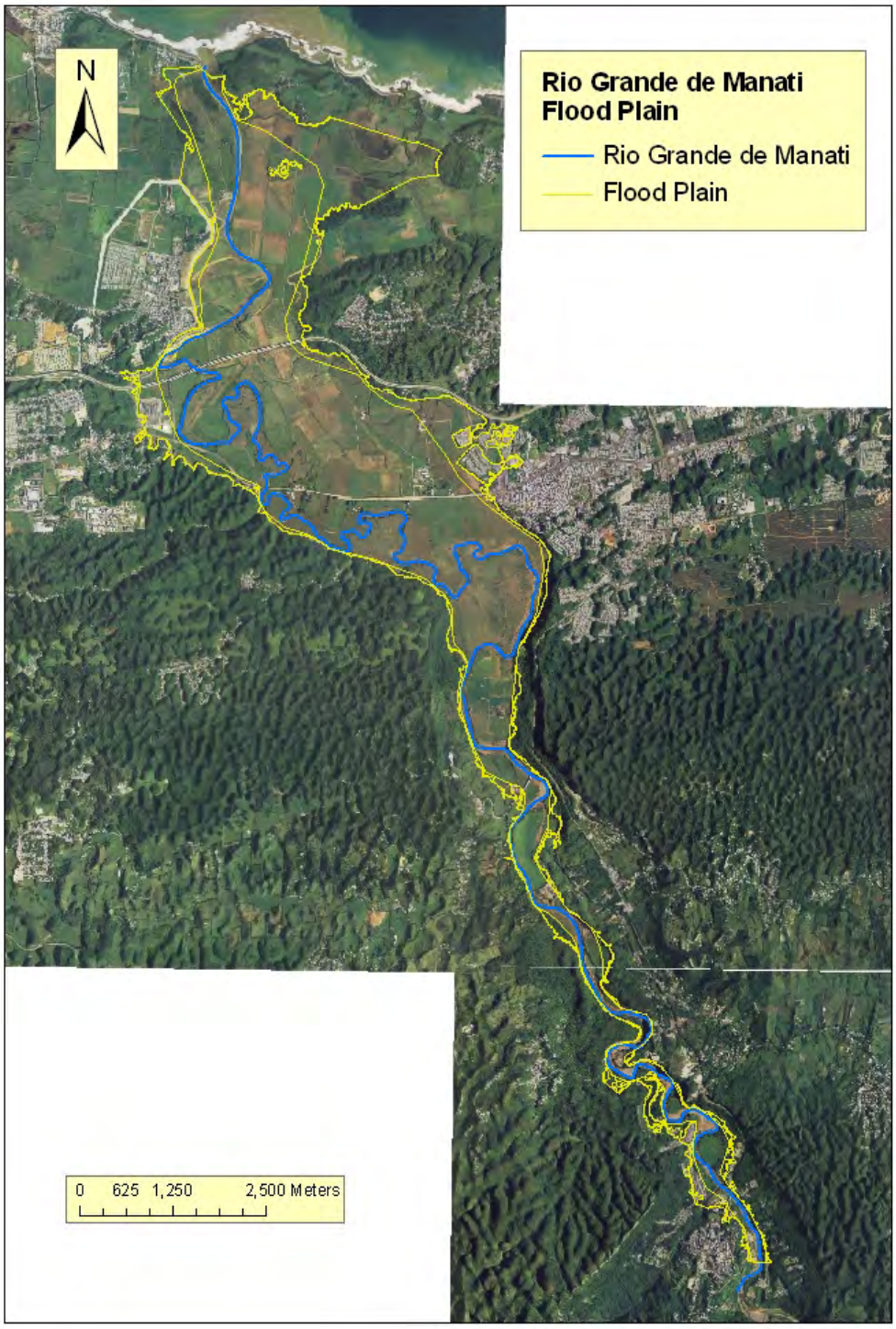

Figure 1 - Rio Grande de Manati Floodplain.

1.3 Alternative 1 (Levee/Floodwall System)

This alternative incorporates the original, locally-developed flood protection works plan and specifications, which included a combined levee/floodwall system, a drainage system and retention pond, as well as channel improvements to reduce flood risk within the community of Dos Rios. High-risk structures in other focal areas not protected by the levee/floodwall system may be relocated to reduce residual risk if incrementally justified.

Alternative 1 also incorporates a 1,200-foot concrete capped I-wall (Type I-2) around the wastewater treatment plant. Height of the floodwall will vary to maintain a constant elevation to protect against the 0.04 AEP event. Maximum height of the floodwall will be 8 feet.

1.3.1 Model Input

1.3.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), as described in section 1.2.1.1, and then the following adjustments were made: 1) inclusion of a levee feature from cross section 32988 to 32455 on the left bank and channel widening from cross section 32988 to 32325 on the right bank, to mimic the design from the 2008 Flood Protection Works Project; and 2) inclusion of a levee feature from cross section 32918 to 32740 on the right bank, around the wastewater treatment plant.

1.3.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.2.

1.3.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.3.

1.3.2 Model Output

The water surface profiles, output table, and cross sections for the project extents are included in the attached H&H HEC-RAS Model Results.

1.4 Alternative 2 (Channel Modification)

This alternative includes excavation and construction of approximately 7,800 feet of new, meandering low flow channel. The bottom of the trapezoidal channel would be 200 feet wide and lined with natural river material. Natural river material would be reused from excavated material on site to the extent possible. Channel slopes would be rock-lined at a 3H:1V slope to a height of 6 feet. Material would be removed from the area adjacent to the constructed channel to flatten the floodplain and tie into existing grade. The newly constructed low flow channel and widening of the channel within the existing floodplain will increase channel capacity and improve floodplain connection. The channel will be aligned to improve hydraulic conductivity by avoiding large bends in order to prevent water backup and associated flood inundation. The channel was designed to maximize benefit within the existing channel morphology and to minimize the need to alter existing public and provide infrastructure.

Alternative 2 also incorporates a floodwall around the wastewater treatment plant, stream bank stabilization, and bridge scour protection as described under Alternative 1.

1.4.1 Model Input

1.4.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), as described in section 1.2.1.1, and then the following adjustments were made: 1)) inclusion of a levee feature from cross section 32918 to 32740 on the right bank, around the wastewater treatment plant; and 2) channel widening/realignment from cross section 32455 to 31041 on both the left and right banks.

1.4.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.2.

1.4.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.32.1..

1.4.2 Model Output

The water surface profiles, output table, and cross sections for the project extents are included in the attached H&H HEC-RAS Model Results.

1.5 Alternative 3 (Non-Structural Relocations)

Structures within the 0.04 AEP floodplain would be acquired and demolished. Residents would be relocated outside of the floodplain. The 0.04 AEP floodplain was selected to include those structures with the majority of recurring flood damages, as well as those with the greatest life and safety risk during major flood events.

Alternative 3 also incorporates a floodwall around the wastewater treatment plant, stream bank stabilization, and bridge scour protection as described under Alternatives 1 and 2.

1.5.1 Model Input

1.5.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), as described in section 1.2.1.1, and then the following adjustments were made: 1) inclusion of a levee feature from cross section 32918 to 32740 on the right bank, around the wastewater treatment plant. No modifications to the geometry were made to account for the properties that are proposed to be bought out (relocation of residents in the 0.04 AEP floodplain) because early in the planning process it was uncertain whether the properties to be purchased would be demolished. Assuming that they would not be demolished was believed to be conservative relative to the Manning's n values used; demolition of the buildings would result in lower roughness values and ultimately lower water surface elevations.

1.5.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.2.

1.5.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.32.1.

1.5.2 Model Output

The water surface profiles, output table, and cross sections for the project extents are included in the attached H&H HEC-RAS Model Results.

1.6 Alternative 4 (Channelization)

Channelization involves construction of approximately 9,000 linear feet of concrete-lined channel within existing riverbank limits. This alternative would require excavating the existing channel to a depth of 17 feet and width of 300 feet. The bottom of the trapezoidal channel would be 100 feet wide, and the side slopes would extend to a height of 15 feet at a 3H:1V slope.

1.6.1 Model Input

1.6.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 0 (No Action), as described in section 1.2.1.1, and then the following adjustment was made: 1) modification to the channel geometry and Manning's n roughness coefficient from cross section 33704 to 30753.

1.6.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.2.

1.6.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.3.

1.6.2 Model Output

The water surface profiles, output table, and cross sections for the project are included in the attached H&H HEC-RAS Model Results.

2 Climate Change Assessment

2.1 Literature Review

An August 2016 report conducted by the United States Environmental Protection Agency (US EPA) on climate change for Puerto Rico summarizes impacts of a changing climate for Puerto Rico. The report states that the Commonwealth has warmed by more than one degree (F) since the mid-20th century, and the surrounding waters have warmed by nearly two degrees since 1901. Furthermore, the ocean has been rising every 15 years by approximately one inch, and tropical storms and hurricanes have become more intense during the past 20 years (EPA, 2016).

The USACE has developed concise reports summarizing observed and projected climate and hydrological patterns, at a hydrologic unit code (HUC2) watershed scale. A June 2015 by USACE literature review report focused on the Caribbean Region summarizes several studies which have projected future changes in hydrometeorology. The document indicates that it is projected that air temperature will increase through the country over the next century. Specifically, projected temperature increases for the Caribbean are projected to be slightly below the global average by 2.5 to 4°C by 2100, but slightly above the tropical average. Projected temperature increases are expected to be significant by late century at all locations. Projections for Puerto Rico show an increase of as little as 0.02°C per year through 2050 and as much as 2-5°C by the year 2100 (PRCCC, 2013).

The USACE literature review (2015) indicate that -12% more precipitation is falling in Puerto Rico now as compared with the first half of the 20th century, and that the precipitation is concentrated in larger events.

Regionally within the island, there are indications that the southern region of Puerto Rico has experienced positive trends in annual rainfall while the western and a portion of the northern region showed decreases. In order to simulate future climate change, global climate models (GCMs) need to accurately represent observed climate. There is uncertainty in the magnitude of precipitation changes in the Caribbean, though a majority of GCMs show future decreases in precipitation are likely. Model projections range from -78 to -10%, and current evidence suggests drier conditions are more likely than wetter for Puerto Rico, a contrast to the global precipitation signal. Specifically the PRCCC analysis found that past and future trends are similar, a decrease of rainfall of -0.0012 to -0.0032 mm/day/yr, are projected to continue through 2050 (PRCCC, 2013).

There is limited information with regards to the effects of climate change on streamflow trends and hydrologic conditions within the Caribbean Region. There is no clear consensus on projected streamflow trends in the Caribbean Region. The Puerto Rico Climate Change Council (PRCCC) also prepared a report assessing the social-ecological vulnerabilities in a changing climate. The report indicates that surface temperatures and sea levels are increasing for the island. It was likely that mean sea level rise will contribute to upward trends in extreme coastal high water levels in the future (PRCCC, 2013).

Figure 2 summarizes observed and projected trends for a variety of variables that were reviewed (USACE, 2015).

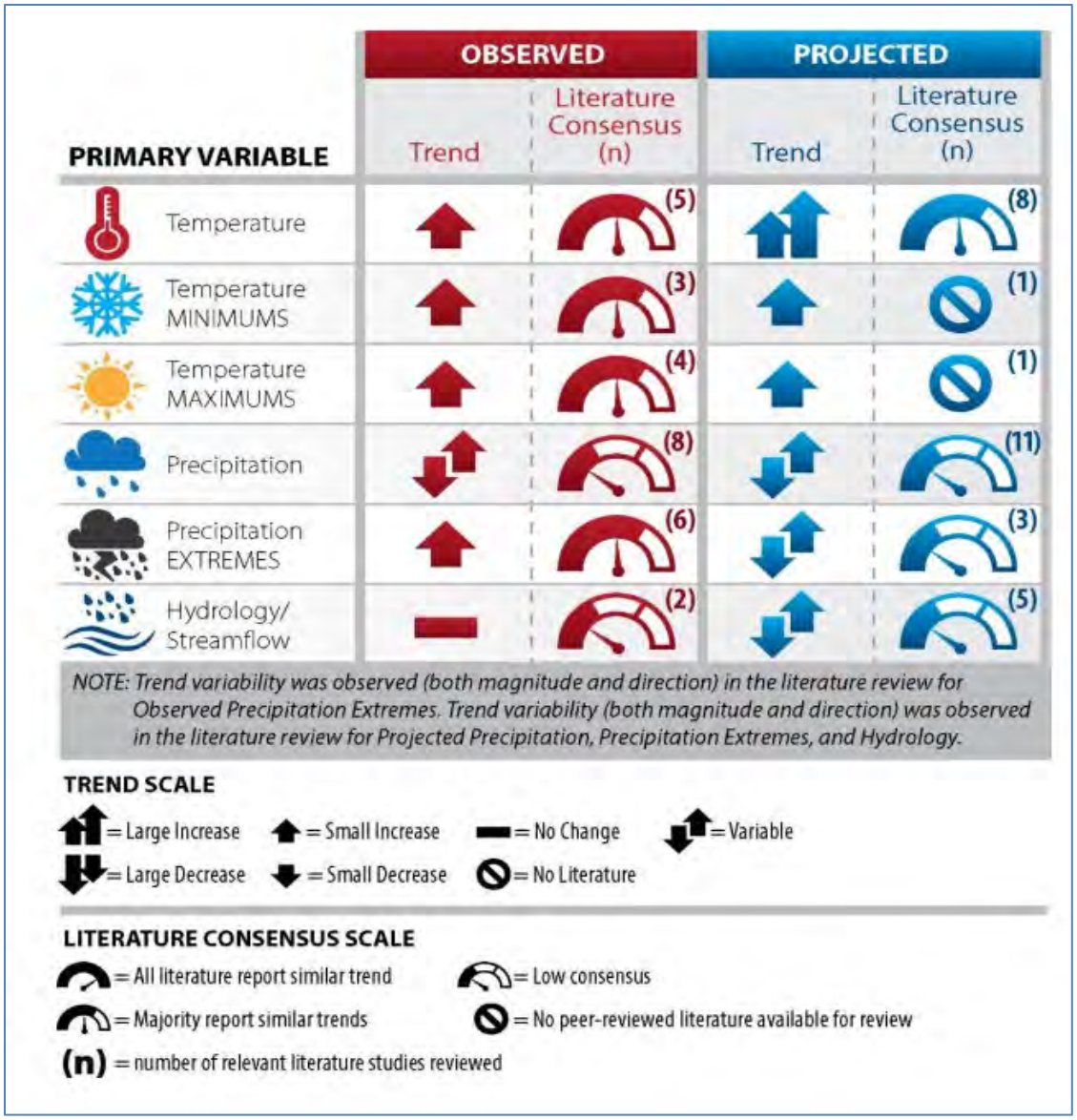

Figure 2 - Summary of observed and projected climate trends and literary consensus (USACE, 2015).

2.2 Inland Hydrology Climate Change Assessment Tools

In accordance with the USACE Engineering and Construction Bulletin (ECB) 2018-14, potential impact of climate change on inland hydrology was assessed using the applicable tools. The tools are qualitative and include the Climate Hydrology Assessment Tool, the Nonstationarity Detection Tool, and Watershed Climate Vulnerability Assessment Tool. The results are described in the following sections.

2.2.1 The USACE Climate Hydrology Assessment Tool

There is a lack of coverage by the USACE Climate Hydrology Assessment Tool (CHAT) at Rio Grande de Manati gage at Ciales, PR (USGS gage 50035000), so future projections of annual peak streamflow could not be performed. However, a trend analysis was performed using the USACE Nonstationarity Detection Tool (NSD), as described below.The USACE Nonstationarity Detection Tool

The USACE Nonstationarity Detection Tool is an analytical tool that enables users to detect abrupt and slowly varying changes in annual peak flows at stream gages with over 30 years of record and conduct monotonic trend analysis on the data. The USACE Nonstationarity Detection Tool was used to analyze changes to the maximum annual flow at the Rio Grande de Manati at Ciales, PR gage (USGS gage 50035000). The Nonstationarity Detection Tool failed to detect significant (p=0.05) nonstationarities in the maximum annual flow at the Rio Grande de Manati at Ciales, PR gage (USGS gage 50035000) during the period of record from 1958 through 2018 (Figure 3). There was missing data from 1953 through 1958, so this period of data was neglected from the analysis, in correspondence with guidance from ETL 1110-2-3. Even when the analysis start year was updated to exclude the period of partially missing data in the 1950's, no change points were detected. There is no regulation of the river upstream of the gage, and potential changes from a changing climate on the mean, variance, and distribution of the maximum annual flow were not identified as being statistically significant. In addition, a monotonic trend analysis was performed on the maximum annual flow at the gage, and no statistically significant trends were identified (Figure 4).

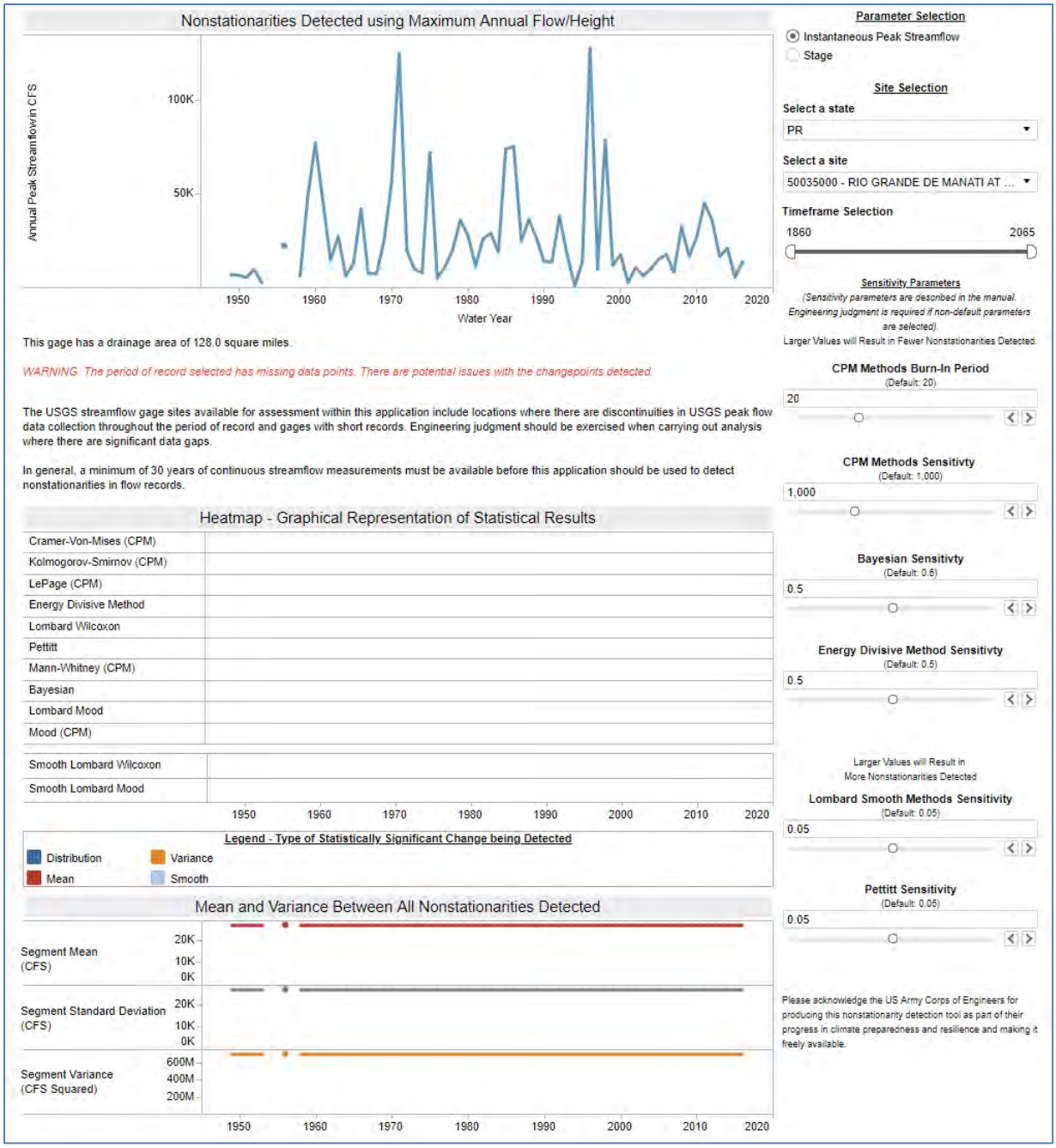

Figure 3 - Nonstationarity Analysis of Maximum Annual Flow, Rio Grande de Manati at Ciales, Puerto Rico.

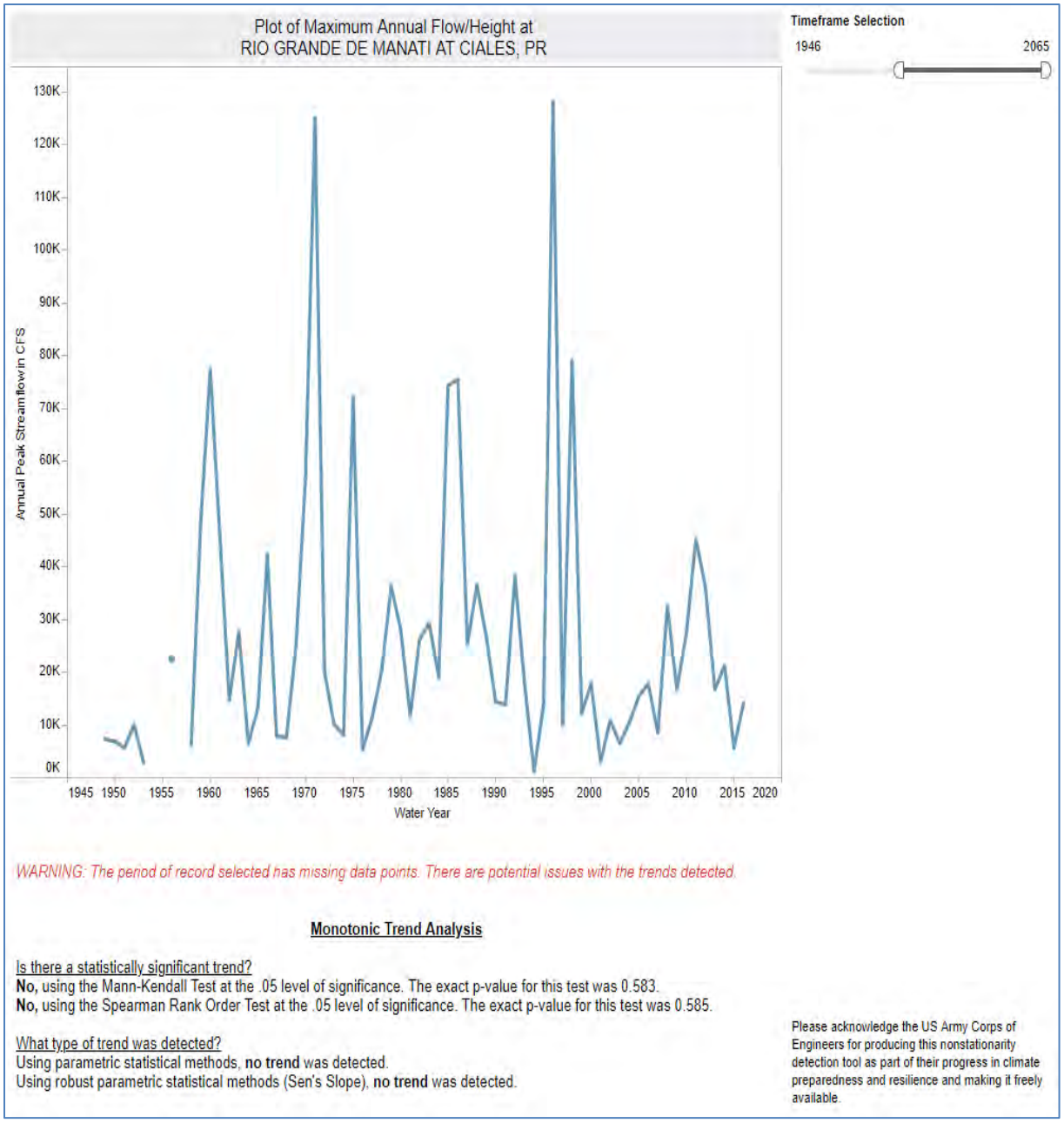

Figure 4 - Nonstationarity Analysis of Maximum Annual Flow, Rio Grande de Manati at Ciales, Puerto Rico.

2.2.2 The USACE Watershed Climate Vulnerability Assessment Tool

The HUC-4 watersheds are not available in the USACE Vulnerability Assessment Tool, so an assessment could not be applied.

2.3 Sea Level Rise

There is high confidence that sea levels are rising and will continue to do so (PRCCC, 2013). In accordance with Engineering Regulation (ER) 1100-2-8162, a quantitative assessment of sea level rise must be considered for waterways with oceanic astronomical tidal influence, as well as connected waterways with base-level controlled by sea level. Although the downstream extent of the study area is approximately 16 miles upstream of the mouth of Rio Grande de Manati, a sea level rise assessment is still required by Engineering Manual (EM) 1110-2-1416 because the river profile computation begins at the outlet of a stream influenced by tidal fluctuations.

Using the USACE Sea Level Change Calculator, Figure 5 shows that for a 100-year planning horizon with sea level rise USACE low to high estimates range from 0.69 to 6.77 feet above current mean sea level by the year 2120 at the San Juan, PR gage (datum PRVD02). Discussion regarding how sea level change was accounted for in the design is provided in the following section.

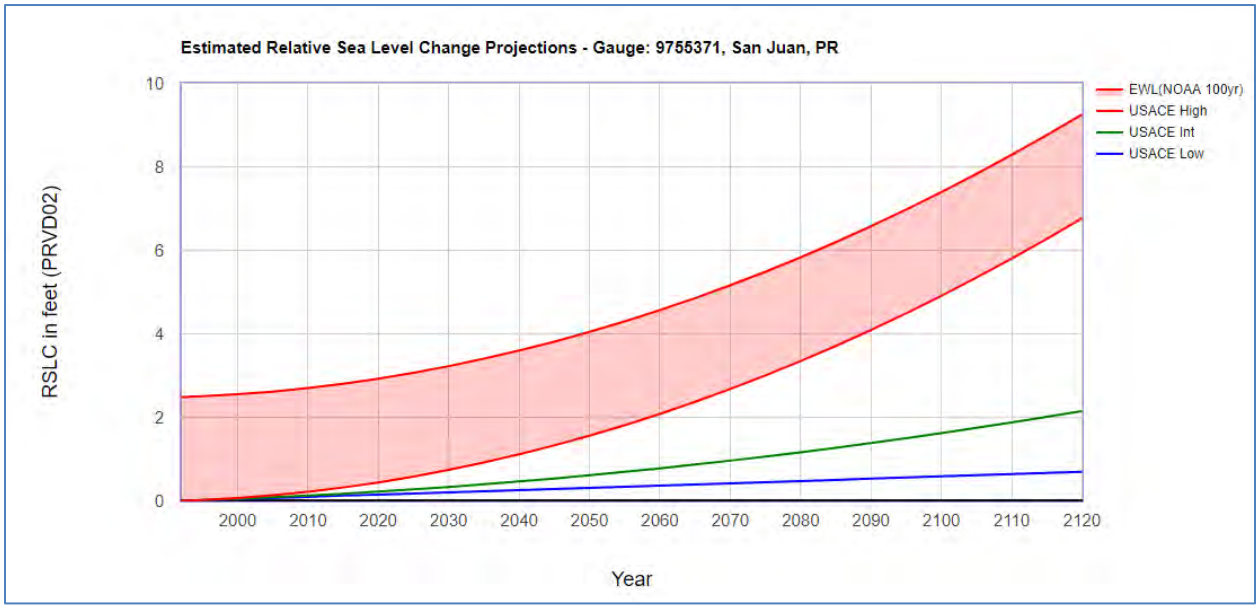

Figure 5 - USACE Sea Level Change Curve Calculator at Gage Closest to Ciales, Puerto Rico.

Although the study area downstream extents are approximately 16 miles upstream of the mouth of Rio Grande de Manati, the downstream boundary of the existing conditions hydraulic model obtained from FEMA goes to the ocean. Therefore, consistent with Engineering Regulation (ER) 1100-2-8162, sea level rise was incorporated into the downstream boundary condition in the hydraulic model. Based on the PRVD02 datum, the summation of the sea level change (SLC), high tide for each of the three scenarios (low, intermediate and high, as determined from the Sea Level Change Calculator), and the NOAA 100 yr (i.e. 1% AEP) estimated extreme water level (EWL) was used to estimate downstream boundary conditions for the base year and year 2120 (100-year project lifespan). Initially, the low, intermediate, and high values for the base year (0.15 ft, 0.22 ft, and 0.44 ft, respectively) were each combined with the EWL (2.49 ft) and MHHW (0.81 ft). These scenarios for the base year are estimated to range from 3.45 ft to 3.74 ft. Then, the low, intermediate, and high values for the 2120 scenario (0.69 ft, 2.15 ft, and 6.77 ft) were analyzed, yielding totals of 3.99 ft to 10.07 ft. Although the base year scenarios were initially analyzed, ultimately the most conservative value from the 2120 scenarios (10.07 ft) was the highest downstream

boundary condition used for the analysis and was compared with the MHHW initially incorporated in the existing conditions hydraulic model. There was no increase in water surface elevation in the study area extents for the future without- and with- project conditions. Therefore, additional analysis with regards to incorporating sea level rise was not completed.

2.4 Residual Risk

A summary table of the residual risk associated with the tentatively selected plan (TSP) is included below.

Table 1. Residual risk associated with TSP.

Feature/Measure	Trigger	Hazard	Harm	Qualitative Likelihood
Non-Structural Relocations	Increased magnitude and frequency of large storm and flood events.	Future flood volumes and velocities may be larger than present.	Increased inundation risk for structures outside of the 0.04 AEP floodplain not included in the project.	Likely

3 WATER RESOURCE CONSIDERATIONS RELATED TO THE RECOMMENDED PLAN

3.1 Alternative 3B - Non-Structural Relocations

The tentatively selected plan (TSP) is an optimized version of Alternative 3 (Non-Structural Relocations). Based on the results from the expert elicitation and an economic analysis, as discussed in the report, there were modifications to Alternative 3. The modifications include removing the proposed floodwall around the wastewater treatment plant.

3.1.1 Model Input

3.1.1.1 Geometry

The baseline geometry for this alternative was copied from the geometry for Alternative 3 (Non-Structural Relocations), as described in section 1.6.1.1, and the following adjustment was made: 1) removal of the levee feature from cross section 32918 to 32740 on the right bank, around the wastewater treatment plant.

3.1.1.2 Steady Flow Data

The steady flow data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.2.

3.1.1.3 Boundary Conditions

The boundary conditions data was kept the same as for Alternative 0 (No Action) and is described in section 1.2.1.3.

3.1.2 Model Output

The water surface profiles, output table, and cross sections for the project extents are included in the attached H&H HEC-RAS Model Results.

4 REFERENCES

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ATTACHMENT: HEC-RAS RESULTS

HEC-RAS CROSS SECTIONS PLAN VIEW

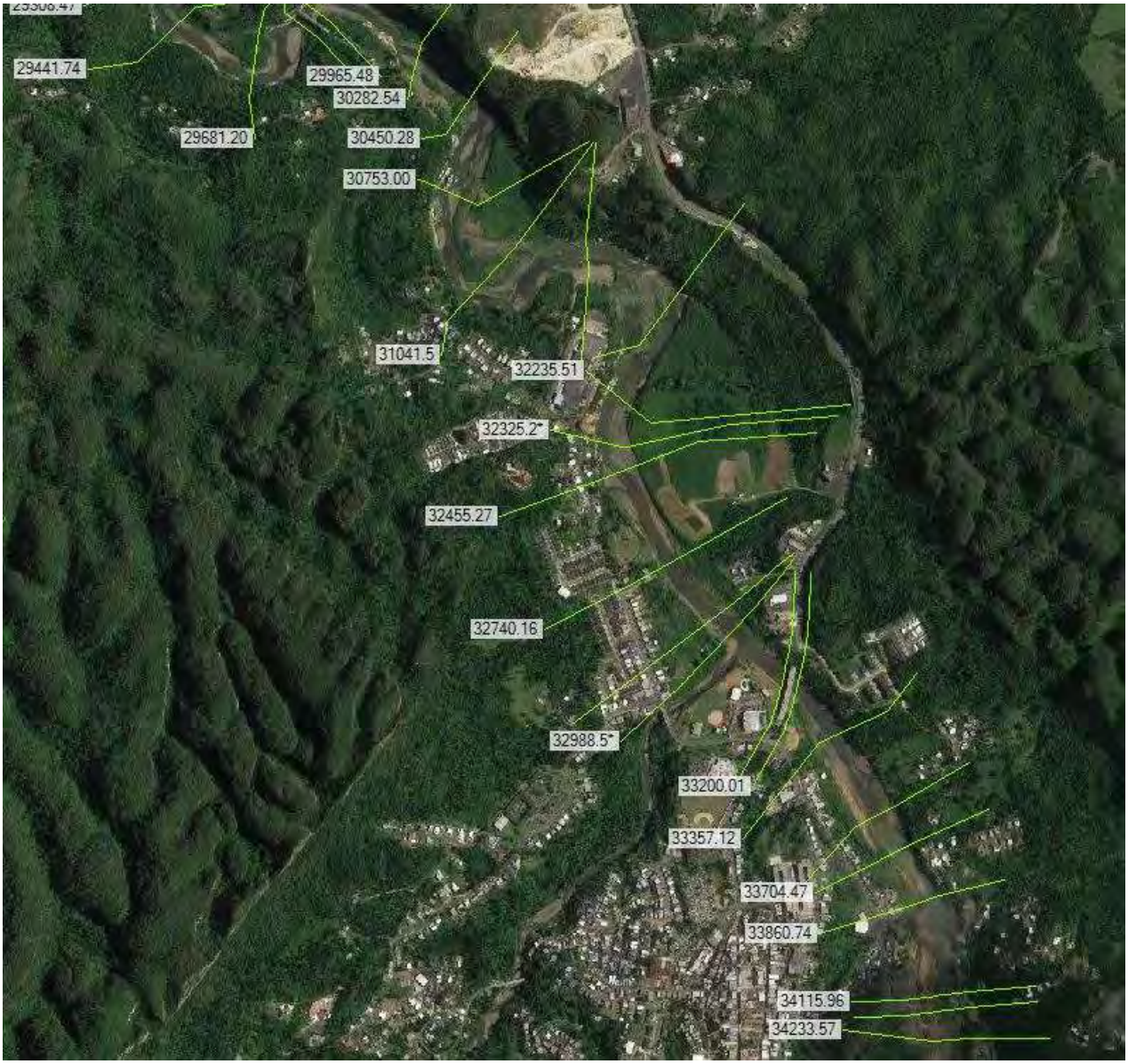


Figure 1. Plan view of cross sections in HEC-RAS model within study area extents.

HEC-RAS OUTPUT TABLES

Alternative 0 (No Action) Results Table for XS in Project Area

HEC-RAS Plan: Alt 1 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	34233.57 34069	0.5 (2 yr)	18434.26	111.45	129.87	121.19	130.40	0.004234	5.84	3159.66	238.79	0.28	3.47	0.29		3.36
Rio Manati	1	34233.57 34069	0.2 (5 yr)	40682.50	111.45	139.51	125.86	140.34	0.003817	7.11	5625.18	270.47	0.26	5.07	1.53		4.69
Rio Manati	1	34233.57 34069	0.1 (10 yr)	63177.94	111.45	143.44	129.56	144.89	0.005287	9.15	6711.32	282.49	0.32	8.18	2.74	0.26	7.38
Rio Manati	1	34233.57 34069	0.04 (25 yr)	108910.40	111.45	151.87	135.35	153.35	0.003729	9.25	11327.18	657.74	0.28	7.63	1.61	1.01	3.86
Rio Manati	1	34233.57 34069	0.02 (50 yr)	142989.10	111.45	155.56	138.83	157.44	0.003212	9.19	13779.02	671.26	0.26	7.27	2.07	1.21	3.96
Rio Manati	1	34233.57 34069	0.01 (100 yr)	193489.10	111.45	160.24	148.32	162.70	0.002800	9.27	17040.68	709.37	0.25	7.12	2.46	1.39	4.03
Rio Manati	1	34233.57 34069	0.005 (200 yr)	256702.30	111.45	165.07	150.84	168.29	0.002532	9.46	20710.83	787.30	0.24	7.16	2.88	0.97	3.99
Rio Manati	1	34233.57 34069	0.002 (500 yr)	364800.50	111.45	171.73	155.15	176.19	0.002338	9.92	26476.56	972.74	0.24	7.53	3.52	0.89	3.82
Rio Manati	1	34155.99 33988	0.5 (2 yr)	18504.88	110.89	128.90	119.21	129.39	0.003601	5.66	3288.79	243.00	0.27	3.06		0.48	2.94
Rio Manati	1	34155.99 33988	0.2 (5 yr)	40859.07	110.89	138.67	124.38	139.48	0.002932	7.27	5947.50	307.12	0.26	4.23	0.67	1.21	3.42
Rio Manati	1	34155.99 33988	0.1 (10 yr)	63495.77	110.89	142.25	128.07	143.67	0.004335	9.70	7141.42	395.49	0.33	7.19	0.81	2.28	4.74
Rio Manati	1	34155.99 33988	0.04 (25 yr)	109440.10	110.89	150.36	134.04	152.24	0.004311	11.50	10878.04	624.26	0.34	9.26	2.01	1.46	4.58
Rio Manati	1	34155.99 33988	0.02 (50 yr)	143730.70	110.89	154.53	137.81	156.53	0.004040	11.99	13629.58	680.01	0.34	9.70	2.50	2.31	4.93
Rio Manati	1	34155.99 33988	0.01 (100 yr)	194477.90	110.89	159.60	145.46	161.82	0.003613	12.29	17191.06	715.76	0.32	9.79	3.10	3.05	5.27
Rio Manati	1	34155.99 33988	0.005 (200 yr)	258044.30	110.89	164.67	152.41	167.31	0.003342	12.70	20890.96	743.71	0.32	10.08	3.66	3.71	5.68
Rio Manati	1	34155.99 33988	0.002 (500 yr)	366742.80	110.89	171.61	157.02	175.06	0.003075	13.28	26391.29	897.95	0.31	10.56	3.35	4.48	5.48
Rio Manati	1	34135.98 33968		Bridge													
Rio Manati	1	34115.96 33947	0.5 (2 yr)	18504.88	110.66	126.05	118.60	126.59	0.001090	5.83	3153.70	264.48	0.29	0.84	0.08	0.28	0.79
Rio Manati	1	34115.96 33947	0.2 (5 yr)	40859.07	110.66	133.39	122.98	134.37	0.001019	7.66	5270.76	302.44	0.30	1.24	0.27	0.44	1.06
Rio Manati	1	34115.96 33947	0.1 (10 yr)	63495.77	110.66	138.32	126.86	139.83	0.001076	9.12	6803.59	324.56	0.32	1.63	0.34	0.67	1.34
Rio Manati	1	34115.96 33947	0.04 (25 yr)	109440.10	110.66	145.75	131.56	147.76	0.001157	11.27	10233.87	576.25	0.35	2.28	0.41	0.61	1.24
Rio Manati	1	34115.96 33947	0.02 (50 yr)	143730.70	110.66	149.85	134.95	152.19	0.001075	11.76	12869.15	609.63	0.34	2.39	0.60	0.77	1.35
Rio Manati	1	34115.96 33947	0.01 (100 yr)	194477.90	110.66	155.38	139.83	158.09	0.000949	12.14	16127.39	642.11	0.33	2.43	0.79	0.91	1.44
Rio Manati	1	34115.96 33947	0.005 (200 yr)	258044.30	110.66	161.36	146.72	164.45	0.000847	12.53	20157.85	768.30	0.32	2.48	0.72	1.04	1.34
Rio Manati	1	34115.96 33947	0.002 (500 yr)	366742.80	110.66	169.75	152.49	173.23	0.000730	12.96	26879.41	827.31	0.30	2.51	0.94	1.08	1.43
Rio Manati	1	33860.74 33690	0.5 (2 yr)	18504.88	108.76	124.39	118.44	125.24	0.002244	8.17	3130.37	293.82	0.40	1.76	1.15		1.44
Rio Manati	1	33860.74 33690	0.2 (5 yr)	40859.07	108.76	131.59	123.34	132.97	0.002658	10.69	5424.25	345.51	0.43	3.07	2.08	0.03	2.49
Rio Manati	1	33860.74 33690	0.1 (10 yr)	63495.77	108.76	136.27	127.07	138.29	0.003000	13.10	7188.89	441.00	0.47	4.30	2.30	0.32	2.93
Rio Manati	1	33860.74 33690	0.04 (25 yr)	109440.10	108.76	143.71	132.58	146.20	0.002844	15.24	11342.41	635.65	0.48	5.32	2.67	0.73	3.27
Rio Manati	1	33860.74 33690	0.02 (50 yr)	143730.70	108.76	148.27	136.39	150.82	0.002572	15.85	14168.90	746.42	0.46	5.51	2.96	0.90	3.48
Rio Manati	1	33860.74 33690	0.01 (100 yr)	194477.90	108.76	154.24	143.49	156.93	0.002306	16.62	18065.46	842.17	0.45	5.75	3.30	0.58	3.56
Rio Manati	1	33860.74 33690	0.005 (200 yr)	258044.30	108.76	160.39	147.26	163.32	0.002157	17.60	22524.75	878.50	0.45	6.16	3.78	1.06	3.94
Rio Manati	1	33860.74 33690	0.002 (500 yr)	366742.80	108.76	168.81	152.39	172.29	0.002114	19.39	28916.31	926.75	0.45	7.09	4.68	1.53	4.64
Rio Manati	1	33704.47 33532	0.5 (2 yr)	18504.88	103.22	123.37	115.26	123.92	0.002646	6.08	3363.48	320.69	0.28	2.35	0.61	0.53	1.69
Rio Manati	1	33704.47 33532	0.2 (5 yr)	40859.07	103.22	130.52	120.05	131.46	0.002833	8.23	6156.65	438.31	0.31	3.76	1.32	1.19	2.42
Rio Manati	1	33704.47 33532	0.1 (10 yr)	63495.77	103.22	135.28	123.59	136.55	0.003078	9.80	8302.04	460.44	0.34	4.99	2.21	1.77	3.36
Rio Manati	1	33704.47 33532	0.04 (25 yr)	109440.10	103.22	142.57	129.69	144.47	0.003475	12.25	11796.78	501.80	0.37	7.19	3.83	2.42	4.92
Rio Manati	1	33704.47 33532	0.02 (50 yr)	143730.70	103.22	146.91	133.19	149.25	0.003723	13.75	14012.33	521.14	0.39	8.70	4.91	3.12	6.01
Rio Manati	1	33704.47 33532	0.01 (100 yr)	194477.90	103.22	152.48	137.10	155.44	0.004012	15.64	16989.94	553.84	0.42	10.75	6.37	3.85	7.38
Rio Manati	1	33704.47 33532	0.005 (200 yr)	258044.30	103.22	158.05	141.51	161.79	0.004395	17.74	20154.08	579.92	0.45	13.28	8.11	5.05	9.14
Rio Manati	1	33704.47 33532	0.002 (500 yr)	366742.80	103.22	165.46	147.84	170.60	0.005108	21.00	24619.80	725.79	0.49	17.76	9.58	6.72	11.25
Rio Manati	1	33597.73 33414	0.5 (2 yr)	18504.88	109.15	122.34	116.27	122.99	0.002606	7.30	3033.69	296.06	0.37	1.87	0.74	1.77	1.59
Rio Manati	1	33597.73 33414	0.2 (5 yr)	40859.07	109.15	129.51	120.49	130.54	0.002427	9.62	5921.87	485.23	0.39	2.79	0.90	2.52	1.78
Rio Manati	1	33597.73 33414	0.1 (10 yr)	63495.77	109.15	134.29	123.88	135.59	0.002445	11.21	8275.07	497.85	0.40	3.51	1.58	3.10	2.43
Rio Manati	1	33597.73 33414	0.04 (25 yr)	109440.10	109.15	141.58	130.12	143.41	0.002621	13.85	12026.14	533.78	0.44	4.91	2.63	4.20	3.52
Rio Manati	1	33597.73 33414	0.02 (50 yr)	143730.70	109.15	145.91	133.00	148.11	0.002743	15.45	14384.00	556.30	0.46	5.85	3.38	4.75	4.22
Rio Manati	1	33597.73 33414	0.01 (100 yr)	194477.90	109.15	151.52	136.42	154.19	0.002871	17.43	17599.13	589.56	0.48	7.09	4.35	5.39	5.09
Rio Manati	1	33597.73 33414	0.005 (200 yr)	258044.30	109.15	157.16	140.98	160.38	0.003071	19.64	20987.03	620.25	0.51	8.62	5.70	6.27	6.28
Rio Manati	1	33597.73 33414	0.002 (500 yr)	366742.80	109.15	164.62	147.08	168.90	0.003512	23.18	25615.00	664.68	0.55	11.42	8.10	8.11	8.48
Rio Manati	1	33357.12 33176	0.5 (2 yr)	18504.88	99.08	120.12	109.16	120.60	0.003491	5.81	4295.34	470.03	0.24	3.80	0.95	0.65	1.90
Rio Manati	1	33357.12 33176	0.2 (5 yr)	40859.07	99.08	127.27	115.10	128.04	0.004153	7.90	7904.03	525.01	0.28	6.28	2.68	1.52	3.71
Rio Manati	1	33357.12 33176	0.1 (10 yr)	63495.77	99.08	131.83	119.48	132.91	0.004969	9.64	10344.30	544.11	0.31	8.87	4.42	2.38	5.59
Rio Manati	1	33357.12 33176	0.04 (25 yr)	109440.10	99.08	138.70	125.58	140.38	0.006273	12.43	14181.49	574.12	0.36	13.75	7.77	4.10	9.14
Rio Manati	1	33357.12 33176	0.02 (50 yr)	143730.70	99.08	142.95	128.59	144.92	0.006584	13.69	16835.35	655.64	0.38	16.09	8.43	4.91	10.01
Rio Manati	1	33357.12 33176	0.01 (100 yr)	194477.90	99.08	148.78	132.38	150.89	0.006246	14.56	21314.72	1064.85	0.37	17.43	6.42	4.33	8.01
Rio Manati	1	33357.12 33176	0.005 (200 yr)	258044.30	99.08	154.77	136.22	156.91	0.005771	15.17	27708.04	1187.18	0.37	18.16	7.24	4.90	8.59
Rio Manati	1	33357.12 33176	0.002 (500 yr)	366742.80	99.08	162.70	144.68	164.99	0.005483	16.22	36999.18	1332.90	0.37	19.83	8.48	5.92	9.66
Rio Manati	1	33200.01 33011	0.5 (2 yr)	18504.88	98.89	118.79	108.04	119.17	0.002413	4.72	3761.29	335.83	0.20	2.46	0.80		1.64
Rio Manati	1	33200.01 33011	0.2 (5 yr)	40859.07	98.89	125.81	113.40	126.65	0.002341	5.18	6249.73	370.50	0.19	3.16	1.69	0.13	2.38
Rio Manati	1	33200.01 33011	0.1 (10 yr)	63495.77	98.89	129.88	118.79	131.27	0.002672	6.19	7802.64	389.64	0.21	4.26	2.49	0.57	3.22
Rio Manati	1	33200.01 33011	0.04 (25 yr)	109440.10	98.89	135.90	121.87	138.27	0.003342	7.93	10360.79	516.00	0.24	6.54	2.93	1.29	4.11
Rio Manati	1	33200.01 33011	0.02 (50 yr)	143730.70	98.89	139.77	126.15	142.72	0.003316	8.51	12363.24	624.12	0.25	7.26	3.69	1.62	4.74
Rio Manati	1	33200.01 33011	0.01 (100 yr)	194477.90	98.89	146.84	132.29	149.33	0.002274	7.93	17858.51	896.11	0.21	5.94	2.04	1.30	2.77
Rio Manati	1	33200.01 33011	0.005 (200 yr)	258044.30	98.89	153.07	137.37	155.64	0.001705	7.51	24034.79	1079.87	0.19	5.09	2.08	0.86	2.32
Rio Manati	1	33200.01 33011	0.002 (500 yr)	366742.80	98.89	160.86	145.90	163.84	0.001384	7.45	32843.29	1166.25	0.17	4.78	2.20	1.23	2.38
Rio Manati	1	33176.74 32988		Bridge													
Rio Manati	1	33153.54 32965	0.5 (2 yr)	18504.88	100.39	118.59	108.32	118.98	0.004903	4.79	3716.71	370.90	0.21	4.95	1.06	0.60	3.01
Rio Manati	1	33153.54 32965	0.2 (5 yr)	40859.07	100.39	125.67	113.62	126.34	0.002892	4.66	6930.95	512.32	0.17	4.17	1.48	1.12	2.47
Rio Manati	1	33153.54 32965	0.1 (10 yr)	63495.77	100.39	129.80	117.93	130.80	0.002736	5.05	9076.44	563.25	0.17	4.63	1.88	1.72	2.82
Rio Manati	1	33153.54 32965	0.04 (25 yr)	109440.10	100.39	135.76	122.70	137.53	0.002575	5.57	12292.27	626.18	0.17	5.29	2.71	2.53	3.60
Rio Manati	1	33153.54 32965	0.02 (50 yr)	143730.70	100.39	139.15	125.49	141.53	0.002642	6.02	14124.82	653.61	0.17	5.98	3.34	3.13	4.24
Rio Manati	1	33153.54 32965	0.01 (100 yr)	194477.90	100.39	143.62	129.63	146.60	0.002574	6.41	17147.34	693.09	0.18	6.53	3.97	2.42	4.56
Rio Manati	1	33153.54 32965	0.005 (200 yr)	258044.30	100.39	149.43	133.53	152.29	0.002217	6.49	22357.12	846.63	0.17	6.41	2.86	2.37	3.58
Rio Manati	1	33153.54 32965	0.002 (500 yr)	366742.80	100.39	158.29	140.04	161.30	0.001798	6.55	30541.47	1131.64	0.15	6.16	2.95	1.07	2.98
Rio Manati	1	32988.5*	0.5 (2 yr)	18504.88	97.75	115.61		116.27	0.004477	6.73	2955.23	245.71	0.30	4.23	1.50	1.23	3.25
Rio Manati	1	32988.5*	0.2 (5 yr)	40859.07	97.75	123.71		124.47	0.003338	7.73	6394.02	636.90	0.28	4.83	0.93	1.92	2.06
Rio Manati	1	32988.5*	0.1 (10 yr)	63495.77	97.75	128.29		129.02	0.002595	7.68	9650.93	790.00	0.26	4.50	1.18	1.79	1.95
Rio Manati	1	32988.5*	0.04 (25 yr)	109440.10	97.75	134.82		135.63	0.001933	7.63	15452.86	971.69	0.23	4.13	1.40	1.63	1.89
Rio Manati	1	32988.5*	0.02 (50 yr)	143730.70	97.75	138.51		139.43	0.001744	7.76	19173.91	1128.09	0.22	4.13	1.56	1.05	1.83
Rio Manati	1	32988.5*	0.01 (100 yr)	194477.90	97.75	143.36		144.35	0.001517	7.84	25515.51	1367.45	0.21	4.05	1.58	1.05	1.75
Rio Manati	1	32988.5*	0.005 (200 yr)	258044.30	97.75	149.29		150.31	0.001239	7.72	33824.18	1456.16	0.19	3.76	1.69	1.15	1.78
Rio Manati	1	32988.5*	0.002 (500 yr)	366742.80	97.75	158.42		159.47	0.000964	7.63	48511.98	1755.26	0.18	3.48	1.64	1.11	1.65
Rio Manati	1	32918.20 32728	0.5 (2 yr)	19634.96	96.62	114.76	106.11	115.43	0.003088	6.80	3275.59	255.78	0.30	3.15	1.20	1.18	2.36
Rio Manati	1	32918.20 32728	0.2 (5 yr)	43754.87	96.62	122.44	111.46	123.61	0.003536	9.40	6059.88	641.68	0.34	5.29	0.63	2.23	2.04
Rio Manati	1	32918.20 32728	0.1 (10 yr)	68333.88	96.62	127.26	115.64	128.31	0.002866	9.55	9679.80	985.89	0.31	5.15	1.18	2.19	2.14
Rio Manati	1	32918.20 32728	0.04 (25 yr)	118304.10	96.62	133.95	125.33	135.05	0.002250	9.72	15711.59	1257.71	0.29	4.98	1.85	1.44	2.22
Rio Manati	1	32918.20 32728	0.02 (50 yr)	155702.40	96.62	137.66	127.54	138.89	0.002069	9.96	19395.22	1474.25	0.28	5.05	2.17	1.64	2.44
Rio Manati	1	32918.20 32728	0.01 (100 yr)	211075.80	96.62	142.39	130.41	143.84	0.001927	10.37	24309.25	1535.29	0.28	5.27	2.58	1.86	2.71
Rio Manati	1	32918.20 32728	0.005 (200 yr)	280504.40	96.62	148.19	133.10	149.86	0.001700	10.58	30772.18	1796.03	0.26	5.26	2.88	1.77	2.71
Rio Manati	1	32918.20 32728	0.002 (500 yr)	399338.30	96.62	158.29	136.70	159.16	0.000885	8.63	58366.64	1930.79	0.20	3.29	1.56	1.38	1.65
Rio Manati	1	32740.16 32548	0.5 (2 yr)	19634.96	95.54	111.94	105.15	112.81	0.006829	7.82	2879.07	282.79	0.36	6.35	1.96	1.75	4.25
Rio Manati	1	32740.16 32548	0.2 (5 yr)	43754.87	95.54	119.65	110.39	120.88	0.006228	9.85	5986.76	782.80	0.36	8.77	1.77	1.26	3.07
Rio Manati	1	32740.16 32548	0.1 (10 yr)	68333.88	95.54	125.13	115.25	126.15	0.004568	9.74	10684.49	1190.67	0.32	7.98	2.56	1.79	3.26
Rio Manati	1	32740.16 32548	0.04 (25 yr)	118304.10	95.54	132.24	122.75	133.28	0.003781	10.30	17825.08	1331.53	0.31	8.27	3.71	2.32	3.90
Rio Manati	1	32740.16 32548	0.02 (50 yr)	155702.40	95.54	136.01	124.95	137.19	0.003792	11.03	22449.90	1685.20	0.31	9.18	4.54	1.82	3.70
Rio Manati	1	32740.16 32548	0.01 (100 yr)	211075.80	95.54	140.89	127.81	142.20	0.003661	11.72	29498.64	1755.38	0.31	9.97	5.39	2.66	4.47
Rio Manati	1	32740.16 32548	0.005 (200 yr)	280504.40	95.54	147.00	130.67	148.36	0.003215	11.98	39091.98	1902.48	0.30	9.98	5.82	3.11	4.74
Rio Manati	1	32740.16 32548	0.002 (500 yr)	399338.30	95.54	156.92	135.33	158.25	0.002532	12.00	55854.33	1985.40	0.27	9.42	5.92	3.79	5.05
Rio Manati	1	32455.27 32258	0.5 (2 yr)	19634.96	85.63	108.33	98.27	108.81	0.002800	5.56	3598.59	269.61	0.25	2.69	1.37	0.44	2.48
Rio Manati	1	32455.27 32258	0.2 (5 yr)	43754.87	85.63	115.20	103.12	116.28	0.003954	8.42	5510.96	349.48	0.31	5.46	3.45	1.16	4.31
Rio Manati	1	32455.27 32258	0.1 (10 yr)	68333.88	85.63	120.10	107.05	121.75	0.004795	10.57	7437.22	685.59	0.36	8.06	5.49	0.88	3.48
Rio Manati	1	32455.27 32258	0.04 (25 yr)	118304.10	85.63	128.29	113.64	129.80	0.003803	11.21	17035.20	1532.82	0.33	8.30	6.08	1.71	2.74
Rio Manati	1	32455.27 32258	0.02 (50 yr)	155702.40	85.63	132.58	118.13	133.97	0.003371	11.38	23465.29	1650.12	0.32	8.25	6.19	2.27	3.16
Rio Manati	1	32455.27 32258	0.01 (100 yr)	211075.80	85.63	137.96	126.80	139.27	0.003004	11.69	32121.71	1793.58	0.31	8.34	6.42	2.80	3.56
Rio Manati	1	32455.27 32258	0.005 (200 yr)	280504.40	85.63	144.68	129.95	145.85	0.002451	11.58	43495.16	1888.83	0.28	7.82	2.03	3.26	3.84
Rio Manati	1	32455.27 32258	0.002 (500 yr)	399338.30	85.63	155.23	133.92	156.29	0.001891	11.50	61959.16	1972.62	0.26	7.25	1.12	3.67	4.02
Rio Manati	1	32325.2*	0.5 (2 yr)	19634.96	84.89	106.91		107.51	0.003238	6.33	3389.79	265.86	0.28	3.09	1.62	0.42	2.52
Rio Manati	1	32325.2*	0.2 (5 yr)	43754.87	84.89	113.02		114.40	0.004920	9.75	5193.75	330.73	0.37	6.55	2.96	1.59	4.71
Rio Manati	1	32325.2*	0.1 (10 yr)	68333.88	84.89	117.41		119.49	0.006001	12.18	6726.41	387.73	0.42	9.61	4.52	2.39	6.35
Rio Manati	1	32325.2*	0.04 (25 yr)	118304.10	84.89	125.88		128.12	0.005130	13.60	14698.25	1458.26	0.41	10.90	4.43	1.77	3.20
Rio Manati	1	32325.2*	0.02 (50 yr)	155702.40	84.89	130.72		132.65	0.004242	13.50	22417.70	1659.34	0.38	10.28	4.47	2.48	3.55

Alternative 0 (No Action) Results Table for XS in Project Area

HEC-RAS Plan: Alt 1 Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	32325.2*	0.01 (100 yr)	211075.80	84.89	136.56		138.24	0.003518	13.48	32249.54	1706.84	0.35	9.80	4.17	3.29	4.11
Rio Manati	1	32325.2*	0.005 (200 yr)	280504.40	84.89	143.66		145.09	0.002777	13.20	44566.35	1759.75	0.32	8.95	3.81	3.77	4.34
Rio Manati	1	32325.2*	0.002 (500 yr)	399338.30	84.89	154.49		155.75	0.002111	13.06	64099.42	1859.70	0.29	8.22	3.80	4.10	4.49
Rio Manati	1	32235.51 32029	0.5 (2 yr)	19634.96	84.38	105.77	97.42	106.53	0.003256	7.17	3125.76	250.96	0.33	3.03	2.02	0.48	2.46
Rio Manati	1	32235.51 32029	0.2 (5 yr)	43754.87	84.38	110.79	102.84	112.77	0.005919	11.71	4496.56	295.14	0.46	7.35	4.13	1.96	5.48
Rio Manati	1	32235.51 32029	0.1 (10 yr)	68333.88	84.38	113.89	107.22	117.32	0.008589	15.53	5464.01	323.92	0.57	12.32	6.74	3.64	8.79
Rio Manati	1	32235.51 32029	0.04 (25 yr)	118304.10	84.38	120.91	114.63	125.99	0.009501	19.48	9394.71	945.57	0.62	17.75	9.26	2.42	5.81
Rio Manati	1	32235.51 32029	0.02 (50 yr)	155702.40	84.38	127.87	122.27	131.31	0.005758	17.41	18156.54	1466.02	0.50	13.24	6.83	2.92	4.40
Rio Manati	1	32235.51 32029	0.01 (100 yr)	211075.80	84.38	134.61	126.11	137.29	0.004233	16.68	28724.06	1666.99	0.44	11.49	5.93	3.51	4.49
Rio Manati	1	32235.51 32029	0.005 (200 yr)	280504.40	84.38	142.29	130.70	144.43	0.003125	15.96	41892.46	1882.25	0.39	9.97	4.89	3.99	4.65
Rio Manati	1	32235.51 32029	0.002 (500 yr)	399338.30	84.38	153.52	135.68	155.29	0.002282	15.55	61538.62	1913.57	0.35	8.87	5.04	4.41	4.90
Rio Manati	1	31723.61 31578	0.5 (2 yr)	19634.96	79.69	98.34	92.33	99.80	0.005709	10.18	2309.29	193.80	0.46	5.42	2.48	1.87	4.05
Rio Manati	1	31723.61 31578	0.2 (5 yr)	43754.87	79.69	105.71	101.69	106.67	0.003232	9.72	6854.67	794.22	0.36	4.54	1.24	1.58	1.71
Rio Manati	1	31723.61 31578	0.1 (10 yr)	68333.88	79.69	111.95	104.65	112.57	0.001641	8.06	11941.44	836.48	0.26	2.94	1.21	1.03	1.43
Rio Manati	1	31723.61 31578	0.04 (25 yr)	118304.10	79.69	121.41	107.64	122.00	0.001015	7.58	20241.18	900.88	0.22	2.41	1.27	0.84	1.39
Rio Manati	1	31723.61 31578	0.02 (50 yr)	155702.40	79.69	128.01	109.41	128.60	0.000789	7.39	26249.57	920.97	0.19	2.19	1.29	0.77	1.36
Rio Manati	1	31723.61 31578	0.01 (100 yr)	211075.80	79.69	134.36	111.76	135.09	0.000773	7.97	32229.35	970.81	0.20	2.45	1.55	0.62	1.55
Rio Manati	1	31723.61 31578	0.005 (200 yr)	280504.40	79.69	141.81	114.37	142.66	0.000730	8.46	39728.45	1176.09	0.19	2.65	1.80	0.56	1.68
Rio Manati	1	31723.61 31578	0.002 (500 yr)	399338.30	79.69	152.85	118.41	153.91	0.000688	9.18	51634.95	1235.61	0.19	2.97	2.16	0.79	1.96
Rio Manati	1	31444.64 31314	0.5 (2 yr)	19634.96	73.62	94.89	87.36	95.79	0.003476	6.97	2649.69	259.01	0.31	3.30	1.03	0.38	2.12
Rio Manati	1	31444.64 31314	0.2 (5 yr)	43754.87	73.62	102.68	93.21	104.20	0.002656	7.94	4776.32	282.78	0.29	3.75	1.88	0.87	2.64
Rio Manati	1	31444.64 31314	0.1 (10 yr)	68333.88	73.62	108.80	97.67	110.87	0.002324	8.65	6553.78	299.46	0.28	4.13	2.32	1.11	2.96
Rio Manati	1	31444.64 31314	0.04 (25 yr)	118304.10	73.62	117.74	103.77	120.62	0.002289	10.22	9603.40	438.93	0.29	5.28	2.08	1.55	2.95
Rio Manati	1	31444.64 31314	0.02 (50 yr)	155702.40	73.62	124.94	108.04	127.49	0.001919	10.48	13031.14	530.86	0.27	5.25	2.07	1.57	2.78
Rio Manati	1	31444.64 31314	0.01 (100 yr)	211075.80	73.62	131.17	117.25	133.96	0.002036	11.75	16633.35	598.11	0.29	6.33	2.65	1.87	3.35
Rio Manati	1	31444.64 31314	0.005 (200 yr)	280504.40	73.62	138.81	121.78	141.60	0.001976	12.68	21935.06	804.02	0.29	7.04	2.62	2.11	3.28
Rio Manati	1	31444.64 31314	0.002 (500 yr)	399338.30	73.62	150.06	128.63	152.91	0.001867	13.82	30920.88	1095.29	0.29	7.90	3.76	2.33	4.24
Rio Manati	1	31041.5 30915	0.5 (2 yr)	19634.96	70.83	92.72	82.62	93.11	0.001240	4.99	3980.28	328.60	0.23	1.14	0.17	0.04	0.92
Rio Manati	1	31041.5 30915	0.2 (5 yr)	43754.87	70.83	101.63	87.00	102.14	0.000902	5.99	8097.90	586.26	0.22	1.32	0.27	0.32	0.76
Rio Manati	1	31041.5 30915	0.1 (10 yr)	68333.88	70.83	108.60	90.48	109.09	0.000663	6.18	13339.67	977.33	0.20	1.26	0.27	0.30	0.56
Rio Manati	1	31041.5 30915	0.04 (25 yr)	118304.10	70.83	118.67	97.70	119.08	0.000373	5.65	24140.48	1105.20	0.16	0.93	0.30	0.37	0.50
Rio Manati	1	31041.5 30915	0.02 (50 yr)	155702.40	70.83	125.88	99.82	126.28	0.000263	5.32	32246.39	1134.47	0.13	0.78	0.28	0.37	0.46
Rio Manati	1	31041.5 30915	0.01 (100 yr)	211075.80	70.83	132.23	104.92	132.71	0.000255	5.70	39513.62	1154.65	0.14	0.85	0.32	0.45	0.53
Rio Manati	1	31041.5 30915	0.005 (200 yr)	280504.40	70.83	139.85	110.54	140.42	0.000237	6.03	48796.38	1246.98	0.13	0.90	0.28	0.52	0.57
Rio Manati	1	31041.5 30915	0.002 (500 yr)	399338.30	70.83	151.10	113.92	151.80	0.000221	6.52	63029.35	1291.26	0.13	0.99	0.39	0.62	0.66
Rio Manati	1	30753.00 30623	0.5 (2 yr)	19634.96	71.39	91.66		92.12	0.000907	5.56	3641.18	250.50	0.24	0.93	0.01	0.30	0.79
Rio Manati	1	30753.00 30623	0.2 (5 yr)	43754.87	71.39	100.42		101.29	0.000980	7.65	5907.47	267.67	0.27	1.53	0.04	0.70	1.25
Rio Manati	1	30753.00 30623	0.1 (10 yr)	68333.88	71.39	107.09		108.34	0.001054	9.27	7840.93	384.00	0.29	2.08	0.20	0.49	1.26
Rio Manati	1	30753.00 30623	0.04 (25 yr)	118304.10	71.39	117.36		118.61	0.000861	10.07	15117.13	898.65	0.27	2.24	0.38	0.49	0.87
Rio Manati	1	30753.00 30623	0.02 (50 yr)	155702.40	71.39	125.05		125.99	0.000554	9.03	22083.34	913.37	0.22	1.71	0.33	0.57	0.80
Rio Manati	1	30753.00 30623	0.01 (100 yr)	211075.80	71.39	131.42		132.45	0.000520	9.48	27961.64	930.38	0.22	1.80	0.38	0.73	0.93
Rio Manati	1	30753.00 30623	0.005 (200 yr)	280504.40	71.39	139.07		140.18	0.000467	9.78	35134.20	943.86	0.22	1.84	0.42	0.86	1.03
Rio Manati	1	30753.00 30623	0.002 (500 yr)	399338.30	71.39	150.29		151.58	0.000423	10.36	45819.00	960.62	0.21	1.96	0.47	1.05	1.18
Rio Manati	1	30450.28 30327	0.5 (2 yr)	19634.96	48.56	90.62		90.78	0.001900	3.22	6401.35	410.59	0.13	2.21	0.46	0.00	1.67
Rio Manati	1	30450.28 30327	0.2 (5 yr)	43754.87	48.56	99.39		99.70	0.002421	4.63	10391.76	481.65	0.15	4.05	1.46	0.00	2.93
Rio Manati	1	30450.28 30327	0.1 (10 yr)	68333.88	48.56	106.15		106.58	0.002627	5.55	13725.27	509.07	0.16	5.44	2.38	0.00	3.94
Rio Manati	1	30450.28 30327	0.04 (25 yr)	118304.10	48.56	116.42		117.08	0.002936	6.96	19034.27	525.66	0.18	7.84	4.18	0.00	5.80
Rio Manati	1	30450.28 30327	0.02 (50 yr)	155702.40	48.56	124.18		124.95	0.002790	7.53	23164.23	537.78	0.18	8.71	5.01	0.00	6.47
Rio Manati	1	30450.28 30327	0.01 (100 yr)	211075.80	48.56	130.36		131.45	0.003451	9.01	26570.52	566.67	0.21	12.02	6.71	0.00	8.67
Rio Manati	1	30450.28 30327	0.005 (200 yr)	280504.40	48.56	137.79		139.21	0.003883	10.33	30828.20	579.34	0.22	15.21	8.85	0.00	10.95
Rio Manati	1	30450.28 30327	0.002 (500 yr)	399338.30	48.56	148.63		150.61	0.004506	12.30	37268.44	613.24	0.25	20.51	11.88	0.00	14.38
Rio Manati	1	30282.54 30154	0.5 (2 yr)	19634.96	62.99	89.65		89.85	0.001411	3.45	5437.75	357.96	0.13	1.72		1.01	1.30
Rio Manati	1	30282.54 30154	0.2 (5 yr)	43754.87	62.99	98.11		98.51	0.001816	4.58	8749.36	425.37	0.15	2.91		1.86	2.26
Rio Manati	1	30282.54 30154	0.1 (10 yr)	68333.88	62.99	104.72		105.27	0.001998	5.27	11603.64	446.36	0.16	3.75	0.01	2.78	3.10
Rio Manati	1	30282.54 30154	0.04 (25 yr)	118304.10	62.99	114.79		115.62	0.002202	6.42	16830.59	540.24	0.18	5.26	1.09	4.23	4.06
Rio Manati	1	30282.54 30154	0.02 (50 yr)	155702.40	62.99	122.68		123.60	0.001993	6.87	21162.57	558.53	0.17	5.67	1.73	4.60	4.43
Rio Manati	1	30282.54 30154	0.01 (100 yr)	211075.80	62.99	128.52		129.80	0.002419	8.16	24468.53	573.59	0.19	7.70	2.70	6.24	6.02
Rio Manati	1	30282.54 30154	0.005 (200 yr)	280504.40	62.99	135.70		137.36	0.002718	9.39	28651.12	592.81	0.21	9.78	3.69	7.93	7.61
Rio Manati	1	30282.54 30154	0.002 (500 yr)	399338.30	62.99	146.15		148.46	0.003145	11.20	35238.20	660.14	0.23	13.23	4.20	10.73	9.52
Rio Manati	1	29965.48 29830	0.5 (2 yr)	19634.96	70.47	85.48	80.34	86.33	0.012704	7.71	2781.06	280.64	0.41	8.87	5.64	1.82	7.76
Rio Manati	1	29965.48 29830	0.2 (5 yr)	43754.87	70.47	93.46	84.79	94.74	0.008060	9.40	5212.26	339.01	0.38	9.62	6.29	3.15	8.16
Rio Manati	1	29965.48 29830	0.1 (10 yr)	68333.88	70.47	99.83	88.37	101.46	0.006633	10.59	7218.06	422.66	0.37	10.54	7.76	3.59	9.09
Rio Manati	1	29965.48 29830	0.04 (25 yr)	118304.10	70.47	109.02	94.13	111.48	0.006375	13.01	10158.56	511.53	0.39	13.77	11.04	4.58	11.89
Rio Manati	1	29965.48 29830	0.02 (50 yr)	155702.40	70.47	117.30	97.67	119.95	0.005044	13.50	12863.51	581.59	0.36	13.49	11.29	4.24	11.49
Rio Manati	1	29965.48 29830	0.01 (100 yr)	211075.80	70.47	123.01	102.41	125.86	0.004946	14.61	20699.79	759.25	0.37	14.99	5.99	4.42	8.16
Rio Manati	1	29965.48 29830	0.005 (200 yr)	280504.40	70.47	130.34	107.78	133.38	0.004545	15.46	26407.46	798.74	0.36	15.84	7.26	4.60	9.08
Rio Manati	1	29965.48 29830	0.002 (500 yr)	399338.30	70.47	140.55	119.70	144.19	0.004562	17.42	35267.42	966.99	0.38	18.79	8.18	5.58	10.03
Rio Manati	1	29939.95 29805		Bridge													
Rio Manati	1	29914.84 29779	0.5 (2 yr)	19634.96	65.13	84.41	76.37	85.25	0.007617	7.57	2864.72	213.98	0.33	7.29	3.47	0.33	6.09
Rio Manati	1	29914.84 29779	0.2 (5 yr)	43754.87	65.13	91.52	81.96	93.26	0.010137	11.15	4558.87	260.20	0.41	14.00	6.51	2.02	10.56
Rio Manati	1	29914.84 29779	0.1 (10 yr)	68333.88	65.13	97.33	86.25	99.83	0.011102	13.54	6304.61	366.51	0.44	19.17	6.87	3.76	11.91
Rio Manati	1	29914.84 29779	0.04 (25 yr)	118304.10	65.13	106.72	93.95	109.82	0.010241	15.69	9646.87	411.56	0.45	23.42	12.23	5.74	16.20
Rio Manati	1	29914.84 29779	0.02 (50 yr)	155702.40	65.13	112.57	99.88	116.09	0.009896	16.95	11777.39	440.71	0.45	26.08	15.38	6.89	18.69
Rio Manati	1	29914.84 29779	0.01 (100 yr)	211075.80	65.13	119.68	104.57	123.89	0.010258	19.06	16018.58	663.50	0.47	31.39	10.14	8.88	14.83
Rio Manati	1	29914.84 29779	0.005 (200 yr)	280504.40	65.13	127.39	109.71	132.17	0.010290	20.96	21924.70	895.37	0.48	36.22	12.01	6.06	15.19
Rio Manati	1	29914.84 29779	0.002 (500 yr)	399338.30	65.13	139.68	117.35	143.41	0.007218	19.91	34175.96	1075.21	0.42	30.69	12.03	7.09	13.70

Alternative 1 (Levee/Floodwall) Results Table for XS in Project Area

HEC-RAS Plan: Alt 3 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	34233.57 34069	0.5 (2 yr)	18434.26	111.45	129.87	121.19	130.40	0.004234	5.84	3159.66	238.79	0.28	3.47	0.29		3.36
Rio Manati	1	34233.57 34069	0.2 (5 yr)	40682.50	111.45	136.63	125.86	137.73	0.005850	8.30	4860.65	261.98	0.33	6.91	1.80		6.44
Rio Manati	1	34233.57 34069	0.1 (10 yr)	63177.94	111.45	142.87	129.56	144.40	0.005726	9.38	6552.67	280.59	0.33	8.67	2.88	0.20	7.86
Rio Manati	1	34233.57 34069	0.04 (25 yr)	108910.40	111.45	151.52	135.35	153.05	0.003998	9.52	11100.57	656.62	0.29	8.10	1.64	1.04	4.06
Rio Manati	1	34233.57 34069	0.02 (50 yr)	142989.10	111.45	155.40	138.83	157.31	0.003299	9.29	13676.86	670.65	0.27	7.44	2.09	1.23	4.04
Rio Manati	1	34233.57 34069	0.01 (100 yr)	193489.10	111.45	159.71	148.32	162.26	0.003033	9.57	16664.92	706.61	0.26	7.61	2.58	1.46	4.29
Rio Manati	1	34233.57 34069	0.005 (200 yr)	256702.30	111.45	164.48	150.84	167.81	0.002730	9.74	20244.43	779.33	0.25	7.62	3.02	1.01	4.25
Rio Manati	1	34233.57 34069	0.002 (500 yr)	364800.50	111.45	171.01	155.15	175.66	0.002529	10.23	25778.46	964.52	0.25	8.04	3.71	0.88	4.05
Rio Manati	1	34155.99 33988	0.5 (2 yr)	18504.88	110.89	128.90	119.21	129.39	0.003601	5.66	3288.79	243.00	0.27	3.06		0.48	2.94
Rio Manati	1	34155.99 33988	0.2 (5 yr)	40859.07	110.89	135.22	124.38	136.35	0.005007	8.56	4944.50	280.38	0.33	6.17	0.94	1.47	5.32
Rio Manati	1	34155.99 33988	0.1 (10 yr)	63495.77	110.89	141.56	128.07	143.08	0.004755	9.99	6881.72	360.36	0.34	7.68	0.99	2.40	5.48
Rio Manati	1	34155.99 33988	0.04 (25 yr)	109440.10	110.89	149.87	134.04	151.85	0.004622	11.80	10581.70	581.93	0.35	9.79	2.03	1.86	5.11
Rio Manati	1	34155.99 33988	0.02 (50 yr)	143730.70	110.89	154.31	137.81	156.36	0.004175	12.15	13482.28	679.31	0.34	9.97	2.53	2.33	5.04
Rio Manati	1	34155.99 33988	0.01 (100 yr)	194477.90	110.89	158.99	145.46	161.33	0.003927	12.69	16752.08	712.54	0.34	10.49	3.25	3.19	5.60
Rio Manati	1	34155.99 33988	0.005 (200 yr)	258044.30	110.89	164.02	152.41	166.78	0.003624	13.10	20407.91	739.32	0.33	10.78	3.87	3.90	6.06
Rio Manati	1	34155.99 33988	0.002 (500 yr)	366742.80	110.89	170.84	157.02	174.47	0.003342	13.72	25714.22	851.47	0.32	11.33	3.86	4.75	6.11
Rio Manati	1	34135.98 33968		Bridge													
Rio Manati	1	34115.96 33947	0.5 (2 yr)	18504.88	110.66	125.73	118.60	126.30	0.001191	5.99	3069.93	263.48	0.30	0.89	0.08	0.30	0.84
Rio Manati	1	34115.96 33947	0.2 (5 yr)	40859.07	110.66	132.69	122.98	133.75	0.001164	7.99	5060.30	300.44	0.32	1.37	0.29	0.47	1.18
Rio Manati	1	34115.96 33947	0.1 (10 yr)	63495.77	110.66	137.40	126.86	139.03	0.001240	9.55	6509.07	315.83	0.34	1.81	0.43	0.73	1.52
Rio Manati	1	34115.96 33947	0.04 (25 yr)	109440.10	110.66	144.81	131.56	147.03	0.001347	11.92	9692.91	564.91	0.38	2.58	0.42	0.64	1.40
Rio Manati	1	34115.96 33947	0.02 (50 yr)	143730.70	110.66	149.37	134.95	151.81	0.001152	12.06	12377.81	607.15	0.36	2.53	0.61	0.80	1.42
Rio Manati	1	34115.96 33947	0.01 (100 yr)	194477.90	110.66	153.76	139.83	156.84	0.001160	13.08	15097.35	632.32	0.36	2.86	0.88	1.04	1.67
Rio Manati	1	34115.96 33947	0.005 (200 yr)	258044.30	110.66	159.43	146.72	162.98	0.001045	13.55	18776.83	667.67	0.35	2.94	1.07	1.19	1.77
Rio Manati	1	34115.96 33947	0.002 (500 yr)	366742.80	110.66	167.79	152.49	171.75	0.000880	13.90	25280.72	808.88	0.33	2.92	1.03	1.32	1.66
Rio Manati	1	33860.74 33690	0.5 (2 yr)	18504.88	108.76	123.92	118.44	124.82	0.002471	8.44	2993.98	279.42	0.42	1.88	1.31		1.59
Rio Manati	1	33860.74 33690	0.2 (5 yr)	40859.07	108.76	130.49	123.34	132.08	0.003241	11.46	5045.35	340.35	0.47	3.55	2.37		2.87
Rio Manati	1	33860.74 33690	0.1 (10 yr)	63495.77	108.76	134.84	127.07	137.17	0.003726	14.02	6593.78	386.39	0.52	5.02	3.11	0.28	3.79
Rio Manati	1	33860.74 33690	0.04 (25 yr)	109440.10	108.76	141.80	132.58	144.98	0.003840	17.00	10227.86	624.18	0.55	6.75	3.24	0.84	4.07
Rio Manati	1	33860.74 33690	0.02 (50 yr)	143730.70	108.76	147.56	136.39	150.31	0.002828	16.41	13722.71	732.30	0.49	5.94	3.13	0.95	3.71
Rio Manati	1	33860.74 33690	0.01 (100 yr)	194477.90	108.76	152.14	143.49	155.37	0.002919	18.08	16652.76	795.15	0.50	6.92	3.91	1.09	4.44
Rio Manati	1	33860.74 33690	0.005 (200 yr)	258044.30	108.76	158.18	147.26	161.63	0.002678	19.01	20898.94	870.09	0.49	7.30	4.36	1.08	4.59
Rio Manati	1	33860.74 33690	0.002 (500 yr)	366742.80	108.76	166.67	152.39	170.60	0.002506	20.58	27250.52	907.46	0.49	8.09	5.26	1.76	5.31
Rio Manati	1	33704.47 33532	0.5 (2 yr)	18504.88	103.22	122.47	115.89	123.19	0.004117	6.98	2881.59	305.44	0.34	3.39	0.91	0.70	2.37
Rio Manati	1	33704.47 33532	0.2 (5 yr)	40859.07	103.22	128.97	120.90	130.11	0.004210	9.19	5293.88	418.25	0.36	5.14	1.83	1.57	3.25
Rio Manati	1	33704.47 33532	0.1 (10 yr)	63495.77	103.22	133.44	124.99	134.92	0.004346	10.70	7266.41	453.80	0.38	6.51	2.82	2.24	4.23
Rio Manati	1	33704.47 33532	0.04 (25 yr)	109440.10	103.22	140.55	130.06	142.61	0.004465	12.86	10591.60	486.49	0.40	8.63	4.62	3.04	5.88
Rio Manati	1	33704.47 33532	0.02 (50 yr)	143730.70	103.22	146.32	133.18	148.53	0.003891	13.43	13509.93	518.45	0.39	8.91	5.19	3.19	6.11
Rio Manati	1	33704.47 33532	0.01 (100 yr)	194477.90	103.22	150.51	136.82	153.53	0.004651	15.77	15723.89	538.10	0.43	11.84	7.17	4.41	8.18
Rio Manati	1	33704.47 33532	0.005 (200 yr)	258044.30	103.22	156.10	140.53	159.87	0.004956	17.71	18833.82	571.67	0.46	14.32	8.96	5.33	9.80
Rio Manati	1	33704.47 33532	0.002 (500 yr)	366742.80	103.22	163.71	147.04	168.76	0.005485	20.59	23317.72	616.53	0.49	18.41	11.84	7.03	12.50
Rio Manati	1	33597.73 33414	0.5 (2 yr)	18504.88	109.15	120.93	116.37	121.77	0.003868	8.43	2582.94	283.17	0.46	2.48	0.94	2.34	2.13
Rio Manati	1	33597.73 33414	0.2 (5 yr)	40859.07	109.15	127.65	120.53	128.85	0.003127	10.58	4976.91	464.37	0.45	3.30	0.88	2.96	2.03
Rio Manati	1	33597.73 33414	0.1 (10 yr)	63495.77	109.15	132.26	123.86	133.69	0.002912	11.98	7216.43	492.49	0.45	3.91	1.55	3.41	2.58
Rio Manati	1	33597.73 33414	0.04 (25 yr)	109440.10	109.15	139.49	129.49	141.35	0.002788	14.21	10866.55	526.15	0.47	4.99	2.51	4.21	3.46
Rio Manati	1	33597.73 33414	0.02 (50 yr)	143730.70	109.15	145.54	132.20	147.43	0.002290	14.62	14126.64	554.14	0.44	4.96	2.79	3.95	3.50
Rio Manati	1	33597.73 33414	0.01 (100 yr)	194477.90	109.15	149.64	135.65	152.19	0.002733	17.20	16449.89	577.88	0.49	6.61	3.91	5.01	4.66
Rio Manati	1	33597.73 33414	0.005 (200 yr)	258044.30	109.15	155.33	139.46	158.41	0.002842	19.20	19825.77	613.29	0.51	7.88	4.99	5.59	5.56
Rio Manati	1	33597.73 33414	0.002 (500 yr)	366742.80	109.15	163.06	145.36	167.07	0.003104	22.32	24585.72	655.88	0.54	10.09	6.91	7.00	7.29
Rio Manati	1	33357.12 33176	0.5 (2 yr)	18504.88	99.08	118.47	109.56	119.13	0.002880	6.81	3454.30	391.70	0.30	2.83	0.69	0.41	1.51
Rio Manati	1	33357.12 33176	0.2 (5 yr)	40859.07	99.08	125.27	115.58	126.32	0.003282	9.15	6725.28	516.31	0.33	4.55	1.75	1.04	2.54
Rio Manati	1	33357.12 33176	0.1 (10 yr)	63495.77	99.08	129.73	120.56	131.14	0.003732	10.96	9074.41	535.57	0.37	6.16	2.90	1.59	3.75
Rio Manati	1	33357.12 33176	0.04 (25 yr)	109440.10	99.08	136.58	125.78	138.67	0.004413	13.81	12840.24	565.29	0.41	9.07	4.99	2.64	5.93
Rio Manati	1	33357.12 33176	0.02 (50 yr)	143730.70	99.08	143.24	128.77	145.25	0.003565	13.95	16890.83	661.53	0.38	8.74	4.58	2.68	5.39
Rio Manati	1	33357.12 33176	0.01 (100 yr)	194477.90	99.08	146.85	132.59	149.55	0.004414	16.42	19464.71	842.82	0.43	11.77	5.55	3.09	6.55
Rio Manati	1	33357.12 33176	0.005 (200 yr)	258044.30	99.08	152.90	136.83	155.72	0.004178	17.38	25496.65	1165.13	0.43	12.64	4.89	3.33	5.84
Rio Manati	1	33357.12 33176	0.002 (500 yr)	366742.80	99.08	161.11	144.68	164.11	0.003944	18.65	34898.38	1266.61	0.43	13.85	6.14	4.01	6.91
Rio Manati	1	33200.01 33011	0.5 (2 yr)	18504.88	98.89	116.88	108.60	117.45	0.004089	5.69	3093.44	259.23	0.26	3.76	1.77		2.97
Rio Manati	1	33200.01 33011	0.2 (5 yr)	40859.07	98.89	123.53	113.52	124.60	0.004480	6.45	5299.76	359.29	0.25	5.39	2.73	0.02	4.01
Rio Manati	1	33200.01 33011	0.1 (10 yr)	63495.77	98.89	127.60	117.24	129.25	0.004643	7.42	6800.71	380.80	0.27	6.72	3.87	0.53	5.02
Rio Manati	1	33200.01 33011	0.04 (25 yr)	109440.10	98.89	133.58	122.67	136.38	0.005336	9.22	9187.72	429.77	0.30	9.63	5.58	1.63	6.89
Rio Manati	1	33200.01 33011	0.02 (50 yr)	143730.70	98.89	141.15	126.36	143.70	0.003156	8.23	12966.20	680.30	0.24	7.12	3.87	1.66	4.70
Rio Manati	1	33200.01 33011	0.01 (100 yr)	194477.90	98.89	145.01	132.28	147.94	0.003290	8.97	16159.18	812.97	0.25	8.19	2.98	1.91	3.99
Rio Manati	1	33200.01 33011	0.005 (200 yr)	258044.30	98.89	151.71	137.30	154.50	0.002285	8.26	22460.22	1051.31	0.21	6.60	2.68	1.06	2.99
Rio Manati	1	33200.01 33011	0.002 (500 yr)	366742.80	98.89	160.08	145.91	163.14	0.001655	7.82	31812.02	1156.86	0.18	5.61	2.61	1.43	2.78
Rio Manati	1	33176.74 32988		Bridge													
Rio Manati	1	33153.54 32965	0.5 (2 yr)	18504.88	100.39	116.41	108.83	117.08	0.009177	6.16	2876.23	307.66	0.29	8.01	1.75	0.57	5.25
Rio Manati	1	33153.54 32965	0.2 (5 yr)	40859.07	100.39	123.19	113.83	124.13	0.005470	6.15	5617.11	488.92	0.24	7.03	2.22	1.31	3.90
Rio Manati	1	33153.54 32965	0.1 (10 yr)	63495.77	100.39	127.30	118.44	128.62	0.004512	6.29	7659.43	533.88	0.22	6.93	2.73	2.18	4.12
Rio Manati	1	33153.54 32965	0.04 (25 yr)	109440.10	100.39	133.37	123.11	135.45	0.003801	6.67	10907.13	601.93	0.21	7.24	3.55	3.20	4.72
Rio Manati	1	33153.54 32965	0.02 (50 yr)	143730.70	100.39	137.24	126.83	139.85	0.003441	6.86	12993.92	636.98	0.20	7.37	4.04	3.68	5.10
Rio Manati	1	33153.54 32965	0.01 (100 yr)	194477.90	100.39	141.75	129.63	145.22	0.003361	7.35	15429.54	676.31	0.21	8.12	4.89	4.49	5.91
Rio Manati	1	33153.54 32965	0.005 (200 yr)	258044.30	100.39	147.36	133.52	150.60	0.002783	7.30	20546.58	787.57	0.19	7.67	3.66	2.82	4.44
Rio Manati	1	33153.54 32965	0.002 (500 yr)	366742.80	100.39	156.72	139.72	159.98	0.002091	7.17	28770.28	971.65	0.17	6.96	3.39	2.02	3.80
Rio Manati	1	32988.5*	0.5 (2 yr)	18504.88	97.75	112.05	106.08	112.88	0.006153	7.39	2575.39	221.63	0.37	4.84	2.04	1.32	4.30
Rio Manati	1	32988.5*	0.2 (5 yr)	40859.07	97.75	119.14	110.61	120.60	0.006176	9.94	4403.85	370.35	0.39	7.57	1.13	2.12	4.46
Rio Manati	1	32988.5*	0.1 (10 yr)	63495.77	97.75	124.56	114.40	125.89	0.004550	10.03	7391.99	658.61	0.35	7.10	1.44	2.42	3.13
Rio Manati	1	32988.5*	0.04 (25 yr)	109440.10	97.75	131.80	123.54	132.94	0.002819	9.34	12973.59	832.72	0.29	5.66	1.82	1.90	2.69
Rio Manati	1	32988.5*	0.02 (50 yr)	143730.70	97.75	136.21	125.81	137.37	0.002239	9.06	16704.79	860.15	0.26	5.11	2.04	1.68	2.65
Rio Manati	1	32988.5*	0.01 (100 yr)	194477.90	97.75	141.19	128.68	142.52	0.001964	9.24	21503.70	1044.03	0.25	5.09	2.36	1.02	2.46
Rio Manati	1	32988.5*	0.005 (200 yr)	258044.30	97.75	147.12	131.14	148.27	0.001460	8.70	31167.70	1412.69	0.22	4.32	1.77	1.12	1.94
Rio Manati	1	32988.5*	0.002 (500 yr)	366742.80	97.75	156.85	134.71	157.96	0.001042	8.31	46233.97	1697.14	0.19	3.71	1.64	1.11	1.72
Rio Manati	1	32918.20 32728	0.5 (2 yr)	19634.96	96.62	111.34	103.96	112.01	0.002354	6.67	3077.74	240.86	0.31	2.06	0.83	0.73	1.81
Rio Manati	1	32918.20 32728	0.2 (5 yr)	43754.87	96.62	118.26	108.63	119.65	0.002906	9.67	4877.58	305.96	0.37	3.78	0.88	1.28	2.77
Rio Manati	1	32918.20 32728	0.1 (10 yr)	68333.88	96.62	123.04	112.37	124.94	0.003179	11.60	7111.80	707.82	0.40	5.08	0.60	1.65	1.95
Rio Manati	1	32918.20 32728	0.04 (25 yr)	118304.10	96.62	130.62	119.44	132.25	0.002309	11.74	13003.18	810.34	0.36	4.77	1.43	1.53	2.25
Rio Manati	1	32918.20 32728	0.02 (50 yr)	155702.40	96.62	135.22	126.22	136.79	0.001938	11.72	16730.14	810.34	0.34	4.56	1.72	1.75	2.41
Rio Manati	1	32918.20 32728	0.01 (100 yr)	211075.80	96.62	140.35	129.16	142.00	0.001747	12.11	22651.19	1039.93	0.33	4.66	2.07	1.25	2.27
Rio Manati	1	32918.20 32728	0.005 (200 yr)	280504.40	96.62	145.95	132.01	147.79	0.001623	12.66	28597.67	1120.12	0.32	4.90	2.44	1.42	2.47
Rio Manati	1	32918.20 32728	0.002 (500 yr)	399338.30	96.62	156.66	137.14	157.67	0.000863	10.54	55864.04	1913.86	0.24	3.18	1.41	1.14	1.51
Rio Manati	1	32740.16 32548	0.5 (2 yr)	19634.96	95.47	106.42	104.55	108.64	0.024604	12.15	1717.86	221.70	0.68	15.04	3.94	3.01	11.72
Rio Manati	1	32740.16 32548	0.2 (5 yr)	43754.87	95.47	112.07	109.79	115.72	0.022782	15.98	3106.88	296.00	0.71	21.88	6.68	6.38	14.64
Rio Manati	1	32740.16 32548	0.1 (10 yr)	68333.88	95.47	117.21	114.59	121.07	0.017292	16.93	4830.24	365.43	0.66	22.09	8.11	7.34	13.98
Rio Manati	1	32740.16 32548	0.04 (25 yr)	118304.10	95.47	126.31	120.21	129.56	0.009843	16.38	9404.24	542.65	0.53	18.10	7.48	5.69	10.28
Rio Manati	1	32740.16 32548	0.02 (50 yr)	155702.40	95.47	131.13	124.11	134.47	0.008566	16.91	12019.99	542.65	0.51	18.30	8.88	6.73	11.24
Rio Manati	1	32740.16 32548	0.01 (100 yr)	211075.80	95.47	137.24	127.71	140.02	0.006817	16.85	20259.88	1176.36	0.47	17.14	9.38	3.63	7.03
Rio Manati	1	32740.16 32548	0.005 (200 yr)	280504.40	95.47	144.77	131.48	146.31	0.003422	13.38	35715.70	1873.16	0.34	10.19	5.31	2.87	4.50
Rio Manati	1	32740.16 32548	0.002 (500 yr)	399338.30	95.47	155.39	135.77	156.79	0.002493	13.06	53467.57	1983.06	0.30	9.06	5.18	3.44	4.59
Rio Manati	1	32455.27 32258	0.5 (2 yr)	19634.96	85.63	107.17	93.71	107.27	0.000235	2.61	7582.15	478.40	0.11	0.25	0.09	0.02	0.24
Rio Manati	1	32455.27 32258	0.2 (5 yr)	43754.87	85.63	113.23	96.68	113.50	0.000415	4.24	10421.74	507.63	0.16	0.59	0.31	0.11	0.56
Rio Manati	1	32455.27 32258	0.1 (10 yr)	68333.88	85.63	118.19	99.12	118.64	0.000521	5.41	12815.30	538.53	0.18	0.90	0.53	0.20	0.83
Rio Manati	1	32455.27 32258	0.04 (25 yr)	118304.10	85.63	126.71	103.31	127.40	0.000586	6.85	21218.43	1501.79	0.20	1.32	0.89	0.18	0.53
Rio Manati	1	32455.27 32258	0.02 (50 yr)	155702.40	85.63	131.55	105.95	132.33	0.000595	7.50	28369.31	1574.88	0.21	1.52	1.08	0.34	0.69
Rio Manati	1	32455.27 32258	0.01 (100 yr)	211075.80	85.63	137.21	109.47	138.13	0.000623	8.36	37346.73	1735.06	0.21	1.81	1.34	0.51	0.86
Rio Manati	1	32455.27 32258	0.005 (200 yr)	280504.40	85.63	144.07	113.46	145.07	0.000602	8.99	48930.84	1885.51	0.22	2.00	0.86	0.73	1.06
Rio Manati	1	32455.27 32258	0.002 (500 yr)	399338.30	85.63	154.70	119.94	155.78	0.000556	9.75	67497.99	1968.60	0.21	2.21	0.50	1.02	1.29
Rio Manati	1	32325.2*	0.5 (2 yr)	19634.96	84.89	106.83		107.10	0.000666	4.21	4784.64	312.82	0.18	0.69	0.31	0.08	0.62
Rio Manati	1	32325.2*	0.2 (5 yr)	43754.87	84.89	112.49		113.18	0.001189	6.82	6667.30	350.35	0.25	1.65	0.68	0.34	1.37
Rio Manati	1	32325.2*	0.1 (10 yr)	68333.88	84.89	117.15		118.23	0.001465	8.57	8348.63	385.00	0.29	2.45	1.10	0.42	1.92
Rio Manati	1	32325.2*	0.04 (25 yr)	118304.10	84.89	125.48		126.95	0.001509	10.39	15845.68	1444.35	0.31	3.30	1.34	0.42	1.02
Rio Manati	1	32325.2*	0.02 (50 yr)	155702.40	84.89	130.36		131.91	0.001443	11.07	23543.91	1656.54	0.31	3.59	1.56	0.75	1.27

Alternative 1 (Levee/Floodwall) Results Table for XS in Project Area

HEC-RAS Plan: Alt 3 Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	32325.2*	0.01 (100 yr)	211075.80	84.89	136.10		137.72	0.001396	11.90	33183.43	1702.80	0.31	3.96	1.71	1.20	1.68
Rio Manati	1	32325.2*	0.005 (200 yr)	280504.40	84.89	143.12		144.71	0.001251	12.37	45338.54	1756.64	0.30	4.09	1.75	1.60	1.99
Rio Manati	1	32325.2*	0.002 (500 yr)	399338.30	84.89	153.91		155.48	0.001070	12.94	64741.76	1853.28	0.29	4.21	1.97	1.99	2.30
Rio Manati	1	32235.51 32029	0.5 (2 yr)	19634.96	84.38	105.79	98.85	106.67	0.002847	7.68	2677.58	238.58	0.36	2.47	1.65	0.42	1.95
Rio Manati	1	32235.51 32029	0.2 (5 yr)	43754.87	84.38	109.98	104.27	112.34	0.005836	12.71	3754.14	273.81	0.52	6.57	4.09	1.77	4.87
Rio Manati	1	32235.51 32029	0.1 (10 yr)	68333.88	84.38	113.32	108.59	117.11	0.007853	16.26	4725.41	306.70	0.62	10.46	6.27	3.13	7.37
Rio Manati	1	32235.51 32029	0.04 (25 yr)	118304.10	84.38	120.50	115.39	125.72	0.008092	19.60	8368.39	881.59	0.64	14.36	8.15	2.01	4.73
Rio Manati	1	32235.51 32029	0.02 (50 yr)	155702.40	84.38	127.63	122.11	131.07	0.004728	17.18	17074.41	1451.73	0.51	10.47	5.74	2.34	3.43
Rio Manati	1	32235.51 32029	0.01 (100 yr)	211075.80	84.38	134.39	126.79	137.09	0.003452	16.36	27584.35	1657.05	0.44	9.09	4.87	2.82	3.54
Rio Manati	1	32235.51 32029	0.005 (200 yr)	280504.40	84.38	142.09	130.24	144.25	0.002501	15.47	40764.79	1881.66	0.38	7.77	3.95	3.16	3.63
Rio Manati	1	32235.51 32029	0.002 (500 yr)	399338.30	84.38	153.29	135.47	155.15	0.001783	14.85	60344.91	1913.12	0.33	6.77	3.99	3.42	3.76
Rio Manati	1	31723.61 31578	0.5 (2 yr)	19634.96	79.69	99.81	92.99	100.77	0.007128	7.95	2572.19	442.46	0.34	7.43	0.91	2.56	2.54
Rio Manati	1	31723.61 31578	0.2 (5 yr)	43754.87	79.69	106.42	101.34	107.01	0.003211	6.65	7250.00	798.13	0.24	4.66	1.34	1.62	1.79
Rio Manati	1	31723.61 31578	0.1 (10 yr)	68333.88	79.69	112.26	103.44	112.78	0.001732	5.67	12033.05	838.55	0.18	3.14	1.30	1.09	1.52
Rio Manati	1	31723.61 31578	0.04 (25 yr)	118304.10	79.69	121.53	106.37	122.09	0.001064	5.33	20174.20	901.20	0.15	2.54	1.34	0.89	1.45
Rio Manati	1	31723.61 31578	0.02 (50 yr)	155702.40	79.69	128.09	108.14	128.67	0.000817	5.19	26153.18	921.36	0.14	2.28	1.34	0.79	1.41
Rio Manati	1	31723.61 31578	0.01 (100 yr)	211075.80	79.69	134.43	110.54	135.16	0.000794	5.58	32129.11	971.56	0.14	2.52	1.59	0.64	1.59
Rio Manati	1	31723.61 31578	0.005 (200 yr)	280504.40	79.69	141.87	113.26	142.74	0.000745	5.92	39624.77	1177.92	0.14	2.71	1.83	0.57	1.71
Rio Manati	1	31723.61 31578	0.002 (500 yr)	399338.30	79.69	152.89	117.50	153.98	0.000697	6.42	51517.36	1235.78	0.14	3.01	2.19	0.80	1.98
Rio Manati	1	31444.64 31314	0.5 (2 yr)	19634.96	73.79	95.10	87.48	96.00	0.004295	7.74	2594.49	260.44	0.34	4.08	1.11	0.50	2.58
Rio Manati	1	31444.64 31314	0.2 (5 yr)	43754.87	73.79	102.87	94.08	104.30	0.003204	8.72	4718.82	283.16	0.32	4.53	2.18	1.07	3.17
Rio Manati	1	31444.64 31314	0.1 (10 yr)	68333.88	73.79	108.96	98.04	110.92	0.002763	9.43	6493.29	299.94	0.30	4.91	2.69	1.33	3.52
Rio Manati	1	31444.64 31314	0.04 (25 yr)	118304.10	73.79	117.88	103.68	120.62	0.002684	11.07	9555.44	440.63	0.31	6.20	2.38	1.82	3.45
Rio Manati	1	31444.64 31314	0.02 (50 yr)	155702.40	73.79	125.01	107.73	127.50	0.002238	11.31	12960.73	533.94	0.29	6.12	2.37	1.84	3.23
Rio Manati	1	31444.64 31314	0.01 (100 yr)	211075.80	73.79	131.21	115.42	133.97	0.002357	12.63	16551.02	598.30	0.31	7.32	3.04	2.17	3.88
Rio Manati	1	31444.64 31314	0.005 (200 yr)	280504.40	73.79	138.83	121.33	141.62	0.002270	13.58	21835.68	804.16	0.31	8.08	2.98	2.42	3.77
Rio Manati	1	31444.64 31314	0.002 (500 yr)	399338.30	73.79	150.05	128.33	152.94	0.002120	14.72	30800.30	1095.26	0.31	8.97	4.24	2.65	4.81
Rio Manati	1	31041.5 30915	0.5 (2 yr)	19634.96	70.83	92.72	82.62	93.11	0.001240	4.99	3980.28	328.60	0.23	1.14	0.17	0.04	0.92
Rio Manati	1	31041.5 30915	0.2 (5 yr)	43754.87	70.83	101.63	87.00	102.14	0.000902	5.99	8097.90	586.26	0.22	1.32	0.27	0.32	0.76
Rio Manati	1	31041.5 30915	0.1 (10 yr)	68333.88	70.83	108.60	90.48	109.09	0.000663	6.18	13339.67	977.33	0.20	1.26	0.27	0.30	0.56
Rio Manati	1	31041.5 30915	0.04 (25 yr)	118304.10	70.83	118.67	97.70	119.08	0.000373	5.65	24140.48	1105.20	0.16	0.93	0.30	0.37	0.50
Rio Manati	1	31041.5 30915	0.02 (50 yr)	155702.40	70.83	125.88	99.82	126.28	0.000263	5.32	32246.39	1134.47	0.13	0.78	0.28	0.37	0.46
Rio Manati	1	31041.5 30915	0.01 (100 yr)	211075.80	70.83	132.23	104.92	132.71	0.000255	5.70	39513.62	1154.65	0.14	0.85	0.32	0.45	0.53
Rio Manati	1	31041.5 30915	0.005 (200 yr)	280504.40	70.83	139.85	110.54	140.42	0.000237	6.03	48796.38	1246.98	0.13	0.90	0.28	0.52	0.57
Rio Manati	1	31041.5 30915	0.002 (500 yr)	399338.30	70.83	151.10	113.92	151.80	0.000221	6.52	63029.35	1291.26	0.13	0.99	0.39	0.62	0.66
Rio Manati	1	30753.00 30623	0.5 (2 yr)	19634.96	71.39	91.66		92.12	0.000907	5.56	3641.18	250.50	0.24	0.93	0.01	0.30	0.79
Rio Manati	1	30753.00 30623	0.2 (5 yr)	43754.87	71.39	100.42		101.29	0.000980	7.65	5907.47	267.67	0.27	1.53	0.04	0.70	1.25
Rio Manati	1	30753.00 30623	0.1 (10 yr)	68333.88	71.39	107.09		108.34	0.001054	9.27	7840.93	384.00	0.29	2.08	0.20	0.49	1.26
Rio Manati	1	30753.00 30623	0.04 (25 yr)	118304.10	71.39	117.36		118.61	0.000861	10.07	15117.13	898.65	0.27	2.24	0.38	0.49	0.87
Rio Manati	1	30753.00 30623	0.02 (50 yr)	155702.40	71.39	125.05		125.99	0.000554	9.03	22083.34	913.37	0.22	1.71	0.33	0.57	0.80
Rio Manati	1	30753.00 30623	0.01 (100 yr)	211075.80	71.39	131.42		132.45	0.000520	9.48	27961.64	930.38	0.22	1.80	0.38	0.73	0.93
Rio Manati	1	30753.00 30623	0.005 (200 yr)	280504.40	71.39	139.07		140.18	0.000467	9.78	35134.20	943.86	0.22	1.84	0.42	0.86	1.03
Rio Manati	1	30753.00 30623	0.002 (500 yr)	399338.30	71.39	150.29		151.58	0.000423	10.36	45819.00	960.62	0.21	1.96	0.47	1.05	1.18
Rio Manati	1	30450.28 30327	0.5 (2 yr)	19634.96	48.56	90.62		90.78	0.001900	3.22	6401.35	410.59	0.13	2.21	0.46	0.00	1.67
Rio Manati	1	30450.28 30327	0.2 (5 yr)	43754.87	48.56	99.39		99.70	0.002421	4.63	10391.76	481.65	0.15	4.05	1.46	0.00	2.93
Rio Manati	1	30450.28 30327	0.1 (10 yr)	68333.88	48.56	106.15		106.58	0.002627	5.55	13725.27	509.07	0.16	5.44	2.38	0.00	3.94
Rio Manati	1	30450.28 30327	0.04 (25 yr)	118304.10	48.56	116.42		117.08	0.002936	6.96	19034.27	525.66	0.18	7.84	4.18	0.00	5.80
Rio Manati	1	30450.28 30327	0.02 (50 yr)	155702.40	48.56	124.18		124.95	0.002790	7.53	23164.23	537.78	0.18	8.71	5.01	0.00	6.47
Rio Manati	1	30450.28 30327	0.01 (100 yr)	211075.80	48.56	130.36		131.45	0.003451	9.01	26570.52	566.67	0.21	12.02	6.71	0.00	8.67
Rio Manati	1	30450.28 30327	0.005 (200 yr)	280504.40	48.56	137.79		139.21	0.003883	10.33	30828.20	579.34	0.22	15.21	8.85	0.00	10.95
Rio Manati	1	30450.28 30327	0.002 (500 yr)	399338.30	48.56	148.63		150.61	0.004506	12.30	37268.44	613.24	0.25	20.51	11.88	0.00	14.38
Rio Manati	1	30282.54 30154	0.5 (2 yr)	19634.96	62.99	89.65		89.85	0.001411	3.45	5437.75	357.96	0.13	1.72		1.01	1.30
Rio Manati	1	30282.54 30154	0.2 (5 yr)	43754.87	62.99	98.11		98.51	0.001816	4.58	8749.36	425.37	0.15	2.91		1.86	2.26
Rio Manati	1	30282.54 30154	0.1 (10 yr)	68333.88	62.99	104.72		105.27	0.001998	5.27	11603.64	446.36	0.16	3.75	0.01	2.78	3.10
Rio Manati	1	30282.54 30154	0.04 (25 yr)	118304.10	62.99	114.79		115.62	0.002202	6.42	16830.59	540.24	0.18	5.26	1.09	4.23	4.06
Rio Manati	1	30282.54 30154	0.02 (50 yr)	155702.40	62.99	122.68		123.60	0.001993	6.87	21162.57	558.53	0.17	5.67	1.73	4.60	4.43
Rio Manati	1	30282.54 30154	0.01 (100 yr)	211075.80	62.99	128.52		129.80	0.002419	8.16	24468.53	573.59	0.19	7.70	2.70	6.24	6.02
Rio Manati	1	30282.54 30154	0.005 (200 yr)	280504.40	62.99	135.70		137.36	0.002718	9.39	28651.12	592.81	0.21	9.78	3.69	7.93	7.61
Rio Manati	1	30282.54 30154	0.002 (500 yr)	399338.30	62.99	146.15		148.46	0.003145	11.20	35238.20	660.14	0.23	13.23	4.20	10.73	9.52
Rio Manati	1	29965.48 29830	0.5 (2 yr)	19634.96	70.47	85.48	80.34	86.33	0.012704	7.71	2781.06	280.64	0.41	8.87	5.64	1.82	7.76
Rio Manati	1	29965.48 29830	0.2 (5 yr)	43754.87	70.47	93.46	84.79	94.74	0.008060	9.40	5212.26	339.01	0.38	9.62	6.29	3.15	8.16
Rio Manati	1	29965.48 29830	0.1 (10 yr)	68333.88	70.47	99.83	88.37	101.46	0.006633	10.59	7218.06	422.66	0.37	10.54	7.76	3.59	9.09
Rio Manati	1	29965.48 29830	0.04 (25 yr)	118304.10	70.47	109.02	94.13	111.48	0.006375	13.01	10158.56	511.53	0.39	13.77	11.04	4.58	11.89
Rio Manati	1	29965.48 29830	0.02 (50 yr)	155702.40	70.47	117.30	97.67	119.95	0.005044	13.50	12863.51	581.59	0.36	13.49	11.29	4.24	11.49
Rio Manati	1	29965.48 29830	0.01 (100 yr)	211075.80	70.47	123.01	102.41	125.86	0.004946	14.61	20699.79	759.25	0.37	14.99	5.99	4.42	8.16
Rio Manati	1	29965.48 29830	0.005 (200 yr)	280504.40	70.47	130.34	107.78	133.38	0.004545	15.46	26407.46	798.74	0.36	15.84	7.26	4.60	9.08
Rio Manati	1	29965.48 29830	0.002 (500 yr)	399338.30	70.47	140.55	119.70	144.19	0.004562	17.42	35267.42	966.99	0.38	18.79	8.18	5.58	10.03
Rio Manati	1	29939.95 29805		Bridge													
Rio Manati	1	29914.84 29779	0.5 (2 yr)	19634.96	65.13	84.41	76.37	85.25	0.007617	7.57	2864.72	213.98	0.33	7.29	3.47	0.33	6.09
Rio Manati	1	29914.84 29779	0.2 (5 yr)	43754.87	65.13	91.52	81.96	93.26	0.010137	11.15	4558.87	260.20	0.41	14.00	6.51	2.02	10.56
Rio Manati	1	29914.84 29779	0.1 (10 yr)	68333.88	65.13	97.33	86.25	99.83	0.011102	13.54	6304.61	366.51	0.44	19.17	6.87	3.76	11.91
Rio Manati	1	29914.84 29779	0.04 (25 yr)	118304.10	65.13	106.72	93.95	109.82	0.010241	15.69	9646.87	411.56	0.45	23.42	12.23	5.74	16.20
Rio Manati	1	29914.84 29779	0.02 (50 yr)	155702.40	65.13	112.57	99.88	116.09	0.009896	16.95	11777.39	440.71	0.45	26.08	15.38	6.89	18.69
Rio Manati	1	29914.84 29779	0.01 (100 yr)	211075.80	65.13	119.68	104.57	123.89	0.010258	19.06	16018.58	663.50	0.47	31.39	10.14	8.88	14.83
Rio Manati	1	29914.84 29779	0.005 (200 yr)	280504.40	65.13	127.39	109.71	132.17	0.010290	20.96	21924.70	895.37	0.48	36.22	12.01	6.06	15.19
Rio Manati	1	29914.84 29779	0.002 (500 yr)	399338.30	65.13	139.68	117.35	143.41	0.007218	19.91	34175.96	1075.21	0.42	30.69	12.03	7.09	13.70

Alternative 2 (Channel Modification) Results Table for XS in Project Area

HEC-RAS Plan: Alt 4 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	34233.57 34069	0.5 (2 yr)	18434.26	111.45	129.87	121.19	130.40	0.004234	5.84	3159.66	238.79	0.28	3.47	0.29		3.36
Rio Manati	1	34233.57 34069	0.2 (5 yr)	40682.50	111.45	136.71	125.86	137.80	0.005781	8.27	4880.37	262.20	0.33	6.85	1.80		6.39
Rio Manati	1	34233.57 34069	0.1 (10 yr)	63177.94	111.45	143.05	129.56	144.55	0.005582	9.31	6602.85	281.20	0.32	8.51	2.83	0.22	7.70
Rio Manati	1	34233.57 34069	0.04 (25 yr)	108910.40	111.45	151.54	135.35	153.07	0.003983	9.50	11112.71	656.68	0.29	8.07	1.64	1.04	4.05
Rio Manati	1	34233.57 34069	0.02 (50 yr)	142989.10	111.45	155.41	138.83	157.31	0.003299	9.29	13677.43	670.66	0.27	7.44	2.09	1.23	4.04
Rio Manati	1	34233.57 34069	0.01 (100 yr)	193489.10	111.45	159.68	148.32	162.24	0.003045	9.58	16646.60	706.47	0.26	7.64	2.58	1.47	4.30
Rio Manati	1	34233.57 34069	0.005 (200 yr)	256702.30	111.45	164.45	150.84	167.79	0.002739	9.76	20225.29	779.03	0.25	7.64	3.03	1.01	4.26
Rio Manati	1	34233.57 34069	0.002 (500 yr)	364800.50	111.45	171.06	155.15	175.69	0.002515	10.20	25826.75	965.05	0.25	8.00	3.70	0.88	4.04
Rio Manati	1	34155.99 33988	0.5 (2 yr)	18504.88	110.89	128.90	119.21	129.39	0.003601	5.66	3288.79	243.00	0.27	3.06		0.48	2.94
Rio Manati	1	34155.99 33988	0.2 (5 yr)	40859.07	110.89	135.32	124.38	136.44	0.004925	8.51	4972.17	280.86	0.33	6.10	0.95	1.46	5.25
Rio Manati	1	34155.99 33988	0.1 (10 yr)	63495.77	110.89	141.78	128.07	143.27	0.004617	9.90	6962.71	372.13	0.34	7.52	0.91	2.37	5.22
Rio Manati	1	34155.99 33988	0.04 (25 yr)	109440.10	110.89	149.90	134.04	151.87	0.004605	11.78	10597.26	584.12	0.35	9.76	2.03	1.83	5.08
Rio Manati	1	34155.99 33988	0.02 (50 yr)	143730.70	110.89	154.31	137.81	156.36	0.004175	12.15	13483.11	679.31	0.34	9.97	2.53	2.33	5.04
Rio Manati	1	34155.99 33988	0.01 (100 yr)	194477.90	110.89	158.96	145.46	161.30	0.003943	12.71	16730.42	712.44	0.34	10.53	3.25	3.20	5.62
Rio Manati	1	34155.99 33988	0.005 (200 yr)	258044.30	110.89	163.99	152.41	166.76	0.003636	13.12	20387.89	739.18	0.33	10.81	3.88	3.91	6.07
Rio Manati	1	34155.99 33988	0.002 (500 yr)	366742.80	110.89	170.89	157.02	174.51	0.003323	13.69	25759.76	856.48	0.32	11.27	3.80	4.73	6.05
Rio Manati	1	34135.98 33968		Bridge													
Rio Manati	1	34115.96 33947	0.5 (2 yr)	18504.88	110.66	125.91	118.60	126.46	0.001133	5.90	3116.72	264.05	0.30	0.86	0.08	0.29	0.81
Rio Manati	1	34115.96 33947	0.2 (5 yr)	40859.07	110.66	132.95	122.98	133.98	0.001108	7.87	5138.03	301.17	0.31	1.32	0.28	0.46	1.13
Rio Manati	1	34115.96 33947	0.1 (10 yr)	63495.77	110.66	137.69	126.86	139.28	0.001186	9.41	6600.58	318.12	0.34	1.76	0.40	0.71	1.47
Rio Manati	1	34115.96 33947	0.04 (25 yr)	109440.10	110.66	144.89	131.56	147.09	0.001330	11.86	9738.78	566.39	0.37	2.55	0.42	0.64	1.38
Rio Manati	1	34115.96 33947	0.02 (50 yr)	143730.70	110.66	149.37	134.95	151.81	0.001152	12.06	12376.70	607.14	0.36	2.53	0.61	0.80	1.42
Rio Manati	1	34115.96 33947	0.01 (100 yr)	194477.90	110.66	153.66	139.83	156.77	0.001175	13.14	15034.56	631.68	0.37	2.89	0.88	1.05	1.69
Rio Manati	1	34115.96 33947	0.005 (200 yr)	258044.30	110.66	159.39	146.72	162.95	0.001050	13.57	18750.85	667.26	0.35	2.95	1.07	1.19	1.78
Rio Manati	1	34115.96 33947	0.002 (500 yr)	366742.80	110.66	167.85	152.49	171.79	0.000875	13.87	25329.49	809.08	0.33	2.91	1.03	1.31	1.65
Rio Manati	1	33860.74 33690	0.5 (2 yr)	18504.88	108.76	124.16	118.44	125.05	0.002378	8.35	3061.68	292.43	0.41	1.83	1.20		1.49
Rio Manati	1	33860.74 33690	0.2 (5 yr)	40859.07	108.76	130.92	123.34	132.42	0.003012	11.14	5191.46	342.35	0.45	3.37	2.26		2.73
Rio Manati	1	33860.74 33690	0.1 (10 yr)	63495.77	108.76	135.29	127.07	137.52	0.003485	13.74	6770.92	409.02	0.50	4.79	2.76	0.30	3.45
Rio Manati	1	33860.74 33690	0.04 (25 yr)	109440.10	108.76	142.01	132.58	145.10	0.003714	16.79	10346.17	625.00	0.54	6.58	3.18	0.82	3.97
Rio Manati	1	33860.74 33690	0.02 (50 yr)	143730.70	108.76	147.55	136.39	150.31	0.002829	16.41	13720.93	732.23	0.49	5.94	3.13	0.95	3.71
Rio Manati	1	33860.74 33690	0.01 (100 yr)	194477.90	108.76	152.00	143.49	155.26	0.002969	18.18	16559.24	794.45	0.51	7.01	3.95	1.10	4.49
Rio Manati	1	33860.74 33690	0.005 (200 yr)	258044.30	108.76	158.14	147.26	161.60	0.002690	19.04	20865.48	869.92	0.49	7.33	4.37	1.08	4.61
Rio Manati	1	33860.74 33690	0.002 (500 yr)	366742.80	108.76	166.74	152.39	170.65	0.002493	20.54	27301.70	907.86	0.49	8.06	5.24	1.76	5.29
Rio Manati	1	33704.47 33532	0.5 (2 yr)	18504.88	103.22	122.83	115.89	123.50	0.003728	6.76	2992.09	311.00	0.32	3.15	0.86	0.68	2.19
Rio Manati	1	33704.47 33532	0.2 (5 yr)	40859.07	103.22	129.57	120.90	130.61	0.003724	8.82	5548.11	426.42	0.34	4.69	1.70	1.46	2.95
Rio Manati	1	33704.47 33532	0.1 (10 yr)	63495.77	103.22	134.07	124.99	135.43	0.003906	10.31	7550.48	456.09	0.36	6.00	2.67	2.09	3.93
Rio Manati	1	33704.47 33532	0.04 (25 yr)	109440.10	103.22	140.78	130.06	142.80	0.004343	12.74	10704.78	494.77	0.40	8.46	4.55	2.72	5.69
Rio Manati	1	33704.47 33532	0.02 (50 yr)	143730.70	103.22	146.32	133.18	148.53	0.003893	13.43	13508.27	518.43	0.39	8.91	5.19	3.19	6.11
Rio Manati	1	33704.47 33532	0.01 (100 yr)	194477.90	103.22	150.35	136.82	153.40	0.004726	15.85	15634.60	537.16	0.44	11.98	7.24	4.46	8.27
Rio Manati	1	33704.47 33532	0.005 (200 yr)	258044.30	103.22	156.05	140.53	159.83	0.004979	17.73	18803.05	571.42	0.46	14.37	8.99	5.35	9.84
Rio Manati	1	33704.47 33532	0.002 (500 yr)	366742.80	103.22	163.79	147.04	168.83	0.005453	20.55	23367.71	617.47	0.49	18.33	11.80	7.00	12.44
Rio Manati	1	33597.73 33414	0.5 (2 yr)	18504.88	109.15	121.55	116.37	122.29	0.003172	7.93	2758.58	288.15	0.42	2.15	0.83	2.02	1.83
Rio Manati	1	33597.73 33414	0.2 (5 yr)	40859.07	109.15	128.50	120.53	129.54	0.002580	9.93	5385.51	482.55	0.41	2.86	0.81	2.55	1.75
Rio Manati	1	33597.73 33414	0.1 (10 yr)	63495.77	109.15	133.05	123.86	134.34	0.002523	11.42	7607.83	494.58	0.43	3.51	1.46	3.05	2.34
Rio Manati	1	33597.73 33414	0.04 (25 yr)	109440.10	109.15	139.76	129.49	141.59	0.002686	14.04	11013.95	528.22	0.46	4.85	2.45	4.09	3.37
Rio Manati	1	33597.73 33414	0.02 (50 yr)	143730.70	109.15	145.53	132.20	147.43	0.002291	14.62	14124.63	554.12	0.44	4.96	2.79	3.95	3.50
Rio Manati	1	33597.73 33414	0.01 (100 yr)	194477.90	109.15	149.45	135.65	152.04	0.002784	17.30	16341.36	576.79	0.49	6.70	3.95	5.09	4.72
Rio Manati	1	33597.73 33414	0.005 (200 yr)	258044.30	109.15	155.27	139.46	158.36	0.002856	19.24	19789.53	613.06	0.51	7.91	5.01	5.61	5.58
Rio Manati	1	33597.73 33414	0.002 (500 yr)	366742.80	109.15	163.15	145.36	167.14	0.003084	22.28	24641.23	656.39	0.54	10.04	6.88	6.97	7.26
Rio Manati	1	33357.12 33176	0.5 (2 yr)	18504.88	99.08	119.64	109.56	120.19	0.002203	6.24	3936.07	449.82	0.26	2.31	0.56	0.38	1.15
Rio Manati	1	33357.12 33176	0.2 (5 yr)	40859.07	99.08	126.63	115.58	127.50	0.002567	8.40	7433.12	522.24	0.30	3.76	1.56	0.90	2.17
Rio Manati	1	33357.12 33176	0.1 (10 yr)	63495.77	99.08	130.93	120.56	132.16	0.003121	10.31	9718.23	540.40	0.34	5.37	2.62	1.43	3.33
Rio Manati	1	33357.12 33176	0.04 (25 yr)	109440.10	99.08	137.00	125.78	139.01	0.004199	13.58	13078.26	567.25	0.40	8.74	4.84	2.56	5.72
Rio Manati	1	33357.12 33176	0.02 (50 yr)	143730.70	99.08	143.24	128.77	145.25	0.003567	13.96	16887.51	661.43	0.38	8.74	4.59	2.68	5.40
Rio Manati	1	33357.12 33176	0.01 (100 yr)	194477.90	99.08	146.57	132.59	149.33	0.004549	16.60	19242.84	825.63	0.44	12.05	5.74	3.20	6.77
Rio Manati	1	33357.12 33176	0.005 (200 yr)	258044.30	99.08	152.81	136.83	155.65	0.004213	17.43	25405.52	1164.64	0.43	12.72	4.91	3.35	5.87
Rio Manati	1	33357.12 33176	0.002 (500 yr)	366742.80	99.08	161.22	144.68	164.20	0.003905	18.58	35035.98	1272.25	0.43	13.74	6.07	3.99	6.84
Rio Manati	1	33200.01 33011	0.5 (2 yr)	18504.88	98.89	118.51	108.60	118.94	0.002867	4.95	3545.81	326.98	0.21	2.87	0.98		1.90
Rio Manati	1	33200.01 33011	0.2 (5 yr)	40859.07	98.89	125.41	113.52	126.27	0.002960	5.56	5981.56	367.87	0.21	3.90	2.11	0.14	2.92
Rio Manati	1	33200.01 33011	0.1 (10 yr)	63495.77	98.89	129.27	117.24	130.68	0.003445	6.69	7444.05	387.23	0.23	5.33	3.16	0.65	4.00
Rio Manati	1	33200.01 33011	0.04 (25 yr)	109440.10	98.89	134.25	122.67	136.90	0.004824	8.90	9476.07	434.12	0.28	8.90	5.17	1.60	6.36
Rio Manati	1	33200.01 33011	0.02 (50 yr)	143730.70	98.89	141.14	126.36	143.69	0.003159	8.23	12962.80	680.20	0.24	7.13	3.87	1.66	4.70
Rio Manati	1	33200.01 33011	0.01 (100 yr)	194477.90	98.89	144.55	132.28	147.60	0.003514	9.20	15785.52	801.45	0.25	8.65	3.15	1.97	4.22
Rio Manati	1	33200.01 33011	0.005 (200 yr)	258044.30	98.89	151.61	137.30	154.43	0.002315	8.30	22357.23	1049.28	0.21	6.67	2.71	1.06	3.02
Rio Manati	1	33200.01 33011	0.002 (500 yr)	366742.80	98.89	160.21	145.91	163.24	0.001632	7.77	31960.39	1157.81	0.18	5.55	2.59	1.42	2.75
Rio Manati	1	33176.74 32988		Bridge													
Rio Manati	1	33153.54 32965	0.5 (2 yr)	18504.88	100.39	118.23	108.83	118.69	0.005090	4.96	3486.12	360.04	0.22	5.00	1.21	0.57	3.02
Rio Manati	1	33153.54 32965	0.2 (5 yr)	40859.07	100.39	125.21	113.83	125.92	0.003100	4.92	6603.53	507.69	0.18	4.36	1.60	1.11	2.55
Rio Manati	1	33153.54 32965	0.1 (10 yr)	63495.77	100.39	129.10	118.44	130.17	0.003013	5.38	8603.35	549.38	0.18	4.96	2.08	1.77	3.01
Rio Manati	1	33153.54 32965	0.04 (25 yr)	109440.10	100.39	134.08	123.11	136.03	0.003351	6.36	11285.92	610.16	0.20	6.53	3.28	2.96	4.31
Rio Manati	1	33153.54 32965	0.02 (50 yr)	143730.70	100.39	137.17	126.83	139.79	0.003480	6.89	12953.98	636.50	0.21	7.43	4.07	3.71	5.14
Rio Manati	1	33153.54 32965	0.01 (100 yr)	194477.90	100.39	141.32	129.63	144.89	0.003551	7.50	15198.29	673.22	0.21	8.48	5.07	4.66	6.15
Rio Manati	1	33153.54 32965	0.005 (200 yr)	258044.30	100.39	147.20	133.52	150.49	0.002834	7.35	20424.94	785.80	0.19	7.79	3.71	2.86	4.51
Rio Manati	1	33153.54 32965	0.002 (500 yr)	366742.80	100.39	156.93	139.72	160.14	0.002046	7.11	28980.60	998.63	0.17	6.83	3.33	1.74	3.64
Rio Manati	1	32988.5*	0.5 (2 yr)	18504.88	97.75	114.94		115.68	0.005258	7.08	2793.84	239.05	0.33	4.75	1.81	1.30	3.71
Rio Manati	1	32988.5*	0.2 (5 yr)	40859.07	97.75	122.75		123.70	0.004307	8.54	5788.74	624.02	0.32	5.98	0.97	2.32	2.45
Rio Manati	1	32988.5*	0.1 (10 yr)	63495.77	97.75	127.23		128.12	0.003362	8.52	8828.95	761.88	0.29	5.60	1.37	2.27	2.40
Rio Manati	1	32988.5*	0.04 (25 yr)	109440.10	97.75	132.47		133.58	0.003045	9.13	13264.40	897.26	0.28	6.07	1.95	2.41	2.77
Rio Manati	1	32988.5*	0.02 (50 yr)	143730.70	97.75	135.88		137.12	0.002747	9.28	16487.86	980.96	0.27	6.05	2.15	2.38	2.84
Rio Manati	1	32988.5*	0.01 (100 yr)	194477.90	97.75	140.62		141.94	0.002282	9.20	21830.54	1309.45	0.26	5.70	2.07	1.33	2.35
Rio Manati	1	32988.5*	0.005 (200 yr)	258044.30	97.75	146.81		148.07	0.001677	8.67	30283.53	1405.52	0.22	4.84	2.08	1.42	2.23
Rio Manati	1	32988.5*	0.002 (500 yr)	366742.80	97.75	156.99		158.14	0.001102	8.03	46023.02	1706.05	0.19	3.88	1.81	1.24	1.84
Rio Manati	1	32918.20 32728	0.5 (2 yr)	19634.96	96.62	113.91	106.11	114.66	0.003747	7.23	3059.51	250.13	0.32	3.63	1.46	1.28	2.74
Rio Manati	1	32918.20 32728	0.2 (5 yr)	43754.87	96.62	121.14	111.47	122.60	0.004598	10.33	5299.03	495.01	0.38	6.52	0.80	2.69	2.99
Rio Manati	1	32918.20 32728	0.1 (10 yr)	68333.88	96.62	125.72	115.63	127.16	0.004079	10.99	8464.16	944.58	0.37	6.94	1.32	2.97	2.72
Rio Manati	1	32918.20 32728	0.04 (25 yr)	118304.10	96.62	131.00	125.33	132.64	0.003869	12.04	12724.60	1084.93	0.37	7.85	2.48	3.30	3.67
Rio Manati	1	32918.20 32728	0.02 (50 yr)	155702.40	96.62	134.45	127.55	136.23	0.003534	12.30	15549.92	1121.62	0.36	7.93	3.01	3.67	4.08
Rio Manati	1	32918.20 32728	0.01 (100 yr)	211075.80	96.62	139.22	130.09	141.17	0.003020	12.35	20988.26	1493.36	0.34	7.67	3.46	2.48	3.74
Rio Manati	1	32918.20 32728	0.005 (200 yr)	280504.40	96.62	145.41	132.49	147.46	0.002355	11.98	27554.32	1578.96	0.31	6.88	3.59	2.44	3.60
Rio Manati	1	32918.20 32728	0.002 (500 yr)	399338.30	96.62	155.48	137.14	157.67	0.001692	11.56	39650.89	1897.22	0.27	6.01	3.63	2.32	3.31
Rio Manati	1	32740.16 32548	0.5 (2 yr)	19634.96	95.54	105.15	105.15	108.77	0.059418	15.45	1329.83	193.13	0.95	30.27	8.29	5.93	25.22
Rio Manati	1	32740.16 32548	0.2 (5 yr)	43754.87	95.54	110.39	110.39	115.86	0.048993	19.49	2476.83	232.86	0.94	40.88	16.87	11.49	31.79
Rio Manati	1	32740.16 32548	0.1 (10 yr)	68333.88	95.54	115.26	115.26	121.22	0.037416	20.92	3916.99	335.06	0.86	42.51	14.84	10.85	26.74
Rio Manati	1	32740.16 32548	0.04 (25 yr)	118304.10	95.54	123.53	122.67	127.86	0.019814	19.52	8608.73	1019.57	0.67	32.67	9.21	10.95	13.99
Rio Manati	1	32740.16 32548	0.02 (50 yr)	155702.40	95.54	130.02	124.95	132.73	0.010127	16.14	13609.34	1049.64	0.49	20.77	8.62	7.18	10.79
Rio Manati	1	32740.16 32548	0.01 (100 yr)	211075.80	95.54	136.29	127.83	138.46	0.006840	14.89	22845.40	1689.55	0.42	16.68	8.29	3.30	6.70
Rio Manati	1	32740.16 32548	0.005 (200 yr)	280504.40	95.54	143.56	130.76	145.39	0.004722	13.85	33577.75	1837.30	0.36	13.65	7.65	3.78	6.17
Rio Manati	1	32740.16 32548	0.002 (500 yr)	399338.30	95.54	154.52	134.94	156.09	0.003138	13.00	51742.17	1981.71	0.30	11.20	6.92	4.18	5.77
Rio Manati	1	32455.27 32258	0.5 (2 yr)	19634.96	85.63	98.53	92.09	99.19	0.002190	6.54	3073.93	275.62	0.33	1.69	0.44	0.45	1.50
Rio Manati	1	32455.27 32258	0.2 (5 yr)	43754.87	85.63	106.16	96.41	107.26	0.002000	8.60	5330.50	326.52	0.34	2.49	1.02	0.86	2.10
Rio Manati	1	32455.27 32258	0.1 (10 yr)	68333.88	85.63	111.91	99.95	113.39	0.001952	10.05	7170.00	355.91	0.35	3.12	1.66	1.17	2.60
Rio Manati	1	32455.27 32258	0.04 (25 yr)	118304.10	85.63	121.09	105.79	123.14	0.001871	12.05	10986.99	810.53	0.36	4.05	2.60	0.47	1.67
Rio Manati	1	32455.27 32258	0.02 (50 yr)	155702.40	85.63	127.78	109.33	129.64	0.001479	12.04	19158.21	1515.11	0.33	3.82	2.63	0.65	1.21
Rio Manati	1	32455.27 32258	0.01 (100 yr)	211075.80	85.63	134.20	113.95	136.04	0.001336	12.59	28842.85	1673.42	0.32	3.98	2.88	1.04	1.52
Rio Manati	1	32455.27 32258	0.005 (200 yr)	280504.40	85.63	141.81	121.48	143.54	0.001134	12.79	41474.70	1851.23	0.30	3.91	2.95	1.33	1.72
Rio Manati	1	32455.27 32258	0.002 (500 yr)	399338.30	85.63	153.10	129.47	154.71	0.000934	13.13	61015.77	1955.73	0.28	3.88	1.36	1.70	1.97
Rio Manati	1	32325.2*	0.5 (2 yr)	19634.96	84.91	97.50		98.19	0.002533	6.72	2987.75	273.49	0.34	1.90	0.49	0.50	1.70
Rio Manati	1	32325.2*	0.2 (5 yr)	43754.87	84.91	105.25		106.38	0.002198	8.70	5279.30	317.40	0.34	2.71	0.92	0.94	2.23
Rio Manati	1	32325.2*	0.1 (10 yr)	68333.88	84.91	111.07		112.55	0.002095	10.08	7245.60	359.35	0.35	3.34	1.12	1.25	2.58
Rio Manati	1	32325.2*	0.04 (25 yr)	118304.10	84.91	120.42		122.33	0.001897	11.79	11490.35	836.55	0.35	4.12	1.58	0.45	1.60
Rio Manati	1	32325.2*	0.02 (50 yr)	155702.40	84.91	127.32		129.03	0.001480	11.74	19822.34	1559.50	0.32	3.85	1.42	0.60	1.16

Alternative 2 (Channel Modification) Results Table for XS in Project Area

HEC-RAS Plan: Alt 4 Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	32325.2*	0.01 (100 yr)	211075.80	84.91	133.82		135.51	0.001341	12.30	30547.82	1685.39	0.31	4.02	1.56	1.04	1.50
Rio Manati	1	32325.2*	0.005 (200 yr)	280504.40	84.91	141.54		143.11	0.001140	12.52	43788.70	1747.16	0.29	3.96	1.53	1.40	1.76
Rio Manati	1	32325.2*	0.002 (500 yr)	399338.30	84.91	152.88		154.38	0.000952	12.93	64056.30	1843.71	0.28	3.98	1.72	1.76	2.04
Rio Manati	1	32235.51 32029	0.5 (2 yr)	19634.96	84.38	96.71	90.83	97.44	0.002574	6.88	2916.99	271.55	0.35	1.89	0.49	0.48	1.70
Rio Manati	1	32235.51 32029	0.2 (5 yr)	43754.87	84.38	104.60	95.15	105.75	0.002130	8.78	5232.50	315.35	0.35	2.61	0.89	0.90	2.16
Rio Manati	1	32235.51 32029	0.1 (10 yr)	68333.88	84.38	110.45	98.69	111.95	0.002029	10.19	7169.60	347.78	0.35	3.22	1.19	1.21	2.55
Rio Manati	1	32235.51 32029	0.04 (25 yr)	118304.10	84.38	119.77	104.53	121.79	0.001900	12.13	11457.22	799.37	0.36	4.11	1.63	0.50	1.67
Rio Manati	1	32235.51 32029	0.02 (50 yr)	155702.40	84.38	126.79	108.23	128.62	0.001472	12.06	19569.29	1439.62	0.33	3.83	1.56	0.65	1.23
Rio Manati	1	32235.51 32029	0.01 (100 yr)	211075.80	84.38	133.30	113.01	135.16	0.001350	12.72	29520.07	1618.75	0.32	4.05	1.69	1.03	1.52
Rio Manati	1	32235.51 32029	0.005 (200 yr)	280504.40	84.38	141.07	120.41	142.82	0.001148	12.95	42705.12	1790.87	0.30	4.00	1.60	1.37	1.75
Rio Manati	1	32235.51 32029	0.002 (500 yr)	399338.30	84.38	152.49	128.08	154.15	0.000936	13.23	62650.13	1911.56	0.28	3.92	1.93	1.74	2.05
Rio Manati	1	31723.61 31578	0.5 (2 yr)	19634.96	79.69	93.18	86.14	93.77	0.001873	6.24	3228.63	277.22	0.30	1.51	0.41	0.41	1.34
Rio Manati	1	31723.61 31578	0.2 (5 yr)	43754.87	79.69	102.31	90.47	103.06	0.001274	7.33	7033.00	730.05	0.27	1.75	0.25	0.61	0.76
Rio Manati	1	31723.61 31578	0.1 (10 yr)	68333.88	79.69	109.42	94.00	109.98	0.000754	6.79	12802.75	854.07	0.22	1.37	0.43	0.52	0.70
Rio Manati	1	31723.61 31578	0.04 (25 yr)	118304.10	79.69	119.65	102.26	120.16	0.000505	6.79	22047.04	946.54	0.19	1.24	0.56	0.50	0.72
Rio Manati	1	31723.61 31578	0.02 (50 yr)	155702.40	79.69	126.85	105.19	127.35	0.000394	6.70	28980.31	980.19	0.17	1.14	0.60	0.47	0.71
Rio Manati	1	31723.61 31578	0.01 (100 yr)	211075.80	79.69	133.35	108.08	133.95	0.000398	7.35	35438.66	1005.89	0.18	1.31	0.75	0.55	0.86
Rio Manati	1	31723.61 31578	0.005 (200 yr)	280504.40	79.69	141.06	111.00	141.76	0.000386	7.91	43288.35	1155.87	0.18	1.45	0.91	0.56	0.98
Rio Manati	1	31723.61 31578	0.002 (500 yr)	399338.30	79.69	152.41	115.35	153.26	0.000366	8.64	55493.37	1233.95	0.18	1.64	1.12	0.61	1.13
Rio Manati	1	31444.64 31314	0.5 (2 yr)	19634.96	73.62	92.72	80.07	92.99	0.000404	4.25	4876.12	308.99	0.17	0.47	0.16	0.15	0.39
Rio Manati	1	31444.64 31314	0.2 (5 yr)	43754.87	73.62	101.80	84.39	102.32	0.000481	6.04	7911.78	359.62	0.20	0.83	0.32	0.31	0.64
Rio Manati	1	31444.64 31314	0.1 (10 yr)	68333.88	73.62	108.67	87.93	109.41	0.000517	7.26	10516.57	397.97	0.22	1.11	0.44	0.44	0.83
Rio Manati	1	31444.64 31314	0.04 (25 yr)	118304.10	73.62	118.46	93.81	119.62	0.000604	9.26	14675.88	452.51	0.25	1.66	0.69	0.68	1.18
Rio Manati	1	31444.64 31314	0.02 (50 yr)	155702.40	73.62	125.51	97.56	126.85	0.000588	10.08	18114.98	548.81	0.25	1.87	0.62	0.74	1.17
Rio Manati	1	31444.64 31314	0.01 (100 yr)	211075.80	73.62	131.68	102.42	133.41	0.000668	11.59	21748.22	604.03	0.27	2.38	0.79	1.02	1.45
Rio Manati	1	31444.64 31314	0.005 (200 yr)	280504.40	73.62	139.13	107.73	141.19	0.000705	12.91	27012.99	808.03	0.28	2.84	0.74	1.29	1.46
Rio Manati	1	31444.64 31314	0.002 (500 yr)	399338.30	73.62	150.15	115.55	152.67	0.000733	14.61	35822.43	1095.49	0.30	3.45	1.27	1.58	1.95
Rio Manati	1	31041.5 30915	0.5 (2 yr)	19634.96	70.83	92.35	77.28	92.55	0.000258	3.69	5696.59	329.25	0.14	0.34	0.12	0.12	0.27
Rio Manati	1	31041.5 30915	0.2 (5 yr)	43754.87	70.83	101.43	81.61	101.79	0.000316	5.18	9801.87	575.25	0.17	0.59	0.22	0.13	0.33
Rio Manati	1	31041.5 30915	0.1 (10 yr)	68333.88	70.83	108.44	85.15	108.86	0.000299	5.78	15011.26	969.69	0.17	0.69	0.26	0.14	0.28
Rio Manati	1	31041.5 30915	0.04 (25 yr)	118304.10	70.83	118.61	91.01	119.00	0.000229	5.95	25901.36	1104.84	0.15	0.67	0.30	0.23	0.33
Rio Manati	1	31041.5 30915	0.02 (50 yr)	155702.40	70.83	125.87	95.59	126.24	0.000181	5.82	34064.55	1134.43	0.14	0.61	0.29	0.26	0.33
Rio Manati	1	31041.5 30915	0.01 (100 yr)	211075.80	70.83	132.24	101.19	132.69	0.000187	6.37	41357.75	1154.68	0.14	0.71	0.34	0.33	0.41
Rio Manati	1	31041.5 30915	0.005 (200 yr)	280504.40	70.83	139.88	106.74	140.41	0.000183	6.82	50669.66	1247.12	0.15	0.78	0.31	0.40	0.45
Rio Manati	1	31041.5 30915	0.002 (500 yr)	399338.30	70.83	151.15	113.37	151.80	0.000179	7.46	64931.73	1291.45	0.15	0.89	0.41	0.50	0.55
Rio Manati	1	30753.00 30623	0.5 (2 yr)	19634.96	71.39	91.66		92.12	0.000907	5.56	3641.18	250.50	0.24	0.93	0.01	0.30	0.79
Rio Manati	1	30753.00 30623	0.2 (5 yr)	43754.87	71.39	100.42		101.29	0.000980	7.65	5907.47	267.67	0.27	1.53	0.04	0.70	1.25
Rio Manati	1	30753.00 30623	0.1 (10 yr)	68333.88	71.39	107.09		108.34	0.001054	9.27	7840.93	384.00	0.29	2.08	0.20	0.49	1.26
Rio Manati	1	30753.00 30623	0.04 (25 yr)	118304.10	71.39	117.36		118.61	0.000861	10.07	15117.13	898.65	0.27	2.24	0.38	0.49	0.87
Rio Manati	1	30753.00 30623	0.02 (50 yr)	155702.40	71.39	125.05		125.99	0.000554	9.03	22083.34	913.37	0.22	1.71	0.33	0.57	0.80
Rio Manati	1	30753.00 30623	0.01 (100 yr)	211075.80	71.39	131.42		132.45	0.000520	9.48	27961.64	930.38	0.22	1.80	0.38	0.73	0.93
Rio Manati	1	30753.00 30623	0.005 (200 yr)	280504.40	71.39	139.07		140.18	0.000467	9.78	35134.20	943.86	0.22	1.84	0.42	0.86	1.03
Rio Manati	1	30753.00 30623	0.002 (500 yr)	399338.30	71.39	150.29		151.58	0.000423	10.36	45819.00	960.62	0.21	1.96	0.47	1.05	1.18
Rio Manati	1	30450.28 30327	0.5 (2 yr)	19634.96	48.56	90.62		90.78	0.001900	3.22	6401.35	410.59	0.13	2.21	0.46	0.00	1.67
Rio Manati	1	30450.28 30327	0.2 (5 yr)	43754.87	48.56	99.39		99.70	0.002421	4.63	10391.76	481.65	0.15	4.05	1.46	0.00	2.93
Rio Manati	1	30450.28 30327	0.1 (10 yr)	68333.88	48.56	106.15		106.58	0.002627	5.55	13725.27	509.07	0.16	5.44	2.38	0.00	3.94
Rio Manati	1	30450.28 30327	0.04 (25 yr)	118304.10	48.56	116.42		117.08	0.002936	6.96	19034.27	525.66	0.18	7.84	4.18	0.00	5.80
Rio Manati	1	30450.28 30327	0.02 (50 yr)	155702.40	48.56	124.18		124.95	0.002790	7.53	23164.23	537.78	0.18	8.71	5.01	0.00	6.47
Rio Manati	1	30450.28 30327	0.01 (100 yr)	211075.80	48.56	130.36		131.45	0.003451	9.01	26570.52	566.67	0.21	12.02	6.71	0.00	8.67
Rio Manati	1	30450.28 30327	0.005 (200 yr)	280504.40	48.56	137.79		139.21	0.003883	10.33	30828.20	579.34	0.22	15.21	8.85	0.00	10.95
Rio Manati	1	30450.28 30327	0.002 (500 yr)	399338.30	48.56	148.63		150.61	0.004506	12.30	37268.44	613.24	0.25	20.51	11.88	0.00	14.38
Rio Manati	1	30282.54 30154	0.5 (2 yr)	19634.96	62.99	89.65		89.85	0.001411	3.45	5437.75	357.96	0.13	1.72		1.01	1.30
Rio Manati	1	30282.54 30154	0.2 (5 yr)	43754.87	62.99	98.11		98.51	0.001816	4.58	8749.36	425.37	0.15	2.91		1.86	2.26
Rio Manati	1	30282.54 30154	0.1 (10 yr)	68333.88	62.99	104.72		105.27	0.001998	5.27	11603.64	446.36	0.16	3.75	0.01	2.78	3.10
Rio Manati	1	30282.54 30154	0.04 (25 yr)	118304.10	62.99	114.79		115.62	0.002202	6.42	16830.59	540.24	0.18	5.26	1.09	4.23	4.06
Rio Manati	1	30282.54 30154	0.02 (50 yr)	155702.40	62.99	122.68		123.60	0.001993	6.87	21162.57	558.53	0.17	5.67	1.73	4.60	4.43
Rio Manati	1	30282.54 30154	0.01 (100 yr)	211075.80	62.99	128.52		129.80	0.002419	8.16	24468.53	573.59	0.19	7.70	2.70	6.24	6.02
Rio Manati	1	30282.54 30154	0.005 (200 yr)	280504.40	62.99	135.70		137.36	0.002718	9.39	28651.12	592.81	0.21	9.78	3.69	7.93	7.61
Rio Manati	1	30282.54 30154	0.002 (500 yr)	399338.30	62.99	146.15		148.46	0.003145	11.20	35238.20	660.14	0.23	13.23	4.20	10.73	9.52
Rio Manati	1	29965.48 29830	0.5 (2 yr)	19634.96	70.47	85.48	80.34	86.33	0.012704	7.71	2781.06	280.64	0.41	8.87	5.64	1.82	7.76
Rio Manati	1	29965.48 29830	0.2 (5 yr)	43754.87	70.47	93.46	84.79	94.74	0.008060	9.40	5212.26	339.01	0.38	9.62	6.29	3.15	8.16
Rio Manati	1	29965.48 29830	0.1 (10 yr)	68333.88	70.47	99.83	88.37	101.46	0.006633	10.59	7218.06	422.66	0.37	10.54	7.76	3.59	9.09
Rio Manati	1	29965.48 29830	0.04 (25 yr)	118304.10	70.47	109.02	94.13	111.48	0.006375	13.01	10158.56	511.53	0.39	13.77	11.04	4.58	11.89
Rio Manati	1	29965.48 29830	0.02 (50 yr)	155702.40	70.47	117.30	97.67	119.95	0.005044	13.50	12863.51	581.59	0.36	13.49	11.29	4.24	11.49
Rio Manati	1	29965.48 29830	0.01 (100 yr)	211075.80	70.47	123.01	102.41	125.86	0.004946	14.61	20699.79	759.25	0.37	14.99	5.99	4.42	8.16
Rio Manati	1	29965.48 29830	0.005 (200 yr)	280504.40	70.47	130.34	107.78	133.38	0.004545	15.46	26407.46	798.74	0.36	15.84	7.26	4.60	9.08
Rio Manati	1	29965.48 29830	0.002 (500 yr)	399338.30	70.47	140.55	119.70	144.19	0.004562	17.42	35267.42	966.99	0.38	18.79	8.18	5.58	10.03
Rio Manati	1	29939.95 29805		Bridge													
Rio Manati	1	29914.84 29779	0.5 (2 yr)	19634.96	65.13	84.41	76.37	85.25	0.007617	7.57	2864.72	213.98	0.33	7.29	3.47	0.33	6.09
Rio Manati	1	29914.84 29779	0.2 (5 yr)	43754.87	65.13	91.52	81.96	93.26	0.010137	11.15	4558.87	260.20	0.41	14.00	6.51	2.02	10.56
Rio Manati	1	29914.84 29779	0.1 (10 yr)	68333.88	65.13	97.33	86.25	99.83	0.011102	13.54	6304.61	366.51	0.44	19.17	6.87	3.76	11.91
Rio Manati	1	29914.84 29779	0.04 (25 yr)	118304.10	65.13	106.72	93.95	109.82	0.010241	15.69	9646.87	411.56	0.45	23.42	12.23	5.74	16.20
Rio Manati	1	29914.84 29779	0.02 (50 yr)	155702.40	65.13	112.57	99.88	116.09	0.009896	16.95	11777.39	440.71	0.45	26.08	15.38	6.89	18.69
Rio Manati	1	29914.84 29779	0.01 (100 yr)	211075.80	65.13	119.68	104.57	123.89	0.010258	19.06	16018.58	663.50	0.47	31.39	10.14	8.88	14.83
Rio Manati	1	29914.84 29779	0.005 (200 yr)	280504.40	65.13	127.39	109.71	132.17	0.010290	20.96	21924.70	895.37	0.48	36.22	12.01	6.06	15.19
Rio Manati	1	29914.84 29779	0.002 (500 yr)	399338.30	65.13	139.68	117.35	143.41	0.007218	19.91	34175.96	1075.21	0.42	30.69	12.03	7.09	13.70

Alternative 3 (Non-Structural Relocations) Results Table for XS in Project Area

HEC-RAS Plan: Alt 5 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	34233.57 34069	0.5 (2 yr)	18434.26	111.45	129.87	121.19	130.40	0.004234	5.84	3159.66	238.79	0.28	3.47	0.29		3.36
Rio Manati	1	34233.57 34069	0.2 (5 yr)	40682.50	111.45	136.73	125.86	137.82	0.005763	8.26	4885.49	262.26	0.33	6.83	1.79		6.37
Rio Manati	1	34233.57 34069	0.1 (10 yr)	63177.94	111.45	143.12	129.56	144.61	0.005528	9.28	6622.29	281.43	0.32	8.45	2.82	0.23	7.64
Rio Manati	1	34233.57 34069	0.04 (25 yr)	108910.40	111.45	151.63	135.35	153.14	0.003910	9.43	11172.45	656.98	0.28	7.94	1.63	1.03	4.00
Rio Manati	1	34233.57 34069	0.02 (50 yr)	142989.10	111.45	155.30	138.83	157.22	0.003359	9.36	13609.25	670.25	0.27	7.55	2.11	1.24	4.09
Rio Manati	1	34233.57 34069	0.01 (100 yr)	193489.10	111.45	159.87	148.32	162.40	0.002958	9.47	16782.09	707.48	0.26	7.45	2.54	1.44	4.21
Rio Manati	1	34233.57 34069	0.005 (200 yr)	256702.30	111.45	164.63	150.84	167.93	0.002678	9.67	20362.43	781.35	0.25	7.50	2.99	1.00	4.18
Rio Manati	1	34233.57 34069	0.002 (500 yr)	364800.50	111.45	171.16	155.15	175.76	0.002488	10.16	25920.29	966.07	0.24	7.93	3.67	0.89	4.00
Rio Manati	1	34155.99 33988	0.5 (2 yr)	18504.88	110.89	128.90	119.21	129.39	0.003601	5.66	3288.79	243.00	0.27	3.06		0.48	2.94
Rio Manati	1	34155.99 33988	0.2 (5 yr)	40859.07	110.89	135.35	124.38	136.46	0.004904	8.50	4979.33	280.98	0.33	6.08	0.95	1.46	5.23
Rio Manati	1	34155.99 33988	0.1 (10 yr)	63495.77	110.89	141.86	128.07	143.34	0.004565	9.86	6994.18	374.56	0.33	7.46	0.91	2.35	5.15
Rio Manati	1	34155.99 33988	0.04 (25 yr)	109440.10	110.89	150.03	134.04	151.98	0.004518	11.70	10674.76	600.12	0.35	9.62	2.03	1.65	4.89
Rio Manati	1	34155.99 33988	0.02 (50 yr)	143730.70	110.89	154.16	137.81	156.25	0.004270	12.25	13382.78	678.84	0.34	10.16	2.56	2.35	5.12
Rio Manati	1	34155.99 33988	0.01 (100 yr)	194477.90	110.89	159.18	145.46	161.48	0.003824	12.56	16889.99	713.44	0.33	10.26	3.20	3.15	5.50
Rio Manati	1	34155.99 33988	0.005 (200 yr)	258044.30	110.89	164.19	152.41	166.92	0.003549	13.00	20530.89	740.37	0.33	10.60	3.82	3.85	5.96
Rio Manati	1	34155.99 33988	0.002 (500 yr)	366742.80	110.89	170.99	157.02	174.59	0.003286	13.63	25849.61	872.37	0.32	11.17	3.65	4.69	5.90
Rio Manati	1	34135.98 33968		Bridge													
Rio Manati	1	34115.96 33947	0.5 (2 yr)	18504.88	110.66	125.93	118.60	126.48	0.001126	5.89	3122.34	264.12	0.29	0.86	0.08	0.29	0.80
Rio Manati	1	34115.96 33947	0.2 (5 yr)	40859.07	110.66	133.01	122.98	134.03	0.001095	7.84	5156.55	301.34	0.31	1.31	0.28	0.46	1.12
Rio Manati	1	34115.96 33947	0.1 (10 yr)	63495.77	110.66	137.80	126.86	139.38	0.001165	9.36	6636.33	319.00	0.33	1.73	0.39	0.71	1.44
Rio Manati	1	34115.96 33947	0.04 (25 yr)	109440.10	110.66	145.12	131.56	147.27	0.001280	11.69	9872.32	568.70	0.37	2.48	0.42	0.63	1.34
Rio Manati	1	34115.96 33947	0.02 (50 yr)	143730.70	110.66	149.02	134.95	151.54	0.001212	12.30	12163.88	604.67	0.36	2.63	0.63	0.82	1.47
Rio Manati	1	34115.96 33947	0.01 (100 yr)	194477.90	110.66	154.24	139.83	157.21	0.001092	12.79	15401.50	635.45	0.35	2.72	0.85	1.00	1.60
Rio Manati	1	34115.96 33947	0.005 (200 yr)	258044.30	110.66	160.00	146.72	163.41	0.000981	13.24	19160.98	673.75	0.34	2.79	1.01	1.14	1.68
Rio Manati	1	34115.96 33947	0.002 (500 yr)	366742.80	110.66	168.17	152.49	172.03	0.000848	13.71	25591.33	810.14	0.33	2.84	1.01	1.28	1.62
Rio Manati	1	33860.74 33690	0.5 (2 yr)	18504.88	108.76	124.20	118.44	125.08	0.002356	8.32	3072.28	292.65	0.41	1.82	1.19		1.49
Rio Manati	1	33860.74 33690	0.2 (5 yr)	40859.07	108.76	131.01	123.34	132.49	0.002962	11.07	5225.22	342.81	0.45	3.32	2.24		2.70
Rio Manati	1	33860.74 33690	0.1 (10 yr)	63495.77	108.76	135.47	127.07	137.66	0.003396	13.63	6842.01	416.19	0.50	4.70	2.66	0.30	3.34
Rio Manati	1	33860.74 33690	0.04 (25 yr)	109440.10	108.76	142.54	132.58	145.42	0.003411	16.28	10654.86	626.95	0.52	6.15	3.02	0.80	3.74
Rio Manati	1	33860.74 33690	0.02 (50 yr)	143730.70	108.76	146.99	136.39	149.92	0.003056	16.87	13367.97	719.29	0.50	6.31	3.27	0.99	3.91
Rio Manati	1	33860.74 33690	0.01 (100 yr)	194477.90	108.76	152.81	143.49	155.84	0.002705	17.59	17088.60	800.20	0.49	6.52	3.70	1.04	4.19
Rio Manati	1	33860.74 33690	0.005 (200 yr)	258044.30	108.76	158.85	147.26	162.13	0.002505	18.56	21388.28	872.65	0.48	6.93	4.17	1.08	4.38
Rio Manati	1	33860.74 33690	0.002 (500 yr)	366742.80	108.76	167.09	152.39	170.93	0.002422	20.33	27575.23	910.08	0.48	7.88	5.13	1.73	5.17
Rio Manati	1	33704.47 33532	0.5 (2 yr)	18504.88	103.22	122.88	115.89	123.55	0.003674	6.73	3008.83	311.83	0.32	3.12	0.86	0.67	2.17
Rio Manati	1	33704.47 33532	0.2 (5 yr)	40859.07	103.22	129.70	120.90	130.73	0.003625	8.74	5605.49	428.24	0.34	4.59	1.67	1.44	2.89
Rio Manati	1	33704.47 33532	0.1 (10 yr)	63495.77	103.22	134.30	124.99	135.63	0.003757	10.18	7655.93	456.92	0.36	5.82	2.62	2.04	3.83
Rio Manati	1	33704.47 33532	0.04 (25 yr)	109440.10	103.22	141.40	130.06	143.31	0.004012	12.41	11012.07	497.36	0.38	7.97	4.33	2.61	5.37
Rio Manati	1	33704.47 33532	0.02 (50 yr)	143730.70	103.22	145.67	133.18	148.00	0.004176	13.75	13175.75	515.49	0.40	9.39	5.43	3.33	6.44
Rio Manati	1	33704.47 33532	0.01 (100 yr)	194477.90	103.22	151.28	136.82	154.15	0.004326	15.39	16137.45	542.29	0.42	11.22	6.83	4.18	7.74
Rio Manati	1	33704.47 33532	0.005 (200 yr)	258044.30	103.22	156.88	140.53	160.48	0.004635	17.31	19281.05	574.98	0.44	13.62	8.55	5.12	9.33
Rio Manati	1	33704.47 33532	0.002 (500 yr)	366742.80	103.22	164.22	147.04	169.15	0.005285	20.33	23633.51	622.48	0.48	17.91	11.57	6.82	12.15
Rio Manati	1	33597.73 33414	0.5 (2 yr)	18504.88	109.15	121.63	116.37	122.36	0.003088	7.87	2783.27	288.84	0.42	2.11	0.82	1.98	1.79
Rio Manati	1	33597.73 33414	0.2 (5 yr)	40859.07	109.15	128.68	120.53	129.69	0.002481	9.81	5470.67	483.05	0.41	2.78	0.80	2.48	1.71
Rio Manati	1	33597.73 33414	0.1 (10 yr)	63495.77	109.15	133.34	123.86	134.57	0.002400	11.24	7748.60	495.33	0.42	3.38	1.43	2.94	2.27
Rio Manati	1	33597.73 33414	0.04 (25 yr)	109440.10	109.15	140.49	129.49	142.19	0.002438	13.59	11398.79	530.45	0.44	4.52	2.32	3.79	3.15
Rio Manati	1	33597.73 33414	0.02 (50 yr)	143730.70	109.15	144.81	132.20	146.82	0.002485	15.02	13723.97	549.93	0.45	5.27	2.94	4.23	3.72
Rio Manati	1	33597.73 33414	0.01 (100 yr)	194477.90	109.15	150.50	135.65	152.90	0.002514	16.74	16947.88	582.84	0.47	6.22	3.70	4.67	4.38
Rio Manati	1	33597.73 33414	0.005 (200 yr)	258044.30	109.15	156.19	139.46	159.11	0.002639	18.74	20347.76	616.57	0.49	7.46	4.77	5.28	5.28
Rio Manati	1	33597.73 33414	0.002 (500 yr)	366742.80	109.15	163.62	145.36	167.52	0.002981	22.03	24935.25	659.06	0.53	9.80	6.74	6.78	7.09
Rio Manati	1	33357.12 33176	0.5 (2 yr)	18504.88	99.08	119.78	109.56	120.32	0.002136	6.17	4001.29	456.71	0.26	2.26	0.55	0.38	1.11
Rio Manati	1	33357.12 33176	0.2 (5 yr)	40859.07	99.08	126.89	115.58	127.72	0.002454	8.27	7568.45	523.36	0.29	3.63	1.53	0.87	2.11
Rio Manati	1	33357.12 33176	0.1 (10 yr)	63495.77	99.08	131.33	120.56	132.51	0.002944	10.11	9936.83	542.03	0.33	5.14	2.54	1.37	3.20
Rio Manati	1	33357.12 33176	0.04 (25 yr)	109440.10	99.08	138.05	125.78	139.88	0.003722	13.04	13672.29	571.48	0.38	7.98	4.49	2.37	5.26
Rio Manati	1	33357.12 33176	0.02 (50 yr)	143730.70	99.08	142.20	128.77	144.41	0.004008	14.55	16211.60	644.44	0.40	9.58	5.07	2.94	5.97
Rio Manati	1	33357.12 33176	0.01 (100 yr)	194477.90	99.08	148.11	132.59	150.54	0.003869	15.66	20530.54	1009.16	0.41	10.60	4.12	2.68	5.06
Rio Manati	1	33357.12 33176	0.005 (200 yr)	258044.30	99.08	154.06	136.83	156.62	0.003725	16.66	26777.87	1173.91	0.41	11.53	4.59	3.09	5.42
Rio Manati	1	33357.12 33176	0.002 (500 yr)	366742.80	99.08	161.82	144.68	164.67	0.003711	18.24	35766.62	1302.68	0.42	13.19	5.73	3.88	6.47
Rio Manati	1	33200.01 33011	0.5 (2 yr)	18504.88	98.89	118.70	108.60	119.12	0.002730	4.85	3609.67	333.38	0.21	2.75	0.93		1.80
Rio Manati	1	33200.01 33011	0.2 (5 yr)	40859.07	98.89	125.74	113.52	126.57	0.002766	5.43	6102.49	370.03	0.20	3.69	2.02	0.15	2.76
Rio Manati	1	33200.01 33011	0.1 (10 yr)	63495.77	98.89	129.80	117.24	131.14	0.003152	6.48	7647.66	389.29	0.22	4.98	2.98	0.66	3.74
Rio Manati	1	33200.01 33011	0.04 (25 yr)	109440.10	98.89	135.82	122.67	138.14	0.003830	8.19	10202.31	514.58	0.25	7.42	3.45	1.48	4.65
Rio Manati	1	33200.01 33011	0.02 (50 yr)	143730.70	98.89	139.76	126.36	142.59	0.003793	8.80	12235.16	622.79	0.26	8.25	4.33	1.85	5.37
Rio Manati	1	33200.01 33011	0.01 (100 yr)	194477.90	98.89	146.85	132.28	149.27	0.002575	8.17	17747.71	896.23	0.22	6.69	2.38	1.48	3.12
Rio Manati	1	33200.01 33011	0.005 (200 yr)	258044.30	98.89	153.06	137.30	155.57	0.001908	7.68	23896.30	1079.36	0.19	5.67	2.37	0.96	2.58
Rio Manati	1	33200.01 33011	0.002 (500 yr)	366742.80	98.89	160.87	145.91	163.78	0.001519	7.56	32734.99	1166.42	0.18	5.22	2.46	1.35	2.60
Rio Manati	1	33176.74 32988		Bridge													
Rio Manati	1	33153.54 32965	0.5 (2 yr)	18504.88	100.39	118.43	108.83	118.88	0.004766	4.85	3562.20	367.65	0.21	4.74	1.15	0.57	2.83
Rio Manati	1	33153.54 32965	0.2 (5 yr)	40859.07	100.39	125.55	113.83	126.23	0.002835	4.75	6774.38	511.15	0.17	4.05	1.51	1.07	2.38
Rio Manati	1	33153.54 32965	0.1 (10 yr)	63495.77	100.39	129.66	118.44	130.66	0.002705	5.17	8904.95	562.20	0.17	4.54	1.90	1.68	2.74
Rio Manati	1	33153.54 32965	0.04 (25 yr)	109440.10	100.39	135.69	123.11	137.40	0.002547	5.73	12158.67	625.60	0.17	5.21	2.75	2.49	3.53
Rio Manati	1	33153.54 32965	0.02 (50 yr)	143730.70	100.39	138.99	126.83	141.28	0.002661	6.23	13937.51	652.50	0.18	5.98	3.41	3.12	4.23
Rio Manati	1	33153.54 32965	0.01 (100 yr)	194477.90	100.39	143.48	129.63	146.34	0.002591	6.64	16961.95	691.37	0.18	6.53	4.04	2.43	4.55
Rio Manati	1	33153.54 32965	0.005 (200 yr)	258044.30	100.39	149.23	133.52	152.01	0.002249	6.74	22082.10	845.02	0.17	6.45	2.94	2.39	3.60
Rio Manati	1	33153.54 32965	0.002 (500 yr)	366742.80	100.39	158.08	139.72	161.03	0.001823	6.81	30210.85	1121.15	0.16	6.22	3.04	1.09	3.02
Rio Manati	1	32988.5*	0.5 (2 yr)	18504.88	97.75	115.48		116.16	0.004607	6.79	2923.51	242.85	0.31	4.31	1.61	1.24	3.35
Rio Manati	1	32988.5*	0.2 (5 yr)	40859.07	97.75	123.54		124.33	0.003485	7.86	6289.68	634.50	0.29	5.01	0.94	1.98	2.12
Rio Manati	1	32988.5*	0.1 (10 yr)	63495.77	97.75	128.11		128.87	0.002710	7.82	9509.05	786.01	0.26	4.67	1.21	1.87	2.02
Rio Manati	1	32988.5*	0.04 (25 yr)	109440.10	97.75	134.70		135.53	0.001974	7.69	15341.47	970.56	0.23	4.21	1.41	1.66	1.92
Rio Manati	1	32988.5*	0.02 (50 yr)	143730.70	97.75	138.25		139.20	0.001820	7.89	18887.03	1094.77	0.23	4.28	1.65	1.12	1.94
Rio Manati	1	32988.5*	0.01 (100 yr)	194477.90	97.75	143.11		144.12	0.001572	7.95	25170.79	1365.08	0.21	4.17	1.62	1.07	1.79
Rio Manati	1	32988.5*	0.005 (200 yr)	258044.30	97.75	149.00		150.05	0.001280	7.82	33413.22	1445.98	0.20	3.87	1.74	1.17	1.83
Rio Manati	1	32988.5*	0.002 (500 yr)	366742.80	97.75	158.15		159.22	0.000989	7.71	48043.28	1750.49	0.18	3.55	1.67	1.13	1.68
Rio Manati	1	32918.20 32728	0.5 (2 yr)	19634.96	96.62	114.60	106.11	115.28	0.003202	6.88	3233.97	254.71	0.30	3.24	1.24	1.20	2.43
Rio Manati	1	32918.20 32728	0.2 (5 yr)	43754.87	96.62	122.22	111.47	123.44	0.003707	9.56	5918.13	630.04	0.34	5.50	0.63	2.30	2.13
Rio Manati	1	32918.20 32728	0.1 (10 yr)	68333.88	96.62	127.02	115.63	128.12	0.003030	9.77	9485.98	983.19	0.32	5.40	1.20	2.30	2.22
Rio Manati	1	32918.20 32728	0.04 (25 yr)	118304.10	96.62	133.83	125.33	134.94	0.002270	9.74	15046.50	1092.96	0.29	5.00	1.85	2.28	2.54
Rio Manati	1	32918.20 32728	0.02 (50 yr)	155702.40	96.62	137.35	127.55	138.63	0.002192	10.20	19077.05	1468.88	0.29	5.31	2.26	1.64	2.51
Rio Manati	1	32918.20 32728	0.01 (100 yr)	211075.80	96.62	142.08	130.09	143.59	0.002024	10.58	23986.80	1532.98	0.28	5.50	2.67	1.86	2.77
Rio Manati	1	32918.20 32728	0.005 (200 yr)	280504.40	96.62	147.86	132.49	149.58	0.001782	10.78	30371.22	1785.11	0.27	5.48	2.98	1.79	2.78
Rio Manati	1	32918.20 32728	0.002 (500 yr)	399338.30	96.62	158.01	137.14	158.91	0.000916	8.75	57827.65	1928.84	0.20	3.39	1.60	1.38	1.68
Rio Manati	1	32740.16 32548	0.5 (2 yr)	19634.96	95.54	111.71	105.15	112.58	0.006994	7.84	2814.46	274.46	0.36	6.41	2.05	1.77	4.38
Rio Manati	1	32740.16 32548	0.2 (5 yr)	43754.87	95.54	119.11	110.39	120.48	0.007028	10.30	5478.86	560.34	0.39	9.66	2.21	2.65	4.23
Rio Manati	1	32740.16 32548	0.1 (10 yr)	68333.88	95.54	124.50	115.26	125.72	0.005401	10.44	9342.39	1028.75	0.35	9.23	2.83	2.87	4.09
Rio Manati	1	32740.16 32548	0.04 (25 yr)	118304.10	95.54	131.79	122.67	133.04	0.004417	11.03	14990.82	1052.47	0.33	9.54	4.22	3.46	5.15
Rio Manati	1	32740.16 32548	0.02 (50 yr)	155702.40	95.54	135.58	124.95	136.83	0.004046	11.31	21858.49	1629.39	0.32	9.69	4.74	1.94	3.96
Rio Manati	1	32740.16 32548	0.01 (100 yr)	211075.80	95.54	140.50	127.83	141.87	0.003844	11.95	28930.54	1752.32	0.32	10.38	5.57	2.65	4.57
Rio Manati	1	32740.16 32548	0.005 (200 yr)	280504.40	95.54	146.60	130.76	148.01	0.003368	12.20	38438.44	1898.42	0.31	10.37	6.02	3.13	4.85
Rio Manati	1	32740.16 32548	0.002 (500 yr)	399338.30	95.54	156.60	134.94	157.97	0.002613	12.15	55305.58	1984.91	0.28	9.66	6.06	3.80	5.12
Rio Manati	1	32455.27 32258	0.5 (2 yr)	19634.96	85.63	108.24	98.75	108.76	0.002565	5.76	3447.28	267.66	0.26	2.40	1.14	0.39	2.17
Rio Manati	1	32455.27 32258	0.2 (5 yr)	43754.87	85.63	114.53	103.83	115.74	0.003793	8.82	5175.25	339.58	0.33	5.02	3.08	1.07	3.97
Rio Manati	1	32455.27 32258	0.1 (10 yr)	68333.88	85.63	119.30	107.57	121.12	0.004445	10.90	6844.81	557.41	0.37	7.18	4.85	0.91	3.70
Rio Manati	1	32455.27 32258	0.04 (25 yr)	118304.10	85.63	127.26	114.03	129.20	0.003865	12.12	15409.66	1508.25	0.36	8.12	6.02	1.51	2.55
Rio Manati	1	32455.27 32258	0.02 (50 yr)	155702.40	85.63	131.73	118.53	133.49	0.003324	12.20	22040.68	1616.09	0.35	7.90	6.05	2.12	2.99
Rio Manati	1	32455.27 32258	0.01 (100 yr)	211075.80	85.63	137.26	127.04	138.89	0.002898	12.44	30820.26	1788.99	0.33	7.86	6.22	2.58	3.30
Rio Manati	1	32455.27 32258	0.005 (200 yr)	280504.40	85.63	144.14	130.30	145.57	0.002321	12.26	42436.35	1885.88	0.30	7.28	3.30	3.01	3.56
Rio Manati	1	32455.27 32258	0.002 (500 yr)	399338.30	85.63	154.86	134.46	156.07	0.001767	12.14	61171.18	1969.86	0.27	6.70	1.59	3.39	3.72
Rio Manati	1	32325.2*	0.5 (2 yr)	19634.96	84.89	106.98		107.57	0.002922	6.20	3228.58	261.40	0.28	2.76	1.38	0.39	2.20
Rio Manati	1	32325.2*	0.2 (5 yr)	43754.87	84.89	112.80		113.96	0.004480	9.46	4879.99	324.43	0.36	5.78	2.57	1.43	4.12
Rio Manati	1	32325.2*	0.1 (10 yr)	68333.88	84.89	117.16		119.12	0.005004	11.39	6454.52	375.46	0.40	7.86	3.75	2.12	5.25
Rio Manati	1	32325.2*	0.04 (25 yr)	118304.10	84.89	125.52		127.64	0.004199	12.61	14006.11	1447.72	0.38	8.76	3.74	1.37	2.51
Rio Manati	1	32325.2*	0.02 (50 yr)	155702.40	84.89	130.43		132.28	0.003483	12.57	21756.97	1657.08	0.36	8.32	3.78	1.97	2.83

Alternative 3 (Non-Structural Relocations) Results Table for XS in Project Area

HEC-RAS Plan: Alt 5 Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	32325.2*	0.01 (100 yr)	211075.80	84.89	136.34		137.95	0.002896	12.60	31697.47	1704.93	0.33	7.97	3.56	2.67	3.33
Rio Manati	1	32325.2*	0.005 (200 yr)	280504.40	84.89	143.49		144.86	0.002302	12.40	44098.91	1758.80	0.30	7.35	3.26	3.11	3.57
Rio Manati	1	32325.2*	0.002 (500 yr)	399338.30	84.89	154.38		155.58	0.001769	12.35	63708.22	1858.42	0.27	6.84	3.28	3.42	3.74
Rio Manati	1	32235.51 32029	0.5 (2 yr)	19634.96	84.38	105.79	98.85	106.67	0.002847	7.68	2677.58	238.58	0.36	2.47	1.65	0.42	1.95
Rio Manati	1	32235.51 32029	0.2 (5 yr)	43754.87	84.38	109.98	104.27	112.34	0.005836	12.71	3754.14	273.81	0.52	6.57	4.09	1.77	4.87
Rio Manati	1	32235.51 32029	0.1 (10 yr)	68333.88	84.38	113.32	108.59	117.11	0.007853	16.26	4725.41	306.70	0.62	10.46	6.27	3.13	7.37
Rio Manati	1	32235.51 32029	0.04 (25 yr)	118304.10	84.38	120.50	115.39	125.72	0.008092	19.60	8368.39	881.59	0.64	14.36	8.15	2.01	4.73
Rio Manati	1	32235.51 32029	0.02 (50 yr)	155702.40	84.38	127.63	122.11	131.07	0.004728	17.18	17074.41	1451.73	0.51	10.47	5.74	2.34	3.43
Rio Manati	1	32235.51 32029	0.01 (100 yr)	211075.80	84.38	134.39	126.79	137.09	0.003452	16.36	27584.35	1657.05	0.44	9.09	4.87	2.82	3.54
Rio Manati	1	32235.51 32029	0.005 (200 yr)	280504.40	84.38	142.09	130.24	144.25	0.002501	15.47	40764.79	1881.66	0.38	7.77	3.95	3.16	3.63
Rio Manati	1	32235.51 32029	0.002 (500 yr)	399338.30	84.38	153.29	135.47	155.15	0.001783	14.85	60344.91	1913.12	0.33	6.77	3.99	3.42	3.76
Rio Manati	1	31723.61 31578	0.5 (2 yr)	19634.96	79.69	99.81	92.99	100.77	0.007128	7.95	2572.19	442.46	0.34	7.43	0.91	2.56	2.54
Rio Manati	1	31723.61 31578	0.2 (5 yr)	43754.87	79.69	106.42	101.34	107.01	0.003211	6.65	7250.00	798.13	0.24	4.66	1.34	1.62	1.79
Rio Manati	1	31723.61 31578	0.1 (10 yr)	68333.88	79.69	112.26	103.44	112.78	0.001732	5.67	12033.05	838.55	0.18	3.14	1.30	1.09	1.52
Rio Manati	1	31723.61 31578	0.04 (25 yr)	118304.10	79.69	121.53	106.37	122.09	0.001064	5.33	20174.20	901.20	0.15	2.54	1.34	0.89	1.45
Rio Manati	1	31723.61 31578	0.02 (50 yr)	155702.40	79.69	128.09	108.14	128.67	0.000817	5.19	26153.18	921.36	0.14	2.28	1.34	0.79	1.41
Rio Manati	1	31723.61 31578	0.01 (100 yr)	211075.80	79.69	134.43	110.54	135.16	0.000794	5.58	32129.11	971.56	0.14	2.52	1.59	0.64	1.59
Rio Manati	1	31723.61 31578	0.005 (200 yr)	280504.40	79.69	141.87	113.26	142.74	0.000745	5.92	39624.77	1177.92	0.14	2.71	1.83	0.57	1.71
Rio Manati	1	31723.61 31578	0.002 (500 yr)	399338.30	79.69	152.89	117.50	153.98	0.000697	6.42	51517.36	1235.78	0.14	3.01	2.19	0.80	1.98
Rio Manati	1	31444.64 31314	0.5 (2 yr)	19634.96	73.79	95.10	87.48	96.00	0.004295	7.74	2594.49	260.44	0.34	4.08	1.11	0.50	2.58
Rio Manati	1	31444.64 31314	0.2 (5 yr)	43754.87	73.79	102.87	94.08	104.30	0.003204	8.72	4718.82	283.16	0.32	4.53	2.18	1.07	3.17
Rio Manati	1	31444.64 31314	0.1 (10 yr)	68333.88	73.79	108.96	98.04	110.92	0.002763	9.43	6493.29	299.94	0.30	4.91	2.69	1.33	3.52
Rio Manati	1	31444.64 31314	0.04 (25 yr)	118304.10	73.79	117.88	103.68	120.62	0.002684	11.07	9555.44	440.63	0.31	6.20	2.38	1.82	3.45
Rio Manati	1	31444.64 31314	0.02 (50 yr)	155702.40	73.79	125.01	107.73	127.50	0.002238	11.31	12960.73	533.94	0.29	6.12	2.37	1.84	3.23
Rio Manati	1	31444.64 31314	0.01 (100 yr)	211075.80	73.79	131.21	115.42	133.97	0.002357	12.63	16551.02	598.30	0.31	7.32	3.04	2.17	3.88
Rio Manati	1	31444.64 31314	0.005 (200 yr)	280504.40	73.79	138.83	121.33	141.62	0.002270	13.58	21835.68	804.16	0.31	8.08	2.98	2.42	3.77
Rio Manati	1	31444.64 31314	0.002 (500 yr)	399338.30	73.79	150.05	128.33	152.94	0.002120	14.72	30800.30	1095.26	0.31	8.97	4.24	2.65	4.81
Rio Manati	1	31041.5 30915	0.5 (2 yr)	19634.96	70.83	92.72	82.62	93.11	0.001240	4.99	3980.28	328.60	0.23	1.14	0.17	0.04	0.92
Rio Manati	1	31041.5 30915	0.2 (5 yr)	43754.87	70.83	101.63	87.00	102.14	0.000902	5.99	8097.90	586.26	0.22	1.32	0.27	0.32	0.76
Rio Manati	1	31041.5 30915	0.1 (10 yr)	68333.88	70.83	108.60	90.48	109.09	0.000663	6.18	13339.67	977.33	0.20	1.26	0.27	0.30	0.56
Rio Manati	1	31041.5 30915	0.04 (25 yr)	118304.10	70.83	118.67	97.70	119.08	0.000373	5.65	24140.48	1105.20	0.16	0.93	0.30	0.37	0.50
Rio Manati	1	31041.5 30915	0.02 (50 yr)	155702.40	70.83	125.88	99.82	126.28	0.000263	5.32	32246.39	1134.47	0.13	0.78	0.28	0.37	0.46
Rio Manati	1	31041.5 30915	0.01 (100 yr)	211075.80	70.83	132.23	104.92	132.71	0.000255	5.70	39513.62	1154.65	0.14	0.85	0.32	0.45	0.53
Rio Manati	1	31041.5 30915	0.005 (200 yr)	280504.40	70.83	139.85	110.54	140.42	0.000237	6.03	48796.38	1246.98	0.13	0.90	0.28	0.52	0.57
Rio Manati	1	31041.5 30915	0.002 (500 yr)	399338.30	70.83	151.10	113.92	151.80	0.000221	6.52	63029.35	1291.26	0.13	0.99	0.39	0.62	0.66
Rio Manati	1	30753.00 30623	0.5 (2 yr)	19634.96	71.39	91.66		92.12	0.000907	5.56	3641.18	250.50	0.24	0.93	0.01	0.30	0.79
Rio Manati	1	30753.00 30623	0.2 (5 yr)	43754.87	71.39	100.42		101.29	0.000980	7.65	5907.47	267.67	0.27	1.53	0.04	0.70	1.25
Rio Manati	1	30753.00 30623	0.1 (10 yr)	68333.88	71.39	107.09		108.34	0.001054	9.27	7840.93	384.00	0.29	2.08	0.20	0.49	1.26
Rio Manati	1	30753.00 30623	0.04 (25 yr)	118304.10	71.39	117.36		118.61	0.000861	10.07	15117.13	898.65	0.27	2.24	0.38	0.49	0.87
Rio Manati	1	30753.00 30623	0.02 (50 yr)	155702.40	71.39	125.05		125.99	0.000554	9.03	22083.34	913.37	0.22	1.71	0.33	0.57	0.80
Rio Manati	1	30753.00 30623	0.01 (100 yr)	211075.80	71.39	131.42		132.45	0.000520	9.48	27961.64	930.38	0.22	1.80	0.38	0.73	0.93
Rio Manati	1	30753.00 30623	0.005 (200 yr)	280504.40	71.39	139.07		140.18	0.000467	9.78	35134.20	943.86	0.22	1.84	0.42	0.86	1.03
Rio Manati	1	30753.00 30623	0.002 (500 yr)	399338.30	71.39	150.29		151.58	0.000423	10.36	45819.00	960.62	0.21	1.96	0.47	1.05	1.18
Rio Manati	1	30450.28 30327	0.5 (2 yr)	19634.96	48.56	90.62		90.78	0.001900	3.22	6401.35	410.59	0.13	2.21	0.46	0.00	1.67
Rio Manati	1	30450.28 30327	0.2 (5 yr)	43754.87	48.56	99.39		99.70	0.002421	4.63	10391.76	481.65	0.15	4.05	1.46	0.00	2.93
Rio Manati	1	30450.28 30327	0.1 (10 yr)	68333.88	48.56	106.15		106.58	0.002627	5.55	13725.27	509.07	0.16	5.44	2.38	0.00	3.94
Rio Manati	1	30450.28 30327	0.04 (25 yr)	118304.10	48.56	116.42		117.08	0.002936	6.96	19034.27	525.66	0.18	7.84	4.18	0.00	5.80
Rio Manati	1	30450.28 30327	0.02 (50 yr)	155702.40	48.56	124.18		124.95	0.002790	7.53	23164.23	537.78	0.18	8.71	5.01	0.00	6.47
Rio Manati	1	30450.28 30327	0.01 (100 yr)	211075.80	48.56	130.36		131.45	0.003451	9.01	26570.52	566.67	0.21	12.02	6.71	0.00	8.67
Rio Manati	1	30450.28 30327	0.005 (200 yr)	280504.40	48.56	137.79		139.21	0.003883	10.33	30828.20	579.34	0.22	15.21	8.85	0.00	10.95
Rio Manati	1	30450.28 30327	0.002 (500 yr)	399338.30	48.56	148.63		150.61	0.004506	12.30	37268.44	613.24	0.25	20.51	11.88	0.00	14.38
Rio Manati	1	30282.54 30154	0.5 (2 yr)	19634.96	62.99	89.65		89.85	0.001411	3.45	5437.75	357.96	0.13	1.72		1.01	1.30
Rio Manati	1	30282.54 30154	0.2 (5 yr)	43754.87	62.99	98.11		98.51	0.001816	4.58	8749.36	425.37	0.15	2.91		1.86	2.26
Rio Manati	1	30282.54 30154	0.1 (10 yr)	68333.88	62.99	104.72		105.27	0.001998	5.27	11603.64	446.36	0.16	3.75	0.01	2.78	3.10
Rio Manati	1	30282.54 30154	0.04 (25 yr)	118304.10	62.99	114.79		115.62	0.002202	6.42	16830.59	540.24	0.18	5.26	1.09	4.23	4.06
Rio Manati	1	30282.54 30154	0.02 (50 yr)	155702.40	62.99	122.68		123.60	0.001993	6.87	21162.57	558.53	0.17	5.67	1.73	4.60	4.43
Rio Manati	1	30282.54 30154	0.01 (100 yr)	211075.80	62.99	128.52		129.80	0.002419	8.16	24468.53	573.59	0.19	7.70	2.70	6.24	6.02
Rio Manati	1	30282.54 30154	0.005 (200 yr)	280504.40	62.99	135.70		137.36	0.002718	9.39	28651.12	592.81	0.21	9.78	3.69	7.93	7.61
Rio Manati	1	30282.54 30154	0.002 (500 yr)	399338.30	62.99	146.15		148.46	0.003145	11.20	35238.20	660.14	0.23	13.23	4.20	10.73	9.52
Rio Manati	1	29965.48 29830	0.5 (2 yr)	19634.96	70.47	85.48	80.34	86.33	0.012704	7.71	2781.06	280.64	0.41	8.87	5.64	1.82	7.76
Rio Manati	1	29965.48 29830	0.2 (5 yr)	43754.87	70.47	93.46	84.79	94.74	0.008060	9.40	5212.26	339.01	0.38	9.62	6.29	3.15	8.16
Rio Manati	1	29965.48 29830	0.1 (10 yr)	68333.88	70.47	99.83	88.37	101.46	0.006633	10.59	7218.06	422.66	0.37	10.54	7.76	3.59	9.09
Rio Manati	1	29965.48 29830	0.04 (25 yr)	118304.10	70.47	109.02	94.13	111.48	0.006375	13.01	10158.56	511.53	0.39	13.77	11.04	4.58	11.89
Rio Manati	1	29965.48 29830	0.02 (50 yr)	155702.40	70.47	117.30	97.67	119.95	0.005044	13.50	12863.51	581.59	0.36	13.49	11.29	4.24	11.49
Rio Manati	1	29965.48 29830	0.01 (100 yr)	211075.80	70.47	123.01	102.41	125.86	0.004946	14.61	20699.79	759.25	0.37	14.99	5.99	4.42	8.16
Rio Manati	1	29965.48 29830	0.005 (200 yr)	280504.40	70.47	130.34	107.78	133.38	0.004545	15.46	26407.46	798.74	0.36	15.84	7.26	4.60	9.08
Rio Manati	1	29965.48 29830	0.002 (500 yr)	399338.30	70.47	140.55	119.70	144.19	0.004562	17.42	35267.42	966.99	0.38	18.79	8.18	5.58	10.03
Rio Manati	1	29939.95 29805		Bridge													
Rio Manati	1	29914.84 29779	0.5 (2 yr)	19634.96	65.13	84.41	76.37	85.25	0.007617	7.57	2864.72	213.98	0.33	7.29	3.47	0.33	6.09
Rio Manati	1	29914.84 29779	0.2 (5 yr)	43754.87	65.13	91.52	81.96	93.26	0.010137	11.15	4558.87	260.20	0.41	14.00	6.51	2.02	10.56
Rio Manati	1	29914.84 29779	0.1 (10 yr)	68333.88	65.13	97.33	86.25	99.83	0.011102	13.54	6304.61	366.51	0.44	19.17	6.87	3.76	11.91
Rio Manati	1	29914.84 29779	0.04 (25 yr)	118304.10	65.13	106.72	93.95	109.82	0.010241	15.69	9646.87	411.56	0.45	23.42	12.23	5.74	16.20
Rio Manati	1	29914.84 29779	0.02 (50 yr)	155702.40	65.13	112.57	99.88	116.09	0.009896	16.95	11777.39	440.71	0.45	26.08	15.38	6.89	18.69
Rio Manati	1	29914.84 29779	0.01 (100 yr)	211075.80	65.13	119.68	104.57	123.89	0.010258	19.06	16018.58	663.50	0.47	31.39	10.14	8.88	14.83
Rio Manati	1	29914.84 29779	0.005 (200 yr)	280504.40	65.13	127.39	109.71	132.17	0.010290	20.96	21924.70	895.37	0.48	36.22	12.01	6.06	15.19
Rio Manati	1	29914.84 29779	0.002 (500 yr)	399338.30	65.13	139.68	117.35	143.41	0.007218	19.91	34175.96	1075.21	0.42	30.69	12.03	7.09	13.70

Alternative 3b (Non-Structural Relocations - Recommended Plan) Results Table for XS in Project Area

HEC-RAS Plan: Alt 1 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	34233.57 34069	0.5 (2 yr)	18434.26	111.45	129.87	121.19	130.40	0.004234	5.84	3159.66	238.79	0.28	3.47	0.29		3.36
Rio Manati	1	34233.57 34069	0.2 (5 yr)	40682.50	111.45	139.51	125.86	140.34	0.003817	7.11	5625.18	270.47	0.26	5.07	1.53		4.69
Rio Manati	1	34233.57 34069	0.1 (10 yr)	63177.94	111.45	143.44	129.56	144.89	0.005287	9.15	6711.32	282.49	0.32	8.18	2.74	0.26	7.38
Rio Manati	1	34233.57 34069	0.04 (25 yr)	108910.40	111.45	151.87	135.35	153.35	0.003729	9.25	11327.18	657.74	0.28	7.63	1.61	1.01	3.86
Rio Manati	1	34233.57 34069	0.02 (50 yr)	142989.10	111.45	155.56	138.83	157.44	0.003212	9.19	13779.02	671.26	0.26	7.27	2.07	1.21	3.96
Rio Manati	1	34233.57 34069	0.01 (100 yr)	193489.10	111.45	160.24	148.32	162.70	0.002800	9.27	17040.68	709.37	0.25	7.12	2.46	1.39	4.03
Rio Manati	1	34233.57 34069	0.005 (200 yr)	256702.30	111.45	165.07	150.84	168.29	0.002532	9.46	20710.83	787.30	0.24	7.16	2.88	0.97	3.99
Rio Manati	1	34233.57 34069	0.002 (500 yr)	364800.50	111.45	171.73	155.15	176.19	0.002338	9.92	26476.56	972.74	0.24	7.53	3.52	0.89	3.82
Rio Manati	1	34155.99 33988	0.5 (2 yr)	18504.88	110.89	128.90	119.21	129.39	0.003601	5.66	3288.79	243.00	0.27	3.06		0.48	2.94
Rio Manati	1	34155.99 33988	0.2 (5 yr)	40859.07	110.89	138.67	124.38	139.48	0.002932	7.27	5947.50	307.12	0.26	4.23	0.67	1.21	3.42
Rio Manati	1	34155.99 33988	0.1 (10 yr)	63495.77	110.89	142.25	128.07	143.67	0.004335	9.70	7141.42	395.49	0.33	7.19	0.81	2.28	4.74
Rio Manati	1	34155.99 33988	0.04 (25 yr)	109440.10	110.89	150.36	134.04	152.24	0.004311	11.50	10878.04	624.26	0.34	9.26	2.01	1.46	4.58
Rio Manati	1	34155.99 33988	0.02 (50 yr)	143730.70	110.89	154.53	137.81	156.53	0.004040	11.99	13629.58	680.01	0.34	9.70	2.50	2.31	4.93
Rio Manati	1	34155.99 33988	0.01 (100 yr)	194477.90	110.89	159.60	145.46	161.82	0.003613	12.29	17191.06	715.76	0.32	9.79	3.10	3.05	5.27
Rio Manati	1	34155.99 33988	0.005 (200 yr)	258044.30	110.89	164.67	152.41	167.31	0.003342	12.70	20890.96	743.71	0.32	10.08	3.66	3.71	5.68
Rio Manati	1	34155.99 33988	0.002 (500 yr)	366742.80	110.89	171.61	157.02	175.06	0.003075	13.28	26391.29	897.95	0.31	10.56	3.35	4.48	5.48
Rio Manati	1	34135.98 33968		Bridge													
Rio Manati	1	34115.96 33947	0.5 (2 yr)	18504.88	110.66	126.05	118.60	126.59	0.001090	5.83	3153.70	264.48	0.29	0.84	0.08	0.28	0.79
Rio Manati	1	34115.96 33947	0.2 (5 yr)	40859.07	110.66	133.39	122.98	134.37	0.001019	7.66	5270.76	302.44	0.30	1.24	0.27	0.44	1.06
Rio Manati	1	34115.96 33947	0.1 (10 yr)	63495.77	110.66	138.32	126.86	139.83	0.001076	9.12	6803.59	324.56	0.32	1.63	0.34	0.67	1.34
Rio Manati	1	34115.96 33947	0.04 (25 yr)	109440.10	110.66	145.75	131.56	147.76	0.001157	11.27	10233.87	576.25	0.35	2.28	0.41	0.61	1.24
Rio Manati	1	34115.96 33947	0.02 (50 yr)	143730.70	110.66	149.85	134.95	152.19	0.001075	11.76	12869.15	609.63	0.34	2.39	0.60	0.77	1.35
Rio Manati	1	34115.96 33947	0.01 (100 yr)	194477.90	110.66	155.38	139.83	158.09	0.000949	12.14	16127.39	642.11	0.33	2.43	0.79	0.91	1.44
Rio Manati	1	34115.96 33947	0.005 (200 yr)	258044.30	110.66	161.36	146.72	164.45	0.000847	12.53	20157.85	768.30	0.32	2.48	0.72	1.04	1.34
Rio Manati	1	34115.96 33947	0.002 (500 yr)	366742.80	110.66	169.75	152.49	173.23	0.000730	12.96	26879.41	827.31	0.30	2.51	0.94	1.08	1.43
Rio Manati	1	33860.74 33690	0.5 (2 yr)	18504.88	108.76	124.39	118.44	125.24	0.002244	8.17	3130.37	293.82	0.40	1.76	1.15		1.44
Rio Manati	1	33860.74 33690	0.2 (5 yr)	40859.07	108.76	131.59	123.34	132.97	0.002658	10.69	5424.25	345.51	0.43	3.07	2.08	0.03	2.49
Rio Manati	1	33860.74 33690	0.1 (10 yr)	63495.77	108.76	136.27	127.07	138.29	0.003000	13.10	7188.89	441.00	0.47	4.30	2.30	0.32	2.93
Rio Manati	1	33860.74 33690	0.04 (25 yr)	109440.10	108.76	143.71	132.58	146.20	0.002844	15.24	11342.41	635.65	0.48	5.32	2.67	0.73	3.27
Rio Manati	1	33860.74 33690	0.02 (50 yr)	143730.70	108.76	148.27	136.39	150.82	0.002572	15.85	14168.90	746.42	0.46	5.51	2.96	0.90	3.48
Rio Manati	1	33860.74 33690	0.01 (100 yr)	194477.90	108.76	154.24	143.49	156.93	0.002306	16.62	18065.46	842.17	0.45	5.75	3.30	0.58	3.56
Rio Manati	1	33860.74 33690	0.005 (200 yr)	258044.30	108.76	160.39	147.26	163.32	0.002157	17.60	22524.75	878.50	0.45	6.16	3.78	1.06	3.94
Rio Manati	1	33860.74 33690	0.002 (500 yr)	366742.80	108.76	168.81	152.39	172.29	0.002114	19.39	28916.31	926.75	0.45	7.09	4.68	1.53	4.64
Rio Manati	1	33704.47 33532	0.5 (2 yr)	18504.88	103.22	123.37	115.26	123.92	0.002646	6.08	3363.48	320.69	0.28	2.35	0.61	0.53	1.69
Rio Manati	1	33704.47 33532	0.2 (5 yr)	40859.07	103.22	130.52	120.05	131.46	0.002833	8.23	6156.65	438.31	0.31	3.76	1.32	1.19	2.42
Rio Manati	1	33704.47 33532	0.1 (10 yr)	63495.77	103.22	135.28	123.59	136.55	0.003078	9.80	8302.04	460.44	0.34	4.99	2.21	1.77	3.36
Rio Manati	1	33704.47 33532	0.04 (25 yr)	109440.10	103.22	142.57	129.69	144.47	0.003475	12.25	11796.78	501.80	0.37	7.19	3.83	2.42	4.92
Rio Manati	1	33704.47 33532	0.02 (50 yr)	143730.70	103.22	146.91	133.19	149.25	0.003723	13.75	14012.33	521.14	0.39	8.70	4.91	3.12	6.01
Rio Manati	1	33704.47 33532	0.01 (100 yr)	194477.90	103.22	152.48	137.10	155.44	0.004012	15.64	16989.94	553.84	0.42	10.75	6.37	3.85	7.38
Rio Manati	1	33704.47 33532	0.005 (200 yr)	258044.30	103.22	158.05	141.51	161.79	0.004395	17.74	20154.08	579.92	0.45	13.28	8.11	5.05	9.14
Rio Manati	1	33704.47 33532	0.002 (500 yr)	366742.80	103.22	165.46	147.84	170.60	0.005108	21.00	24619.80	725.79	0.49	17.76	9.58	6.72	11.25
Rio Manati	1	33597.73 33414	0.5 (2 yr)	18504.88	109.15	122.34	116.27	122.99	0.002606	7.30	3033.69	296.06	0.37	1.87	0.74	1.77	1.59
Rio Manati	1	33597.73 33414	0.2 (5 yr)	40859.07	109.15	129.51	120.49	130.54	0.002427	9.62	5921.87	485.23	0.39	2.79	0.90	2.52	1.78
Rio Manati	1	33597.73 33414	0.1 (10 yr)	63495.77	109.15	134.29	123.88	135.59	0.002445	11.21	8275.07	497.85	0.40	3.51	1.58	3.10	2.43
Rio Manati	1	33597.73 33414	0.04 (25 yr)	109440.10	109.15	141.58	130.12	143.41	0.002621	13.85	12026.14	533.78	0.44	4.91	2.63	4.20	3.52
Rio Manati	1	33597.73 33414	0.02 (50 yr)	143730.70	109.15	145.91	133.00	148.11	0.002743	15.45	14384.00	556.30	0.46	5.85	3.38	4.75	4.22
Rio Manati	1	33597.73 33414	0.01 (100 yr)	194477.90	109.15	151.52	136.42	154.19	0.002871	17.43	17599.13	589.56	0.48	7.09	4.35	5.39	5.09
Rio Manati	1	33597.73 33414	0.005 (200 yr)	258044.30	109.15	157.16	140.98	160.38	0.003071	19.64	20987.03	620.25	0.51	8.62	5.70	6.27	6.28
Rio Manati	1	33597.73 33414	0.002 (500 yr)	366742.80	109.15	164.62	147.08	168.90	0.003512	23.18	25615.00	664.68	0.55	11.42	8.10	8.11	8.48
Rio Manati	1	33357.12 33176	0.5 (2 yr)	18504.88	99.08	120.12	109.16	120.60	0.003491	5.81	4295.34	470.03	0.24	3.80	0.95	0.65	1.90
Rio Manati	1	33357.12 33176	0.2 (5 yr)	40859.07	99.08	127.27	115.10	128.04	0.004153	7.90	7904.03	525.01	0.28	6.28	2.68	1.52	3.71
Rio Manati	1	33357.12 33176	0.1 (10 yr)	63495.77	99.08	131.83	119.48	132.91	0.004969	9.64	10344.30	544.11	0.31	8.87	4.42	2.38	5.59
Rio Manati	1	33357.12 33176	0.04 (25 yr)	109440.10	99.08	138.70	125.58	140.38	0.006273	12.43	14181.49	574.12	0.36	13.75	7.77	4.10	9.14
Rio Manati	1	33357.12 33176	0.02 (50 yr)	143730.70	99.08	142.95	128.59	144.92	0.006584	13.69	16835.35	655.64	0.38	16.09	8.43	4.91	10.01
Rio Manati	1	33357.12 33176	0.01 (100 yr)	194477.90	99.08	148.78	132.38	150.89	0.006246	14.56	21314.72	1064.85	0.37	17.43	6.42	4.33	8.01
Rio Manati	1	33357.12 33176	0.005 (200 yr)	258044.30	99.08	154.77	136.22	156.91	0.005771	15.17	27708.04	1187.18	0.37	18.16	7.24	4.90	8.59
Rio Manati	1	33357.12 33176	0.002 (500 yr)	366742.80	99.08	162.70	144.68	164.99	0.005483	16.22	36999.18	1332.90	0.37	19.83	8.48	5.92	9.66
Rio Manati	1	33200.01 33011	0.5 (2 yr)	18504.88	98.89	118.79	108.04	119.17	0.002413	4.72	3761.29	335.83	0.20	2.46	0.80		1.64
Rio Manati	1	33200.01 33011	0.2 (5 yr)	40859.07	98.89	125.81	113.40	126.65	0.002341	5.18	6249.73	370.50	0.19	3.16	1.69	0.13	2.38
Rio Manati	1	33200.01 33011	0.1 (10 yr)	63495.77	98.89	129.88	118.79	131.27	0.002672	6.19	7802.64	389.64	0.21	4.26	2.49	0.57	3.22
Rio Manati	1	33200.01 33011	0.04 (25 yr)	109440.10	98.89	135.90	121.87	138.27	0.003342	7.93	10360.79	516.00	0.24	6.54	2.93	1.29	4.11
Rio Manati	1	33200.01 33011	0.02 (50 yr)	143730.70	98.89	139.77	126.15	142.72	0.003316	8.51	12363.24	624.12	0.25	7.26	3.69	1.62	4.74
Rio Manati	1	33200.01 33011	0.01 (100 yr)	194477.90	98.89	146.84	132.29	149.33	0.002274	7.93	17858.51	896.11	0.21	5.94	2.04	1.30	2.77
Rio Manati	1	33200.01 33011	0.005 (200 yr)	258044.30	98.89	153.07	137.37	155.64	0.001705	7.51	24034.79	1079.87	0.19	5.09	2.08	0.86	2.32
Rio Manati	1	33200.01 33011	0.002 (500 yr)	366742.80	98.89	160.86	145.90	163.84	0.001384	7.45	32843.29	1166.25	0.17	4.78	2.20	1.23	2.38
Rio Manati	1	33176.74 32988		Bridge													
Rio Manati	1	33153.54 32965	0.5 (2 yr)	18504.88	100.39	118.59	108.32	118.98	0.004903	4.79	3716.71	370.90	0.21	4.95	1.06	0.60	3.01
Rio Manati	1	33153.54 32965	0.2 (5 yr)	40859.07	100.39	125.67	113.62	126.34	0.002892	4.66	6930.95	512.32	0.17	4.17	1.48	1.12	2.47
Rio Manati	1	33153.54 32965	0.1 (10 yr)	63495.77	100.39	129.80	117.93	130.80	0.002736	5.05	9076.44	563.25	0.17	4.63	1.88	1.72	2.82
Rio Manati	1	33153.54 32965	0.04 (25 yr)	109440.10	100.39	135.76	122.70	137.53	0.002575	5.57	12292.27	626.18	0.17	5.29	2.71	2.53	3.60
Rio Manati	1	33153.54 32965	0.02 (50 yr)	143730.70	100.39	139.15	125.49	141.53	0.002642	6.02	14124.82	653.61	0.17	5.98	3.34	3.13	4.24
Rio Manati	1	33153.54 32965	0.01 (100 yr)	194477.90	100.39	143.62	129.63	146.60	0.002574	6.41	17147.34	693.09	0.18	6.53	3.97	2.42	4.56
Rio Manati	1	33153.54 32965	0.005 (200 yr)	258044.30	100.39	149.43	133.53	152.29	0.002217	6.49	22357.12	846.63	0.17	6.41	2.86	2.37	3.58
Rio Manati	1	33153.54 32965	0.002 (500 yr)	366742.80	100.39	158.29	140.04	161.30	0.001798	6.55	30541.47	1131.64	0.15	6.16	2.95	1.07	2.98
Rio Manati	1	32988.5*	0.5 (2 yr)	18504.88	97.75	115.61		116.27	0.004477	6.73	2955.23	245.71	0.30	4.23	1.50	1.23	3.25
Rio Manati	1	32988.5*	0.2 (5 yr)	40859.07	97.75	123.71		124.47	0.003338	7.73	6394.02	636.90	0.28	4.83	0.93	1.92	2.06
Rio Manati	1	32988.5*	0.1 (10 yr)	63495.77	97.75	128.29		129.02	0.002595	7.68	9650.93	790.00	0.26	4.50	1.18	1.79	1.95
Rio Manati	1	32988.5*	0.04 (25 yr)	109440.10	97.75	134.82		135.63	0.001933	7.63	15452.86	971.69	0.23	4.13	1.40	1.63	1.89
Rio Manati	1	32988.5*	0.02 (50 yr)	143730.70	97.75	138.51		139.43	0.001744	7.76	19173.91	1128.09	0.22	4.13	1.56	1.05	1.83
Rio Manati	1	32988.5*	0.01 (100 yr)	194477.90	97.75	143.36		144.35	0.001517	7.84	25515.51	1367.45	0.21	4.05	1.58	1.05	1.75
Rio Manati	1	32988.5*	0.005 (200 yr)	258044.30	97.75	149.29		150.31	0.001239	7.72	33824.18	1456.16	0.19	3.76	1.69	1.15	1.78
Rio Manati	1	32988.5*	0.002 (500 yr)	366742.80	97.75	158.42		159.47	0.000964	7.63	48511.98	1755.26	0.18	3.48	1.64	1.11	1.65
Rio Manati	1	32918.20 32728	0.5 (2 yr)	19634.96	96.62	114.76	106.11	115.43	0.003088	6.80	3275.59	255.78	0.30	3.15	1.20	1.18	2.36
Rio Manati	1	32918.20 32728	0.2 (5 yr)	43754.87	96.62	122.44	111.46	123.61	0.003536	9.40	6059.88	641.68	0.34	5.29	0.63	2.23	2.04
Rio Manati	1	32918.20 32728	0.1 (10 yr)	68333.88	96.62	127.26	115.64	128.31	0.002866	9.55	9679.80	985.89	0.31	5.15	1.18	2.19	2.14
Rio Manati	1	32918.20 32728	0.04 (25 yr)	118304.10	96.62	133.95	125.33	135.05	0.002250	9.72	15711.59	1257.71	0.29	4.98	1.85	1.44	2.22
Rio Manati	1	32918.20 32728	0.02 (50 yr)	155702.40	96.62	137.66	127.54	138.89	0.002069	9.96	19395.22	1474.25	0.28	5.05	2.17	1.64	2.44
Rio Manati	1	32918.20 32728	0.01 (100 yr)	211075.80	96.62	142.39	130.41	143.84	0.001927	10.37	24309.25	1535.29	0.28	5.27	2.58	1.86	2.71
Rio Manati	1	32918.20 32728	0.005 (200 yr)	280504.40	96.62	148.19	133.10	149.86	0.001700	10.58	30772.18	1796.03	0.26	5.26	2.88	1.77	2.71
Rio Manati	1	32918.20 32728	0.002 (500 yr)	399338.30	96.62	158.29	136.70	159.16	0.000885	8.63	58366.64	1930.79	0.20	3.29	1.56	1.38	1.65
Rio Manati	1	32740.16 32548	0.5 (2 yr)	19634.96	95.54	111.94	105.15	112.81	0.006829	7.82	2879.07	282.79	0.36	6.35	1.96	1.75	4.25
Rio Manati	1	32740.16 32548	0.2 (5 yr)	43754.87	95.54	119.65	110.39	120.88	0.006228	9.85	5986.76	782.80	0.36	8.77	1.77	1.26	3.07
Rio Manati	1	32740.16 32548	0.1 (10 yr)	68333.88	95.54	125.13	115.25	126.15	0.004568	9.74	10684.49	1190.67	0.32	7.98	2.56	1.79	3.26
Rio Manati	1	32740.16 32548	0.04 (25 yr)	118304.10	95.54	132.24	122.75	133.28	0.003781	10.30	17825.08	1331.53	0.31	8.27	3.71	2.32	3.90
Rio Manati	1	32740.16 32548	0.02 (50 yr)	155702.40	95.54	136.01	124.95	137.19	0.003792	11.03	22449.90	1685.20	0.31	9.18	4.54	1.82	3.70
Rio Manati	1	32740.16 32548	0.01 (100 yr)	211075.80	95.54	140.89	127.81	142.20	0.003661	11.72	29498.64	1755.38	0.31	9.97	5.39	2.66	4.47
Rio Manati	1	32740.16 32548	0.005 (200 yr)	280504.40	95.54	147.00	130.67	148.36	0.003215	11.98	39091.98	1902.48	0.30	9.98	5.82	3.11	4.74
Rio Manati	1	32740.16 32548	0.002 (500 yr)	399338.30	95.54	156.92	135.33	158.25	0.002532	12.00	55854.33	1985.40	0.27	9.42	5.92	3.79	5.05
Rio Manati	1	32455.27 32258	0.5 (2 yr)	19634.96	85.63	108.33	98.27	108.81	0.002800	5.56	3598.59	269.61	0.25	2.69	1.37	0.44	2.48
Rio Manati	1	32455.27 32258	0.2 (5 yr)	43754.87	85.63	115.20	103.12	116.28	0.003954	8.42	5510.96	349.48	0.31	5.46	3.45	1.16	4.31
Rio Manati	1	32455.27 32258	0.1 (10 yr)	68333.88	85.63	120.10	107.05	121.75	0.004795	10.57	7437.22	685.59	0.36	8.06	5.49	0.88	3.48
Rio Manati	1	32455.27 32258	0.04 (25 yr)	118304.10	85.63	128.29	113.64	129.80	0.003803	11.21	17035.20	1532.82	0.33	8.30	6.08	1.71	2.74
Rio Manati	1	32455.27 32258	0.02 (50 yr)	155702.40	85.63	132.58	118.13	133.97	0.003371	11.38	23465.29	1650.12	0.32	8.25	6.19	2.27	3.16
Rio Manati	1	32455.27 32258	0.01 (100 yr)	211075.80	85.63	137.96	126.80	139.27	0.003004	11.69	32121.71	1793.58	0.31	8.34	6.42	2.80	3.56
Rio Manati	1	32455.27 32258	0.005 (200 yr)	280504.40	85.63	144.68	129.95	145.85	0.002451	11.58	43495.16	1888.83	0.28	7.82	2.03	3.26	3.84
Rio Manati	1	32455.27 32258	0.002 (500 yr)	399338.30	85.63	155.23	133.92	156.29	0.001891	11.50	61959.16	1972.62	0.26	7.25	1.12	3.67	4.02
Rio Manati	1	32325.2*	0.5 (2 yr)	19634.96	84.89	106.91		107.51	0.003238	6.33	3389.79	265.86	0.28	3.09	1.62	0.42	2.52
Rio Manati	1	32325.2*	0.2 (5 yr)	43754.87	84.89	113.02		114.40	0.004920	9.75	5193.75	330.73	0.37	6.55	2.96	1.59	4.71
Rio Manati	1	32325.2*	0.1 (10 yr)	68333.88	84.89	117.41		119.49	0.006001	12.18	6726.41	387.73	0.42	9.61	4.52	2.39	6.35
Rio Manati	1	32325.2*	0.04 (25 yr)	118304.10	84.89	125.88		128.12	0.005130	13.60	14698.25	1458.26	0.41	10.90	4.43	1.77	3.20
Rio Manati	1	32325.2*	0.02 (50 yr)	155702.40	84.89	130.72		132.65	0.004242	13.50	22417.70	1659.34	0.38	10.28	4.47	2.48	3.55

Alternative 3b (Non-Structural Relocations-Recommended Plan) Results Table for XS in Project Area

HEC-RAS Plan: Alt 1 Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	32325.2*	0.01 (100 yr)	211075.80	84.89	136.56		138.24	0.003518	13.48	32249.54	1706.84	0.35	9.80	4.17	3.29	4.11
Rio Manati	1	32325.2*	0.005 (200 yr)	280504.40	84.89	143.66		145.09	0.002777	13.20	44566.35	1759.75	0.32	8.95	3.81	3.77	4.34
Rio Manati	1	32325.2*	0.002 (500 yr)	399338.30	84.89	154.49		155.75	0.002111	13.06	64099.42	1859.70	0.29	8.22	3.80	4.10	4.49
Rio Manati	1	32235.51 32029	0.5 (2 yr)	19634.96	84.38	105.77	97.42	106.53	0.003256	7.17	3125.76	250.96	0.33	3.03	2.02	0.48	2.46
Rio Manati	1	32235.51 32029	0.2 (5 yr)	43754.87	84.38	110.79	102.84	112.77	0.005919	11.71	4496.56	295.14	0.46	7.35	4.13	1.96	5.48
Rio Manati	1	32235.51 32029	0.1 (10 yr)	68333.88	84.38	113.89	107.22	117.32	0.008589	15.53	5464.01	323.92	0.57	12.32	6.74	3.64	8.79
Rio Manati	1	32235.51 32029	0.04 (25 yr)	118304.10	84.38	120.91	114.63	125.99	0.009501	19.48	9394.71	945.57	0.62	17.75	9.26	2.42	5.81
Rio Manati	1	32235.51 32029	0.02 (50 yr)	155702.40	84.38	127.87	122.27	131.31	0.005758	17.41	18156.54	1466.02	0.50	13.24	6.83	2.92	4.40
Rio Manati	1	32235.51 32029	0.01 (100 yr)	211075.80	84.38	134.61	126.11	137.29	0.004233	16.68	28724.06	1666.99	0.44	11.49	5.93	3.51	4.49
Rio Manati	1	32235.51 32029	0.005 (200 yr)	280504.40	84.38	142.29	130.70	144.43	0.003125	15.96	41892.46	1882.25	0.39	9.97	4.89	3.99	4.65
Rio Manati	1	32235.51 32029	0.002 (500 yr)	399338.30	84.38	153.52	135.68	155.29	0.002282	15.55	61538.62	1913.57	0.35	8.87	5.04	4.41	4.90
Rio Manati	1	31723.61 31578	0.5 (2 yr)	19634.96	79.69	98.34	92.33	99.80	0.005709	10.18	2309.29	193.80	0.46	5.42	2.48	1.87	4.05
Rio Manati	1	31723.61 31578	0.2 (5 yr)	43754.87	79.69	105.71	101.69	106.67	0.003232	9.72	6854.67	794.22	0.36	4.54	1.24	1.58	1.71
Rio Manati	1	31723.61 31578	0.1 (10 yr)	68333.88	79.69	111.95	104.65	112.57	0.001641	8.06	11941.44	836.48	0.26	2.94	1.21	1.03	1.43
Rio Manati	1	31723.61 31578	0.04 (25 yr)	118304.10	79.69	121.41	107.64	122.00	0.001015	7.58	20241.18	900.88	0.22	2.41	1.27	0.84	1.39
Rio Manati	1	31723.61 31578	0.02 (50 yr)	155702.40	79.69	128.01	109.41	128.60	0.000789	7.39	26249.57	920.97	0.19	2.19	1.29	0.77	1.36
Rio Manati	1	31723.61 31578	0.01 (100 yr)	211075.80	79.69	134.36	111.76	135.09	0.000773	7.97	32229.35	970.81	0.20	2.45	1.55	0.62	1.55
Rio Manati	1	31723.61 31578	0.005 (200 yr)	280504.40	79.69	141.81	114.37	142.66	0.000730	8.46	39728.45	1176.09	0.19	2.65	1.80	0.56	1.68
Rio Manati	1	31723.61 31578	0.002 (500 yr)	399338.30	79.69	152.85	118.41	153.91	0.000688	9.18	51634.95	1235.61	0.19	2.97	2.16	0.79	1.96
Rio Manati	1	31444.64 31314	0.5 (2 yr)	19634.96	73.62	94.89	87.36	95.79	0.003476	6.97	2649.69	259.01	0.31	3.30	1.03	0.38	2.12
Rio Manati	1	31444.64 31314	0.2 (5 yr)	43754.87	73.62	102.68	93.21	104.20	0.002656	7.94	4776.32	282.78	0.29	3.75	1.88	0.87	2.64
Rio Manati	1	31444.64 31314	0.1 (10 yr)	68333.88	73.62	108.80	97.67	110.87	0.002324	8.65	6553.78	299.46	0.28	4.13	2.32	1.11	2.96
Rio Manati	1	31444.64 31314	0.04 (25 yr)	118304.10	73.62	117.74	103.77	120.62	0.002289	10.22	9603.40	438.93	0.29	5.28	2.08	1.55	2.95
Rio Manati	1	31444.64 31314	0.02 (50 yr)	155702.40	73.62	124.94	108.04	127.49	0.001919	10.48	13031.14	530.86	0.27	5.25	2.07	1.57	2.78
Rio Manati	1	31444.64 31314	0.01 (100 yr)	211075.80	73.62	131.17	117.25	133.96	0.002036	11.75	16633.35	598.11	0.29	6.33	2.65	1.87	3.35
Rio Manati	1	31444.64 31314	0.005 (200 yr)	280504.40	73.62	138.81	121.78	141.60	0.001976	12.68	21935.06	804.02	0.29	7.04	2.62	2.11	3.28
Rio Manati	1	31444.64 31314	0.002 (500 yr)	399338.30	73.62	150.06	128.63	152.91	0.001867	13.82	30920.88	1095.29	0.29	7.90	3.76	2.33	4.24
Rio Manati	1	31041.5 30915	0.5 (2 yr)	19634.96	70.83	92.72	82.62	93.11	0.001240	4.99	3980.28	328.60	0.23	1.14	0.17	0.04	0.92
Rio Manati	1	31041.5 30915	0.2 (5 yr)	43754.87	70.83	101.63	87.00	102.14	0.000902	5.99	8097.90	586.26	0.22	1.32	0.27	0.32	0.76
Rio Manati	1	31041.5 30915	0.1 (10 yr)	68333.88	70.83	108.60	90.48	109.09	0.000663	6.18	13339.67	977.33	0.20	1.26	0.27	0.30	0.56
Rio Manati	1	31041.5 30915	0.04 (25 yr)	118304.10	70.83	118.67	97.70	119.08	0.000373	5.65	24140.48	1105.20	0.16	0.93	0.30	0.37	0.50
Rio Manati	1	31041.5 30915	0.02 (50 yr)	155702.40	70.83	125.88	99.82	126.28	0.000263	5.32	32246.39	1134.47	0.13	0.78	0.28	0.37	0.46
Rio Manati	1	31041.5 30915	0.01 (100 yr)	211075.80	70.83	132.23	104.92	132.71	0.000255	5.70	39513.62	1154.65	0.14	0.85	0.32	0.45	0.53
Rio Manati	1	31041.5 30915	0.005 (200 yr)	280504.40	70.83	139.85	110.54	140.42	0.000237	6.03	48796.38	1246.98	0.13	0.90	0.28	0.52	0.57
Rio Manati	1	31041.5 30915	0.002 (500 yr)	399338.30	70.83	151.10	113.92	151.80	0.000221	6.52	63029.35	1291.26	0.13	0.99	0.39	0.62	0.66
Rio Manati	1	30753.00 30623	0.5 (2 yr)	19634.96	71.39	91.66		92.12	0.000907	5.56	3641.18	250.50	0.24	0.93	0.01	0.30	0.79
Rio Manati	1	30753.00 30623	0.2 (5 yr)	43754.87	71.39	100.42		101.29	0.000980	7.65	5907.47	267.67	0.27	1.53	0.04	0.70	1.25
Rio Manati	1	30753.00 30623	0.1 (10 yr)	68333.88	71.39	107.09		108.34	0.001054	9.27	7840.93	384.00	0.29	2.08	0.20	0.49	1.26
Rio Manati	1	30753.00 30623	0.04 (25 yr)	118304.10	71.39	117.36		118.61	0.000861	10.07	15117.13	898.65	0.27	2.24	0.38	0.49	0.87
Rio Manati	1	30753.00 30623	0.02 (50 yr)	155702.40	71.39	125.05		125.99	0.000554	9.03	22083.34	913.37	0.22	1.71	0.33	0.57	0.80
Rio Manati	1	30753.00 30623	0.01 (100 yr)	211075.80	71.39	131.42		132.45	0.000520	9.48	27961.64	930.38	0.22	1.80	0.38	0.73	0.93
Rio Manati	1	30753.00 30623	0.005 (200 yr)	280504.40	71.39	139.07		140.18	0.000467	9.78	35134.20	943.86	0.22	1.84	0.42	0.86	1.03
Rio Manati	1	30753.00 30623	0.002 (500 yr)	399338.30	71.39	150.29		151.58	0.000423	10.36	45819.00	960.62	0.21	1.96	0.47	1.05	1.18
Rio Manati	1	30450.28 30327	0.5 (2 yr)	19634.96	48.56	90.62		90.78	0.001900	3.22	6401.35	410.59	0.13	2.21	0.46	0.00	1.67
Rio Manati	1	30450.28 30327	0.2 (5 yr)	43754.87	48.56	99.39		99.70	0.002421	4.63	10391.76	481.65	0.15	4.05	1.46	0.00	2.93
Rio Manati	1	30450.28 30327	0.1 (10 yr)	68333.88	48.56	106.15		106.58	0.002627	5.55	13725.27	509.07	0.16	5.44	2.38	0.00	3.94
Rio Manati	1	30450.28 30327	0.04 (25 yr)	118304.10	48.56	116.42		117.08	0.002936	6.96	19034.27	525.66	0.18	7.84	4.18	0.00	5.80
Rio Manati	1	30450.28 30327	0.02 (50 yr)	155702.40	48.56	124.18		124.95	0.002790	7.53	23164.23	537.78	0.18	8.71	5.01	0.00	6.47
Rio Manati	1	30450.28 30327	0.01 (100 yr)	211075.80	48.56	130.36		131.45	0.003451	9.01	26570.52	566.67	0.21	12.02	6.71	0.00	8.67
Rio Manati	1	30450.28 30327	0.005 (200 yr)	280504.40	48.56	137.79		139.21	0.003883	10.33	30828.20	579.34	0.22	15.21	8.85	0.00	10.95
Rio Manati	1	30450.28 30327	0.002 (500 yr)	399338.30	48.56	148.63		150.61	0.004506	12.30	37268.44	613.24	0.25	20.51	11.88	0.00	14.38
Rio Manati	1	30282.54 30154	0.5 (2 yr)	19634.96	62.99	89.65		89.85	0.001411	3.45	5437.75	357.96	0.13	1.72		1.01	1.30
Rio Manati	1	30282.54 30154	0.2 (5 yr)	43754.87	62.99	98.11		98.51	0.001816	4.58	8749.36	425.37	0.15	2.91		1.86	2.26
Rio Manati	1	30282.54 30154	0.1 (10 yr)	68333.88	62.99	104.72		105.27	0.001998	5.27	11603.64	446.36	0.16	3.75	0.01	2.78	3.10
Rio Manati	1	30282.54 30154	0.04 (25 yr)	118304.10	62.99	114.79		115.62	0.002202	6.42	16830.59	540.24	0.18	5.26	1.09	4.23	4.06
Rio Manati	1	30282.54 30154	0.02 (50 yr)	155702.40	62.99	122.68		123.60	0.001993	6.87	21162.57	558.53	0.17	5.67	1.73	4.60	4.43
Rio Manati	1	30282.54 30154	0.01 (100 yr)	211075.80	62.99	128.52		129.80	0.002419	8.16	24468.53	573.59	0.19	7.70	2.70	6.24	6.02
Rio Manati	1	30282.54 30154	0.005 (200 yr)	280504.40	62.99	135.70		137.36	0.002718	9.39	28651.12	592.81	0.21	9.78	3.69	7.93	7.61
Rio Manati	1	30282.54 30154	0.002 (500 yr)	399338.30	62.99	146.15		148.46	0.003145	11.20	35238.20	660.14	0.23	13.23	4.20	10.73	9.52
Rio Manati	1	29965.48 29830	0.5 (2 yr)	19634.96	70.47	85.48	80.34	86.33	0.012704	7.71	2781.06	280.64	0.41	8.87	5.64	1.82	7.76
Rio Manati	1	29965.48 29830	0.2 (5 yr)	43754.87	70.47	93.46	84.79	94.74	0.008060	9.40	5212.26	339.01	0.38	9.62	6.29	3.15	8.16
Rio Manati	1	29965.48 29830	0.1 (10 yr)	68333.88	70.47	99.83	88.37	101.46	0.006633	10.59	7218.06	422.66	0.37	10.54	7.76	3.59	9.09
Rio Manati	1	29965.48 29830	0.04 (25 yr)	118304.10	70.47	109.02	94.13	111.48	0.006375	13.01	10158.56	511.53	0.39	13.77	11.04	4.58	11.89
Rio Manati	1	29965.48 29830	0.02 (50 yr)	155702.40	70.47	117.30	97.67	119.95	0.005044	13.50	12863.51	581.59	0.36	13.49	11.29	4.24	11.49
Rio Manati	1	29965.48 29830	0.01 (100 yr)	211075.80	70.47	123.01	102.41	125.86	0.004946	14.61	20699.79	759.25	0.37	14.99	5.99	4.42	8.16
Rio Manati	1	29965.48 29830	0.005 (200 yr)	280504.40	70.47	130.34	107.78	133.38	0.004545	15.46	26407.46	798.74	0.36	15.84	7.26	4.60	9.08
Rio Manati	1	29965.48 29830	0.002 (500 yr)	399338.30	70.47	140.55	119.70	144.19	0.004562	17.42	35267.42	966.99	0.38	18.79	8.18	5.58	10.03
Rio Manati	1	29939.95 29805		Bridge													
Rio Manati	1	29914.84 29779	0.5 (2 yr)	19634.96	65.13	84.41	76.37	85.25	0.007617	7.57	2864.72	213.98	0.33	7.29	3.47	0.33	6.09
Rio Manati	1	29914.84 29779	0.2 (5 yr)	43754.87	65.13	91.52	81.96	93.26	0.010137	11.15	4558.87	260.20	0.41	14.00	6.51	2.02	10.56
Rio Manati	1	29914.84 29779	0.1 (10 yr)	68333.88	65.13	97.33	86.25	99.83	0.011102	13.54	6304.61	366.51	0.44	19.17	6.87	3.76	11.91
Rio Manati	1	29914.84 29779	0.04 (25 yr)	118304.10	65.13	106.72	93.95	109.82	0.010241	15.69	9646.87	411.56	0.45	23.42	12.23	5.74	16.20
Rio Manati	1	29914.84 29779	0.02 (50 yr)	155702.40	65.13	112.57	99.88	116.09	0.009896	16.95	11777.39	440.71	0.45	26.08	15.38	6.89	18.69
Rio Manati	1	29914.84 29779	0.01 (100 yr)	211075.80	65.13	119.68	104.57	123.89	0.010258	19.06	16018.58	663.50	0.47	31.39	10.14	8.88	14.83
Rio Manati	1	29914.84 29779	0.005 (200 yr)	280504.40	65.13	127.39	109.71	132.17	0.010290	20.96	21924.70	895.37	0.48	36.22	12.01	6.06	15.19
Rio Manati	1	29914.84 29779	0.002 (500 yr)	399338.30	65.13	139.68	117.35	143.41	0.007218	19.91	34175.96	1075.21	0.42	30.69	12.03	7.09	13.70

Alternative 4 (Channelization) Results Table for XS in Project Area

HEC-RAS Plan: Alt 2 Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	34233.57 34069	0.5 (2 yr)	18434.26	111.45	129.87	121.19	130.40	0.004234	5.84	3159.66	238.79	0.28	3.47	0.29		3.36
Rio Manati	1	34233.57 34069	0.2 (5 yr)	40682.50	111.45	134.98	125.88	136.30	0.007662	9.14	4432.33	257.10	0.38	8.39	1.93		7.86
Rio Manati	1	34233.57 34069	0.1 (10 yr)	63177.94	111.45	143.25	129.56	144.73	0.005429	9.22	6658.14	281.86	0.32	8.34	2.79	0.24	7.53
Rio Manati	1	34233.57 34069	0.04 (25 yr)	108910.40	111.45	150.25	135.35	152.02	0.005200	10.59	10268.61	652.51	0.33	10.14	1.74	1.18	4.93
Rio Manati	1	34233.57 34069	0.02 (50 yr)	142989.10	111.45	154.72	138.83	156.72	0.003730	9.76	13216.11	667.91	0.28	8.26	2.22	1.31	4.43
Rio Manati	1	34233.57 34069	0.01 (100 yr)	193489.10	111.45	159.10	148.32	161.75	0.003331	9.93	16233.45	703.41	0.27	8.24	2.72	1.55	4.61
Rio Manati	1	34233.57 34069	0.005 (200 yr)	256702.30	111.45	164.43	150.84	167.77	0.002748	9.77	20204.71	778.74	0.25	7.66	3.04	1.02	4.27
Rio Manati	1	34233.57 34069	0.002 (500 yr)	364800.50	111.45	172.09	155.15	176.45	0.002251	9.78	26821.91	987.66	0.23	7.30	3.43	0.86	3.67
Rio Manati	1	34155.99 33988	0.5 (2 yr)	18504.88	110.89	128.90	119.21	129.39	0.003601	5.66	3288.79	243.00	0.27	3.06		0.48	2.94
Rio Manati	1	34155.99 33988	0.2 (5 yr)	40859.07	110.89	132.85	124.38	134.31	0.007631	9.72	4293.65	266.96	0.40	8.30	0.90	1.68	7.40
Rio Manati	1	34155.99 33988	0.1 (10 yr)	63495.77	110.89	142.02	128.07	143.47	0.004471	9.80	7052.78	382.40	0.33	7.35	0.87	2.32	4.99
Rio Manati	1	34155.99 33988	0.04 (25 yr)	109440.10	110.89	148.09	134.04	150.46	0.005839	12.81	9629.58	492.53	0.39	11.74	2.30	3.24	6.92
Rio Manati	1	34155.99 33988	0.02 (50 yr)	143730.70	110.89	153.28	137.81	155.59	0.004862	12.88	12786.30	674.76	0.37	11.31	2.68	2.44	5.61
Rio Manati	1	34155.99 33988	0.01 (100 yr)	194477.90	110.89	158.26	145.46	160.76	0.004347	13.21	16235.39	710.22	0.35	11.42	3.42	3.36	6.04
Rio Manati	1	34155.99 33988	0.005 (200 yr)	258044.30	110.89	163.96	152.41	166.74	0.003649	13.14	20366.38	739.04	0.33	10.85	3.89	3.92	6.09
Rio Manati	1	34155.99 33988	0.002 (500 yr)	366742.80	110.89	171.98	157.02	175.35	0.002954	13.08	26727.68	899.53	0.31	10.21	3.27	4.35	5.32
Rio Manati	1	34135.98 33968		Bridge													
Rio Manati	1	34115.96 33947	0.5 (2 yr)	18504.88	110.66	123.42	118.60	124.30	0.002434	7.45	2471.15	256.03	0.42	1.48	0.01	0.48	1.43
Rio Manati	1	34115.96 33947	0.2 (5 yr)	40859.07	110.66	129.54	122.98	131.09	0.002256	9.87	4128.97	289.76	0.43	2.21	0.37	0.63	1.94
Rio Manati	1	34115.96 33947	0.1 (10 yr)	63495.77	110.66	134.18	126.86	136.38	0.002128	11.36	5512.31	304.74	0.44	2.69	0.62	0.99	2.30
Rio Manati	1	34115.96 33947	0.04 (25 yr)	109440.10	110.66	141.45	131.56	144.90	0.002027	13.55	7987.78	429.61	0.45	3.47	0.41	1.51	2.26
Rio Manati	1	34115.96 33947	0.02 (50 yr)	143730.70	110.66	147.09	134.95	150.13	0.001619	13.69	11014.27	589.36	0.42	3.33	0.68	0.95	1.83
Rio Manati	1	34115.96 33947	0.01 (100 yr)	194477.90	110.66	151.74	139.83	155.37	0.001513	14.43	13828.57	619.73	0.41	3.54	0.99	1.21	2.04
Rio Manati	1	34115.96 33947	0.005 (200 yr)	258044.30	110.66	159.31	146.72	162.89	0.001059	13.62	18697.53	666.72	0.35	2.97	1.08	1.20	1.79
Rio Manati	1	34115.96 33947	0.002 (500 yr)	366742.80	110.66	170.41	152.49	173.73	0.000687	12.67	27426.63	841.95	0.30	2.39	0.91	0.98	1.35
Rio Manati	1	33860.74 33690	0.5 (2 yr)	18504.88	105.45	117.45	116.66	120.25	0.008660	13.98	1630.84	239.14	0.81	4.90	2.02		3.59
Rio Manati	1	33860.74 33690	0.2 (5 yr)	40859.07	105.45	123.68	121.77	127.31	0.007594	16.59	3279.94	278.52	0.76	6.81	3.94		5.35
Rio Manati	1	33860.74 33690	0.1 (10 yr)	63495.77	105.45	128.26	125.70	132.66	0.007858	18.62	4665.59	317.55	0.75	8.86	5.29		6.89
Rio Manati	1	33860.74 33690	0.04 (25 yr)	109440.10	105.45	135.72	131.51	141.35	0.007421	21.61	7303.48	427.20	0.74	11.40	5.70	0.70	7.57
Rio Manati	1	33860.74 33690	0.02 (50 yr)	143730.70	105.45	144.20	134.84	147.96	0.003780	18.60	11989.01	641.67	0.56	7.69	3.62	1.01	4.54
Rio Manati	1	33860.74 33690	0.01 (100 yr)	194477.90	105.45	149.51	142.52	153.46	0.003487	19.64	15303.80	770.95	0.55	8.18	4.26	1.22	5.05
Rio Manati	1	33860.74 33690	0.005 (200 yr)	258044.30	105.45	158.14	146.50	161.54	0.002443	18.73	21222.50	869.93	0.47	6.97	3.97	0.98	4.25
Rio Manati	1	33860.74 33690	0.002 (500 yr)	366742.80	105.45	169.55	151.84	172.86	0.001869	18.85	29854.52	930.47	0.43	6.58	4.21	1.40	4.21
Rio Manati	1	33704.47 33532	0.5 (2 yr)	18504.88	103.22	115.44	112.48	117.35	0.003426	11.09	1668.16	172.87	0.63	2.02			2.02
Rio Manati	1	33704.47 33532	0.2 (5 yr)	40859.07	103.22	121.50	118.03	124.74	0.003344	14.49	3035.43	295.12	0.67	2.99	0.50	0.33	2.10
Rio Manati	1	33704.47 33532	0.1 (10 yr)	63495.77	103.22	125.86	122.27	130.21	0.003248	16.98	4489.05	373.33	0.69	3.77	0.94	0.88	2.37
Rio Manati	1	33704.47 33532	0.04 (25 yr)	109440.10	103.22	133.63	128.91	139.18	0.002769	19.69	7794.25	454.54	0.67	4.52	1.76	1.48	2.88
Rio Manati	1	33704.47 33532	0.02 (50 yr)	143730.70	103.22	141.73	133.06	146.59	0.001791	18.88	11618.91	498.62	0.56	3.81	1.92	1.23	2.52
Rio Manati	1	33704.47 33532	0.01 (100 yr)	194477.90	103.22	144.12	137.80	151.63	0.002564	23.61	12821.13	508.39	0.68	5.83	3.07	1.99	3.89
Rio Manati	1	33704.47 33532	0.005 (200 yr)	258044.30	103.22	151.47	143.14	159.86	0.002322	25.32	16684.41	543.33	0.67	6.31	3.62	2.33	4.28
Rio Manati	1	33704.47 33532	0.002 (500 yr)	366742.80	103.22	160.55	150.84	171.11	0.002356	28.86	21864.05	591.23	0.69	7.71	4.67	2.98	5.21
Rio Manati	1	33597.73 33414	0.5 (2 yr)	18504.88	102.69	111.95	111.95	115.76	0.004745	15.65	1182.55	155.24	1.00	2.21			2.21
Rio Manati	1	33597.73 33414	0.2 (5 yr)	40859.07	102.69	117.50	117.50	123.19	0.004205	19.13	2135.88	188.30	1.00	2.90			2.90
Rio Manati	1	33597.73 33414	0.1 (10 yr)	63495.77	102.69	122.33	121.68	128.88	0.003072	20.62	3364.89	295.99	0.91	3.00	0.57	0.37	2.13
Rio Manati	1	33597.73 33414	0.04 (25 yr)	109440.10	102.69	131.09	128.95	138.22	0.001956	21.99	7026.66	489.40	0.78	2.96	0.94	0.69	1.71
Rio Manati	1	33597.73 33414	0.02 (50 yr)	143730.70	102.69	140.71	132.79	146.08	0.001008	19.64	11899.65	531.12	0.59	2.11	1.00	0.61	1.36
Rio Manati	1	33597.73 33414	0.01 (100 yr)	194477.90	102.69	141.29	137.44	150.72	0.001735	26.05	12207.14	532.90	0.78	3.70	1.77	1.07	2.40
Rio Manati	1	33597.73 33414	0.005 (200 yr)	258044.30	102.69	149.05	143.14	159.07	0.001461	27.32	16493.83	574.45	0.74	3.80	2.09	1.00	2.52
Rio Manati	1	33597.73 33414	0.002 (500 yr)	366742.80	102.69	157.24	151.11	170.21	0.001543	31.56	21372.58	620.57	0.78	4.79	2.94	1.32	3.25
Rio Manati	1	33357.12 33176	0.5 (2 yr)	18504.88	99.08	110.32	108.34	112.68	0.002368	12.32	1501.65	168.63	0.72	1.30	0.02		1.29
Rio Manati	1	33357.12 33176	0.2 (5 yr)	40859.07	99.08	116.76	114.01	120.28	0.001959	15.10	3165.39	337.71	0.71	1.68	0.38	0.11	1.10
Rio Manati	1	33357.12 33176	0.1 (10 yr)	63495.77	99.08	122.47	117.97	126.52	0.001463	16.37	5658.11	503.96	0.65	1.76	0.53	0.27	0.98
Rio Manati	1	33357.12 33176	0.04 (25 yr)	109440.10	99.08	131.33	124.65	136.43	0.001174	18.76	10310.38	542.97	0.62	2.05	0.98	0.44	1.33
Rio Manati	1	33357.12 33176	0.02 (50 yr)	143730.70	99.08	140.57	128.56	145.17	0.000752	18.08	15559.28	619.53	0.52	1.73	0.90	0.43	1.12
Rio Manati	1	33357.12 33176	0.01 (100 yr)	194477.90	99.08	140.94	133.68	149.17	0.001327	24.18	15792.04	621.90	0.69	3.09	1.61	0.78	2.00
Rio Manati	1	33357.12 33176	0.005 (200 yr)	258044.30	99.08	148.98	140.19	157.67	0.001135	25.39	21759.29	1071.47	0.66	3.20	1.13	0.65	1.48
Rio Manati	1	33357.12 33176	0.002 (500 yr)	366742.80	99.08	158.19	150.22	168.35	0.001106	28.29	31861.91	1226.20	0.67	3.74	1.54	0.88	1.83
Rio Manati	1	33200.01 33011	0.5 (2 yr)	18504.88	97.44	109.41	106.71	111.43	0.001888	11.39	1624.02	171.35	0.65	1.09			1.09
Rio Manati	1	33200.01 33011	0.2 (5 yr)	40859.07	97.44	116.09	112.26	119.15	0.001564	14.11	3047.74	272.55	0.64	1.44	0.22	0.13	1.07
Rio Manati	1	33200.01 33011	0.1 (10 yr)	63495.77	97.44	122.27	116.68	125.45	0.001078	14.72	5062.02	356.08	0.56	1.39	0.42	0.24	0.93
Rio Manati	1	33200.01 33011	0.04 (25 yr)	109440.10	97.44	131.61	123.33	135.19	0.000803	16.20	8573.24	404.01	0.52	1.49	0.69	0.31	1.03
Rio Manati	1	33200.01 33011	0.02 (50 yr)	143730.70	97.44	141.14	126.85	144.02	0.000478	14.97	13175.07	680.21	0.42	1.17	0.52	0.31	0.72
Rio Manati	1	33200.01 33011	0.01 (100 yr)	194477.90	97.44	142.11	131.28	147.02	0.000794	19.60	13689.32	694.92	0.54	1.98	0.91	0.53	1.24
Rio Manati	1	33200.01 33011	0.005 (200 yr)	258044.30	97.44	150.96	137.59	154.97	0.000557	18.70	21893.68	1035.52	0.47	1.69	0.58	0.29	0.72
Rio Manati	1	33200.01 33011	0.002 (500 yr)	366742.80	97.44	161.13	145.41	164.81	0.000441	18.83	33247.11	1170.86	0.43	1.61	0.68	0.42	0.76
Rio Manati	1	33176.74 32988		Bridge													
Rio Manati	1	33153.54 32965	0.5 (2 yr)	18504.88	97.44	108.80	106.70	111.10	0.000822	12.17	1520.33	167.70	0.71	0.46			0.46
Rio Manati	1	33153.54 32965	0.2 (5 yr)	40859.07	97.44	115.30	112.27	118.79	0.000686	15.01	2814.96	263.34	0.70	0.60	0.06	0.05	0.45
Rio Manati	1	33153.54 32965	0.1 (10 yr)	63495.77	97.44	121.15	116.52	124.99	0.000493	16.00	4910.95	452.78	0.63	0.60	0.13	0.11	0.33
Rio Manati	1	33153.54 32965	0.04 (25 yr)	109440.10	97.44	130.04	123.78	134.26	0.000362	17.51	9365.07	565.12	0.57	0.64	0.25	0.25	0.39
Rio Manati	1	33153.54 32965	0.02 (50 yr)	143730.70	97.44	134.33	127.47	139.20	0.000361	19.17	11683.43	613.18	0.59	0.73	0.34	0.34	0.48
Rio Manati	1	33153.54 32965	0.01 (100 yr)	194477.90	97.44	140.50	132.29	146.00	0.000340	20.83	15010.10	666.88	0.58	0.82	0.45	0.45	0.58
Rio Manati	1	33153.54 32965	0.005 (200 yr)	258044.30	97.44	148.03	136.96	153.67	0.000294	21.75	21339.11	803.33	0.56	0.84	0.37	0.32	0.48
Rio Manati	1	33153.54 32965	0.002 (500 yr)	366742.80	97.44	158.36	143.89	164.53	0.000264	23.53	30787.26	1137.94	0.55	0.92	0.43	0.17	0.44
Rio Manati	1	32988.5*	0.5 (2 yr)	18504.88	97.08	108.09	106.33	110.58	0.000919	12.65	1462.95	165.65	0.75	0.50			0.50
Rio Manati	1	32988.5*	0.2 (5 yr)	40859.07	97.08	114.79	111.87	118.38	0.000712	15.20	2745.02	233.21	0.71	0.61	0.06	0.06	0.51
Rio Manati	1	32988.5*	0.1 (10 yr)	63495.77	97.08	119.97	115.81	124.49	0.000598	17.14	4281.67	432.43	0.69	0.70	0.08	0.16	0.36
Rio Manati	1	32988.5*	0.04 (25 yr)	109440.10	97.08	129.77	123.97	134.04	0.000364	17.57	10868.40	861.90	0.57	0.64	0.18	0.20	0.28
Rio Manati	1	32988.5*	0.02 (50 yr)	143730.70	97.08	134.28	128.32	138.85	0.000341	18.74	14922.91	959.17	0.57	0.70	0.24	0.22	0.33
Rio Manati	1	32988.5*	0.01 (100 yr)	194477.90	97.08	140.79		145.34	0.000292	19.50	22036.56	1313.92	0.54	0.71	0.27	0.14	0.30
Rio Manati	1	32988.5*	0.005 (200 yr)	258044.30	97.08	148.55		152.85	0.000237	19.78	32740.36	1439.72	0.50	0.69	0.32	0.19	0.33
Rio Manati	1	32988.5*	0.002 (500 yr)	366742.80	97.08	159.13		163.49	0.000202	20.87	49743.06	1772.19	0.48	0.72	0.35	0.22	0.35
Rio Manati	1	32918.20 32728	0.5 (2 yr)	19634.96	96.62	106.22	106.22	110.15	0.001692	15.89	1235.40	157.26	1.00	0.81			0.81
Rio Manati	1	32918.20 32728	0.2 (5 yr)	43754.87	96.62	112.02	112.02	117.91	0.001486	19.48	2247.33	199.14	1.00	1.07	0.01	0.01	1.02
Rio Manati	1	32918.20 32728	0.1 (10 yr)	68333.88	96.62	116.21	116.21	123.97	0.001308	22.38	3255.52	263.03	0.99	1.28	0.18	0.27	0.99
Rio Manati	1	32918.20 32728	0.04 (25 yr)	118304.10	96.62	125.13	125.13	133.51	0.000819	23.79	7608.93	895.23	0.84	1.24	0.23	0.42	0.51
Rio Manati	1	32918.20 32728	0.02 (50 yr)	155702.40	96.62	129.23	129.23	138.28	0.000763	25.42	10872.26	1085.68	0.83	1.35	0.39	0.39	0.61
Rio Manati	1	32918.20 32728	0.01 (100 yr)	211075.80	96.62	138.30	134.12	145.04	0.000444	23.25	19640.82	1481.16	0.66	1.03	0.48	0.31	0.53
Rio Manati	1	32918.20 32728	0.005 (200 yr)	280504.40	96.62	146.07	138.66	152.56	0.000360	23.67	27892.46	1628.17	0.62	1.00	0.56	0.33	0.55
Rio Manati	1	32918.20 32728	0.002 (500 yr)	399338.30	96.62	158.88	145.18	163.42	0.000218	21.74	59111.69	1934.81	0.50	0.78	0.39	0.33	0.41
Rio Manati	1	32740.16 32548	0.5 (2 yr)	19634.96	95.54	104.85	105.14	109.08	0.001885	16.49	1190.74	155.56	1.05	0.88			0.88
Rio Manati	1	32740.16 32548	0.2 (5 yr)	43754.87	95.54	110.24	110.94	116.89	0.001785	20.69	2114.77	187.63	1.09	1.22			1.22
Rio Manati	1	32740.16 32548	0.1 (10 yr)	68333.88	95.54	113.93	115.25	122.97	0.001693	24.17	3103.35	322.40	1.11	1.53	0.24	0.17	1.00
Rio Manati	1	32740.16 32548	0.04 (25 yr)	118304.10	95.54	120.78	123.14	132.56	0.001361	27.93	6486.19	892.38	1.06	1.79	0.33	0.31	0.68
Rio Manati	1	32740.16 32548	0.02 (50 yr)	155702.40	95.54	126.10	127.28	137.52	0.001032	28.15	11219.67	1220.47	0.96	1.70	0.56	0.40	0.75
Rio Manati	1	32740.16 32548	0.01 (100 yr)	211075.80	95.54	132.30	132.30	144.17	0.000858	29.45	17513.48	1333.56	0.90	1.73	0.78	0.52	0.87
Rio Manati	1	32740.16 32548	0.005 (200 yr)	280504.40	95.54	138.21	138.21	151.56	0.000807	31.87	25218.74	1706.30	0.90	1.92	1.01	0.48	0.87
Rio Manati	1	32740.16 32548	0.002 (500 yr)	399338.30	95.54	145.93	145.93	162.03	0.000807	35.94	36976.41	1887.76	0.93	2.30	1.35	0.74	1.14
Rio Manati	1	32455.27 32258	0.5 (2 yr)	19634.96	85.63	91.35	95.23	104.70	0.010441	29.30	670.03	134.15	2.31	3.21			3.21
Rio Manati	1	32455.27 32258	0.2 (5 yr)	43754.87	85.63	95.75	101.02	112.90	0.006973	33.22	1317.00	160.32	2.04	3.50			3.50
Rio Manati	1	32455.27 32258	0.1 (10 yr)	68333.88	85.63	99.19	105.17	119.20	0.005869	35.88	1904.59	180.84	1.95	3.77			3.77
Rio Manati	1	32455.27 32258	0.04 (25 yr)	118304.10	85.63	104.91	112.20	129.24	0.004201	39.59	3084.38	241.02	1.76	4.02	0.69	0.51	3.39
Rio Manati	1	32455.27 32258	0.02 (50 yr)	155702.40	85.63	109.41	116.93	134.59	0.003121	40.36	4187.72	285.03	1.58	3.84	1.38	0.75	3.04
Rio Manati	1	32455.27 32258	0.01 (100 yr)	211075.80	85.63	125.31	124.78	138.28	0.000769	29.50	13061.46	1483.41	0.87	1.69	1.10	0.23	0.44
Rio Manati	1	32455.27 32258	0.005 (200 yr)	280504.40	85.63	134.72	131.90	146.19	0.000539	28.81	27130.85	1691.80	0.75	1.49	1.08	0.43	0.57
Rio Manati	1	32455.27 32258	0.002 (500 yr)	399338.30	85.63	147.88	140.27	158.43	0.000388	28.96	49324.48	1906.30	0.67	1.38	0.60	0.59	0.68
Rio Manati	1	32325.2*	0.5 (2 yr)	19634.96	84.91	91.97	94.50	100.17	0.005023	22.97	854.76	142.11	1.65	1.86			1.86
Rio Manati	1	32325.2*	0.2 (5 yr)	43754.87	84.91	96.20	100.25	109.25	0.004689	28.98	1509.94	167.33	1.70	2.58			2.58
Rio Manati	1	32325.2*	0.1 (10 yr)	68333.88	84.91	99.55	104.41	115.96	0.004425	32.49	2102.94	187.26	1.71	3.03			3.03
Rio Manati	1	32325.2*	0.04 (25 yr)	118304.10	84.91	105.08	111.58	126.84	0.003492	37.45	3304.20	248.38	1.62	3.53	0.63	0.45	2.83
Rio Manati	1	32325.2*	0.02 (50 yr)	155702.40	84.91	120.28	116.25	129.96	0.000666	25.23	8813.75	821.44	0.79	1.29	0.47	0.14	0.44

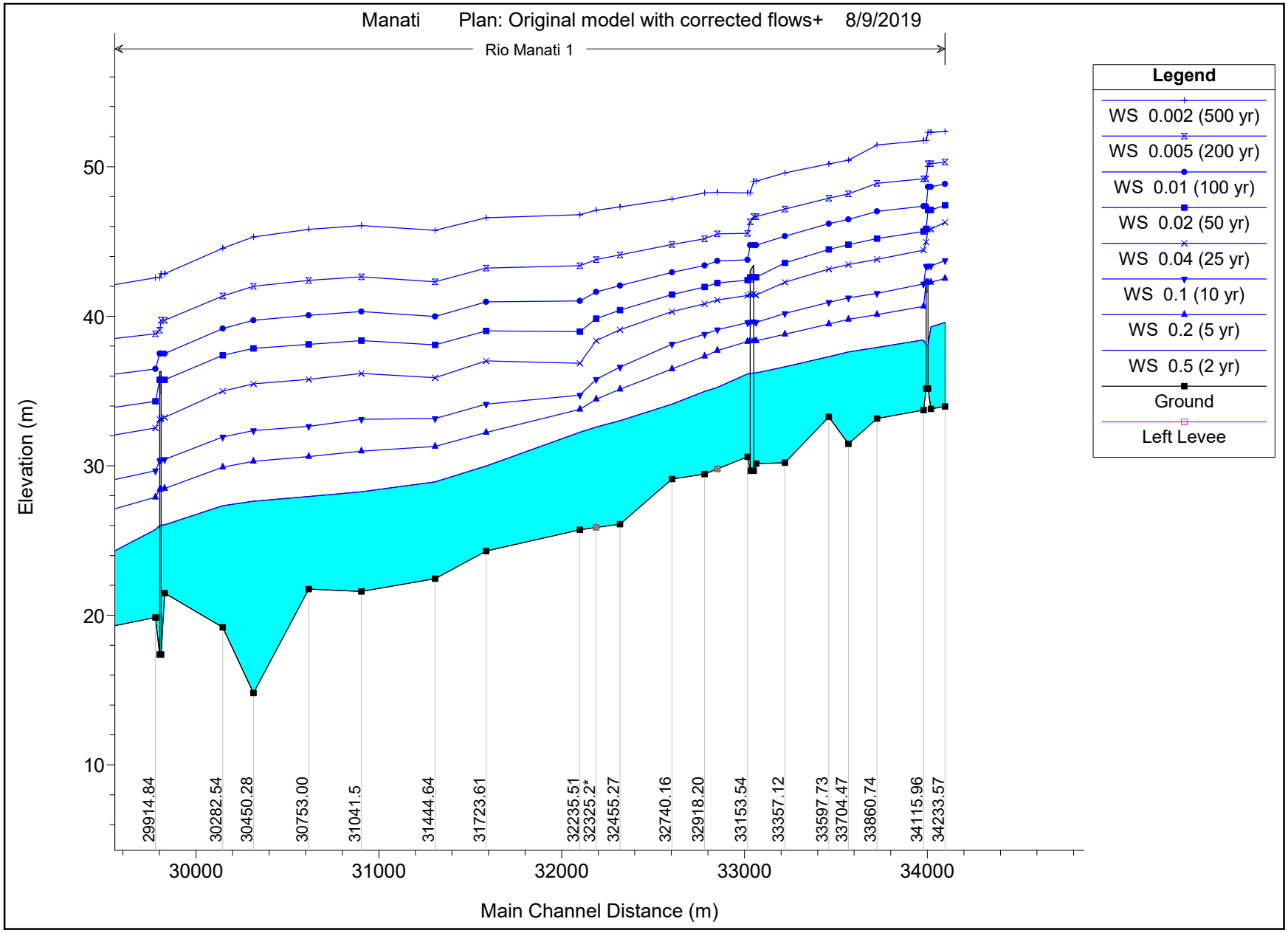
Alternative 4 (Channelization) Results Table for XS in Project Area

HEC-RAS Plan: Alt 2 Locations: User Defined (Continued)

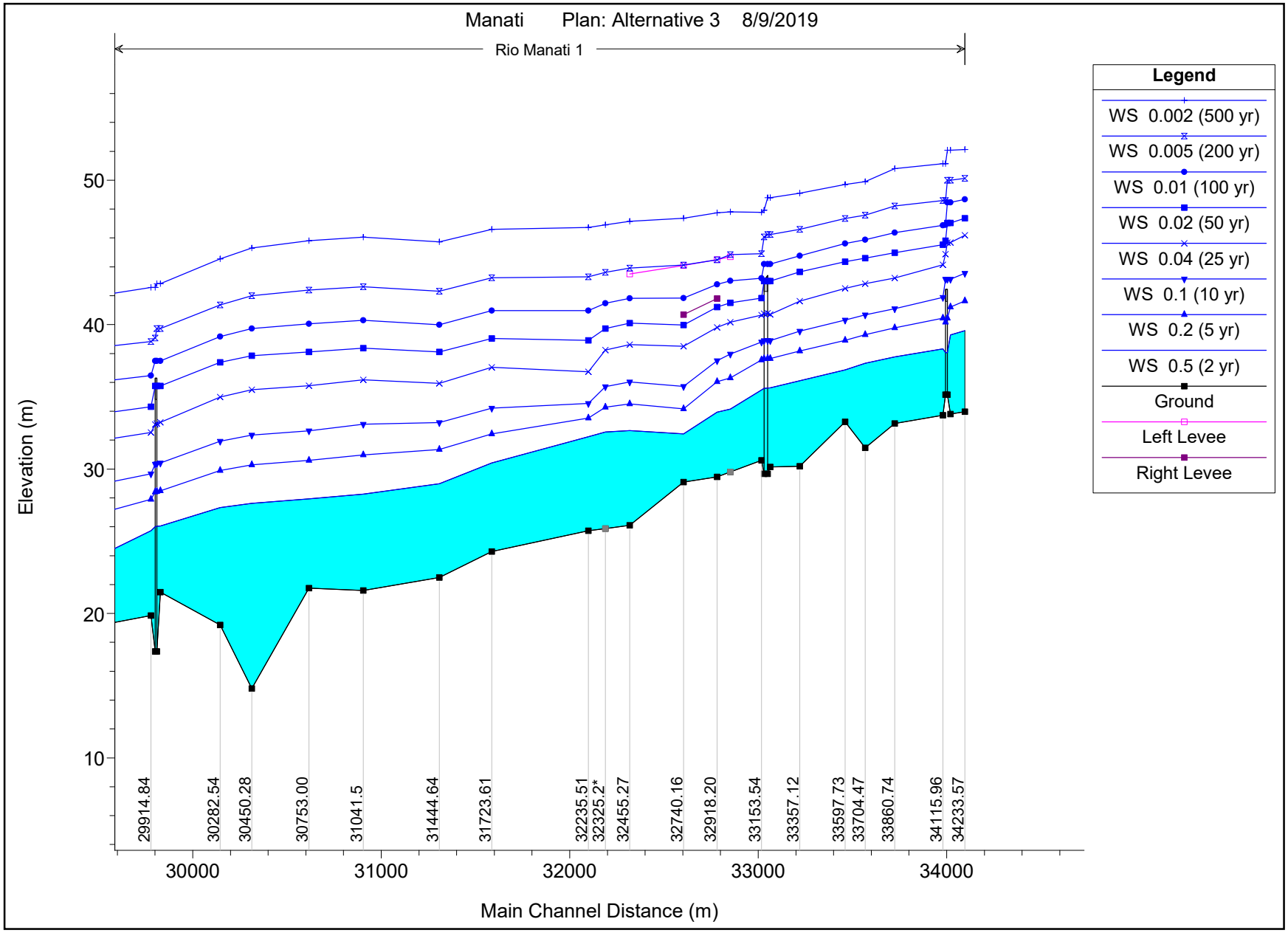
River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan	Shear LOB	Shear ROB	Shear Total
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Rio Manati	1	32325.2*	0.01 (100 yr)	211075.80	84.91	125.69	123.63	137.69	0.000688	28.47	14803.88	1453.07	0.82	1.56	0.53	0.24	0.43
Rio Manati	1	32325.2*	0.005 (200 yr)	280504.40	84.91	134.56	131.13	145.96	0.000524	28.65	29229.17	1690.51	0.74	1.47	0.56	0.43	0.56
Rio Manati	1	32325.2*	0.002 (500 yr)	399338.30	84.91	147.04	139.62	158.22	0.000405	29.54	50935.02	1777.65	0.68	1.44	0.59	0.63	0.72
Rio Manati	1	32235.51 32029	0.5 (2 yr)	19634.96	84.38	92.62	93.98	98.31	0.002921	19.14	1025.92	149.11	1.29	1.23			1.23
Rio Manati	1	32235.51 32029	0.2 (5 yr)	43754.87	84.38	96.53	99.77	107.39	0.003600	26.44	1654.84	172.42	1.50	2.11			2.11
Rio Manati	1	32235.51 32029	0.1 (10 yr)	68333.88	84.38	99.77	103.90	114.18	0.003636	30.45	2244.16	192.32	1.56	2.61	0.03	0.03	2.58
Rio Manati	1	32235.51 32029	0.04 (25 yr)	118304.10	84.38	105.15	111.02	125.44	0.003105	36.16	3403.18	242.77	1.54	3.25	0.53	0.46	2.65
Rio Manati	1	32235.51 32029	0.02 (50 yr)	155702.40	84.38	120.23	115.68	129.71	0.000637	24.92	9207.89	872.45	0.77	1.25	0.43	0.15	0.41
Rio Manati	1	32235.51 32029	0.01 (100 yr)	211075.80	84.38	125.69	123.39	137.41	0.000658	28.11	15425.03	1423.97	0.81	1.51	0.56	0.25	0.44
Rio Manati	1	32235.51 32029	0.005 (200 yr)	280504.40	84.38	133.77	130.57	145.75	0.000548	29.18	27759.42	1633.33	0.76	1.53	0.62	0.43	0.57
Rio Manati	1	32235.51 32029	0.002 (500 yr)	399338.30	84.38	145.84	139.58	158.00	0.000438	30.51	48491.05	1892.60	0.71	1.54	0.68	0.65	0.75
Rio Manati	1	31723.61 31578	0.5 (2 yr)	19634.96	79.69	88.11	89.29	93.51	0.002698	18.63	1053.90	150.23	1.24	1.16			1.16
Rio Manati	1	31723.61 31578	0.2 (5 yr)	43754.87	79.69	97.95	95.08	101.77	0.000721	15.68	2816.94	207.35	0.72	0.64	0.07	0.04	0.59
Rio Manati	1	31723.61 31578	0.1 (10 yr)	68333.88	79.69	105.17	99.63	108.57	0.000403	15.31	7087.25	790.65	0.58	0.54	0.12	0.07	0.22
Rio Manati	1	31723.61 31578	0.04 (25 yr)	118304.10	79.69	116.42	107.23	119.29	0.000226	15.11	16507.58	887.45	0.46	0.46	0.21	0.08	0.26
Rio Manati	1	31723.61 31578	0.02 (50 yr)	155702.40	79.69	124.64	110.65	127.21	0.000162	14.81	23910.41	910.52	0.41	0.41	0.22	0.08	0.26
Rio Manati	1	31723.61 31578	0.01 (100 yr)	211075.80	79.69	131.30	115.05	134.39	0.000165	16.56	30065.00	938.62	0.42	0.48	0.29	0.08	0.32
Rio Manati	1	31723.61 31578	0.005 (200 yr)	280504.40	79.69	139.27	119.67	142.82	0.000161	18.11	37859.94	1050.46	0.43	0.55	0.36	0.07	0.36
Rio Manati	1	31723.61 31578	0.002 (500 yr)	399338.30	79.69	150.99	126.42	155.30	0.000158	20.36	50347.18	1228.24	0.44	0.65	0.47	0.13	0.44
Rio Manati	1	31444.64 31314	0.5 (2 yr)	19634.96	73.62	90.70	83.22	91.61	0.000192	7.65	2574.25	198.22	0.37	0.16	0.01	0.01	0.15
Rio Manati	1	31444.64 31314	0.2 (5 yr)	43754.87	73.62	99.20	89.01	100.81	0.000181	10.29	4618.00	274.24	0.39	0.24	0.06	0.04	0.18
Rio Manati	1	31444.64 31314	0.1 (10 yr)	68333.88	73.62	105.79	93.16	107.97	0.000176	12.08	6476.04	290.22	0.40	0.31	0.11	0.06	0.23
Rio Manati	1	31444.64 31314	0.04 (25 yr)	118304.10	73.62	115.71	100.53	119.06	0.000186	15.13	9575.47	377.77	0.43	0.43	0.13	0.10	0.28
Rio Manati	1	31444.64 31314	0.02 (50 yr)	155702.40	73.62	123.05	104.84	126.93	0.000174	16.44	12884.66	494.39	0.43	0.48	0.14	0.12	0.27
Rio Manati	1	31444.64 31314	0.01 (100 yr)	211075.80	73.62	128.52	110.46	133.99	0.000213	19.65	15871.95	587.34	0.48	0.67	0.20	0.17	0.34
Rio Manati	1	31444.64 31314	0.005 (200 yr)	280504.40	73.62	135.06	117.08	142.28	0.000244	22.78	19868.12	702.21	0.53	0.86	0.26	0.22	0.41
Rio Manati	1	31444.64 31314	0.002 (500 yr)	399338.30	73.62	144.47	127.11	154.54	0.000286	27.22	27230.50	1082.86	0.59	1.17	0.42	0.31	0.58
Rio Manati	1	31041.5 30915	0.5 (2 yr)	19634.96	70.83	90.73	80.43	91.34	0.000101	6.31	3342.50	261.61	0.28	0.10	0.02	0.01	0.08
Rio Manati	1	31041.5 30915	0.2 (5 yr)	43754.87	70.83	99.34	86.22	100.49	0.000112	8.79	6748.47	516.49	0.31	0.17	0.07	0.04	0.09
Rio Manati	1	31041.5 30915	0.1 (10 yr)	68333.88	70.83	106.12	90.44	107.58	0.000110	10.21	11073.00	780.85	0.32	0.21	0.08	0.05	0.10
Rio Manati	1	31041.5 30915	0.04 (25 yr)	118304.10	70.83	116.81	98.31	118.36	0.000091	11.33	22017.32	1095.17	0.31	0.24	0.10	0.08	0.11
Rio Manati	1	31041.5 30915	0.02 (50 yr)	155702.40	70.83	124.65	102.86	126.06	0.000073	11.31	30776.94	1131.03	0.28	0.22	0.10	0.10	0.12
Rio Manati	1	31041.5 30915	0.01 (100 yr)	211075.80	70.83	131.03	110.76	132.71	0.000079	12.72	38050.36	1150.83	0.30	0.27	0.13	0.14	0.16
Rio Manati	1	31041.5 30915	0.005 (200 yr)	280504.40	70.83	138.62	115.09	140.55	0.000080	14.00	47188.57	1240.48	0.31	0.31	0.12	0.17	0.19
Rio Manati	1	31041.5 30915	0.002 (500 yr)	399338.30	70.83	149.74	121.03	152.05	0.000083	15.80	61224.65	1286.46	0.32	0.38	0.17	0.23	0.24
Rio Manati	1	30753.00 30623	0.5 (2 yr)	19634.96	71.39	90.56		91.23	0.000118	6.61	3098.33	240.30	0.30	0.11	0.02	0.01	0.09
Rio Manati	1	30753.00 30623	0.2 (5 yr)	43754.87	71.39	99.01		100.35	0.000134	9.40	5261.61	262.22	0.34	0.20	0.07	0.07	0.16
Rio Manati	1	30753.00 30623	0.1 (10 yr)	68333.88	71.39	105.43		107.41	0.000146	11.46	7027.34	294.94	0.37	0.27	0.09	0.09	0.20
Rio Manati	1	30753.00 30623	0.04 (25 yr)	118304.10	71.39	115.24		118.13	0.000154	14.21	13039.57	756.29	0.39	0.38	0.14	0.08	0.16
Rio Manati	1	30753.00 30623	0.02 (50 yr)	155702.40	71.39	123.13		125.85	0.000124	14.38	20062.20	910.03	0.37	0.36	0.14	0.11	0.16
Rio Manati	1	30753.00 30623	0.01 (100 yr)	211075.80	71.39	129.15		132.47	0.000137	16.30	25585.40	926.18	0.39	0.45	0.18	0.17	0.23
Rio Manati	1	30753.00 30623	0.005 (200 yr)	280504.40	71.39	136.50		140.28	0.000140	17.94	32435.09	939.47	0.40	0.52	0.21	0.23	0.29
Rio Manati	1	30753.00 30623	0.002 (500 yr)	399338.30	71.39	147.22		151.75	0.000144	20.25	42606.76	956.30	0.42	0.63	0.25	0.33	0.38
Rio Manati	1	30450.28 30327	0.5 (2 yr)	19634.96	48.56	90.62		90.78	0.001900	3.22	6401.35	410.59	0.13	2.21	0.46	0.00	1.67
Rio Manati	1	30450.28 30327	0.2 (5 yr)	43754.87	48.56	99.39		99.70	0.002421	4.63	10391.76	481.65	0.15	4.05	1.46	0.00	2.93
Rio Manati	1	30450.28 30327	0.1 (10 yr)	68333.88	48.56	106.15		106.58	0.002627	5.55	13725.27	509.07	0.16	5.44	2.38	0.00	3.94
Rio Manati	1	30450.28 30327	0.04 (25 yr)	118304.10	48.56	116.42		117.08	0.002936	6.96	19034.27	525.66	0.18	7.84	4.18	0.00	5.80
Rio Manati	1	30450.28 30327	0.02 (50 yr)	155702.40	48.56	124.18		124.95	0.002790	7.53	23164.23	537.78	0.18	8.71	5.01	0.00	6.47
Rio Manati	1	30450.28 30327	0.01 (100 yr)	211075.80	48.56	130.36		131.45	0.003451	9.01	26570.52	566.67	0.21	12.02	6.71	0.00	8.67
Rio Manati	1	30450.28 30327	0.005 (200 yr)	280504.40	48.56	137.79		139.21	0.003883	10.33	30828.20	579.34	0.22	15.21	8.85	0.00	10.95
Rio Manati	1	30450.28 30327	0.002 (500 yr)	399338.30	48.56	148.63		150.61	0.004506	12.30	37268.44	613.24	0.25	20.51	11.88	0.00	14.38
Rio Manati	1	30282.54 30154	0.5 (2 yr)	19634.96	62.99	89.65		89.85	0.001411	3.45	5437.75	357.96	0.13	1.72		1.01	1.30
Rio Manati	1	30282.54 30154	0.2 (5 yr)	43754.87	62.99	98.11		98.51	0.001816	4.58	8749.36	425.37	0.15	2.91		1.86	2.26
Rio Manati	1	30282.54 30154	0.1 (10 yr)	68333.88	62.99	104.72		105.27	0.001998	5.27	11603.64	446.36	0.16	3.75	0.01	2.78	3.10
Rio Manati	1	30282.54 30154	0.04 (25 yr)	118304.10	62.99	114.79		115.62	0.002202	6.42	16830.59	540.24	0.18	5.26	1.09	4.23	4.06
Rio Manati	1	30282.54 30154	0.02 (50 yr)	155702.40	62.99	122.68		123.60	0.001993	6.87	21162.57	558.53	0.17	5.67	1.73	4.60	4.43
Rio Manati	1	30282.54 30154	0.01 (100 yr)	211075.80	62.99	128.52		129.80	0.002419	8.16	24468.53	573.59	0.19	7.70	2.70	6.24	6.02
Rio Manati	1	30282.54 30154	0.005 (200 yr)	280504.40	62.99	135.70		137.36	0.002718	9.39	28651.12	592.81	0.21	9.78	3.69	7.93	7.61
Rio Manati	1	30282.54 30154	0.002 (500 yr)	399338.30	62.99	146.15		148.46	0.003145	11.20	35238.20	660.14	0.23	13.23	4.20	10.73	9.52
Rio Manati	1	29965.48 29830	0.5 (2 yr)	19634.96	70.47	85.48	80.34	86.33	0.012704	7.71	2781.06	280.64	0.41	8.87	5.64	1.82	7.76
Rio Manati	1	29965.48 29830	0.2 (5 yr)	43754.87	70.47	93.46	84.79	94.74	0.008060	9.40	5212.26	339.01	0.38	9.62	6.29	3.15	8.16
Rio Manati	1	29965.48 29830	0.1 (10 yr)	68333.88	70.47	99.83	88.37	101.46	0.006633	10.59	7218.06	422.66	0.37	10.54	7.76	3.59	9.09
Rio Manati	1	29965.48 29830	0.04 (25 yr)	118304.10	70.47	109.02	94.13	111.48	0.006375	13.01	10158.56	511.53	0.39	13.77	11.04	4.58	11.89
Rio Manati	1	29965.48 29830	0.02 (50 yr)	155702.40	70.47	117.30	97.67	119.95	0.005044	13.50	12863.51	581.59	0.36	13.49	11.29	4.24	11.49
Rio Manati	1	29965.48 29830	0.01 (100 yr)	211075.80	70.47	123.01	102.41	125.86	0.004946	14.61	20699.79	759.25	0.37	14.99	5.99	4.42	8.16
Rio Manati	1	29965.48 29830	0.005 (200 yr)	280504.40	70.47	130.34	107.78	133.38	0.004545	15.46	26407.46	798.74	0.36	15.84	7.26	4.60	9.08
Rio Manati	1	29965.48 29830	0.002 (500 yr)	399338.30	70.47	140.55	119.70	144.19	0.004562	17.42	35267.42	966.99	0.38	18.79	8.18	5.58	10.03
Rio Manati	1	29939.95 29805		Bridge													
Rio Manati	1	29914.84 29779	0.5 (2 yr)	19634.96	65.13	84.41	76.37	85.25	0.007617	7.57	2864.72	213.98	0.33	7.29	3.47	0.33	6.09
Rio Manati	1	29914.84 29779	0.2 (5 yr)	43754.87	65.13	91.52	81.96	93.26	0.010137	11.15	4558.87	260.20	0.41	14.00	6.51	2.02	10.56
Rio Manati	1	29914.84 29779	0.1 (10 yr)	68333.88	65.13	97.33	86.25	99.83	0.011102	13.54	6304.61	366.51	0.44	19.17	6.87	3.76	11.91
Rio Manati	1	29914.84 29779	0.04 (25 yr)	118304.10	65.13	106.72	93.95	109.82	0.010241	15.69	9646.87	411.56	0.45	23.42	12.23	5.74	16.20
Rio Manati	1	29914.84 29779	0.02 (50 yr)	155702.40	65.13	112.57	99.88	116.09	0.009896	16.95	11777.39	440.71	0.45	26.08	15.38	6.89	18.69
Rio Manati	1	29914.84 29779	0.01 (100 yr)	211075.80	65.13	119.68	104.57	123.89	0.010258	19.06	16018.58	663.50	0.47	31.39	10.14	8.88	14.83
Rio Manati	1	29914.84 29779	0.005 (200 yr)	280504.40	65.13	127.39	109.71	132.17	0.010290	20.96	21924.70	895.37	0.48	36.22	12.01	6.06	15.19
Rio Manati	1	29914.84 29779	0.002 (500 yr)	399338.30	65.13	139.68	117.35	143.41	0.007218	19.91	34175.96	1075.21	0.42	30.69	12.03	7.09	13.70

HEC-RAS PROFILES

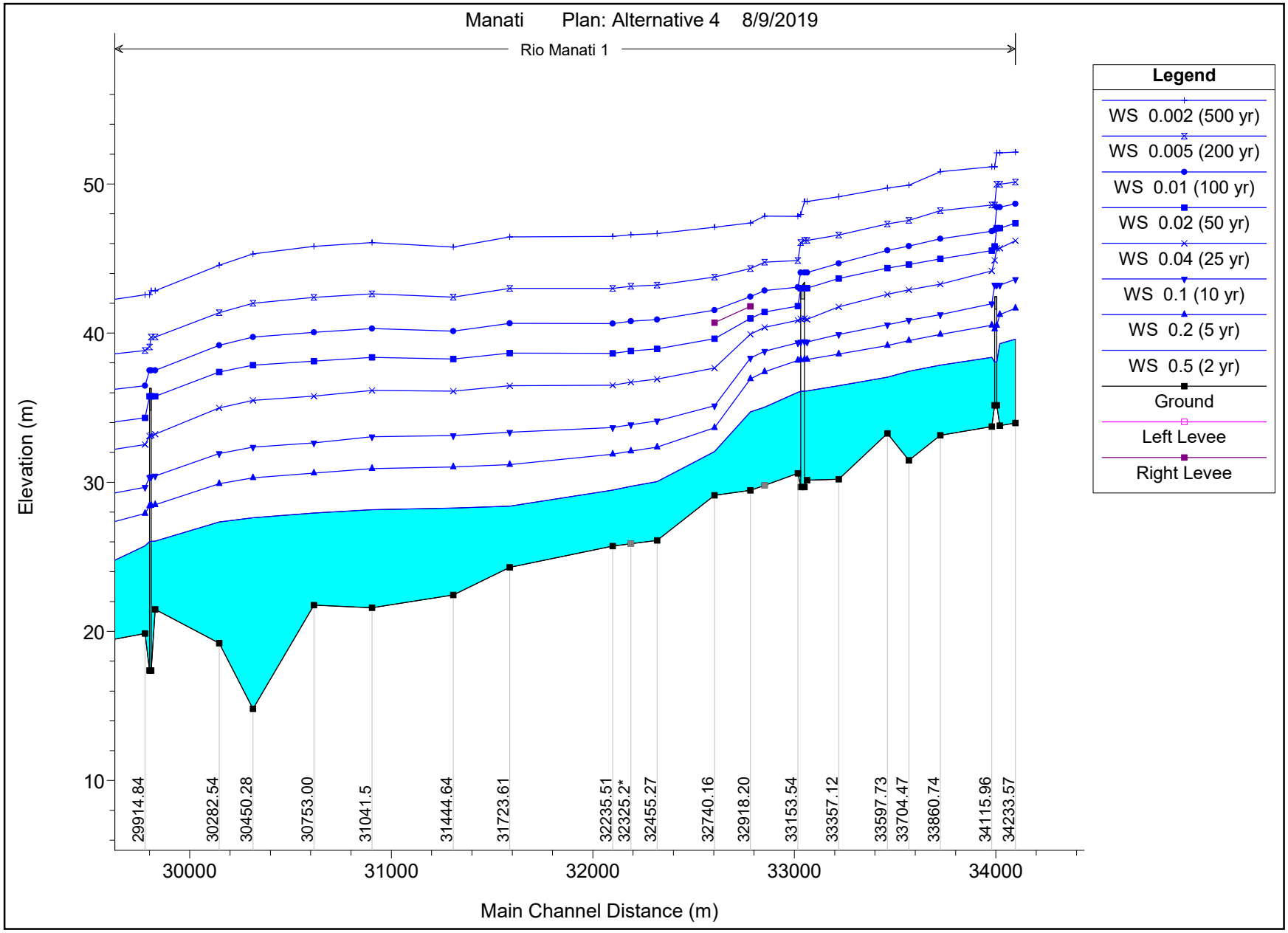
Alternative 0 (No Action) Results Profile for XS in Project Area



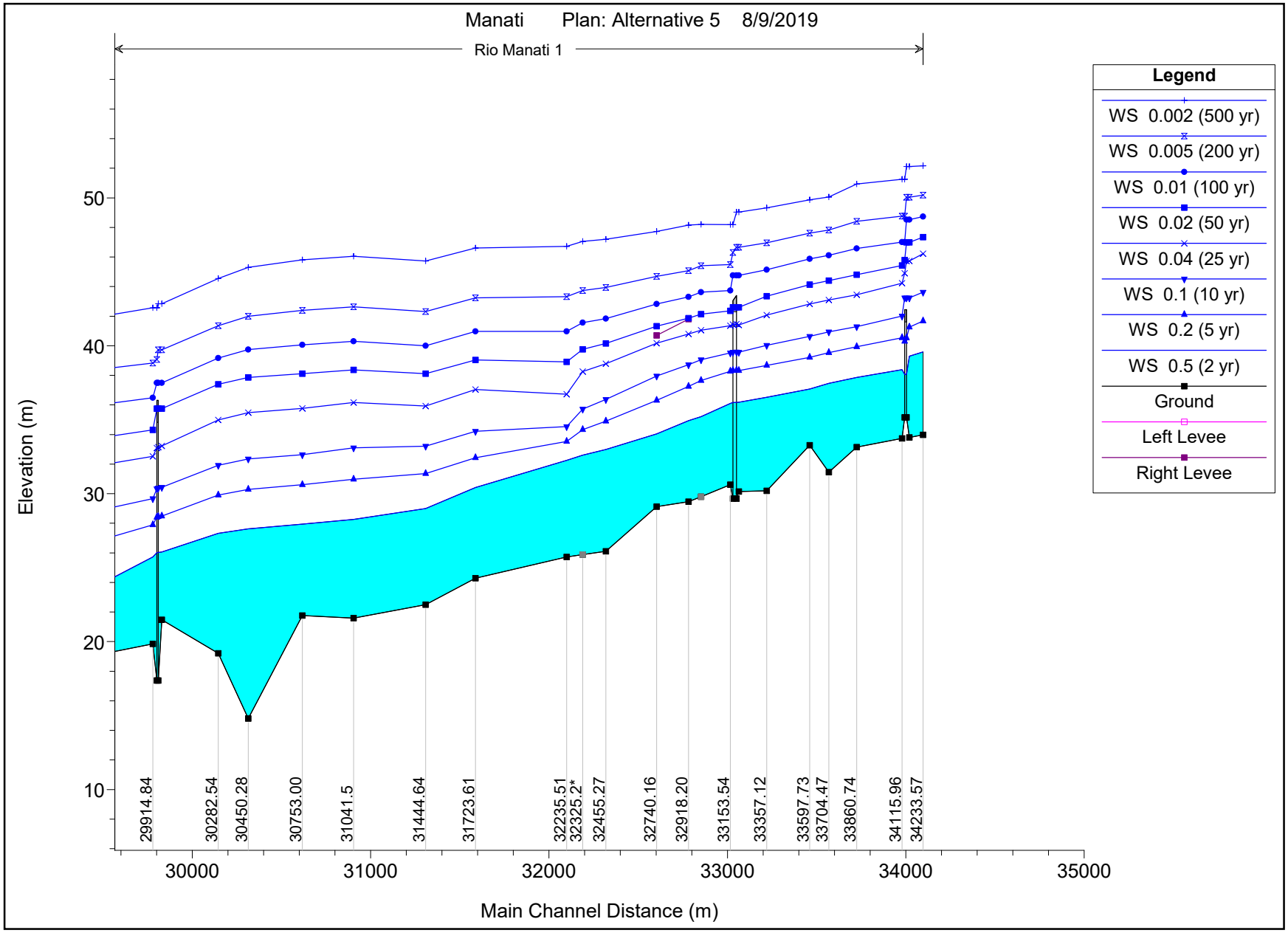
Alternative 1 (Levee/Floodwall) Results Table for XS in Project Area



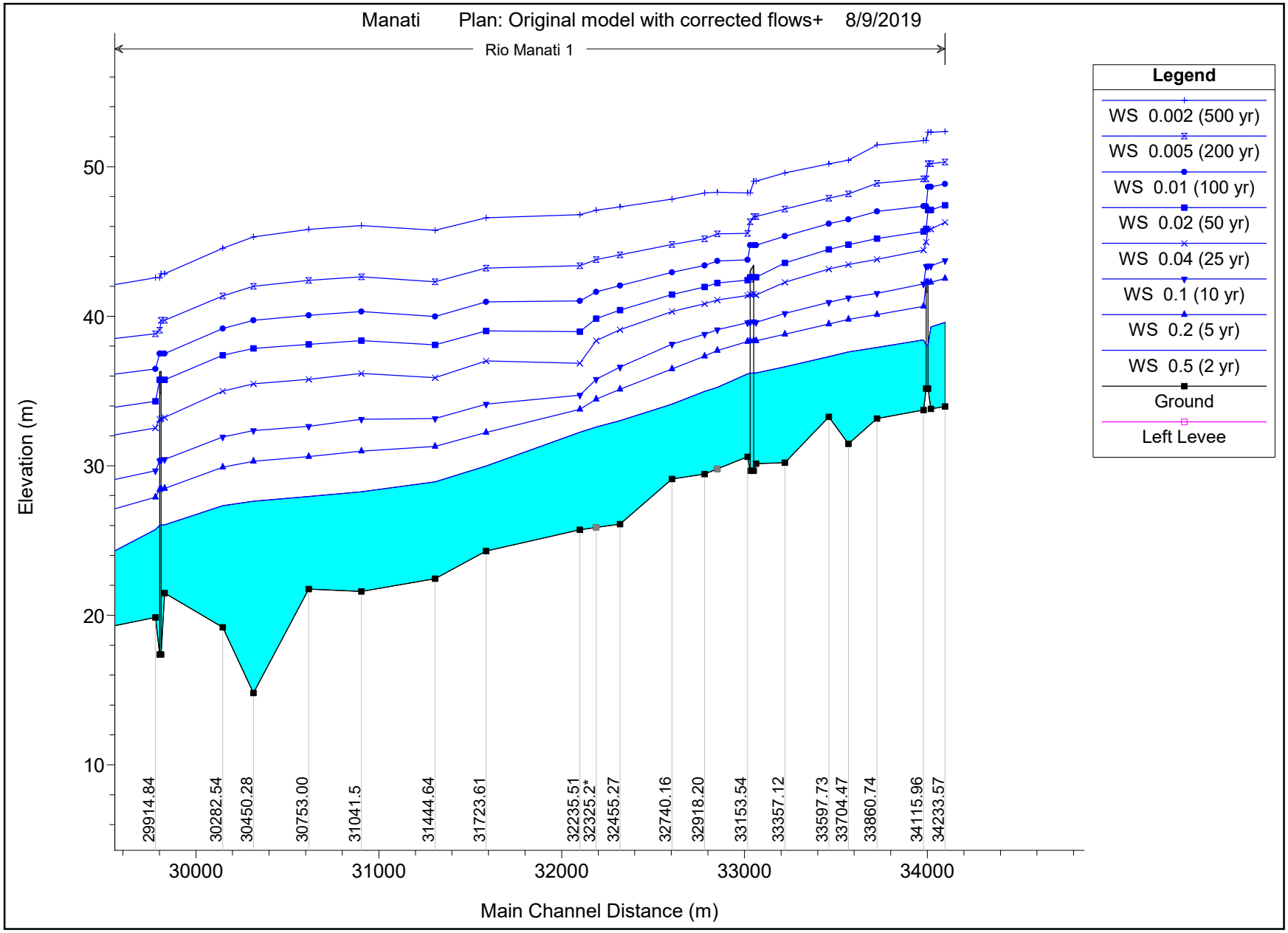
Alternative 2 (Channel Modification) Results Table for XS in Project Area



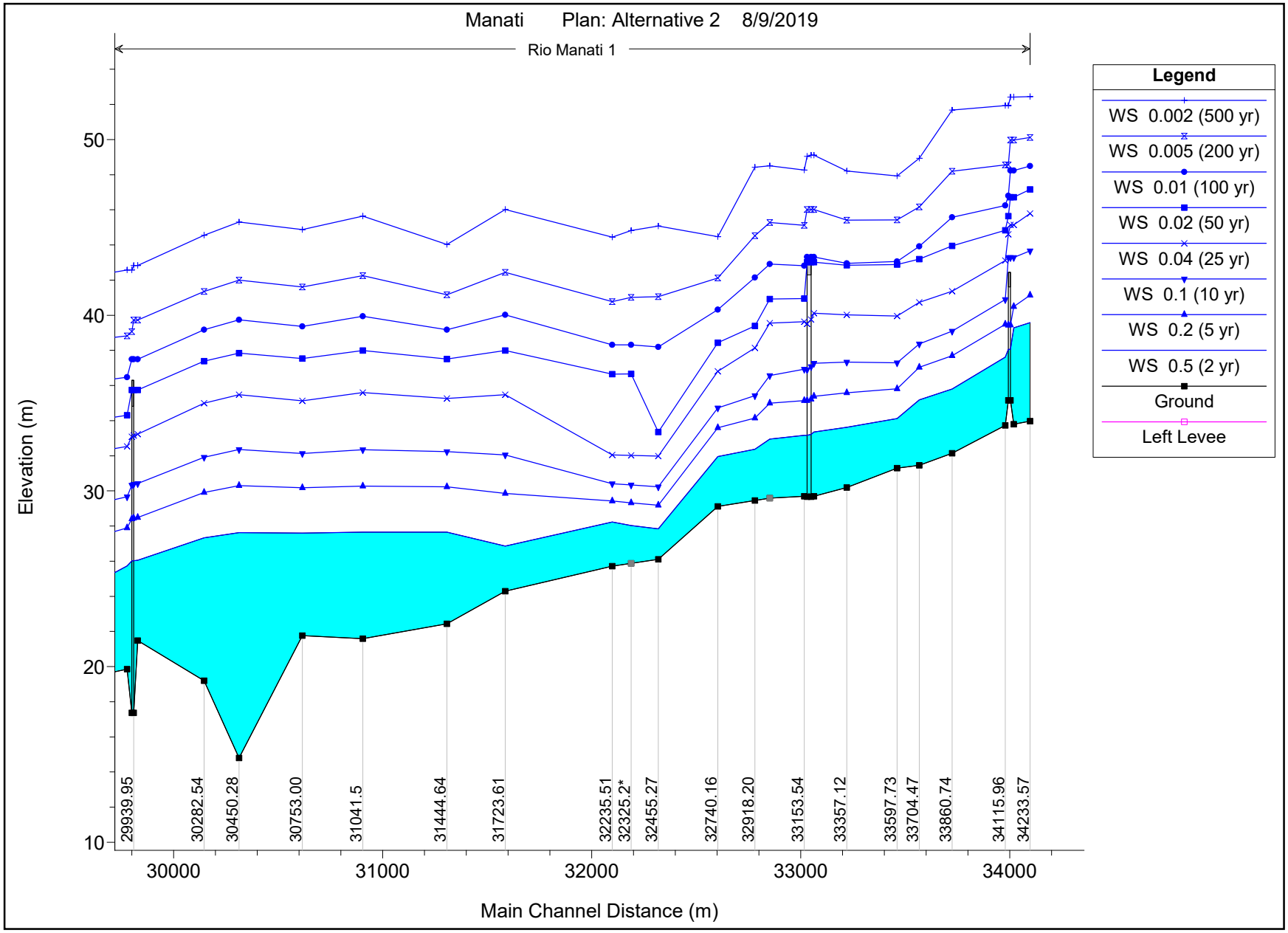
Alternative 3 (Non-Structural Relocations) Results Table for XS in Project Area



Alternative 3b (Non-Structural Relocations - Recommended Plan) Results Profile for XS in Project Area

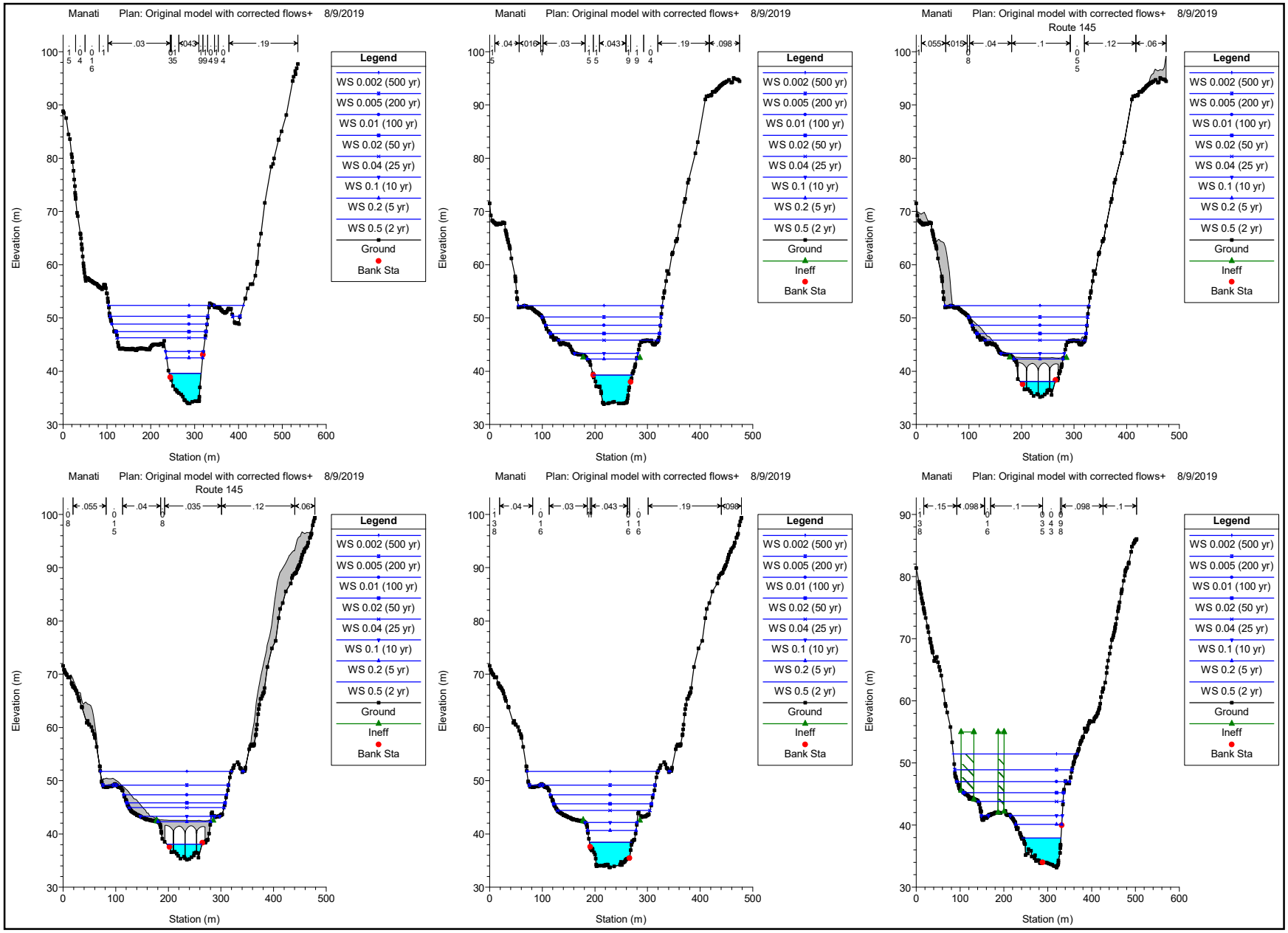


Alternative 4 (Channelization) Results Table for XS in Project Area

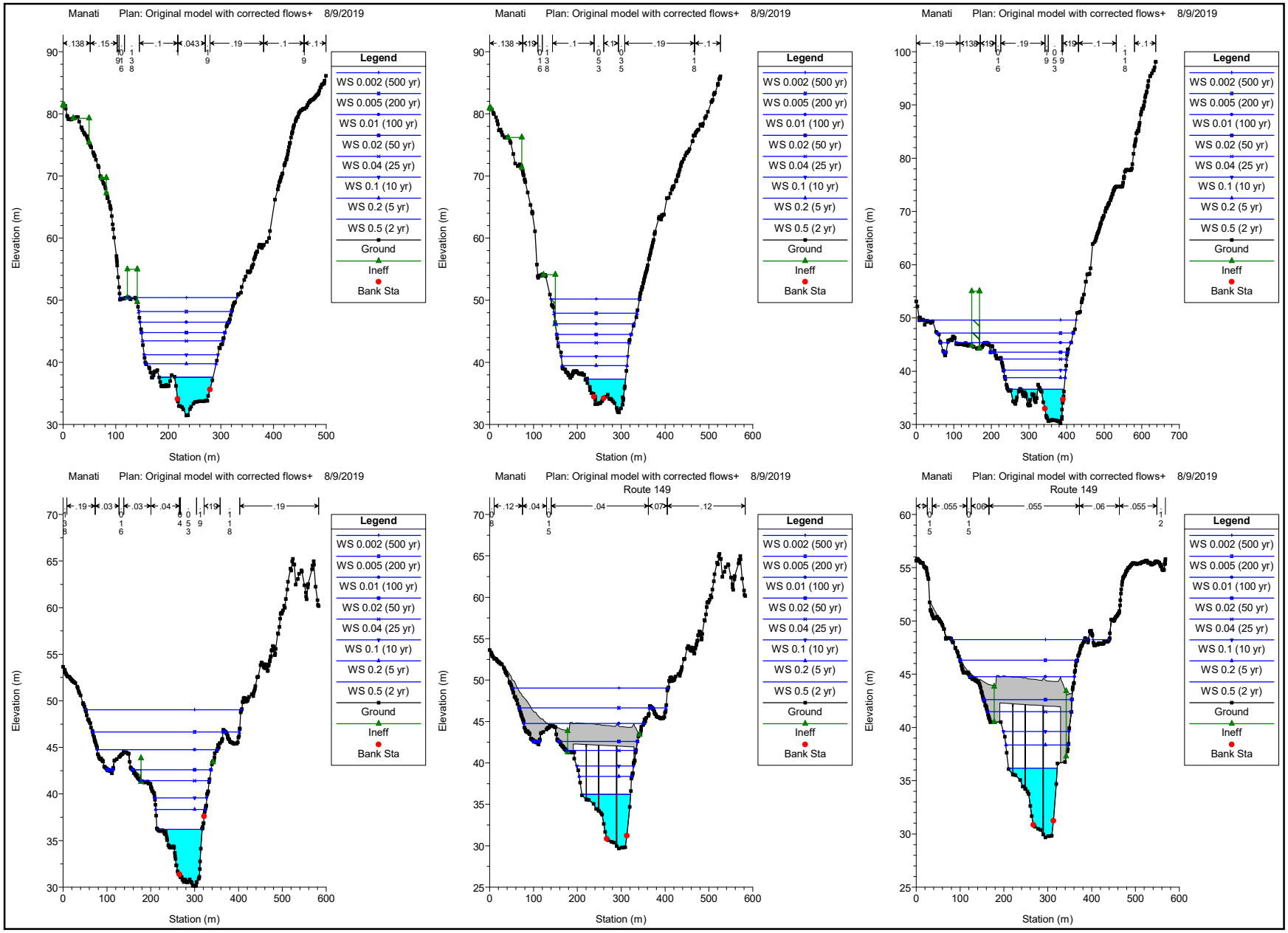


HEC-RAS CROSS SECTIONS

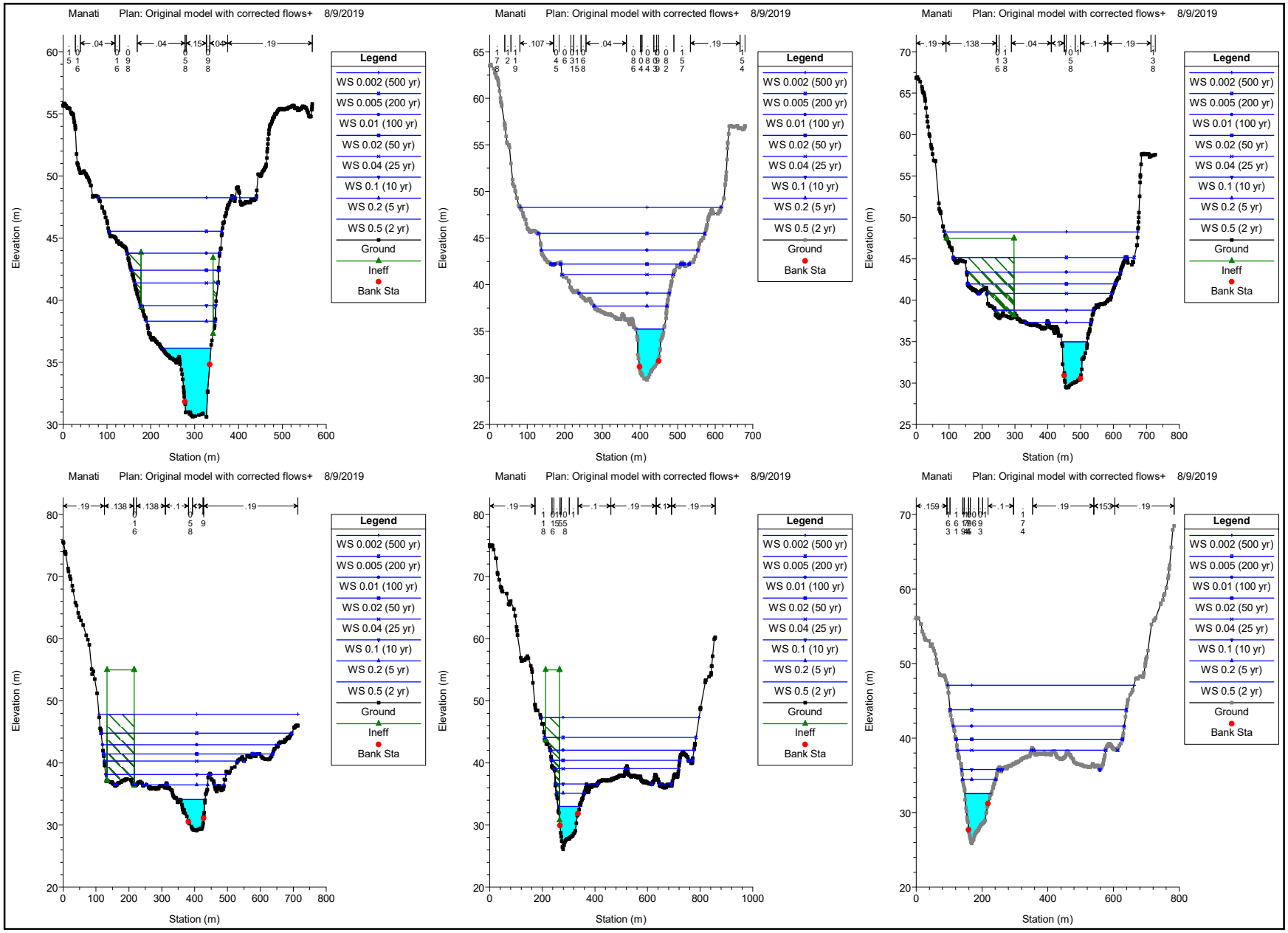
Alternative 0 (No Action) Results In Project Area



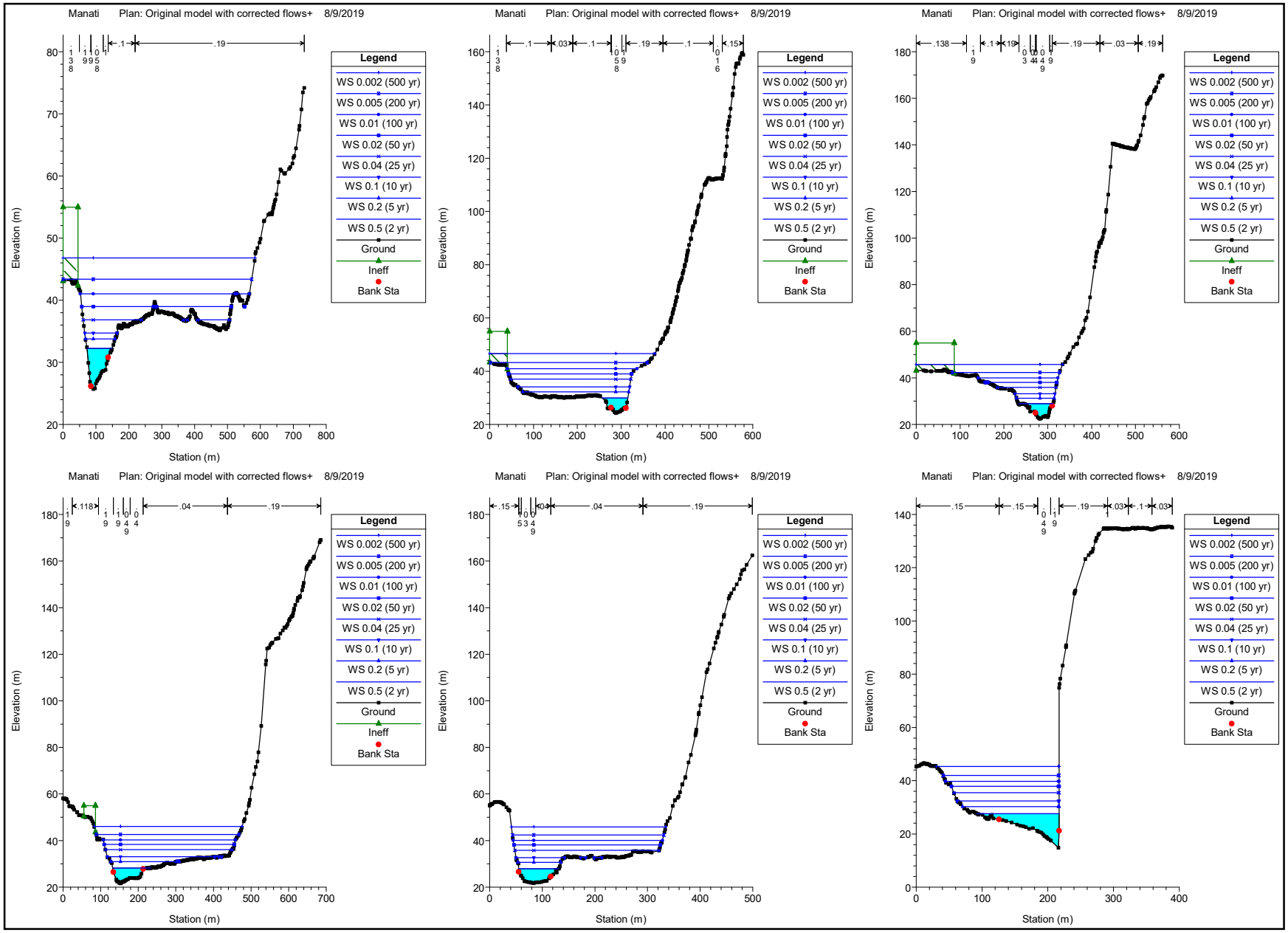
Alternative 0 (No Action) Results in Project Area



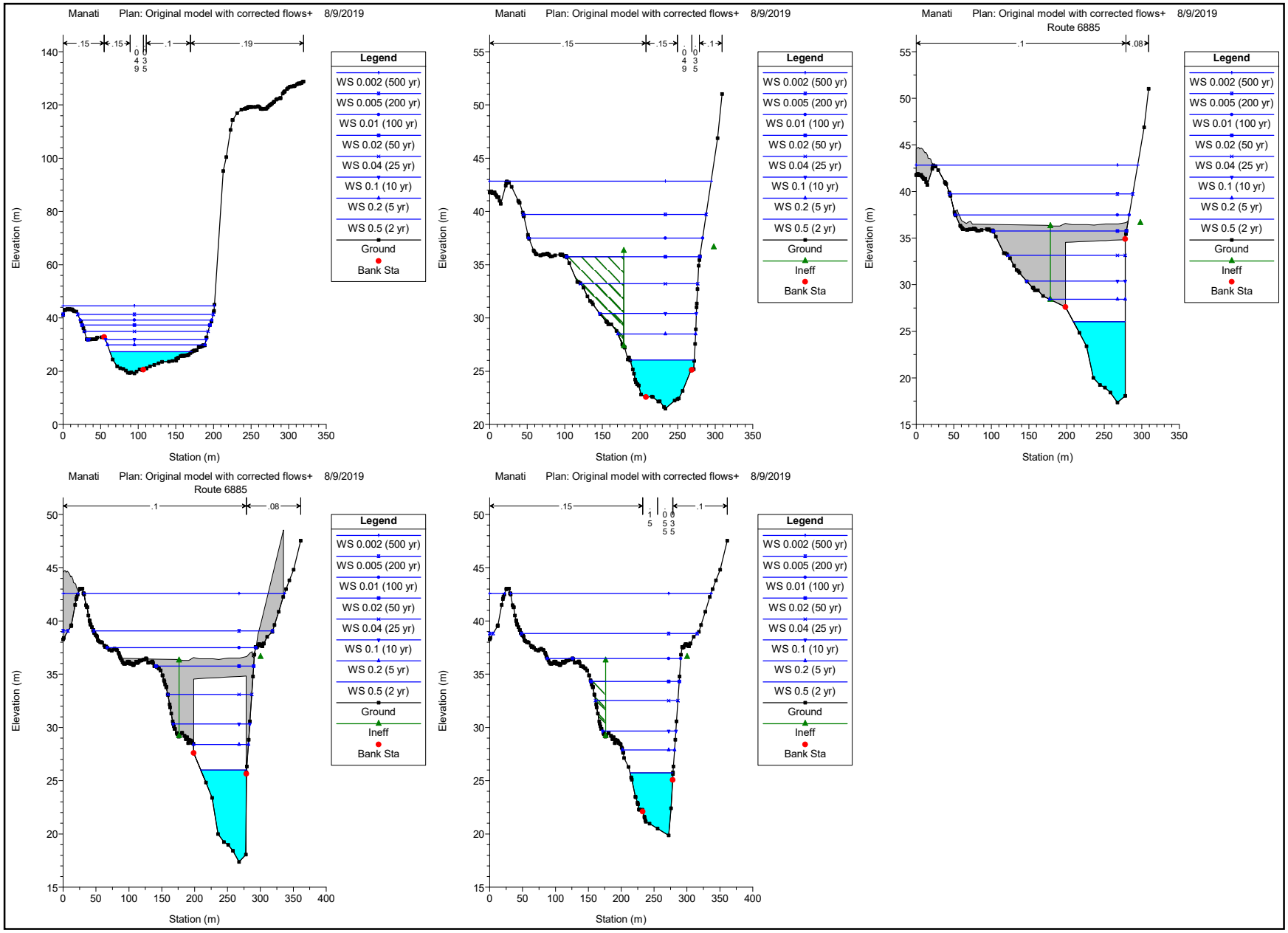
Alternative 0 (No Action) Results in Project Area



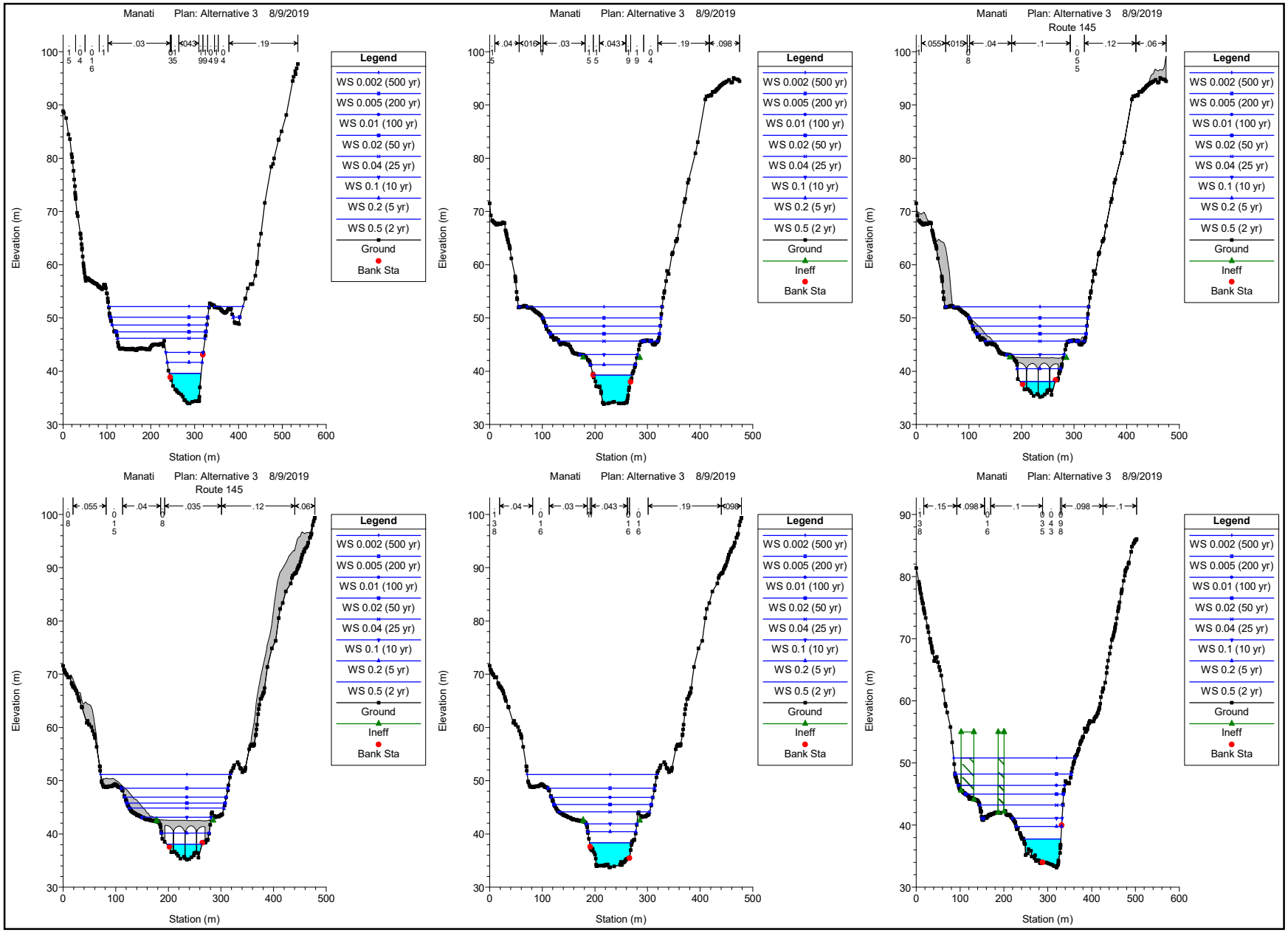
Alternative 0 (No Action) Results in Project Area



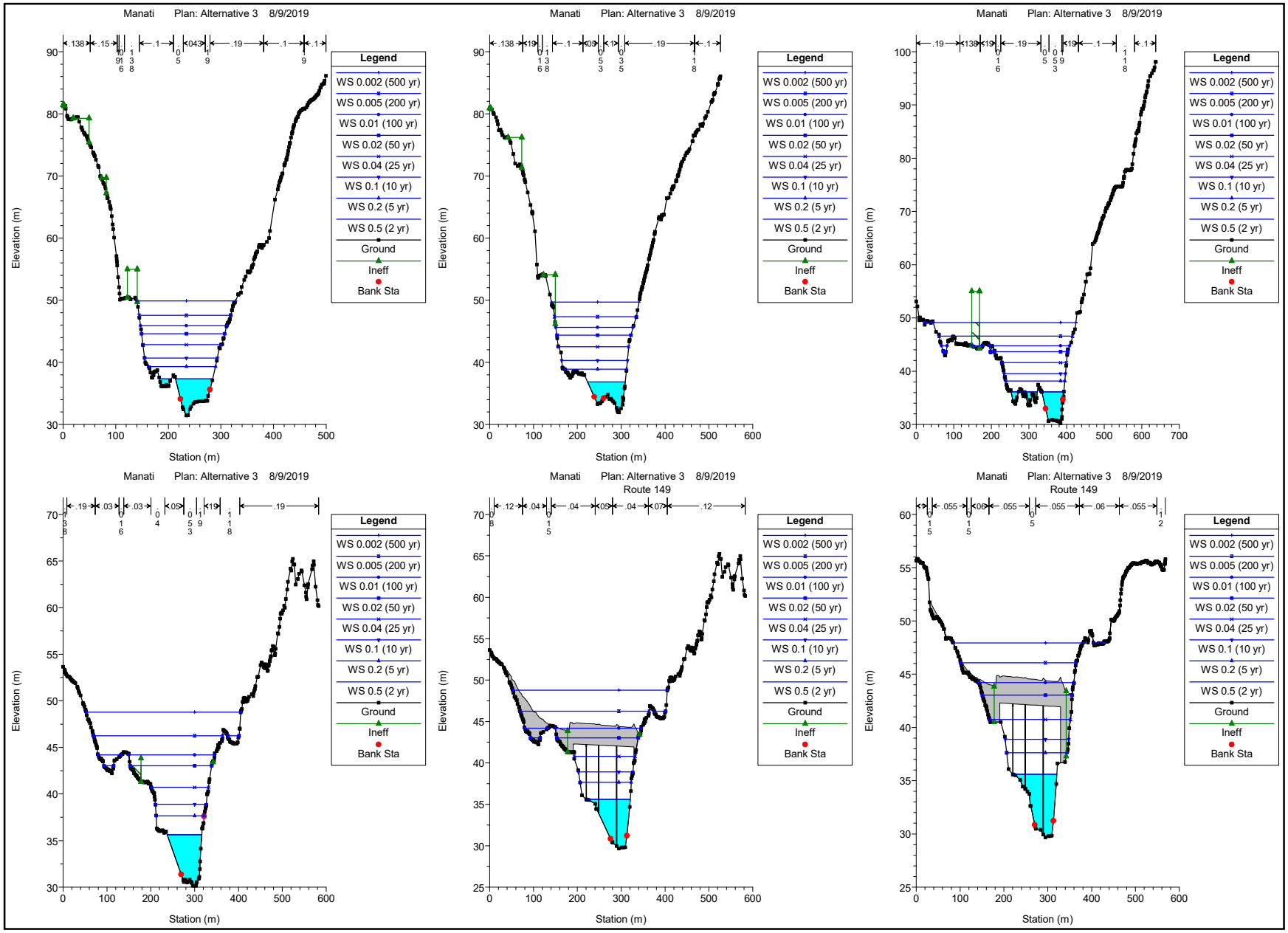
Alternative 0 (No Action) Results in Project Area



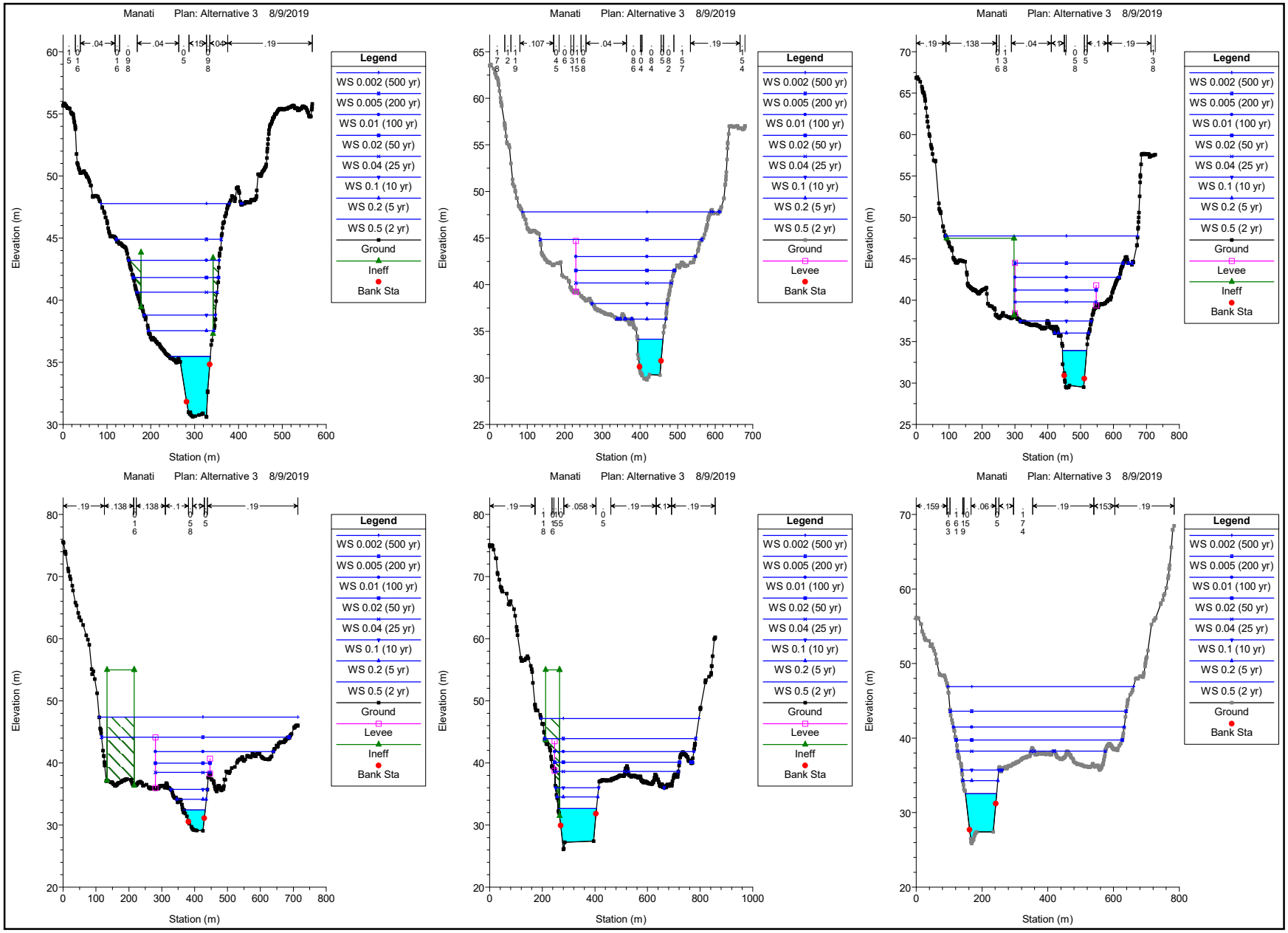
Alternative 1 (Levee/Floodwall) Results in Project Area



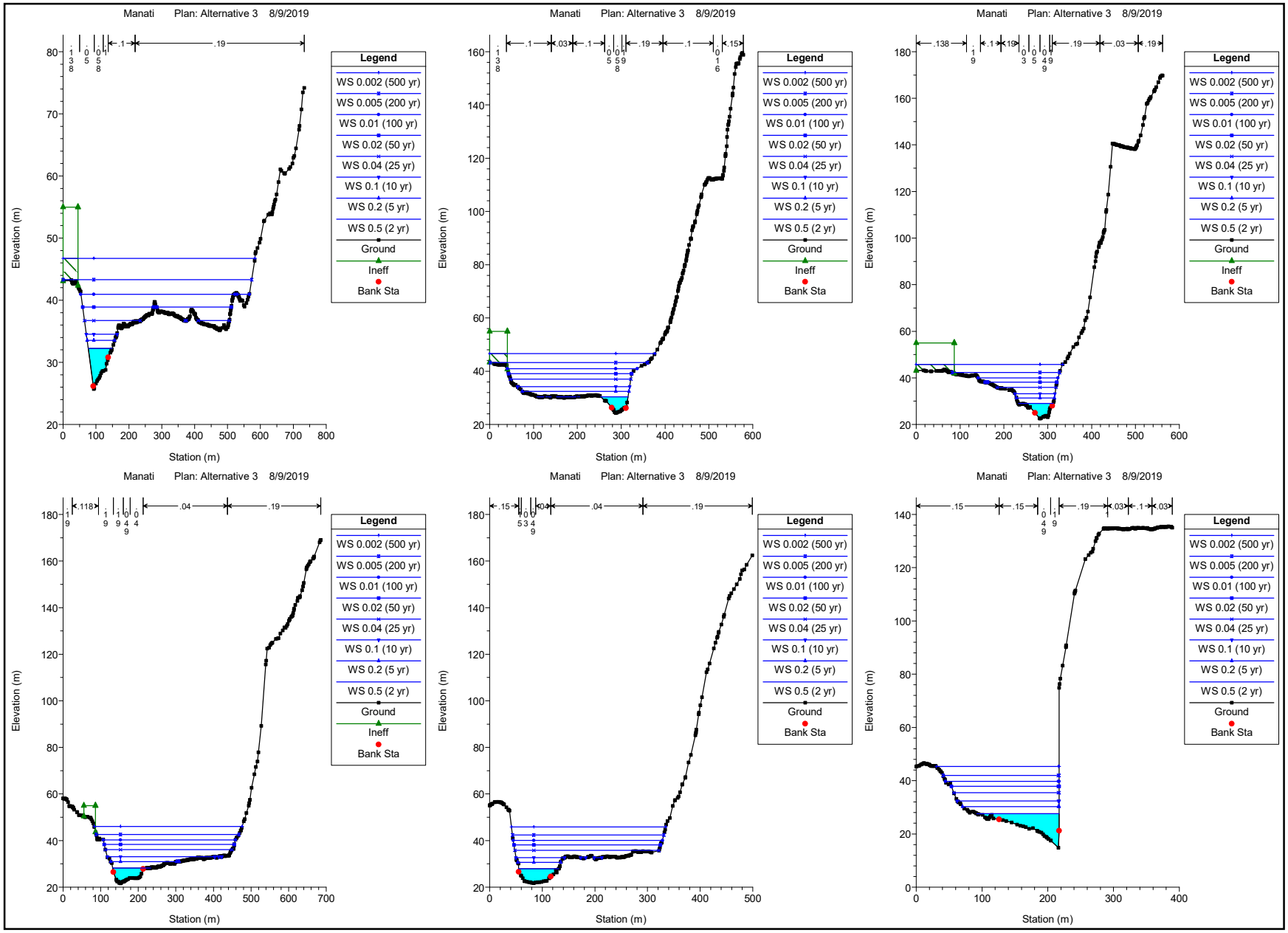
Alternative 1 (Levee/Floodwall) Results in Project Area



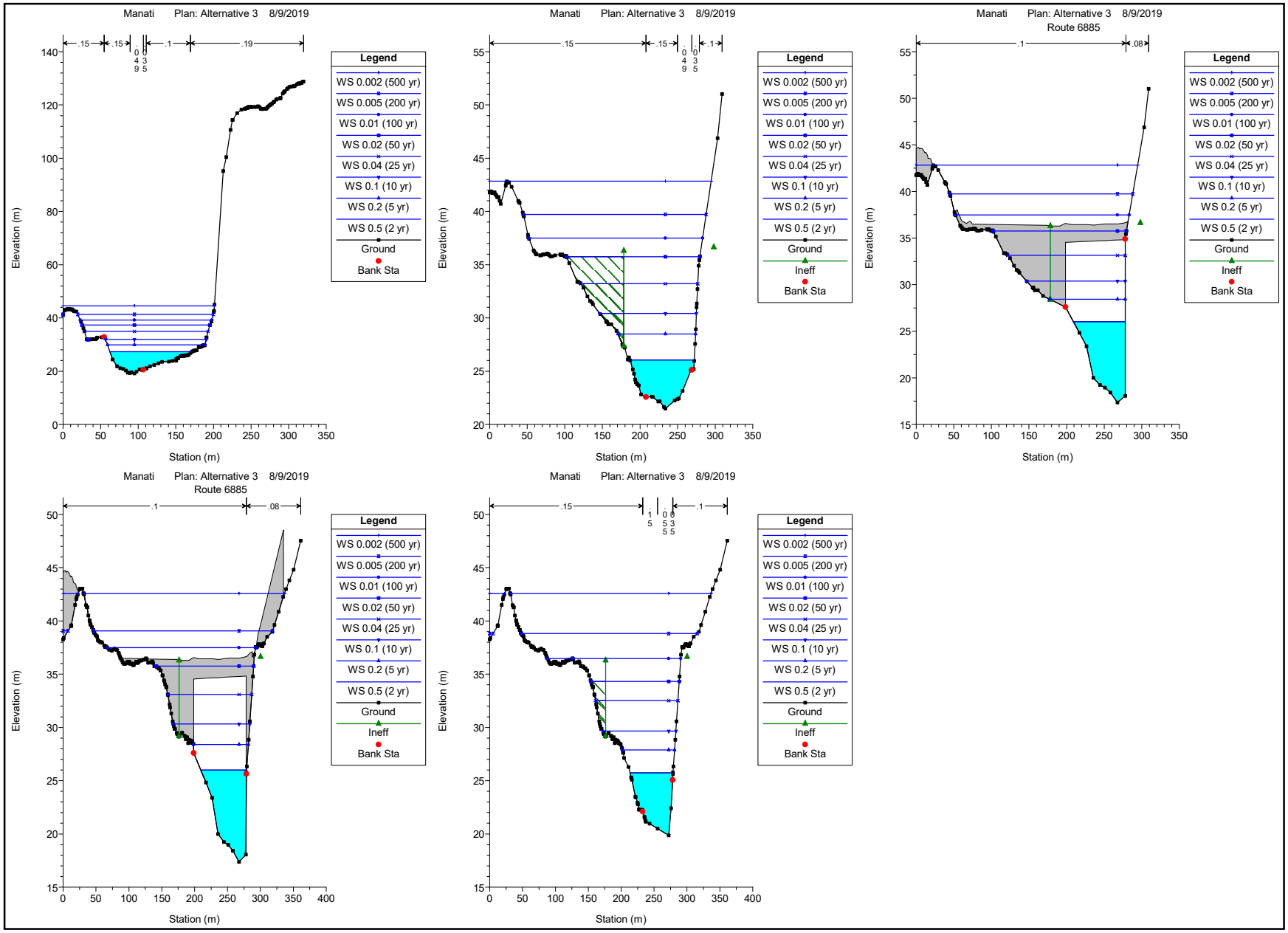
Alternative 1 (Levee/Floodwall) Results in Project Area



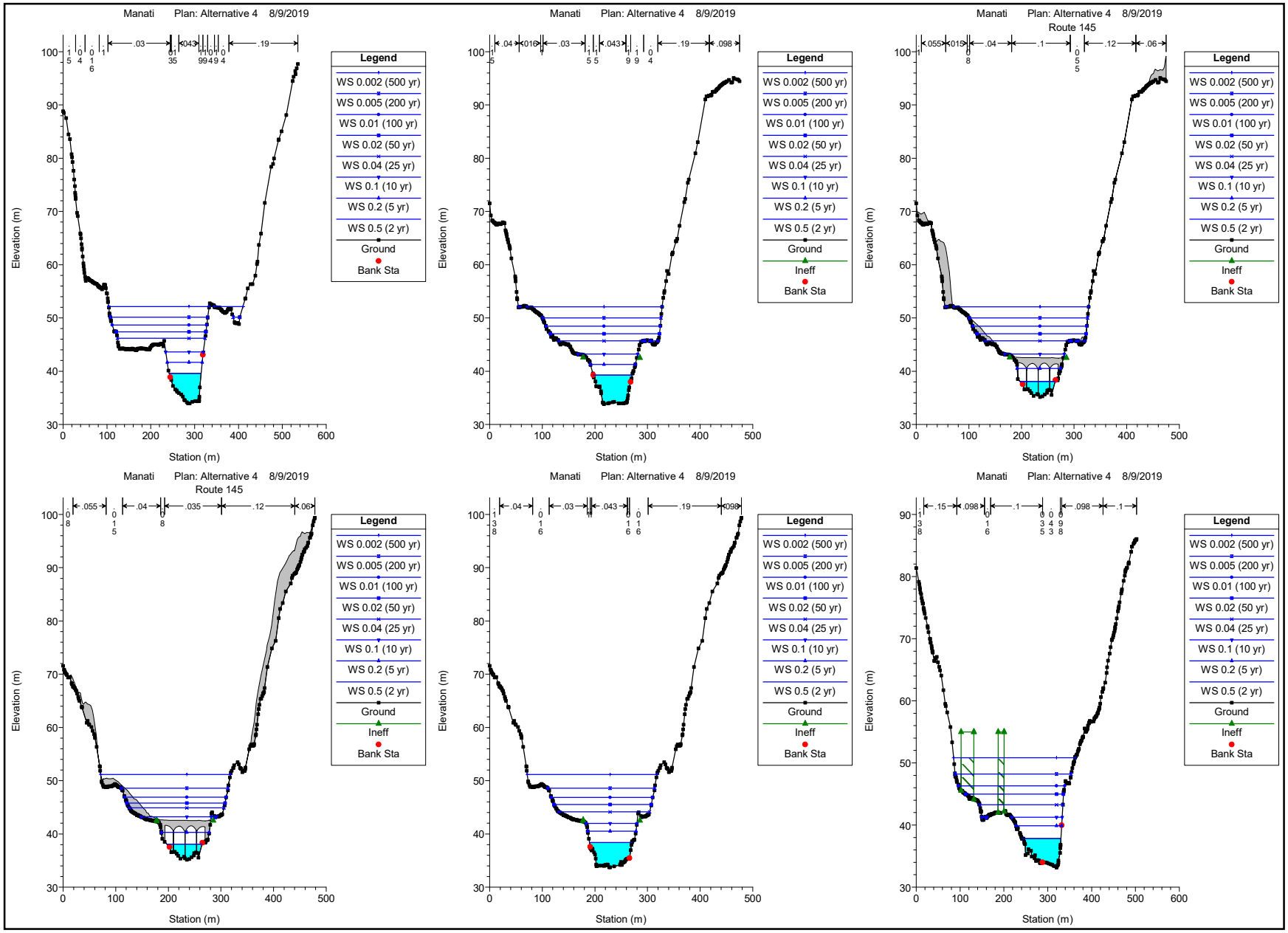
Alternative 1 (Levee/Floodwall) Results in Project Area



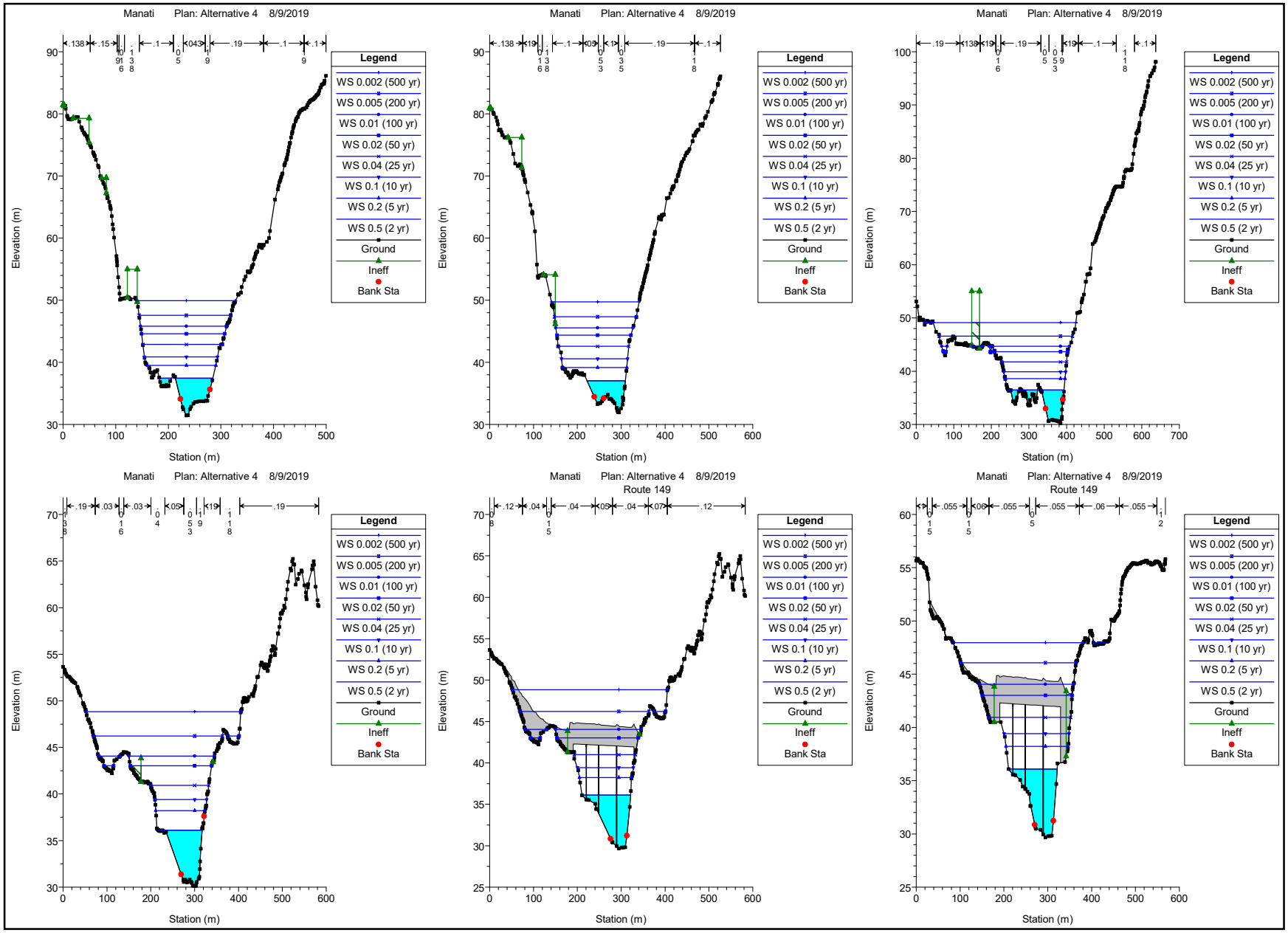
Alternative 1 (Levee/Floodwall) Results in Project Area



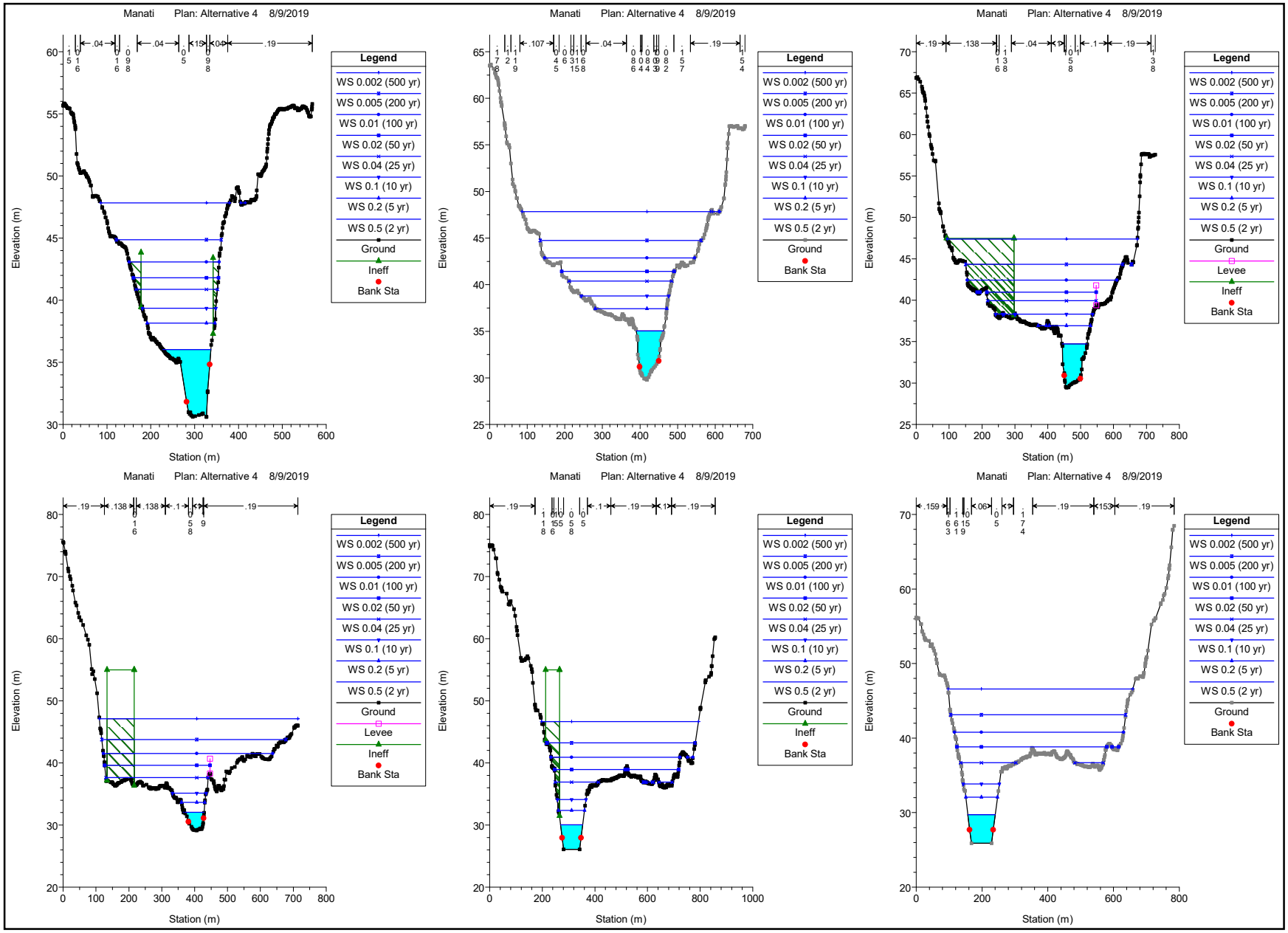
Alternative 2 (Channel Modification) Results in Project Area



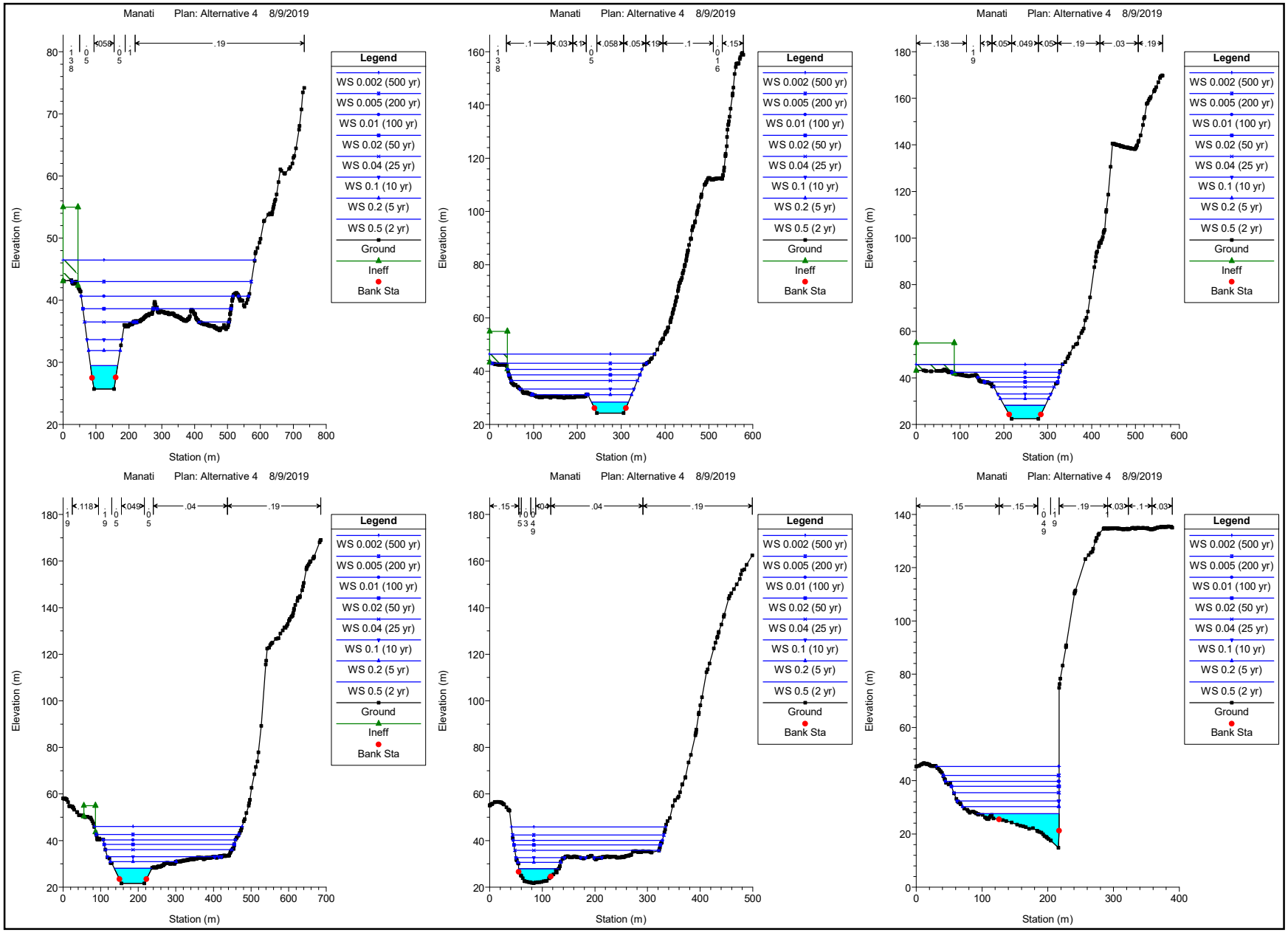
Alternative 2 (Channel Modification) Results in Project Area



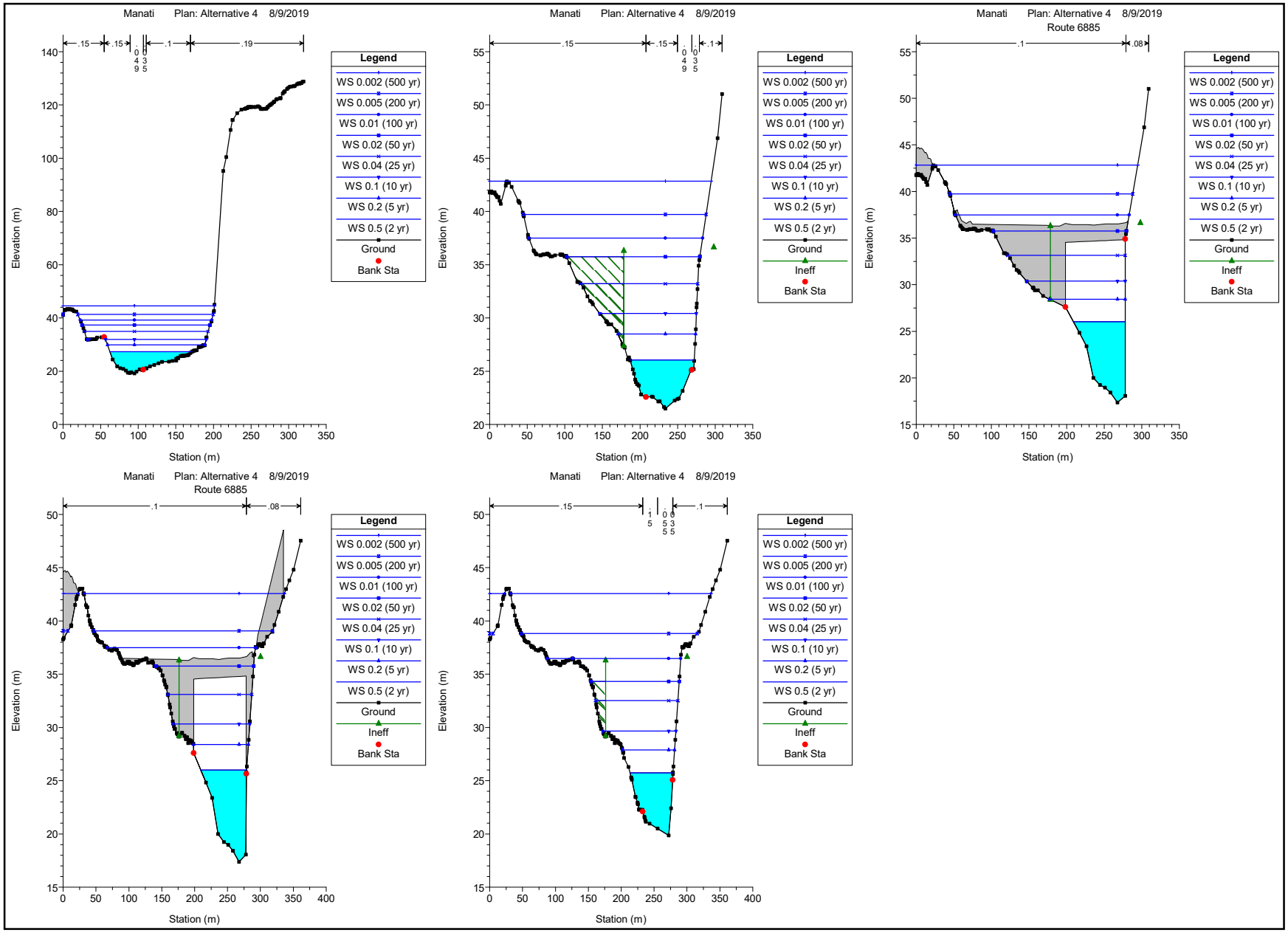
Alternative 2 (Channel Modification) Results in Project Area



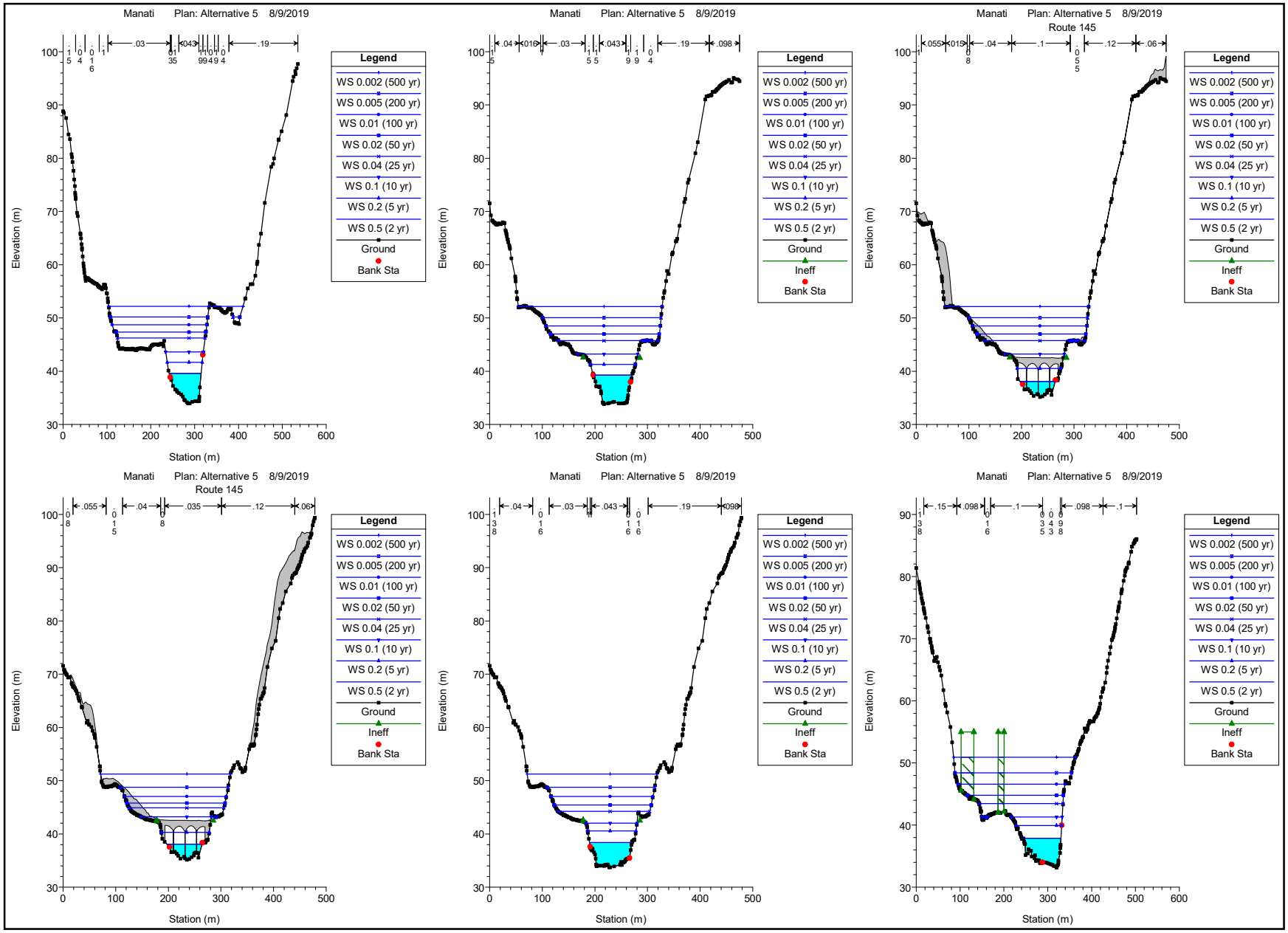
Alternative 2 (Channel Modification) Results in Project Area



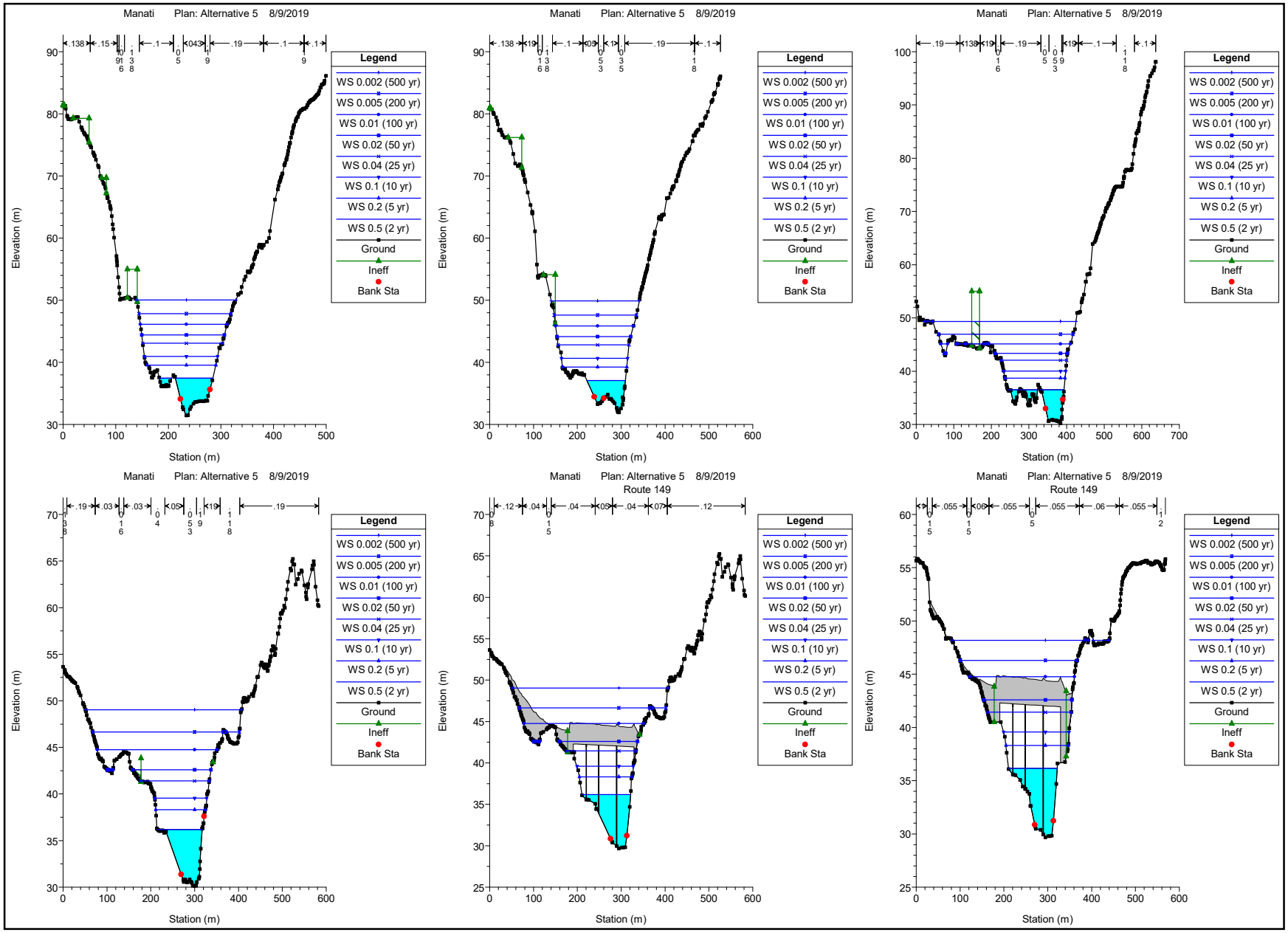
Alternative 2 (Channel Modification) Results in Project Area



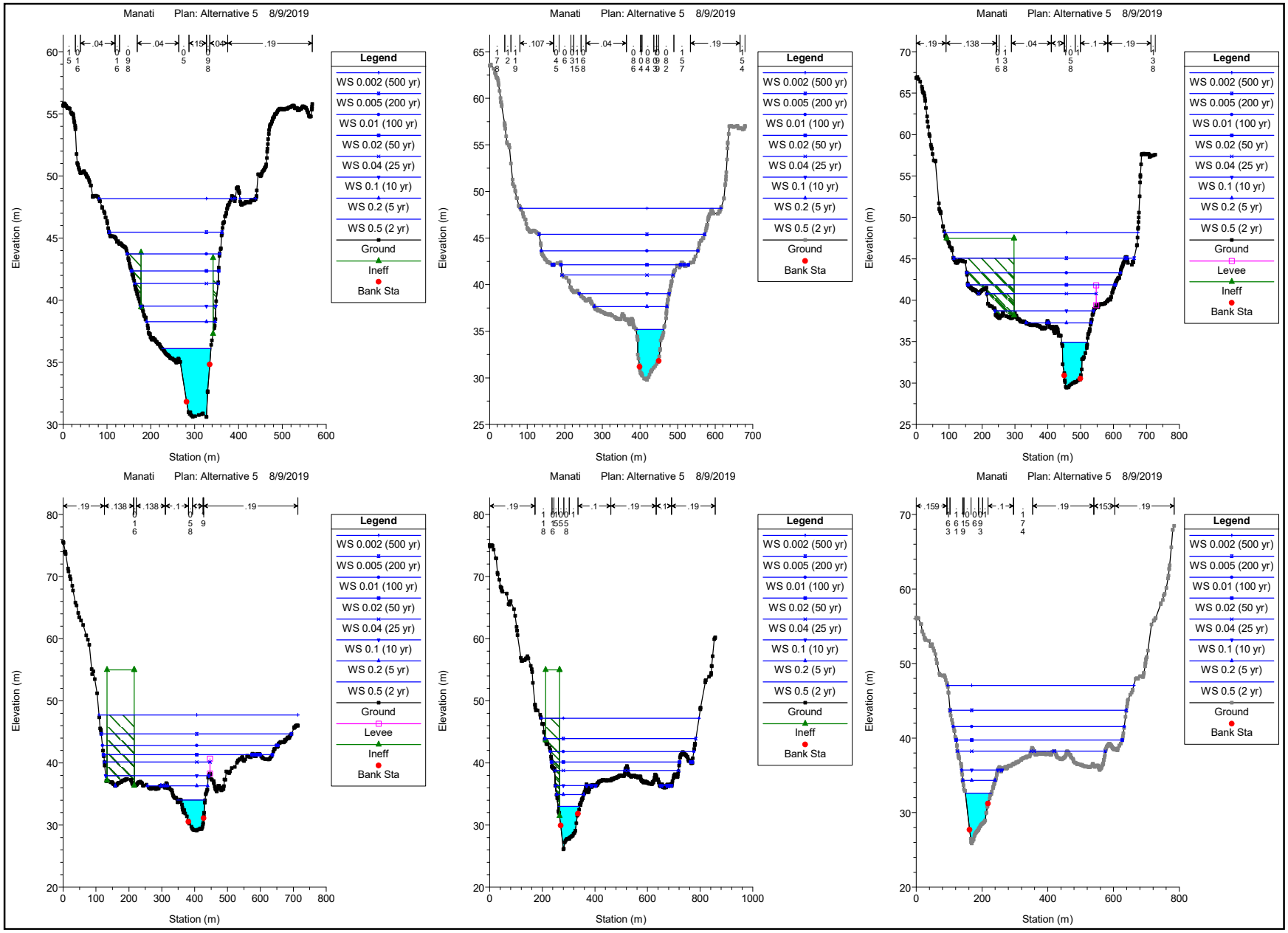
Alternative 3 (Non-Structural Relocations) Results in Project Area



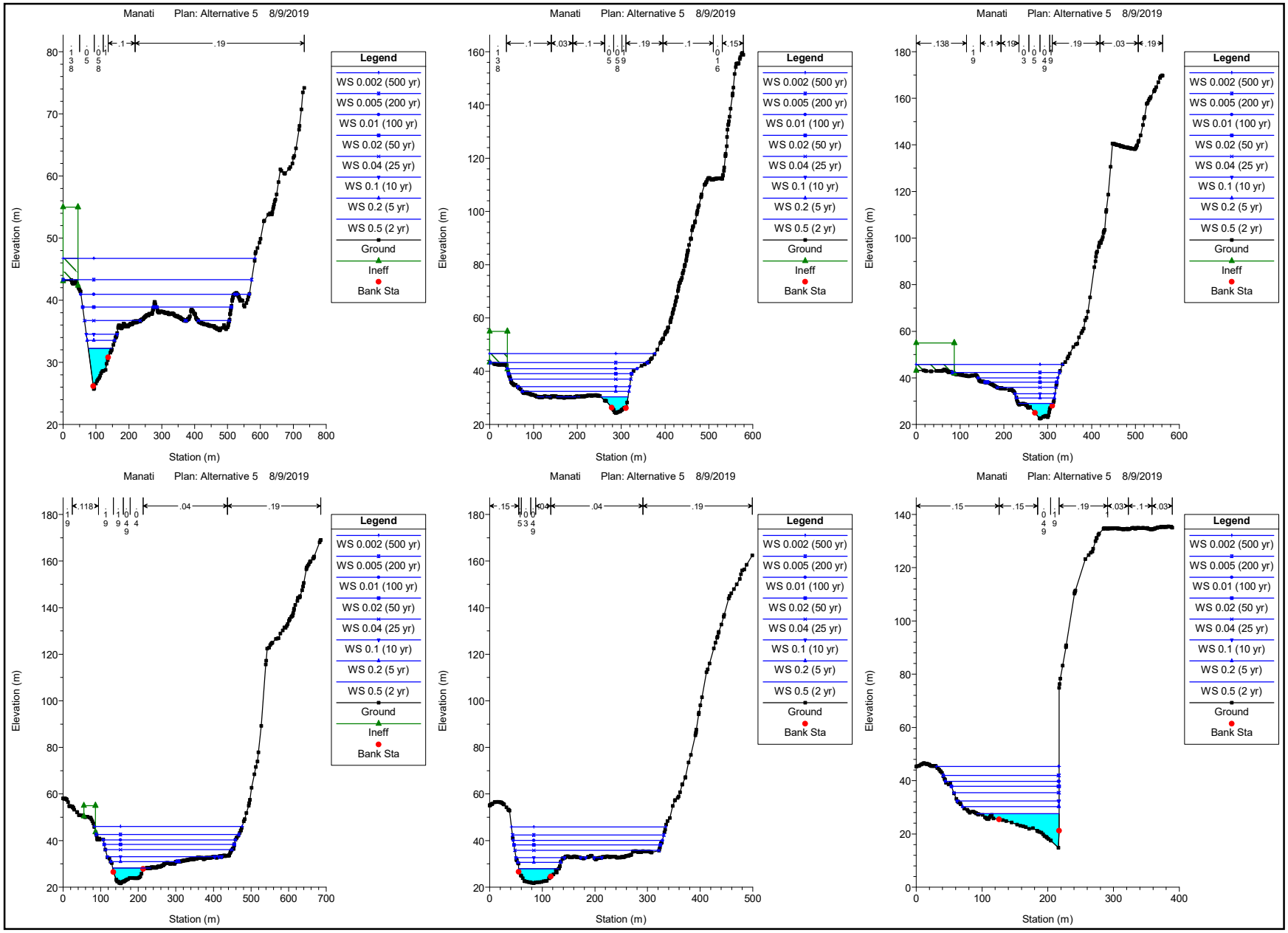
Alternative 3 (Non-Structural Relocations) Results in Project Area



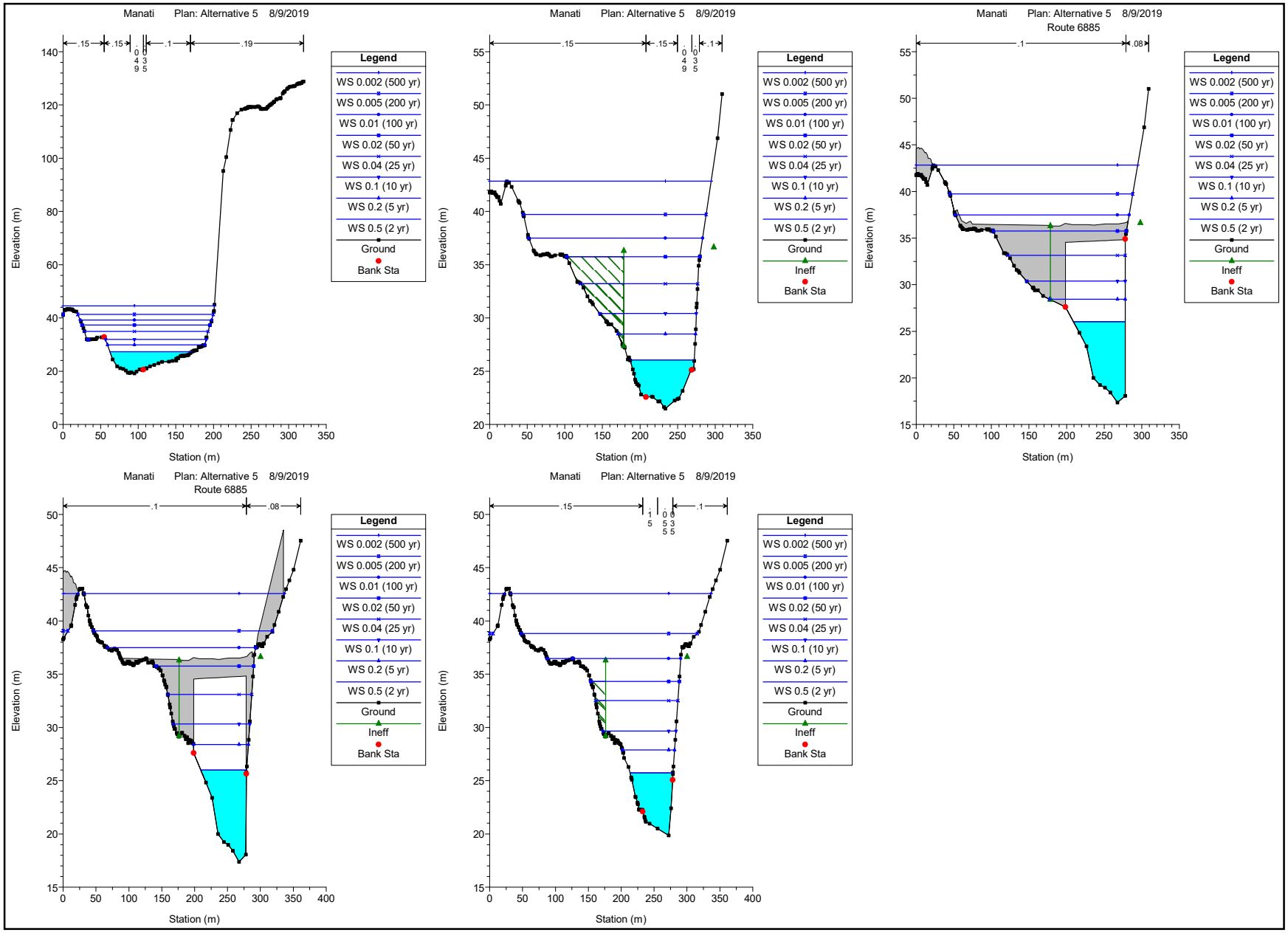
Alternative 3 (Non-Structural Relocations) Results in Project Area



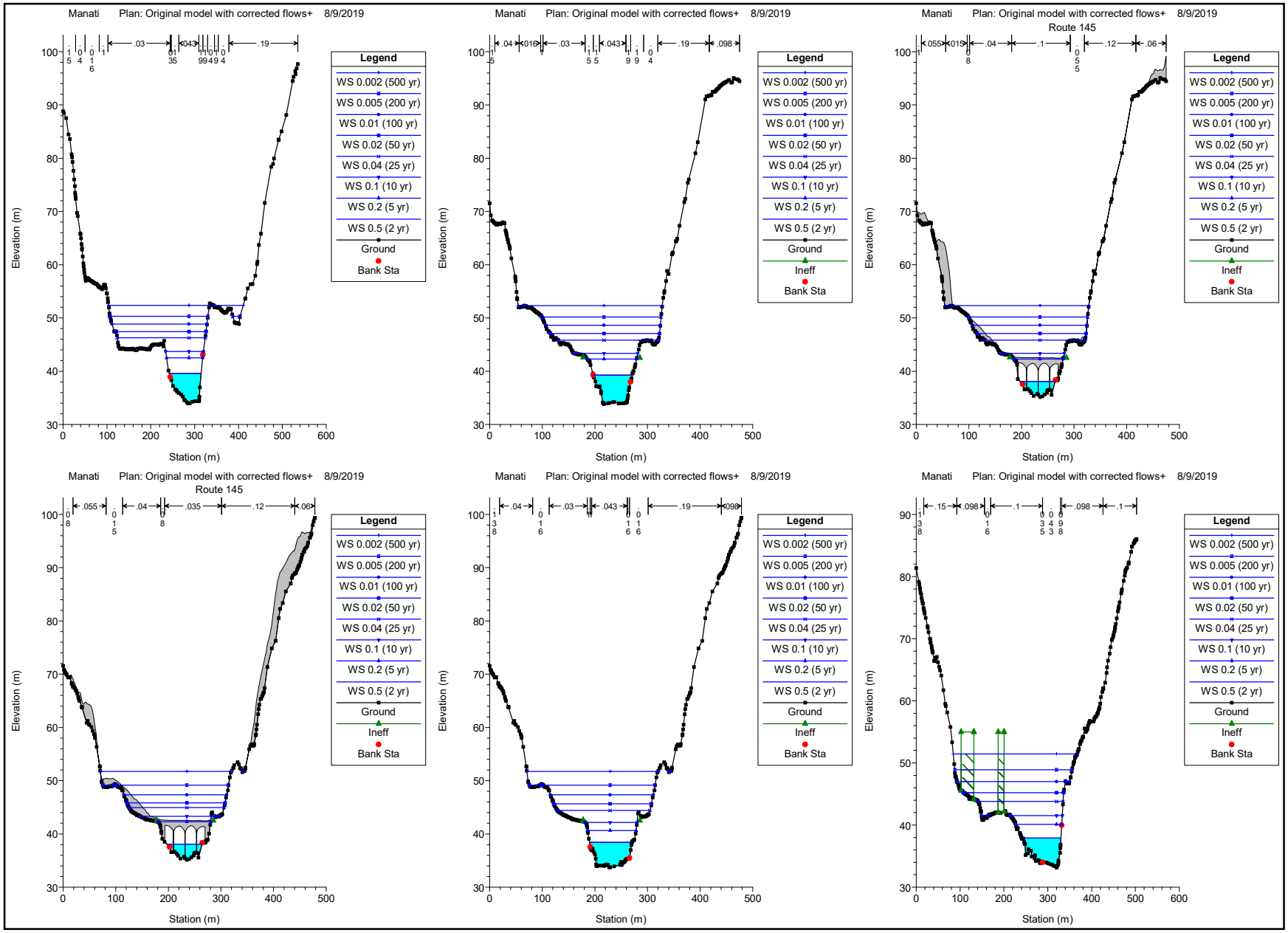
Alternative 3 (Non-Structural Relocations) Results in Project Area



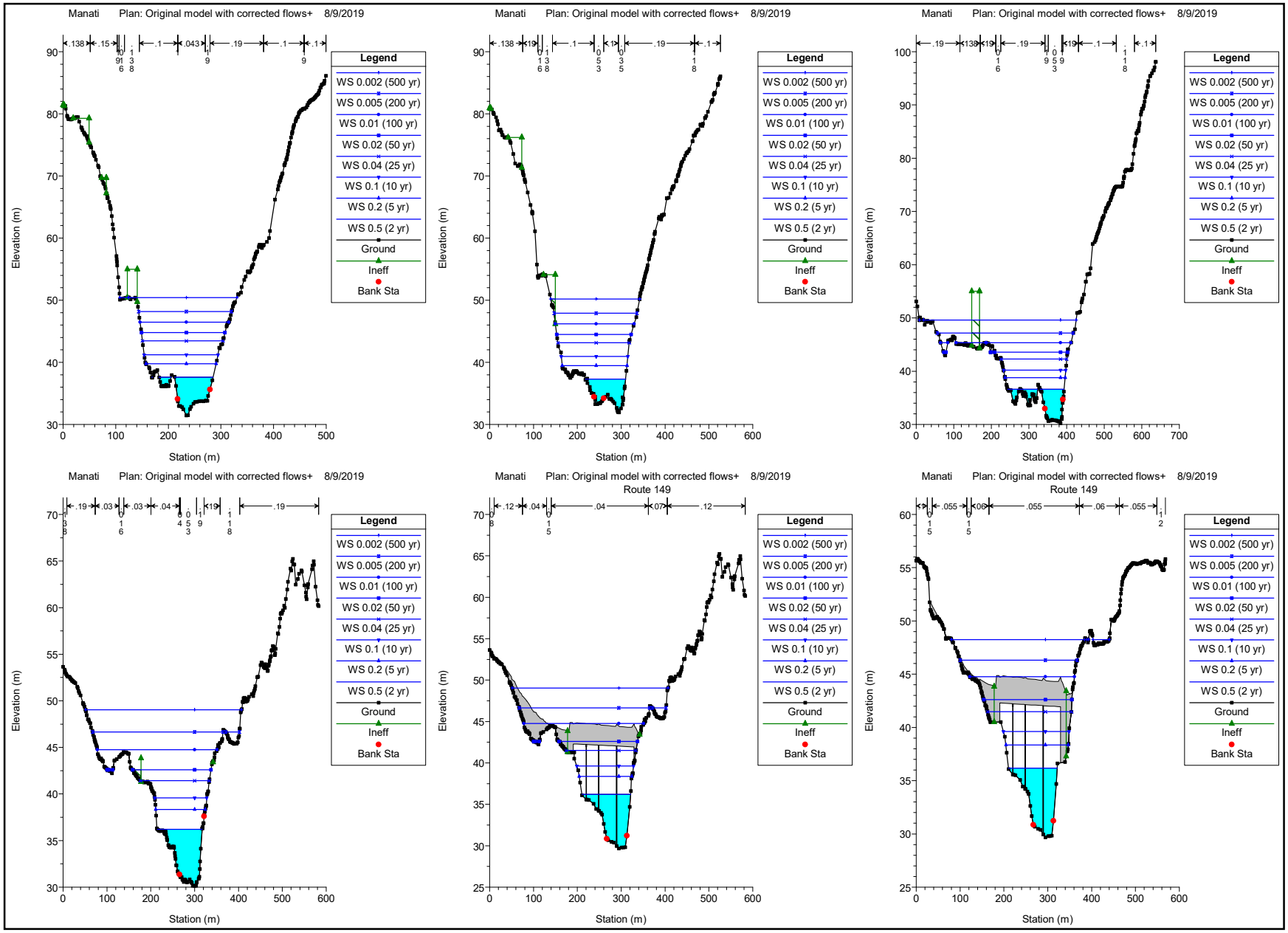
Alternative 3 (Non-Structural Relocations) Results in Project Area



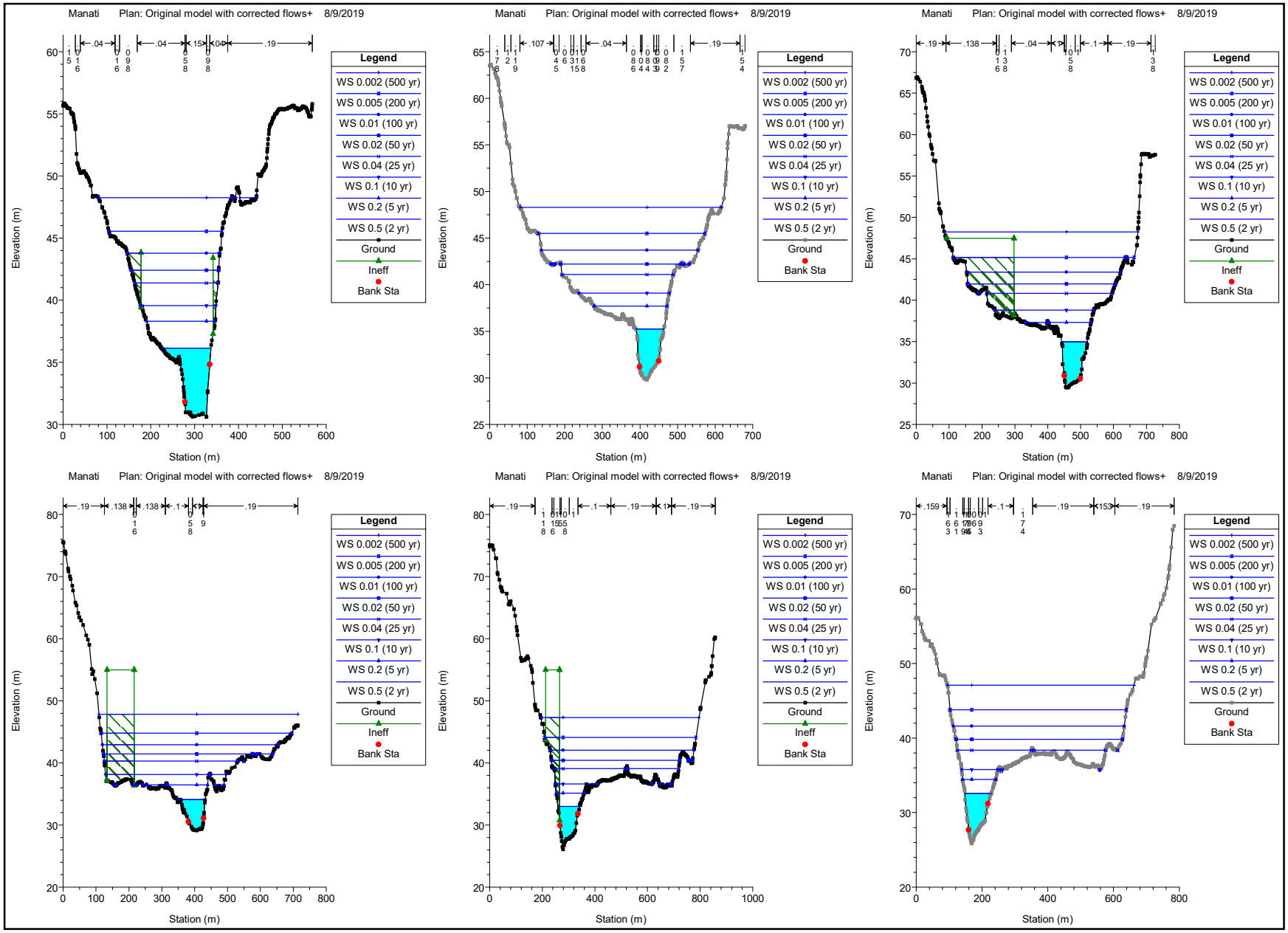
Alternative 3b (Non-Structural Relocations - Recommended Plan) Results In Project Area



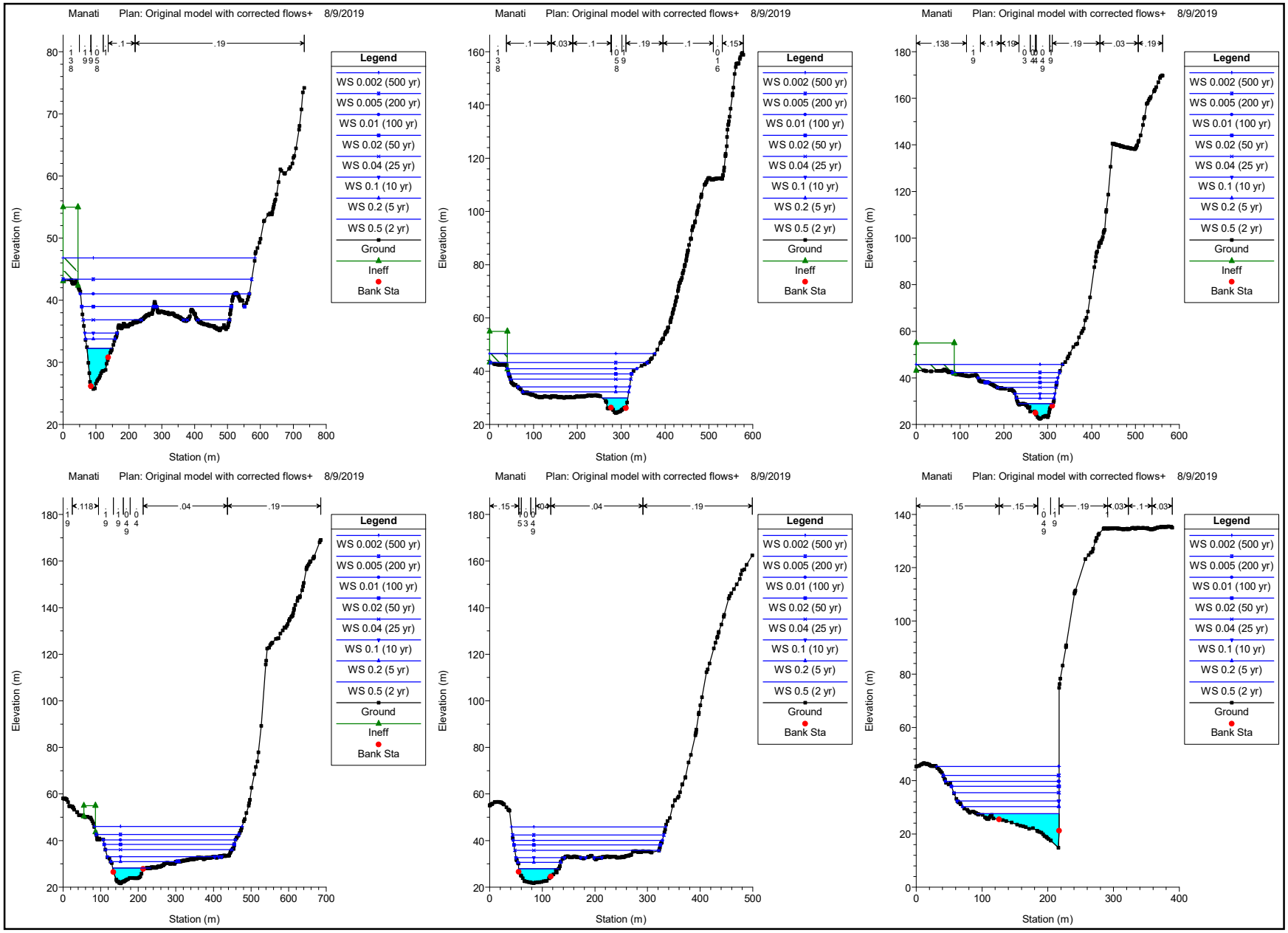
Alternative 3b (Non-Structural Relocations - Recommended Plan) Results in Project Area



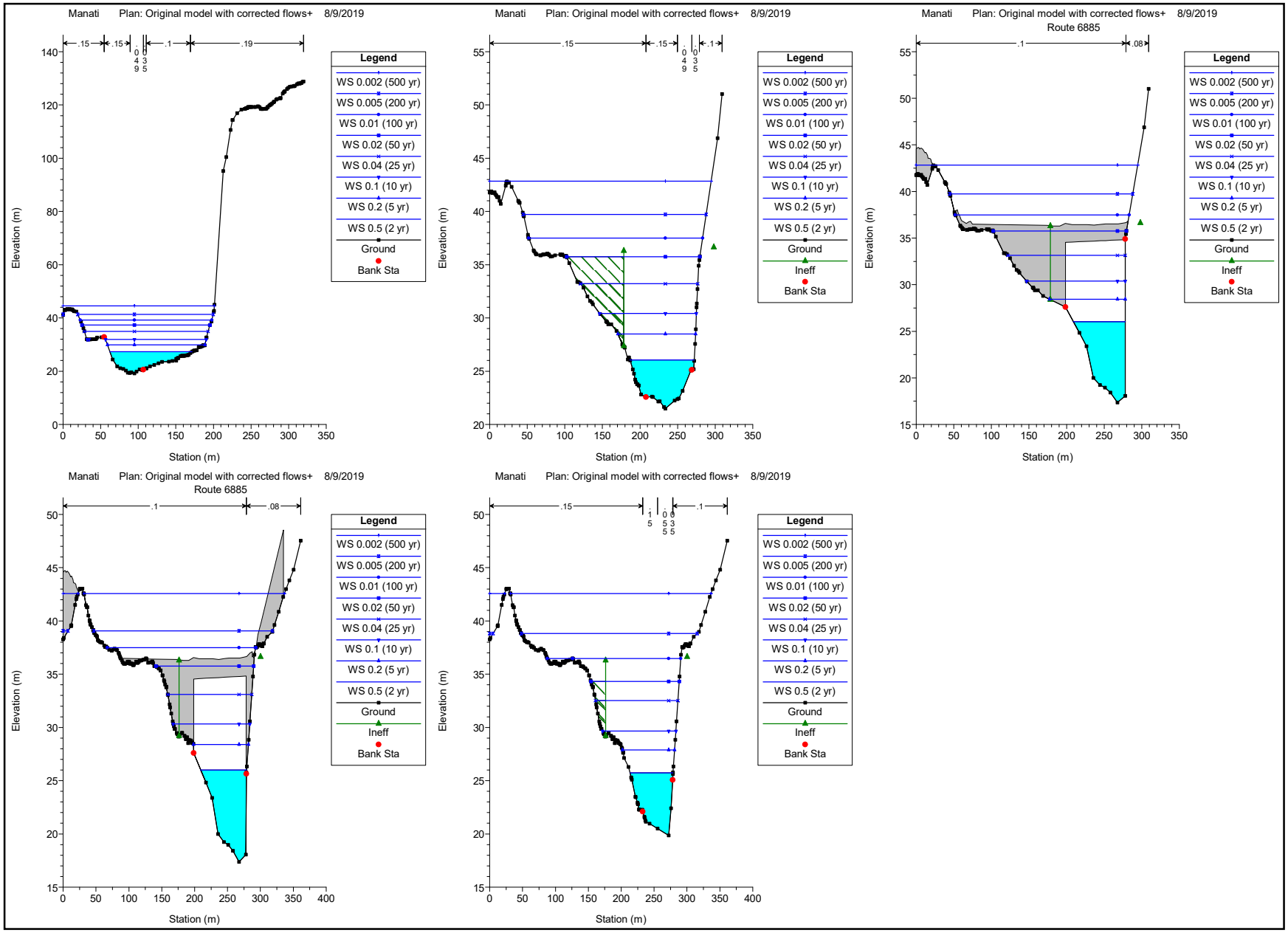
Alternative 3b (Non-Structural Relocations - Recommended Plan) Results in Project Area



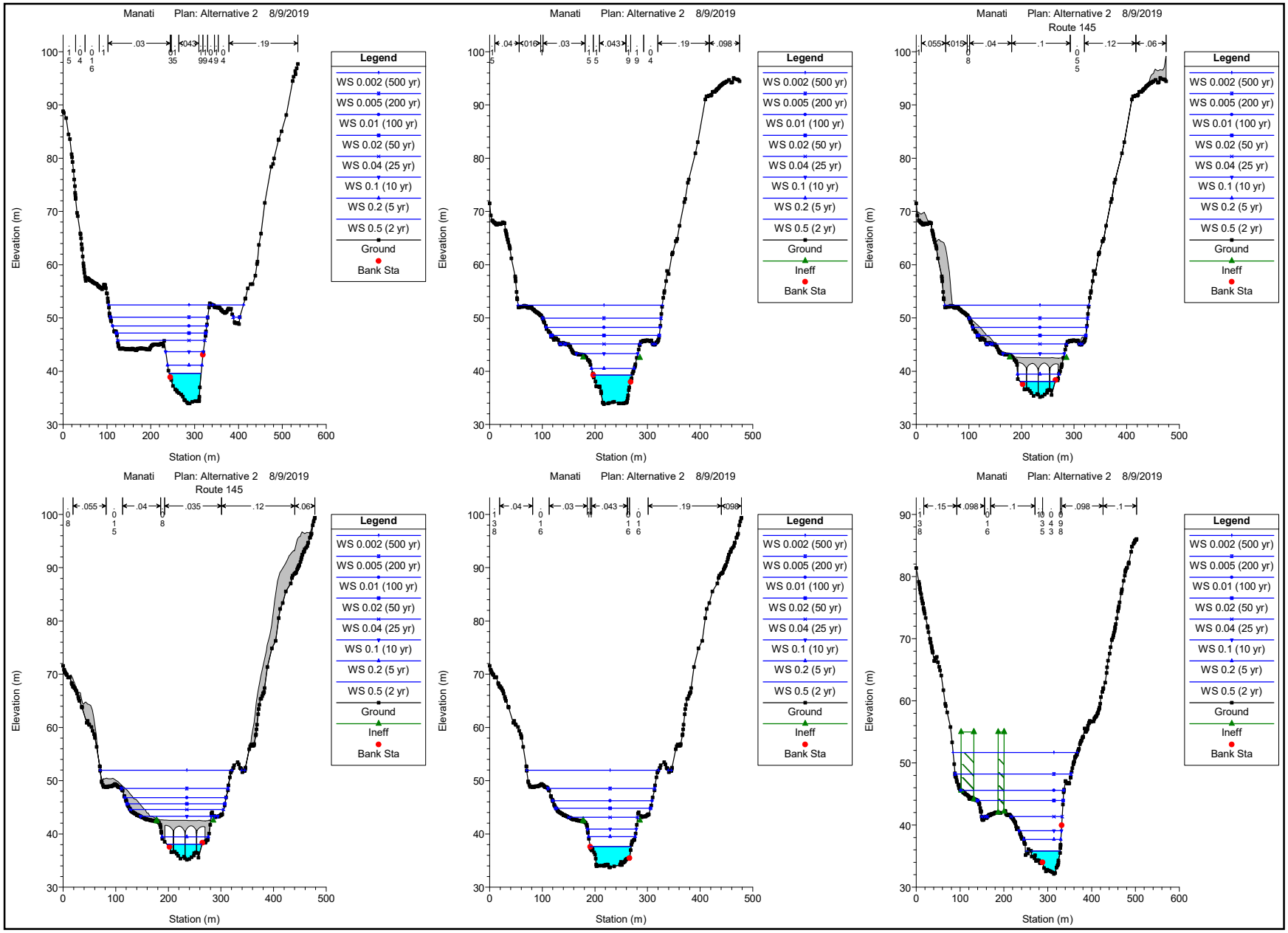
Alternative 3b (Non-Structural Relocations - Recommended Plan) Results in Project Area



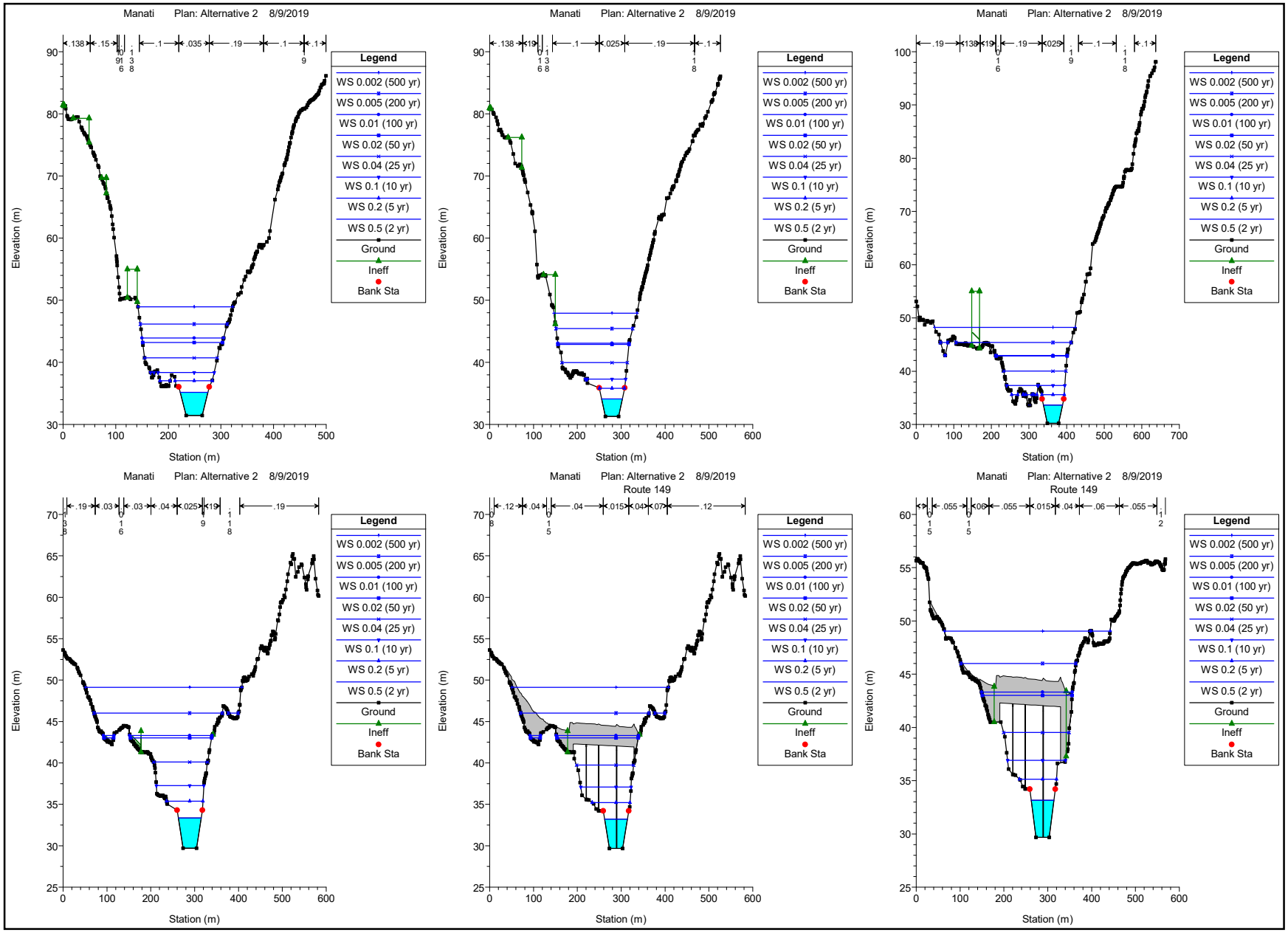
Alternative 3b (Non-Structural Relocations - Recommended Plan) Results in Project Area



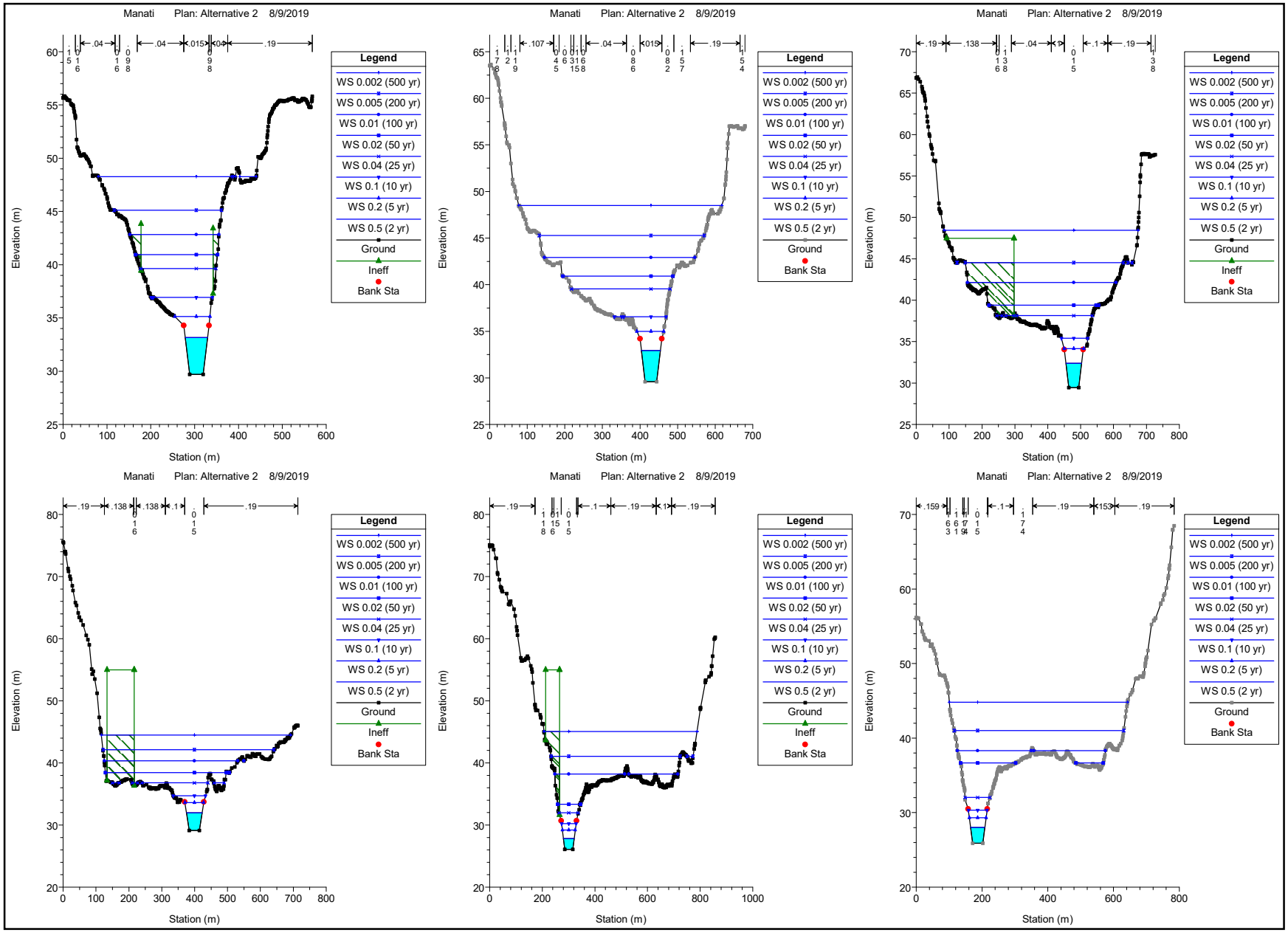
Alternative 4 (Channelization) Results in Project Area



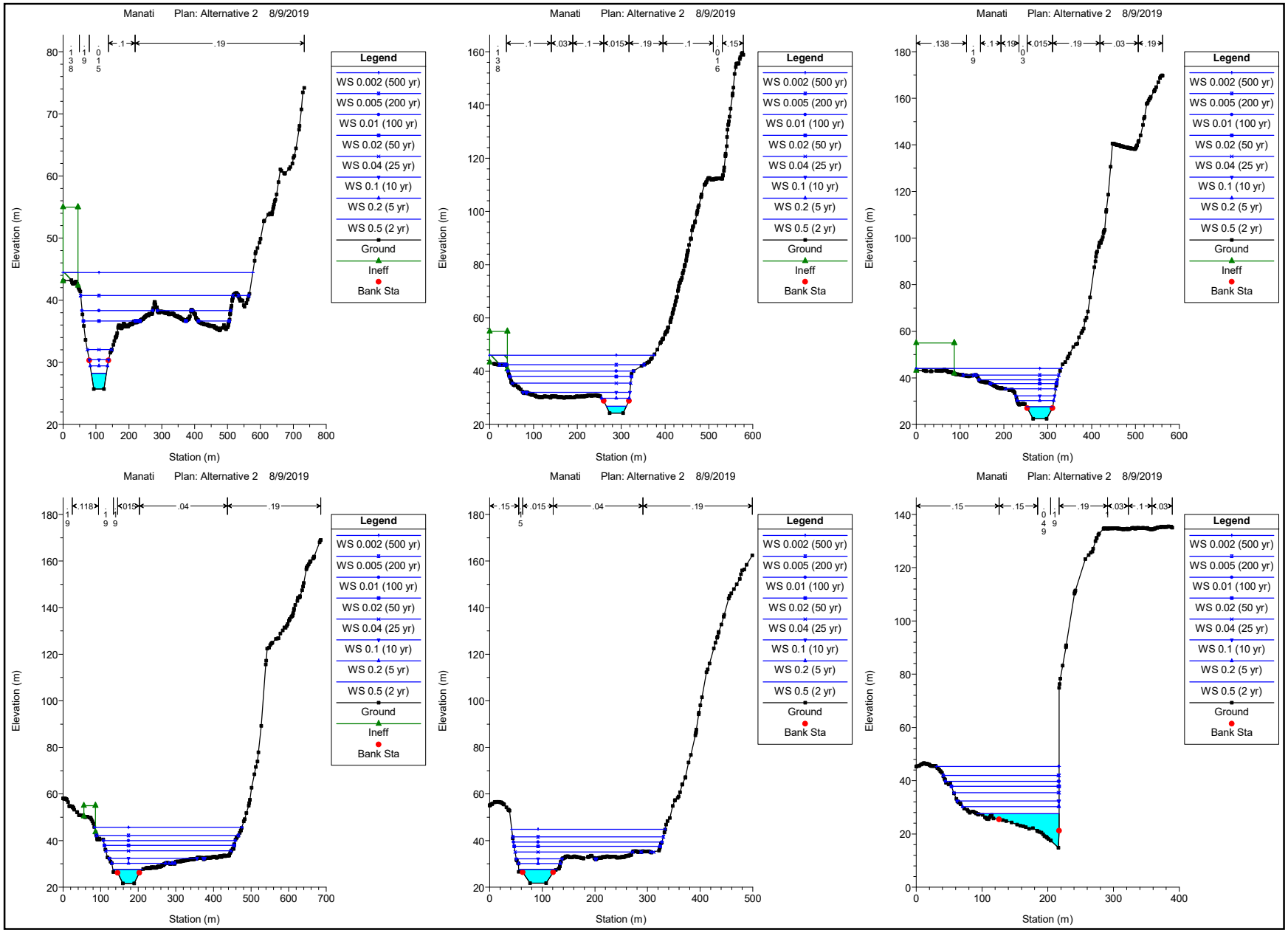
Alternative 4 (Channelization) Results in Project Area



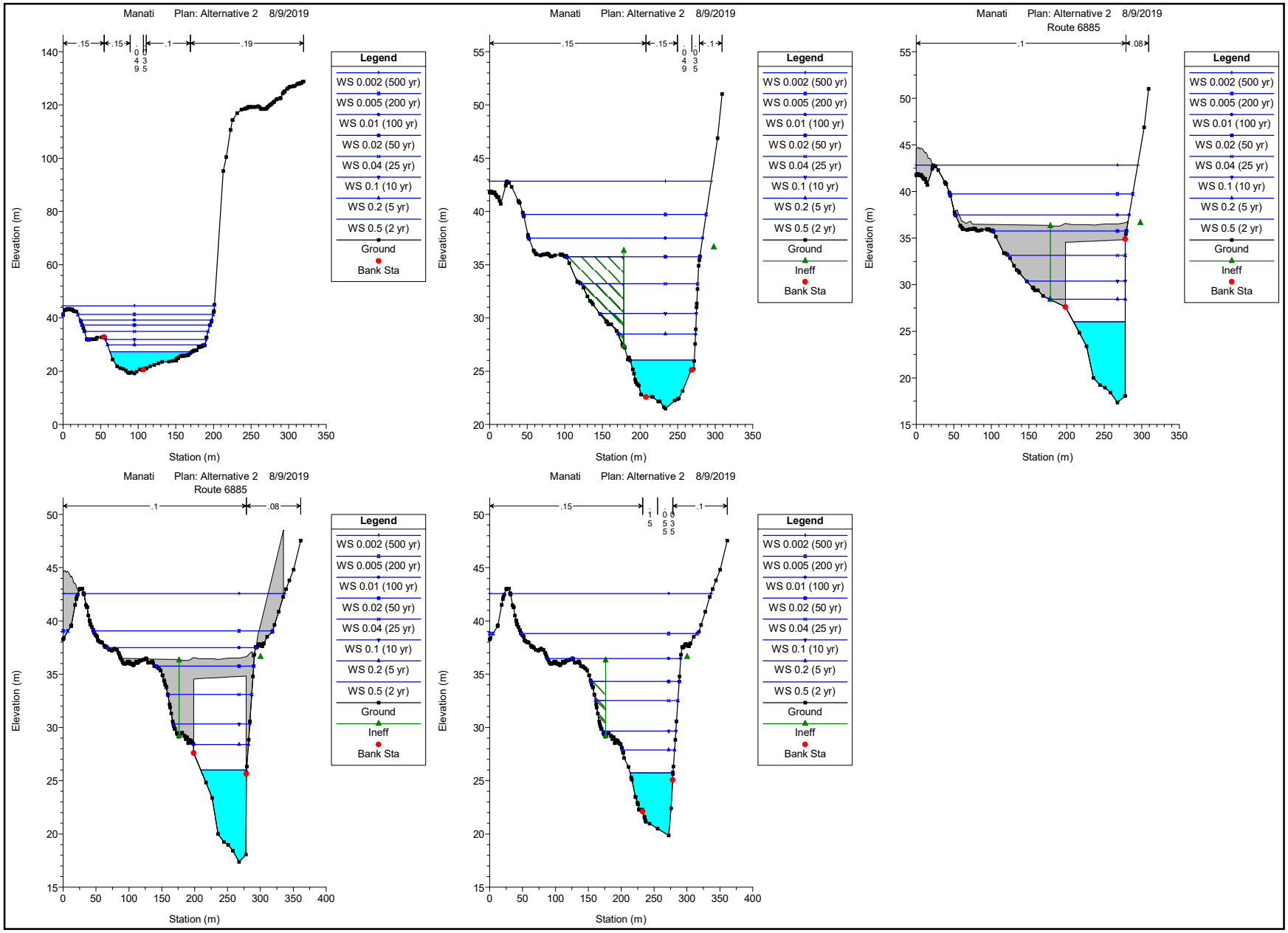
Alternative 4 (Channelization) Results in Project Area



Alternative 4 (Channelization) Results in Project Area



Alternative 4 (Channelization) Results in Project Area



Attachment 4
Quantity Summaries for Options Considered In Alternatives

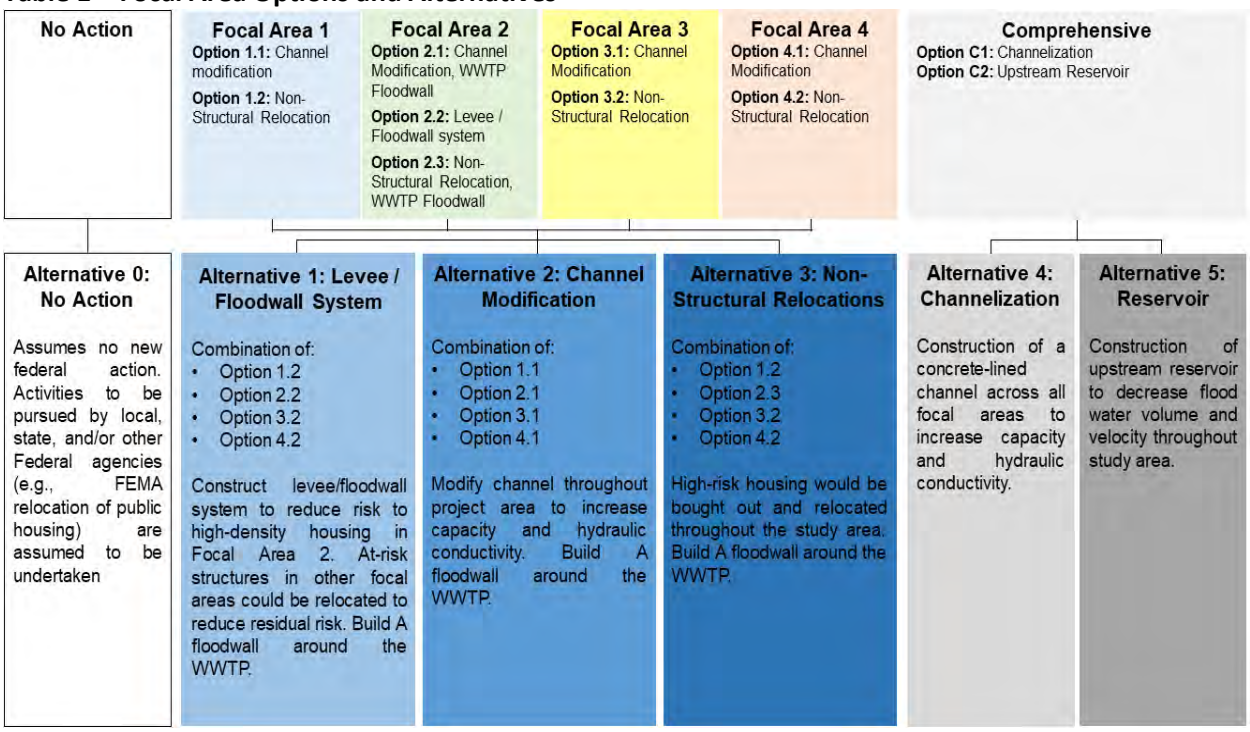
Quantity Summaries for Options Considered in Alternatives

The Alternatives considered were based on the combination of one or more Flood Risk Management Measures (or Options) within each Focal Area.

Quantities for each Option were then calculated and provided to the PDT Cost Engineer. Depending on the Alternative, summary sheets and / or detailed quantity workbooks are included in this Attachment.

The combinations of Options per Focal Area are listed and shown graphically in the Main Report with the descriptions and summary reproduced here. (See Table 1 below)

Table 1 – Focal Area Options and Alternatives



Alternatives are named for the primary flood risk management measure included with each option within that Alternative described below.

1. <u>Alternative 1</u>. - Levee/Floodwall System

   - <u>Options 1.2., 3.2., 4.2. Non-Structural Relocations</u>: High-risk structures within the floodplain would be bought out and residents relocated outside of the floodplain. Participation in the acquisition and relocation program would be mandatory. The floodplain would be planted with native vegetation. The local sponsor would retain ownership of the acquired property and must ensure no future development or fill

would occur. The acquired area could be deeded to the local government and/or converted to undeveloped public space.

- Option 2.2. Levee/Floodwall System: This option would include construction of a floodwall/levee system similar to that proposed under the original Flood Protection Works plan. This option would include a floodwall or ring levee around the wastewater treatment plant to protect this critical infrastructure that also serves areas outside of Dos Rios and Alturas de Ciales (e.g., Ciales Pueblo).

2. Alternative 2. - Channel Modification

- Options 1.1., 3.1., 4.1. Channel Modification: Channel modifications would include channel widening to increase capacity and realignment to improve hydraulic conductivity and prevent water backup upstream of the existing river bend. A floodplain bench would also be constructed to restore natural floodplain processes.

- Option 2.1. Channel Modification and Protection of Wastewater Treatment Plant: Channel modifications would include channel realignment through the field opposite of Dos Rios to improve hydraulic conductivity. The channel would be designed to increase capacity and create improved floodplain connection. This option would also include a floodwall or ring levee around the wastewater treatment plant to protect this critical infrastructure.

3. Alternative 3. - Non-Structural Relocations

- Options 1.2., 3.2., 4.2. Non-Structural Relocations: High-risk structures within the floodplain would be acquired and residents relocated outside of the floodplain. Participation in the acquisition and relocation program would be mandatory. The floodplain would be planted with native vegetation. The local sponsor would retain ownership of the acquired property and must ensure no future development or fill would occur; however, the acquired area could be deeded to the local government and/or converted to undeveloped public space

- Option 2.3. Non-Structural Relocations & Protection of Wastewater Treatment Plant: High-risk structures within the Dos Rios and Alturas de Ciales communities would be bought out and residents relocated outside of the floodplain. Participation in the acquisition and relocation program would be mandatory. The floodplain would be planted with native vegetation. The local sponsor would retain ownership of the acquired property and must ensure no future development or fill would occur; however, the acquired area could be deeded to the local government and/or converted to undeveloped public space. This option would include a floodwall or ring levee around the wastewater treatment plant to protect this critical

infrastructure that also serves areas outside of Dos Rios and Alturas de Ciales (e.g., Ciales Pueblo).

4. Alternative 4. - Channelization

- Option C1. Channelization: Channelization would involve channel improvements (i.e., widening and deepening) to increase capacity. The channel would be lined with concrete to decrease roughness, increase hydraulic conductivity, and maintain desired channel geometry and location. Channelization would be designed to reduce inundation of structures, infrastructure (i.e., roadways), and public facilities (i.e., wastewater treatment plant). Channelization would also reduce risks associated with flood-caused bank failure.

The Recommended Plan is a modified version of Alternative 3. More specifically, the Recommended Plan includes the following generalized scope of work:

- Non-Structural Relocations. Structures located within the 0.04 AEP floodplain would be acquired and demolished. Residents would be relocated outside of the floodplain. The floodplain would be planted with native vegetation. The local sponsor would retain ownership of the acquired property and must ensure no future development or fill would occur; however, the acquired area could be deeded to the local government and/or converted to undeveloped public space (e.g., recreational/sports fields).

Estimated Construction Line Item (CLIN) quantities for Options OTHER THAN the Non-structural Relocations Option are herein provided.

Quantities for the Recommended Alternative, Non Structural Relocations Option are provided in the Cost Appendix.

Alternative 1
Levee and Floodwall System

FLOOD POTECTION WORKS
DOS RIOS, CIALES, PR
BID SCHEDULE

Item No.	Spec. No.	Approx. Quantity	Unit	Description	Unit Price	Amount Bid
				GENERAL		
1	01511	1	LS	Mobilization	$120,000.00	$120,000.00
2	01506	18	MO	Field Engineer's Office	$1,950.00	$35,100.00
3	01515	2	EA	Project Signs	$1,000.00	$2,000.00
4	02050	14	CDA	Site Preparation	$1,000.00	$14,000.00
5	02530	260	LM	Chain -link Fence	$60.00	$15,600.00
6	02530	1	EA	Chain -link Gate	$1,000.00	$1,000.00
7	02531	1,050	LM	Babed Wire Fence	$15.00	$15,750.00
8	MOT Dwgs.	1	LS	Maintenance of Traffic	$15,000.00	$15,000.00
				EARTH DIKE		
9	02250	1,925	CM	12" Gabion Mattress	$150.00	$288,750.00
10	02545	2,600	SM	Slope Vegetating	$2.00	$5,200.00
11	02200	500	CM	Uncl. Exc. for Access Road Ret. Walls	$12.00	$6,000.00
12	03300	600	CM	Reinforced Concrete	$450.00	$270,000.00
13	02500	40	CM	Aggregate for Access Road	$25.00	$1,000.00
14	02500	36	TON	Hot Plant Mix S-1 for Access Road	$135.00	$4,860.00
				FLOOD WALLS		
15	02200	47,100	CM	Uncl. Excavation for Structures	$15.00	$706,500.00
16	03300	9,300	CM	Reinforced Concrete	$450.00	$4,185,000.00
17	RW Dwgs.	1,386	CM	2" Gravel Bedding	$20.00	$27,720.00
18	02307	1	EA	12" Flap Valve	$600.00	$600.00
19	02307	1	EA	24" Flap Valve	$1,495.00	$1,495.00
20	02307	2	EA	30" Flap Valve	$1,950.00	$3,900.00
				RETENTION POND		
21	02200	27,100	CM	Uncl. Excavation for Retention Pond	$15.00	$406,500.00
22	02545	1,640	SM	Slope Vegetating	$2.00	$3,280.00
23	02500	25	CM	Aggregate for Access Ramp	$25.00	$625.00
24	02500	23	TON	Hot Plant Mix S-1	$135.00	$3,105.00
				RIVER WIDENING		
25	02200	173,400	CM	Uncl. Excavation for River Widening	$10.00	$1,734,000.00
26	02250	4,300	CM	12" Gabion Mattress	$100.00	$430,000.00
				DRAINAGE		
27	02200	2,860	CM	Trench Excavation	$25.00	$71,500.00
28	Dwg. DR-05	260	CM	Bedding (Granular Material)	$20.00	$5,200.00
29	02265	33	LM	18" RC Pipe, Class III	$120.00	$3,960.00
30	02265	243	LM	24" RC Pipe, Class III	$200.00	$48,600.00
31	02265	275	LM	30" RC Pipe, Class III	$300.00	$82,500.00
32	02265	102	LM	42" RC Pipe, Class III	$560.00	$57,120.00
33	02265	30	LM	42" Polyethylene Pipe	$400.00	$12,000.00
34	02265	53	LM	48" x 24" for R.C. Box	$650.00	$34,450.00
35	02215	4	EA	Inlet Type I	$3,500.00	$14,000.00
36	02215	11	EA	Inlet Type 2	$4,000.00	$44,000.00
37	02215	1	EA	Inlet Type 3	$5,200.00	$5,200.00
38	Dwg. DR-04	2	EA	Special Inlet for R.C. Box Culvert	$2,000.00	$4,000.00
39	Dwg. DR-05	580	LM	Pavement Saw Cut	$15.00	$8,700.00
40	02500	50	CM	Aggregate Base Course "Class A" (6" Layer)	$45.00	$2,250.00
41	02500	45	TON	Hot Plant Mix B-1 (8" Layer)	$135.00	$6,075.00
42	02500	174	TON	Hot Plant Mix S-1 (2" Layer)	$135.00	$23,490.00
43	02215	1	EA	Grate Inlet	$4,500.00	$4,500.00
44	02215	1	EA	24" Headwall	$2,800.00	$2,800.00
45	02215	2	EA	42" Headwall	$4,500.00	$9,000.00
46	02215	4	EA	Manhole Type I	$5,000.00	$20,000.00

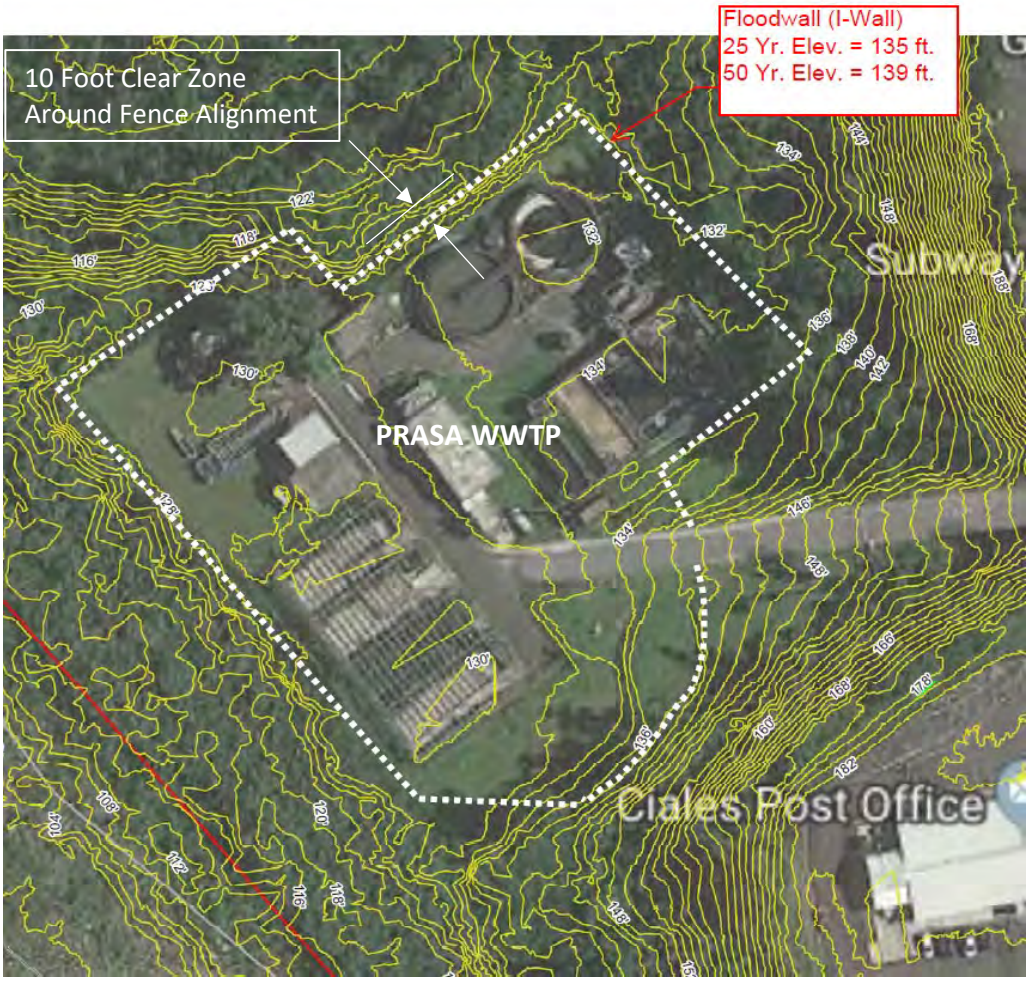
Cont.

Item No.	Spec. No.	Approx. Quantity	Unit	Description	Unit Price	Amount Bid
				LANDSCAPING		
47	RD Dwgs.	16	EA	Planting Annona Glabra	$100.00	$1,600.00
48	RD Dwgs.	16	EA	Planting Thespesia populnea	$100.00	$1,600.00
49	RD Dwgs.	16	EA	Planting Calophyllim calaba	$120.00	$1,920.00
50	RD Dwgs.	16	EA	Planting Hibiscus pernambucencis	$100.00	$1,600.00
51	RD Dwgs.	16	EA	Planting Mammea americana	$100.00	$1,600.00
52	RD Dwgs.	16	EA	Planting Prestoea montana	$120.00	$1,920.00
				ESTIMATED CONSTRUCTION COST		$8,766,570.00
				CONTINGENCIES (10%)		$876,657.00
				TOTAL WITH CONTINGENCIES		**$9,643,227.00**

Alternative 2
Channel Modification

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 8/28/2019
		Checked By:
	Subject: **Rio Grande de Manati - Bank Protection Project**	Date:
	Comp: CLIN 0010, Clear and Grub for Floodwall	Page: 1 of 1

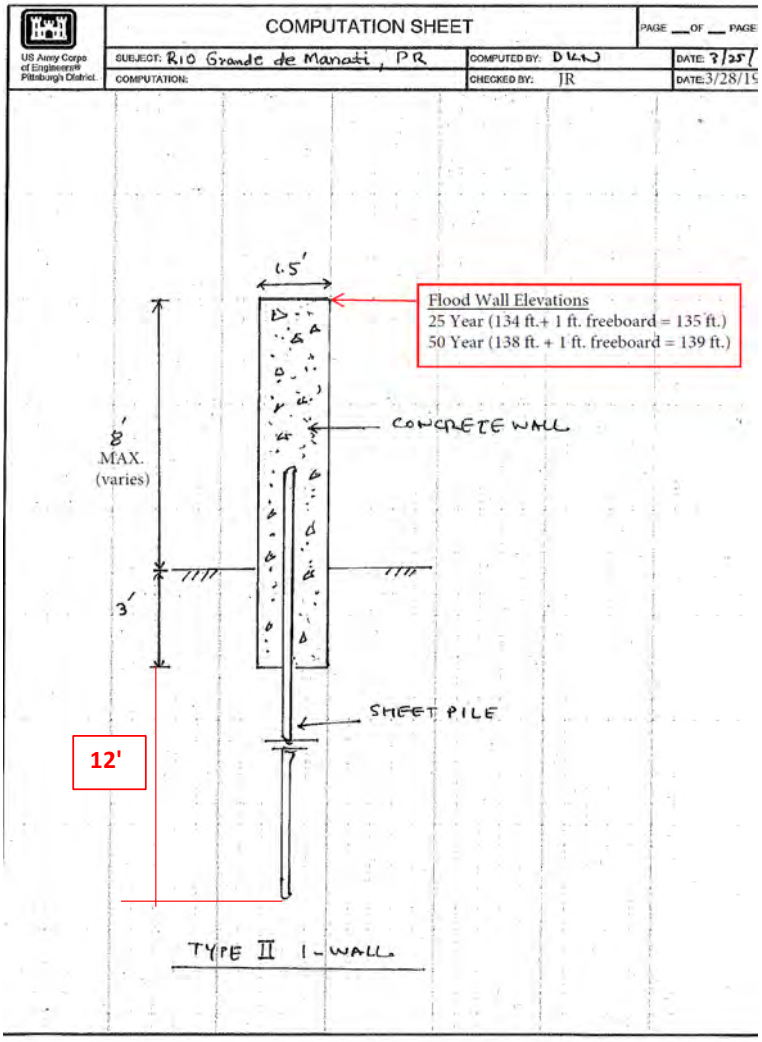
Item	Description	Quant	Unit
0010	Clear and Grub for Floodwall	1,467	SY



Length of Floodwall	1,200	LF	Area (SF)	12,000	SF
Width of Clearing	10	LF			
			Area (SY)	1,333	SY
			Add (10%)	133	SY
			Say	**1,467**	**SY**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 8/28/2019
		Checked By:
	Subject: **Rio Grande de Manati - Bank Protection Project**	Date:
	Comp: CLIN 0011, Sediment Removal and Disposal	Page: 1 of 1

Item	Description	Quant	Unit
0011	Construct Conc Cap Sheet Pile (Type I-2) Floodwall	1,200	LF



Assume: Floodwall height might vary. For the ppurpose of this estimate we are assuming a constant wall height of eight feet and a length of 1,200 feet.

Concrete Volume estimate = (1,200 ft x 1.5 ft x 11 ft. / 27) + 10% = 806 CY

Note: For sheet pile driving, consider difficult to drive when calculating cost.

Length	Sheetpile	**1,200**	LF	(assume 18 ft depth) =	**21,600**	**SF**
	Concrete	**806**	CY			

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By:	JR
			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative**	Date:	8/15/2019
	Comp:	**Quantities Summary**	Page:	1 of 1

Item	Description	Quantity	Unit	Unit Price	Extended Price	Remarks
	General Construction Activities					
0001	Reimbursement for Actual Performance and Payment Bonds Premiums	**1**	JOB	0.00	**0.00**	
0002	Digital Progress Images	**18**	SET	0.00	**0.00**	one set per month of construction
0003	Mobilization and Demobilization	**1**	JOB	0.00	**0.00**	
0004	Protection and Maintenance of Traffic During Construction	**1**	JOB	0.00	**0.00**	
0005	Erosion and Sediment Controls	**1**	JOB	0.00	**0.00**	
	Rock Construction Entrance Geotextile	450	SY	0.00	0.00	5 access points
	Rock Construction Entrance AASHTO 1	100	CY	0.00	0.00	
	Temporary Cofferdam / Stream Diversion	0	LF	0.00	0.00	along entire length of channelized area
0006	Field Survey	**1**	JOB	0.00	**0.00**	
0007	Clearing and Grubbing for Channelization	**30**	AC	0.00	**0.00**	
0009	Site Restoration	**1**	JOB	0.00	**0.00**	
	Construct Channel Improvement					
0008	Excavation for Improved Channel	**1,110,000**	CY	0.00	**0.00**	
0008(1)	Channel Slope Stone Lining	**18,200**	CY	0.00	**0.00**	
0008(2)	Channel Bottom Material	**63,600**	CY	0.00	**0.00**	
					0.00	

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By: JR Date: 8/12/2019 Checked By: NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date: 8/15/2019
	Comp:	CLIN 0001, Reimbursement for Actual Performance and Payment Bonds Premiums	Page: 1 of 1

Item	Description	Quant	Unit
0001	Reimbursement for Actual Performance and Payment Bonds Premiums	1	JOB

Standard Contract Requirements. No quantities to calculate

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By:	JR
			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date:	8/15/2019
	Comp:	CLIN 0002, Digital Progress Images	Page:	1 of 1

Item	Description	Quant	Unit
0002	Digital Progress Images	18	SET

Contract duration is assumed 18 months, with some inactive time.
Units defined as "SET" is a technical spec section requirement.
One SET per month during period of construction.

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By:	JR
			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date:	8/15/2019
	Comp:	CLIN 0003, Mobilization and Demobilization	Page:	1 of 1

Item	Description	Quant	Unit
0003	Mobilization and Demobilization	1	JOB

Mobilization and demobilization requirements may be different for each type of contract. For this effort it is calculated as a one time mobilization and a one time demobilization during the period of construction.

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By:	JR
			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date:	8/15/2019
	Comp:	CLIN 0004, Protection and Maintenance of Traffic During Co	Page:	1 of 1

Item	Description	Quant	Unit
0004	Protection and Maintenance of Traffic During Construction	1	JOB

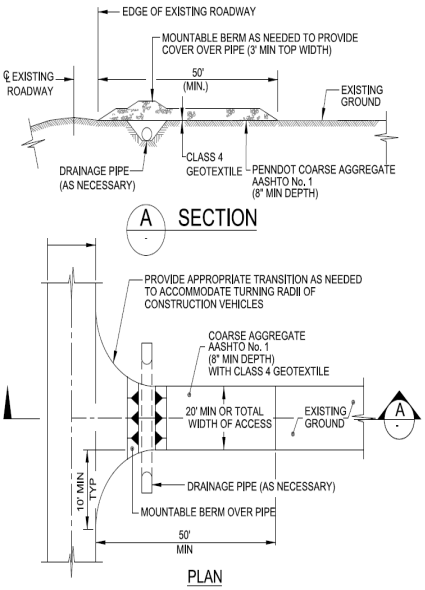
Contractor shall adequately maintain traffic at construction entrances to river and repair sites.
Assume **three** locations needing two std traffic signs and possibly
flag personnel for duration of construction period.
It is likely that for the three locations chosen, that construction crew members act as flaggers.

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By: JR
			Date: 8/12/2019
			Checked By: NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date: 8/15/2019
	Comp:	CLIN 005, Erosion and Sediment Controls	Page: 1 of 2

Item	Description	Quant	Unit
0005	Erosion and Sediment Controls	1	JOB

Rock Construction Entrance:

Assume **four** construction access locations		4.0	EA
Length		50.0	LF
Width		20.0	LF
Geotextile for RCE:		**450.0**	**SY**
Surface Area of RCE		1000.0	SF
Total Area		4000.0	SF
		444.4	SY
	SAY	**450.0**	**SY**
AASHTO 1:		**100.0**	**CY**
Thickness		0.7	LF
Volume per RCE		666.7	CF
Total Volume		2666.7	CF
		98.8	CY
	SAY	**100**	**CY**



US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By: JR Date: 5/24/2019 Checked By: NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date: 8/15/2019
	Comp:	CLIN 005, Erosion and Sediment Controls	Page: 2 of 2

Assume Work is 1,900 feet of river at a time requires 4 diversions of some type

Temp. Cofferdam / Stream Diversion :

Location Of Channel Section	Length per Location *Length*	*Total*
Location 1 -	**1,900**	**1,900**
Location 2 -	**1,900**	**1,900**
Location 3-	**1,900**	**1,900**
Location 4 -	**1,900**	**1,900**
TOTAL LENGTH OF BANK PROTECTION		**7,600**
Add 25 feet of diagonal diversion to shore each for U/S and D/S Portions	**200**	**7,800**
Length of Temporary Cofferdam / Diversion		**7,800**
10% waste factor / overlap		**780**
Length of Temporary Cofferdam / Diversion		**8,580**

Cofferdam / Stream diversion: **Say** **8,580**

Cofferdams / diversions to be constructed for each of the **four** locations of bank protection, independently. *(Assume jersey Barrier Type cofferdam on top of one layer of sandbags and plastic sheeting construction)* . Angle 45 degrees to shore each location upstream and downstream

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			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date:	8/15/2019
	Comp:	CLIN 0006, Field Survey	Page:	1 of 1

Item	Description	Quant	Unit
0006	Field Survey	1	JOB

Field Surveying to include:

pre and post topographic survey of all areas to allow for .

1. verification of current contours in order to verify existing conditions,
2. calculate post construction contours, height, width, length of bank protection and excavation.

Assume amount of acreage to be 100 feet on either side of channel

(440 feet x 7,800 feet)/ 43560 = **78.78788** Acres

Say **79** Acres

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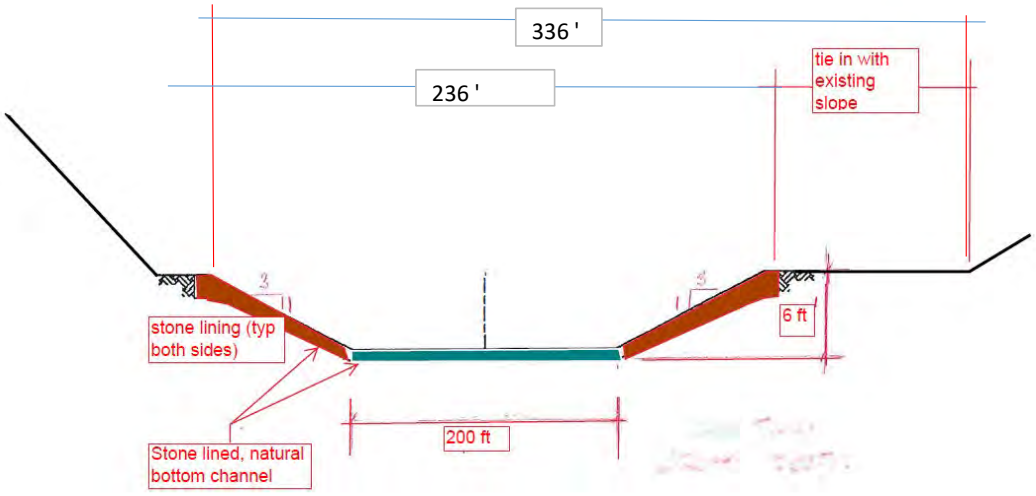
			Date: 8/12/2019
			Checked By: NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date: 8/15/2019
	Comp:	CLIN 0007, Clearing and Grubbing for Bank Protection	Page: 1 of 1

Item	Description	Quant	Unit
0007	Clearing and Grubbing for Channelization	30	AC

Assume 50% of area receiving channel as overgrown and that will have to be cleared and grubbed.



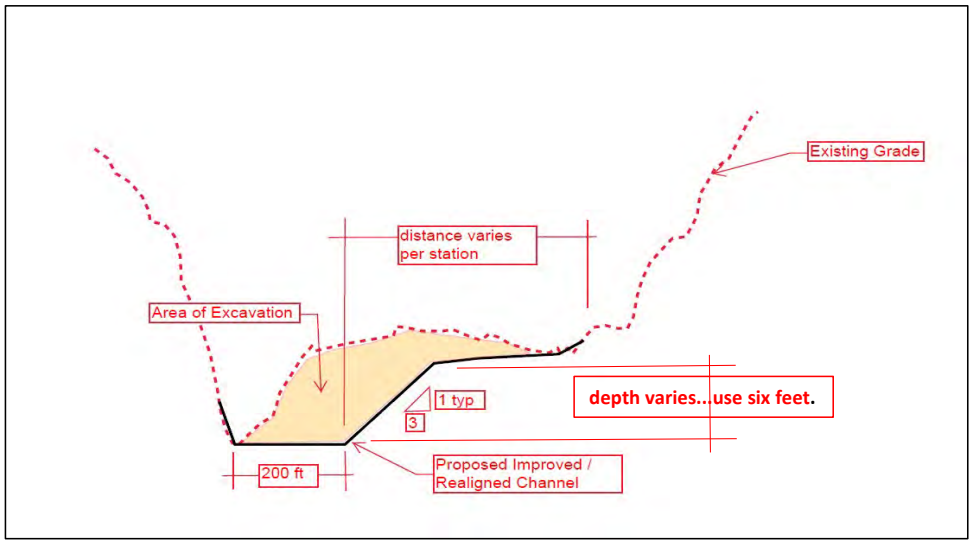
Also assume that areas outside of channel to be cleared for access, storage of material; etc.
Assume additional 100 feet outside of channel.

Total length of replacement

Channel Length	**7,800**	LF	Total Area	2,620,800	SF
Addn'l length	**0**	LF	50 % needing cleared	1,310,400	SF
Total length	**7,800**	LF			
Width	**336**	LF			
			Total Area (Acres)	**30**	**AC**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By:	JR
			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date:	8/15/2019
	Comp:	CLIN 0008, Excavation for Improved Channel	Page:	1 of 1

Item	Description	Quant	Unit
0008	Excavation for Improved Channel	1,110,000	CY



Typical Excavation within channel along improved river reach

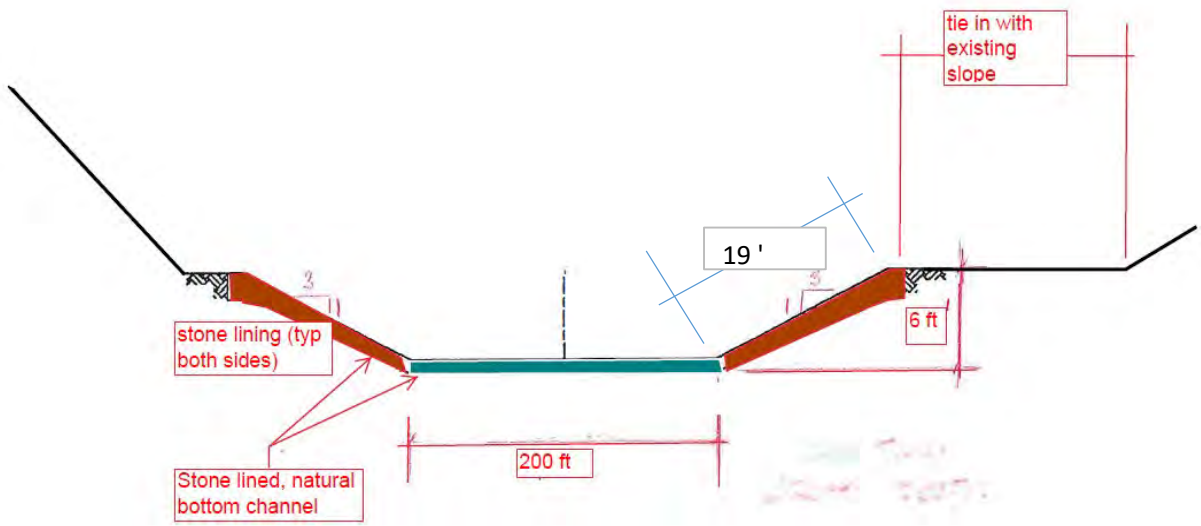
For entire length of improved channel reach, assume typical cross section for excavation and flattening out floodway areas and tie into existing grade.

River Station	Area (sq.mtr.)	Distance (meter)	Volume (cu.mtr.)	Volume (CY)
32740	0			
		285	57,000	**74,550**
32455	**400**			
		130	52,000	**68,011**
32325	**400**			
		90	43,110	**56,384**
32235	558			
		512	320,768	**419,532**
31723	695			
		279	185,535	**242,661**
31444	**635**			
		430	159,100	**208,087**
31014	**105**			
		564	29,610	**38,727**
30450	0			
SUM			**847,123**	**1,107,952**
			Say	**1,110,000**
		2,290	meters	
		7,513	feet	

1 meter	=	3.281	Ft
1 cu.mtr	=	1.3079	CY

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By:	JR
			Date:	8/12/2019
			Checked By:	NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date:	8/15/2019
	Comp:	CLIN 0008(1), Channel Slope Stone Lining	Page:	1 of 1

Item	Description	Quant	Unit
0008(1)	Channel Slope Stone Lining	18,200	CY



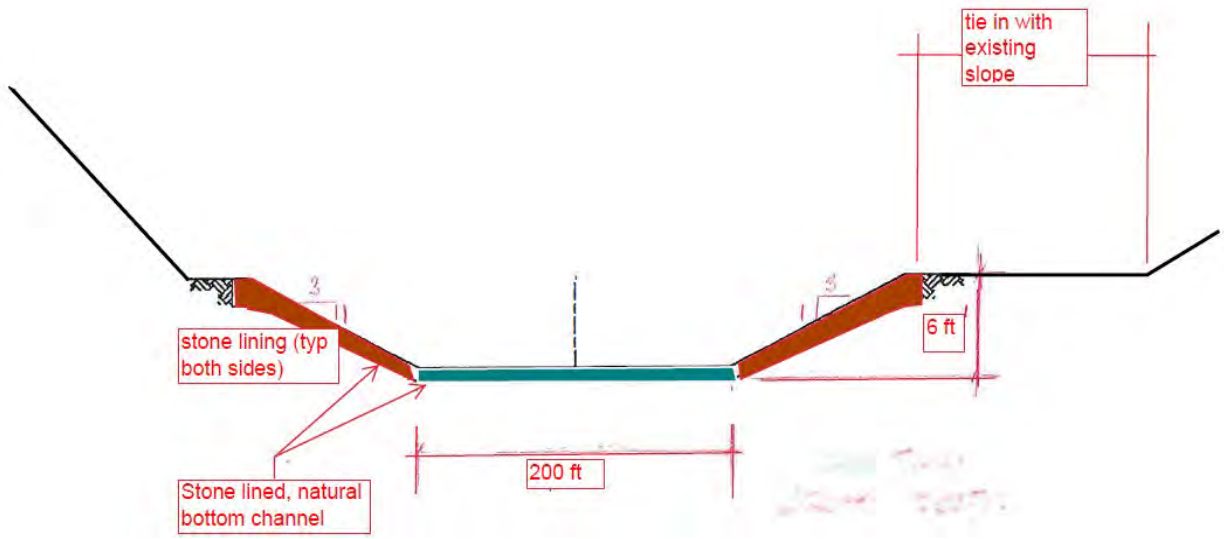
For entire length of improved channel alignment, assume R-5 Riprap Stone lining 18-inches depth, both sloped banks

Total length of Channel Lining		**7,800**	LF X	**2**	Sides	=	**15,600**	
Total	Length	**15,600**	LF	Total Volume			444,600	CF
	Depth	**1.5**	LF					
	Width	**19**	**LF**	Volume (CY)			16,467	CY
				Waste (10%)			1,647	CY
				Total			18,113	CY
						Say	**18,200**	**CY**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET		Computed By: JR
			Date: 8/12/2019
			Checked By: NL
	Subject:	**Rio Grande de Manati - Channel Improvement - Alternative No. 4**	Date: 8/15/2019
	Comp:	CLIN 0008(2), Channel Bottom Material	Page: 1 of 1

Item	Description	Quant	Unit
0008(2)	Channel Bottom Material	63,600	CY

12-inch depth of river run material for natural bottom of channel



For entire length of channel improvement alignment

Total length of Channel Lining	**7,800**	LF X	**1**	Sides	=	**7,800**

Total	Length	**7,800**	LF	Total Volume	1,560,000	CF
	Depth	**1**	LF			
	Width	**200**	**LF**	Volume (CY)	57,778	CY
				Waste (10%)	5,778	CY
				Total	63,556	CY
				Say	**63,600**	**CY**

Alternative 3
Nonstructural Relocations / Recommended Plan

(See Cost Appendix for Quantities associated with non-Structural Relocations)

Alternative 4
Channelization

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By:	JR
		Date:	5/24/2019
		Checked By:	
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:	
	Comp: **Quantities Summary**	Page:	1 of 1

Item	Description	Quantity	Unit	Unit Price	Extended Price	Remarks
	General Construction Activities					
0001	Reimbursement for Actual Performance and Payment Bonds Premiums	**1**	JOB	0.00	**0.00**	
0002	Digital Progress Images	**18**	SET	0.00	**0.00**	one set per month of construction
0003	Mobilization and Demobilization	**1**	JOB	0.00	**0.00**	
0004	Protection and Maintenance of Traffic During Construction	**1**	JOB	0.00	**0.00**	
0005	Erosion and Sediment Controls	**1**	JOB	0.00	**0.00**	
	Rock Construction Entrance Geotextile	450	SY	0.00	0.00	5 access points
	Rock Construction Entrance AASHTO 1	100	CY	0.00	0.00	
	Temporary Cofferdam / Stream Diversion	11,000	LF	0.00	0.00	along entire length of channelized area
0006	Field Survey	**1**	JOB	0.00	**0.00**	
0007	Clearing and Grubbing for Channelization	**39**	AC	0.00	**0.00**	
0009	Site Restoration	**1**	JOB	0.00	**0.00**	
	Construct Concrete Channel					
0008	Excavation for Channel Construction	**1,870,000**	CY	0.00	**0.00**	
0008(1)	Geotextile Fabric Separation Layer	**40,000**	SY	0.00	**0.00**	
0008(2)	Aggregate Base for Concrete	**36,667**	CY	0.00	**0.00**	
0008(3)	Concrete for Channel	**53,350**	CY	0.00	**0.00**	
0008(4)	Steel for Channel	**213,400**	SY	0.00	**0.00**	
					0.00	

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR Date: 5/24/2019 Checked By:
Subject:	**Rio Grande de Manati - Channelization Alternative**	Date:
Comp:	CLIN 0001, Reimbursement for Actual Performance and Payment Bonds Premiums	Page: 1 of 1

Item	Description	Quant	Unit
0001	Reimbursement for Actual Performance and Payment Bonds Premiums	1	JOB

Standard Contract Requirements. No quantities to calculate

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0002, Digital Progress Images	Page: 1 of 1

Item	Description	Quant	Unit
0002	Digital Progress Images	18	SET

Contract duration is assumed 18 months, with some inactive time.
Units defined as "SET" will is a spec section requirement.
One SET per month during period of construction.

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0003, Mobilization and Demobilization	Page: 1 of 1

Item	Description	Quant	Unit
0003	Mobilization and Demobilization	1	JOB

Mob and demob requirements may be different for each type of contract.
For this effort it is calculated as a one time mobilization and a one time demob.
during the period of construction.

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0004, Protection and Maintenance of Traffic During Co	Page: 1 of 1

Item	Description	Quant	Unit
0004	Protection and Maintenance of Traffic During Construction	1	JOB

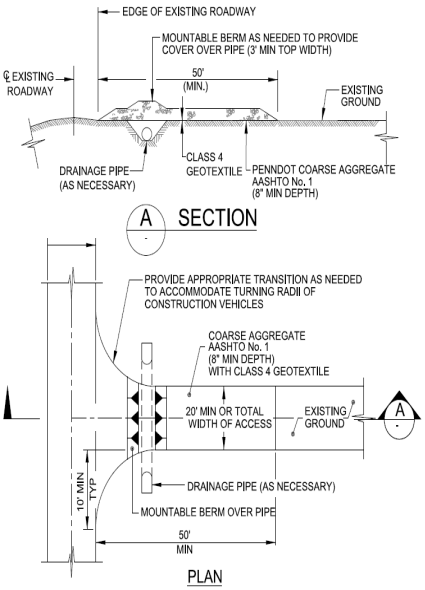
Contractor shall adequately maintain traffic at construction entrances to river and repair sites.
Assume **three** locations needing two std traffic signs and possibly
flag personnel for duration of construction period.
It is likely that for the three locations chosen, that construction crew members act as flaggers.

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 005, Erosion and Sediment Controls	Page: 1 of 2

Item	Description	Quant	Unit
0005	Erosion and Sediment Controls	1	JOB

Rock Construction Entrance:

Assume **four** construction access locations		4.0	EA
Length		50.0	LF
Width		20.0	LF
Geotextile for RCE:		**450.0**	**SY**
Surface Area of RCE		1000.0	SF
Total Area		4000.0	SF
		444.4	SY
	SAY	**450.0**	**SY**
AASHTO 1:		**100.0**	**CY**
Thickness		0.7	LF
Volume per RCE		666.7	CF
Total Volume		2666.7	CF
		98.8	CY
	SAY	**100**	**CY**



Cofferdam / Stream diversion: **11000 LF**

Cofferdams / diversions to be constructed for each of the **five** locations of bank protection, independently. *(Assume jersey Barrier Type cofferdam on top of one layer of sandbags and plastic sheeting construction)* . Angle 45 degrees to shore each location upstream and downstream

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 005, Erosion and Sediment Controls	Page: 2 of 2

Assume Work in1, 500 feet of river at a time requires 6 diversions of some type

Temp. Cofferdam / Stream Diversion :

Location Of Channel Section	*Length*	Length per Location	*Total*
Location 1 -	1,500		1,500
Location 2 -	1,500		1,500
Location 3-	1,500		1,500
Location 4 -	1,500		1,500
Location 5-	1,500		1,500
Location 6-	1,500		1,500
TOTAL LENGTH OF BANK PROTECTION			9,000
Add 25 feet of diagonal diversion to shore each for U/S and D/S Portions	300		300
Length of Temporary Cofferdam / Diversion			9,300
10% waste factor / overlap			930
Length of Temporary Cofferdam / Diversion			10,230
		Say	11,000

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0006, Field Survey	Page: 1 of 1

Item	Description	Quant	Unit
0006	Field Survey	1	JOB

Field Surveying to include:

pre and post topographic survey of all areas to allow for .

1. verification of current contours in order to verify existing conditions,
2. calculate post construction contours, height, width, length of bank protection and excavation.

Assume amount of acreage to be 1) 100 feet on either side of channel plus .

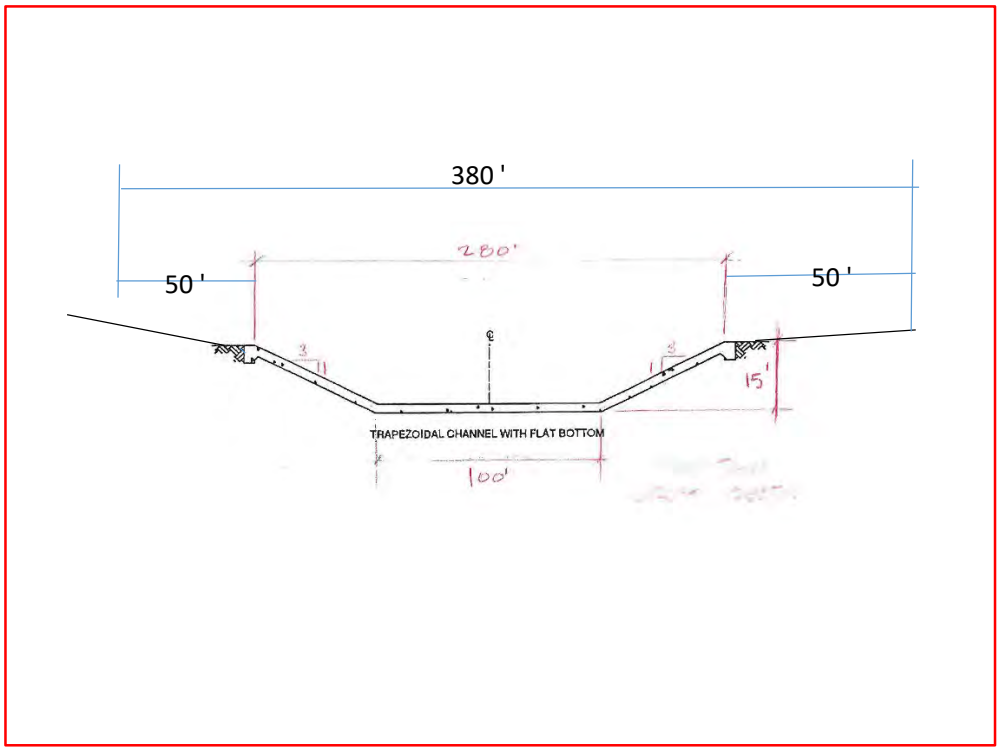
(480 feet x 9000 feet)/ 43560 = 99 Acres

Say 100 Acres

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0007, Clearing and Grubbing for Bank Protection	Page: 1 of 1

Item	Description	Quant	Unit
0007	Clearing and Grubbing for Channelization	39	AC

Assume 50% of area receiving channel as overgrown and that will have to be cleared and grubbed.



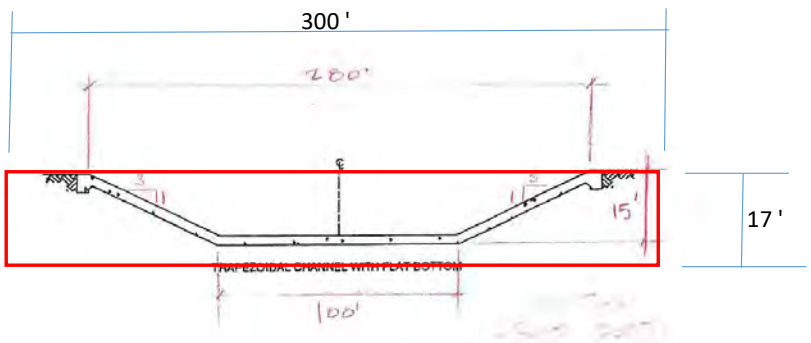
Also assume that areas outside of channel to be cleared for access, storage of material; etc. Assume additional 50 feet each side.

Total length of replacement

Channel Length	**9,000**	LF	Total Area	3,420,000	SF
Addn'l length	**0**	LF	50 % needing cleared	1,710,000	SF
Total length	**9,000**	LF			
Width	**380**	LF			
			Total Area (Acres)	**39**	**AC**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0008, Excavation for Bank Protection	Page: 1 of 1

Item	Description	Quant	Unit
0008	Excavation for Channel Construction	1,870,000	CY



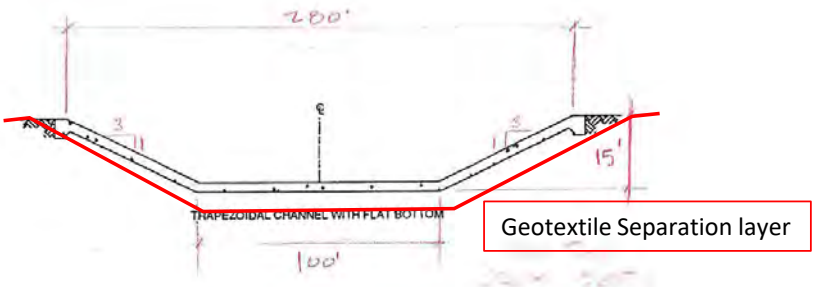
For entire length of channel, assume 100% excavation depth of 17 feet.

Total length of Channel			**3,000**	LF			
Length of Excavation	**9,000**	LF			Excavation Area	**2700000.0**	**SF**
Width of Excavation	**300**	LF					**SF**

Segment	**Height or Length**					
1A	**17**			Volume	45,900,000	CF
					1,700,000	CY
				10% overexcavate	170,000	CY
				Total	1,870,000	CY
Subtotal		0	0			
				Say	**1,870,000**	**CY**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0008(1), Geotextile Fabric Separation Layer	Page: 1 of 1

Item	Description	Quant	Unit
0008(1)	Geotextile Fabric Separation Layer	40,000	CY



For entire length of all bank protection, assume backfill needed for 50% of total length (Scoured Areas). Assume backfill will be placed in a right triangular configuration.

Total length of channel **9,000** LF Area (SF) **300,000** SF

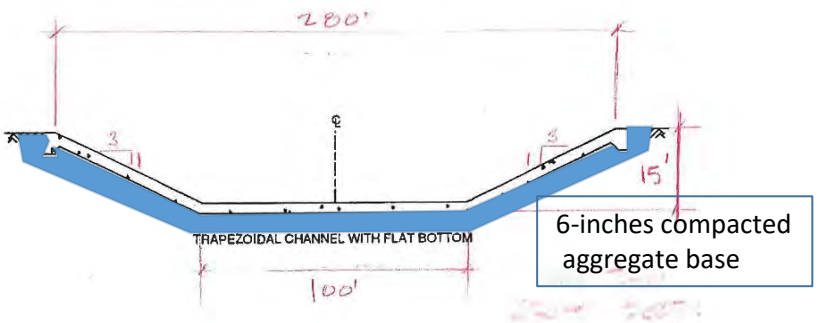
Location	Bottom Channel Perimeter	Length	Area
1	200	3000	**300,000**
Subtotal			**300,000**
TOTAL			

Area (SY)	33,333	SY
20% waste	6,667	SY
Total	40,000	SY
	300,000	
Say	**40,000**	**SY**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Channelization Alternative**	Date:
	Comp: CLIN 0008(2), Aggregate Base for Channel Concrete	Page: 1 of 1

Item	Description	Quant	Unit
0008(2)	Aggregate Base for Concrete	36,667	CY

Six-inch depth of aggregate base layer on top of geotextile



For entire length of all bank protection

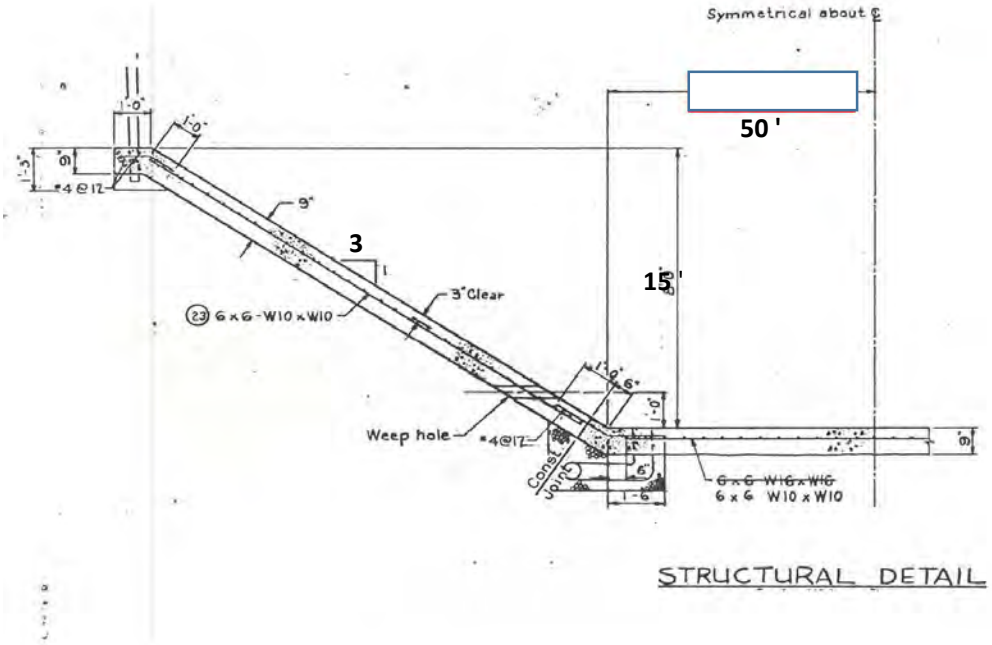
Total length of bank Protection **9,000** LF

Total	Length	200	LF	Total Volume	900,000	CF
	Depth	0.5	LF			
				Volume (CY)	33,333	CY
				Waste (10%)	3,333	CY
				Total	36,667	CY
				Say	**36,667**	**CY**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Bank Protection Project**	Date:
	Comp: CLIN 0008(3), Concrete for Channel	Page: 1 of 1

Item	Description	Quant	Unit
0008(3)	Concrete for Channel	53,350	CY

Assume 9-inch thick trapezoidal concrete channel



Typical Partial Cross Section of Concrete Channel

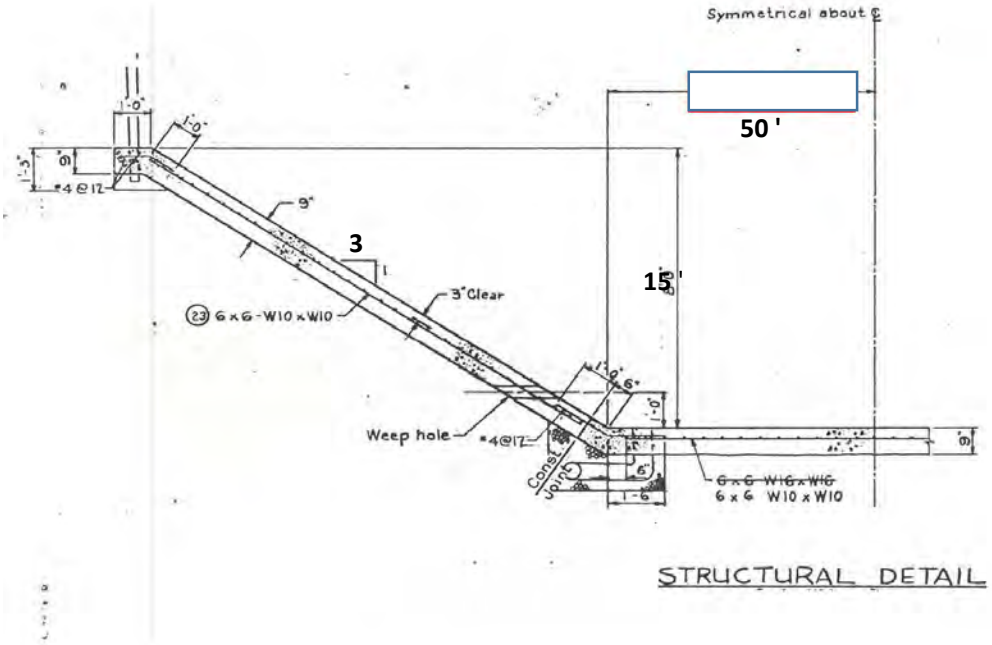
Total length of replacement

	Length	**9,000**	LF	Total Partial X-Sectional Area	73	SF
				X 2	146	SF
Segment	Length	Depth	Area			
	(ft)	*(ft)*	*(SF)*			
1	47	0.75	35.25	Volume	1,309,500	CF
2	50	0.75	37.5		48,500	CY
				10% for waste and transitions	4,850	CY
Total			72.75	Total	53,350	CY
				Say	**53,350**	**CY**

US Army Corps of Engineers Pittsburgh District	COMPUTATION SHEET	Computed By: JR
		Date: 5/24/2019
		Checked By:
	Subject: **Rio Grande de Manati - Bank Protection Project**	Date:
	Comp: CLIN 0008(4), Steel for Channel	Page: 1 of 1

Item	Description	Quant	Unit
0008(4)	Steel for Channel	213,400	CY

Assume al steel is 6 x 6 x 10 x10 WWF



Typical Partial Cross Section of Concrete Channel

Total length

	Length	**9,000**	LF	Total Partial X-Sectional Area	873,000	SF
				X 2	**1,746,000**	SF
Segment	Length	Depth	Area			
	(ft)	*(ft)*	*(SF)*			
Slope	9000	47	423,000		1,746,000	SF
Bottom	9000	50	450,000	Area	194,000	SY
				10% for waste and transitions	19,400	SY
Total			873,000	Total	213,400	SY
				Say	**213,400**	**SY**