1. Wetland Enhancement (treatment and planting). The proposed wetland enhancement is located in several wetland areas throughout the TLC. The enhancement will consist of a combination of treating existing populations of invasive/exotic species, and then planting emergent aquatic vegetation where necessary. Treatment of invasive/exotic species will include mainly the use of herbicides, but some mechanical removal may be necessary. Some areas will be excavated to remove the seed source and encourage additional hydrologic flow. Due to the varying sizes and conditions of the proposed enhancement areas, each wetland will be assessed individually to determine the best combination of treatment, excavation and planting. See Figures 7-6, 7-6a through 7-6d for details of the specific action for each wetland.

The wetland enhancement areas will be planted on three-foot centers at a density of 4,840 stems/acre with bare-root size Florida native aquatic plants including:

Pickerelweed
Duck potato
Soft rush
Maidencane
Fire flag

A total of 159,720 aquatic herbaceous plants will be installed within the wetland enhancement areas.

2. Wetland Enhancement (treatment only). Some of the wetlands that contain invasive/exotic species are strand wetlands that are located both within the TLC and the adjacent areas. These wetlands have an established seed source within the open canopy areas. UMAM credits are being sought for the treatment and removal of these species and removing the seed source as a possible source of contamination for the rest of the adjacent wetland. This is only being proposed for wetlands that are on the west side of the TLC and are hydrologically connected to the areas within the TLC. See Figures 7-6, 7-6a through 7-6d for details of the specific wetlands that will receive benefit from this treatment.

3. Ditch Treatment Area. A large ditch is located along the eastern side of the access road within the TLC which totals 1.9 ac. This ditch is the result of the construction of the access road, during which the fill excavated from the ditch was used to construct the elevated road. This ditch contains the nuisance species cattails throughout it and is spreading the seed source into other adjacent wetlands. The cattails within the ditch will be treated using aquatic herbicides on a regular basis until the cattails and their seed source reach the success criteria within the monitoring period.

4. Low Water Crossings. Two LWC (Brooker North LWC and Brooker South LWC) are proposed within the TLC to help restore historic flow patterns for tributaries that ultimately convey water from the east across The Preserve towards Lake Tarpon. These historic flow patterns were identified and established in the Pinellas County Brooker Creek Preserve management plan. The two proposed LWC will help to reestablish these historic connections and improve water quality within the Brooker Creek system. Wetlands adjacent to the proposed LWC will be enhanced by restoring a more historic hydrologic regime due to the removal of the raised roadway. The presence of the raised roadway has resulted in several pooled areas which now contain a monoculture of cattails. These areas will be treated once the LWC is installed and additional planting will occur, if an acceptable level of natural regeneration does not occur. Wetlands both upstream and downstream of the proposed LWC's will be enhanced through additional hydrologic flow, higher aquatic wildlife usage, an increase in plant diversity and by creating more sheet flow throughout the area. For details please see Section 7.11 for Engineering and Planting Detail Drawings.

7.5 Hydrology & Hydraulics

7.5.1 Objective

The hydrologic and hydraulic engineering analysis for the BCP simulated existing and proposed project condition. The results demonstrated improved flow patterns that better represent historic, unaltered conditions at sites within The Preserve. These improvements (proposed project conditions) addressed mitigation modifications – including re-grading existing road and establishing low-water crossings of wetlands – at two sites. The first mitigation site referred to as Brooker North LWC, located west of Silver Dollar Ranch Golf Club (see Figure 7-8), involves construction of a 140-feet wide low-water crossing along PEF's transmission corridor service road. The second mitigation site referred to as Brooker South LWC, located west of Eagles Golf Course Club (see

Figure 7-9), involves construction of a 300-feet wide low-water crossing along PEF's transmission corridor service road. To demonstrate improved water movement, a hydrologic and hydraulic modeling analysis was conducted for these two mitigation sites as described below.

7.5.2 Model Setup

This study applied two separate models – one for the Brooker North LWC site and another for the Brooker South LWC site. The Brooker North LWC site was modeled with the U.S Army Corps of Engineers Hydrologic Engineering Center's River Analysis System (HEC-RAS version 4.1) to simulate conveyance, and flooding conditions in the Brooker North LWC mitigation area. This HEC-RAS model was created using data from a SWFWMD model for the Brooker Creek watershed (SWFWMD, 2009) called Hillsborough Stormwater Management Model (HC-SWMM). HC-SWMM is a one-dimensional, dynamic rainfall runoff model that estimates runoff from the selected storm events based on NRCS Runoff CN method and routes the flow hydrographs through a drainage system represented as a series of links and nodes. HC-SWMM model for the Brooker Creek watershed provided the rainfall-runoff flow hydrographs at various locations within the mitigation site.

Currently, for the Brooker South LWC site, the elevated service road located along the eastern edge of the transmission corridor acts as a basin divide and blocks the sheet flow of water that historically crossed the corridor. Based on an initial assessment of the topography (LiDAR surveys), the north-south ditch running along the service road intercepts the westerly sheet flow of water from the forested wetland located east of the corridor, and drains south along the corridor outside the study area. The construction of a low-water crossing would divert a portion of the southerly flow to the west into the historical Channel GG if an appropriate water surface gradient across the service road allowed such diversion. A one-dimensional model would not be able accurately simulate these multi-dimensional flow paths and demonstrate the presence of an appropriate water surface gradient. In fact, the low water crossing might create an undesirable easterly flow from the wetland west of the service road into the ditch if water levels west of the service road are sufficiently high. Due to the complex flow pattern of sheet flow within the study area, combined with the presence of the elevated road and ditch, it is necessary to evaluate these multi-dimensional flow patterns with a two-dimensional model. Hence, the Brooker South LWC site was modeled with the Danish Hydraulic Institute's two-dimensional hydro-dynamic model, MIKE 21. MIKE 21 demonstrated the desired flow

diversion was feasible and better defined the areas by sheet flow flooding. As with the Booker North LWC site, the SWFWMD's HC-SWMM model for Brooker Creek watershed provided the rainfall-runoff flow hydrographs at various locations within the Brooker South LWC mitigation site. This section describes the hydrology and hydraulic input parameters for each mitigation site.

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Study Area - Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-8
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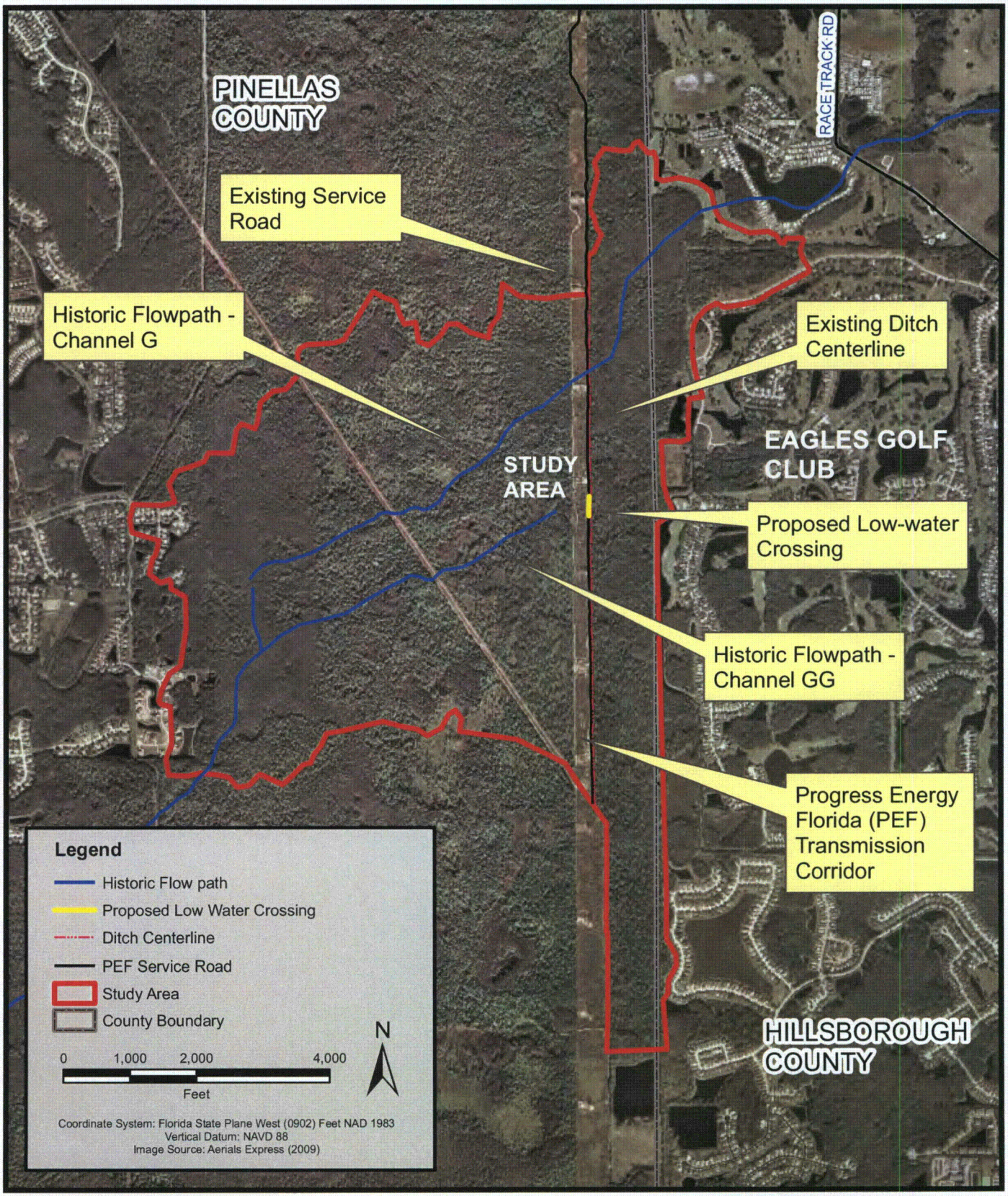
DATE	JULY 2011



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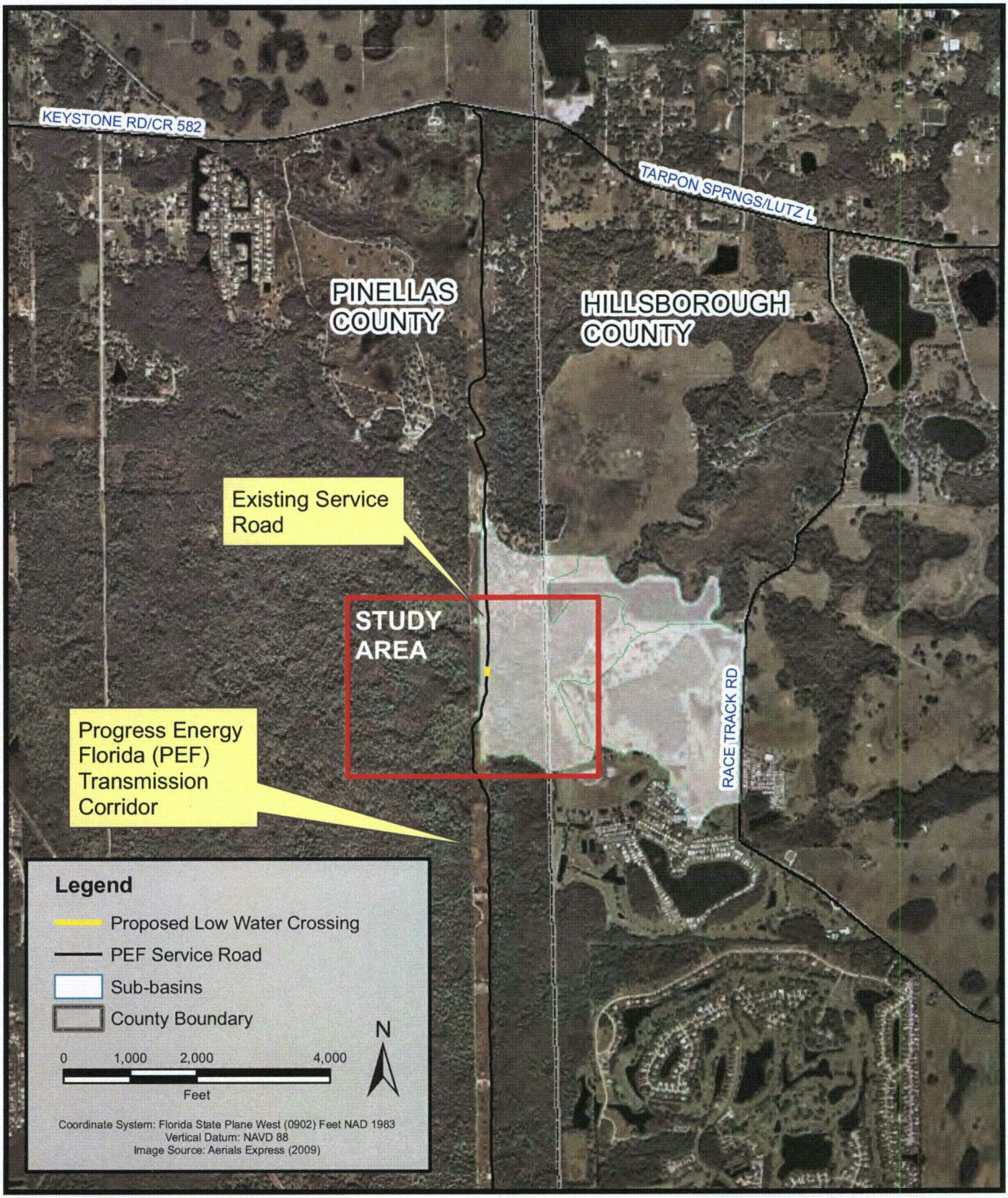
Study Area - Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-9
DRAWN BY	RP
DATE	JULY 2011

Brooker North LWC

The service road located along the eastern side of PEF's transmission corridor blocks the natural sheet flow of water that historically crossed the corridor into Channel S (see Figure 7-8). The road elevations are about 2-4' higher than the surrounding grade. A ditch located east of the service road runs parallel to the road and captures the flow coming from the easterly wetland along the historic Channel S. Water fills up the ditch and overflows the road only when the water level in the ditch exceeds the road elevations. In the current existing condition, the water level in the ditch does not overtop the road regularly. In order to restore the historic Channel S, it is necessary to re-establish a continuous sheet flow of water between the eastern and western wetland forests located on either side of the road. The proposed LWC located along the service road would allow for continuous passage of sheet flow of water, there by connecting the wetlands along the historic flow path. A one-dimensional hydraulic model was developed with HEC-RAS model to demonstrate the effects of LWC in restoring the historic sheet flow.

1. Hydrology inflows from HC-SWMM model. Brooker North LWC receives flows from an area covering 278 acres located east of transmission line corridor. As seen from Figure 7-10, three sub-basins drain water from the east of the transmission corridor towards PEF's service road. Flow hydrographs from the district's HC-SWMM model provides the necessary boundary condition for the hydraulic model. Figure 7-11 shows the flow hydrographs for the 2.33-, 10-, 25-, 50- and 100-year storm events. The HEC-RAS model uses these inflow hydrographs as a boundary condition for existing and proposed conditions models.



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Sub-basins Map for Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-10
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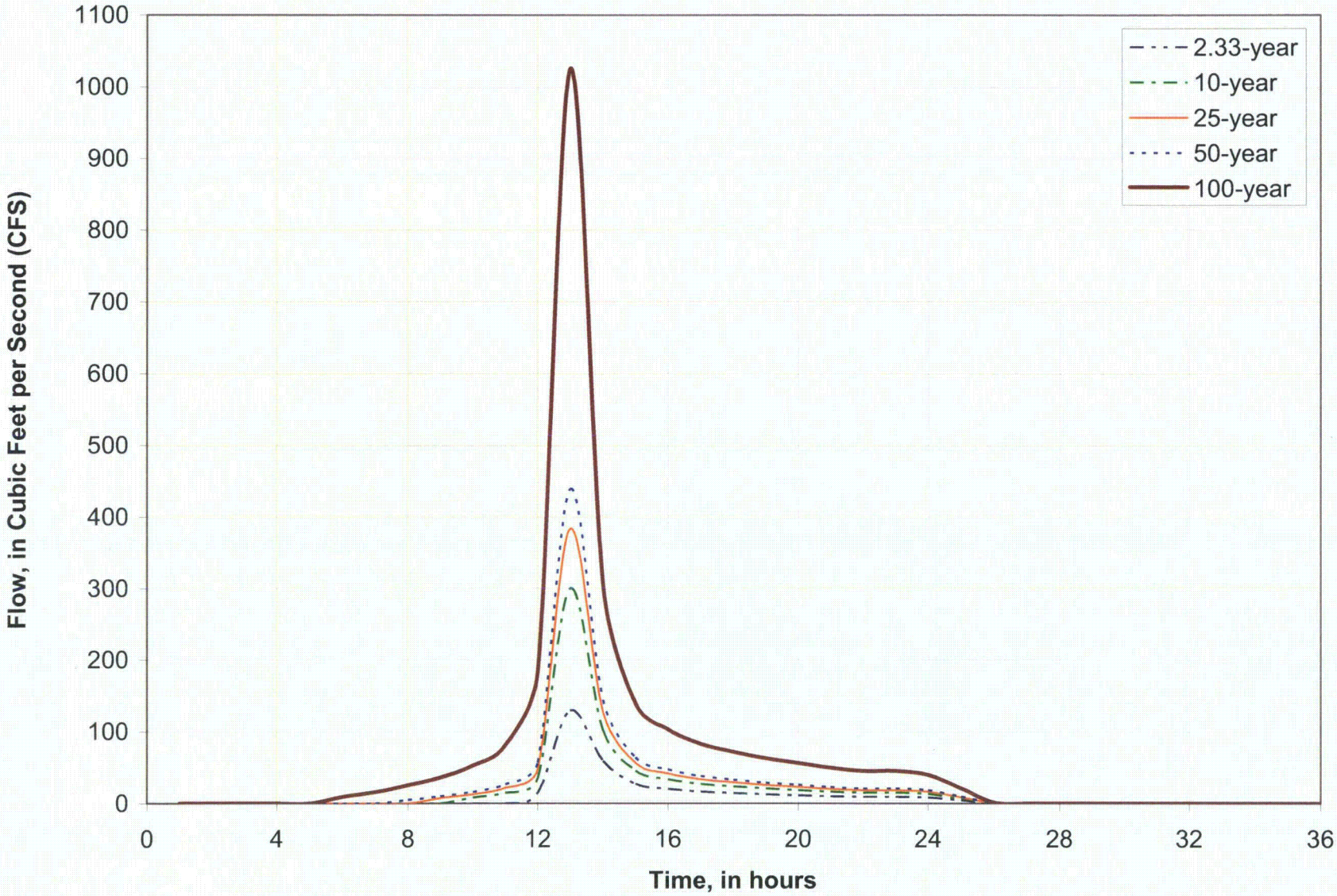
DATE	JULY 2011



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Inflow Hydrographs for Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-11
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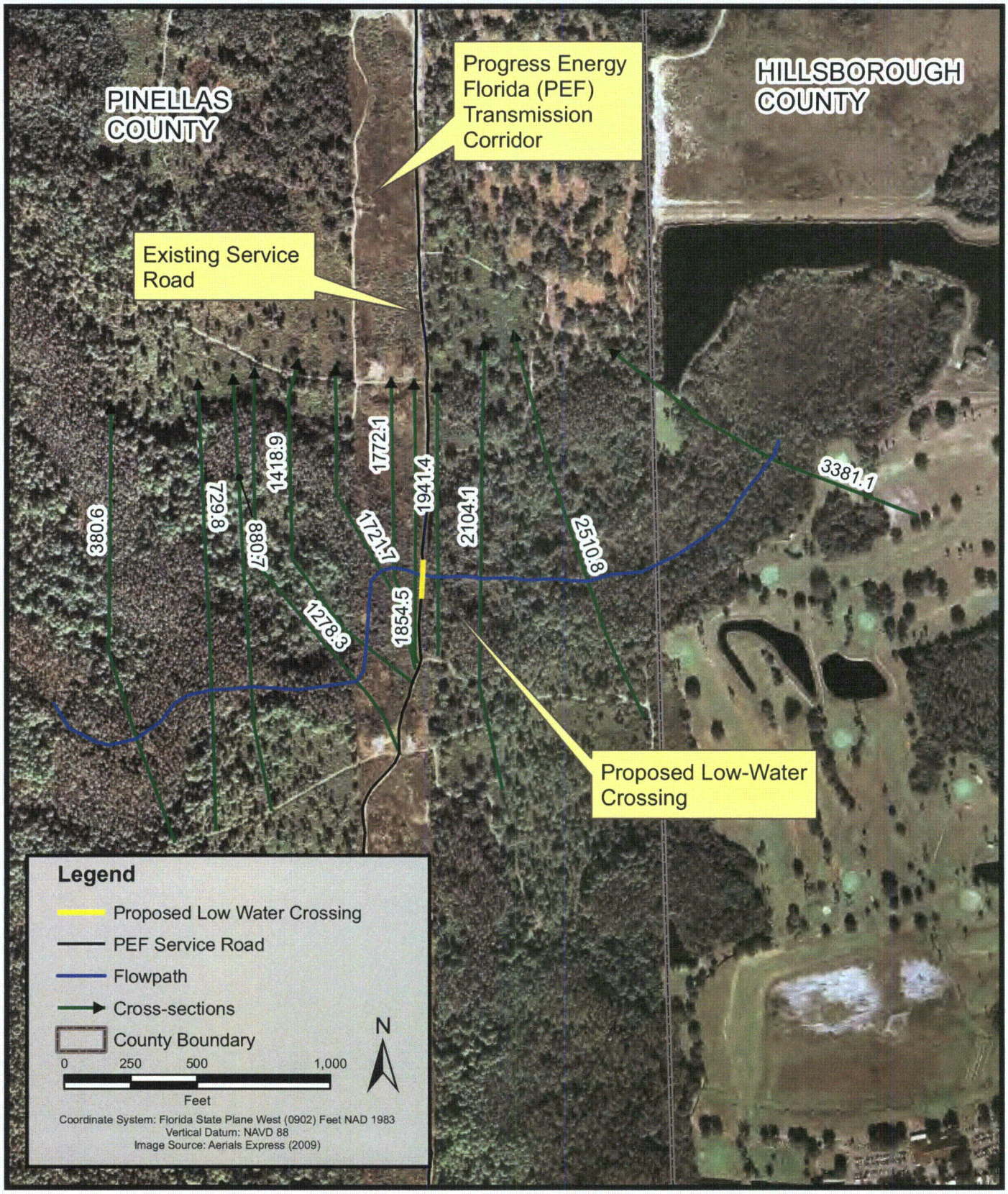
DATE	JULY 2011

2. One dimensional hydraulic model (HEC-RAS) geometry. The HEC-RAS model applies a defined flow path with cross sections at specified distances. The cross section elevations assigned within the model reflect the LIDAR data collected by Florida Division of Emergency Management in 2007 (FDEM, 2007) and survey data collected by SurvTech Solutions Inc. in June 2011. Figure 7-12 shows the cross-section layout for the HEC-RAS model for existing and proposed conditions. Typical values of overland roughness co-efficient (also referred to as Manning's N co-efficient) for the various land use segments within our study area were obtained from widely published USGS report on Manning's N co-efficient (USGS, 1989).

3. One dimensional hydraulic model (HEC-RAS) boundary conditions. Two types of boundary conditions were applied within the HEC-RAS model. One boundary condition was the tailwater condition at the model outlet. It was assumed that the areas draining west of the transmission corridor would not affect the downstream boundary condition. Hence, a normal depth boundary condition corresponding to the slope of downstream area was used as a boundary condition at the model outlet.

The second boundary condition is the rainfall-runoff inflow hydrograph obtained from the district HC-SWMM model (see Figure 7-11). This inflow hydrograph was applied at the upstream end of the model boundary. The HEC-RAS model routes the flows from the inflow hydrograph to estimate the flow and stage at different cross-sections within the model domain.



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HEC-RAS Model Cross-sections for Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-12
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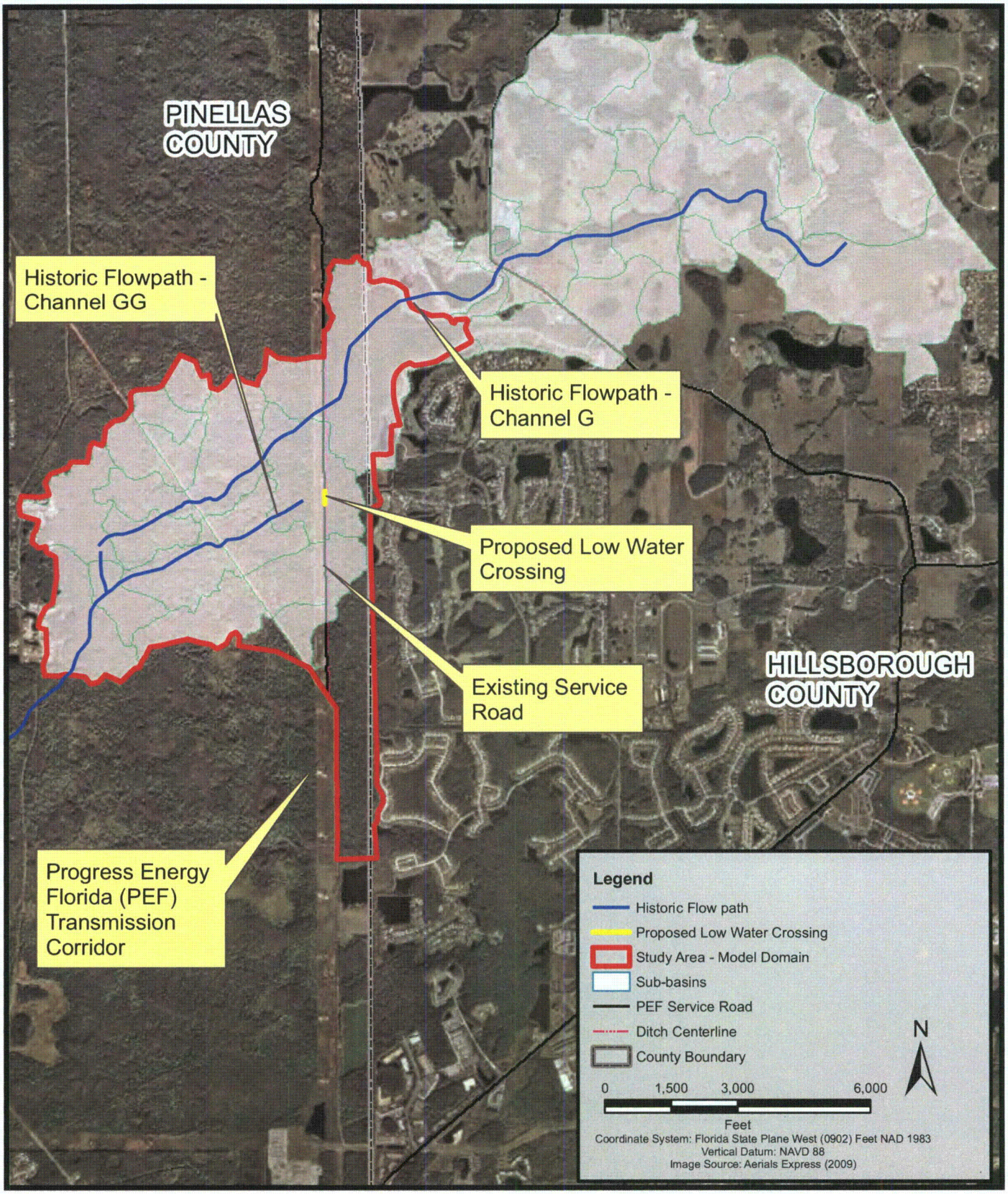
DATE	JULY 2011

Brooker South LWC

The objective of the Brooker South LWC is to evaluate the feasibility of re-establishing the historic sheet flow between the wetland areas located east and west of the transmission corridor within The Preserve (see Figure 7-9). Currently, the elevated service road located along the eastern edge of the transmission corridor acts as a basin divide and blocks the sheet flow of water that historically crossed the corridor into Channel GG. Based on an initial assessment of the topography (LiDAR and surveys), the ditch intercepts the westerly sheet flow of water from the wetland located east of the corridor, and drains south along the corridor. Due to the complex flow pattern of sheet flow within the study area, combined with the presence of the elevated road and ditch, it was necessary to evaluate the flow patterns with two-dimensional model. A two-dimensional model was developed using DHI's MIKE 21 model to evaluate existing conditions flow paths and to demonstrate the restoration of historic Channel GG by constructing a low-water crossing along the service road.

1. Hydrology inflows from HC-SWMM model. Brooker South LWC receives flows from a large area located east of TLC. As seen from Figure 7-13, 21 sub-basins encompassing an area of 1,476 acres drains water from the eastern section of the transmission corridor toward the service road. The SWFWMD's HC-SWMM model provided the inflow hydrograph that captures the flow coming into the model domain and for the 20 sub-basins located within the model domain. Figure 7-14 shows the location of inflow hydrographs used in the two-dimensional model for the 2.33-, 5-, 25-, 50- and 100-year storm events.



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Sub-basins Map for Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-13
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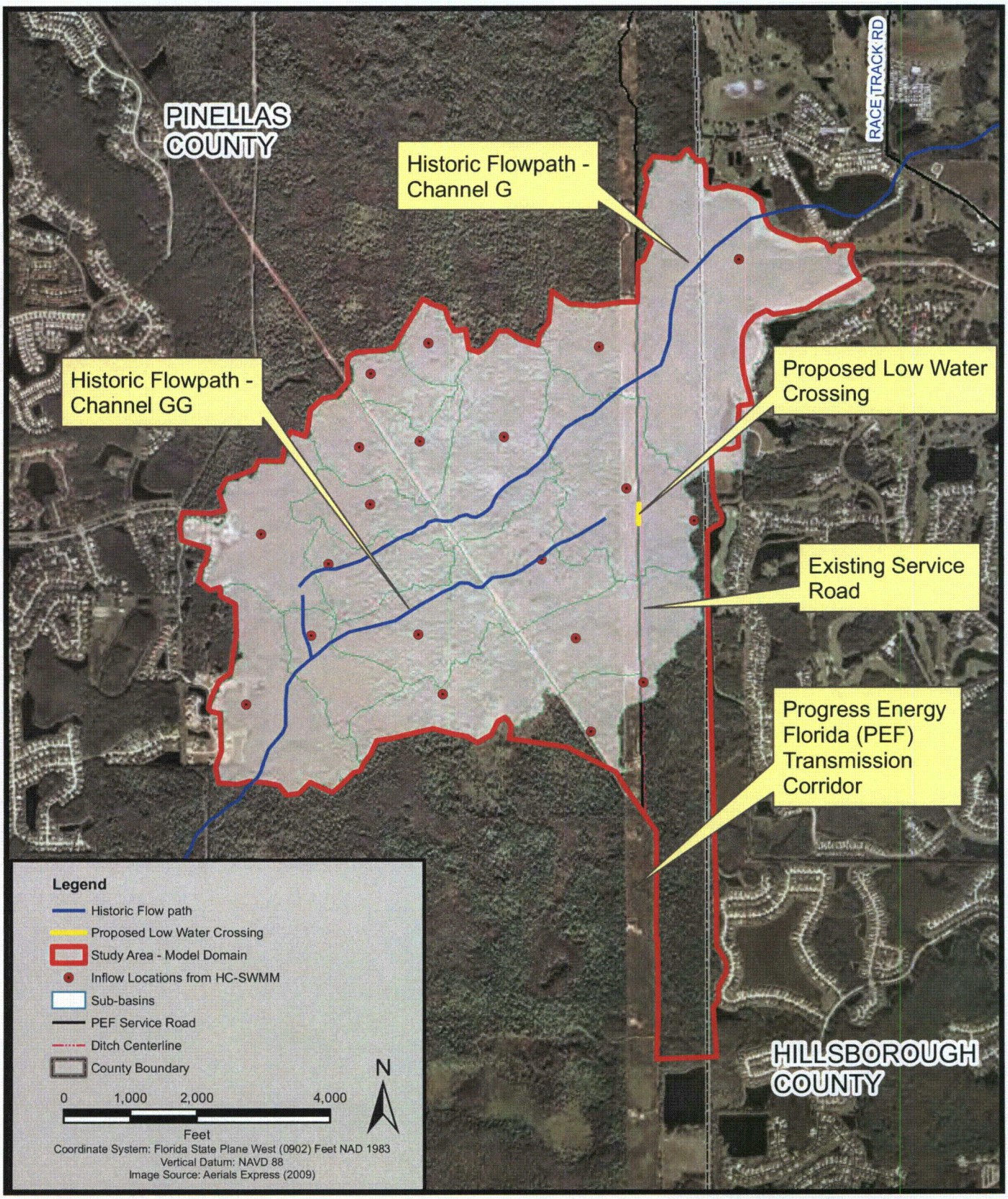
DATE	JULY 2011



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Location of Inflow Hydrographs for Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-14
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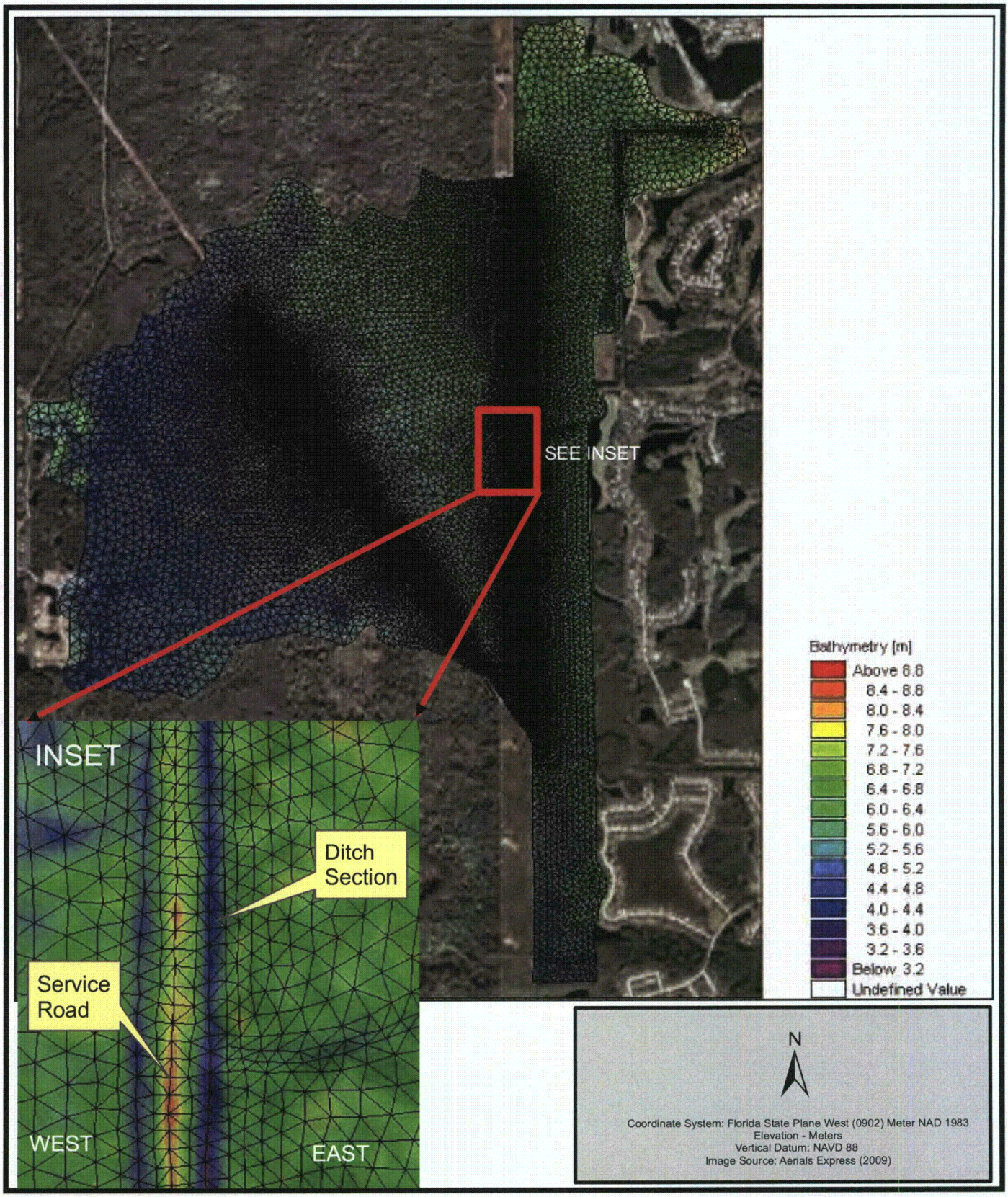
DATE	JULY 2011

2. Two-Dimensional Model (MIKE-21) Mesh Development. Given the initial water surface elevations and the hydraulic conditions at the boundaries, MIKE21 model employs finite volume methods to compute the water surface elevation, and velocity magnitude and direction. A model mesh was developed in MIKE 21 to represent the ground topography within the Brooker Creek study area, the service road elevations, and the ditch sections as finite elements interpolated from LiDAR (FDEM, 2007) and surveys collected by SurvTech Solutions Inc. The Brooker South LWC model applies a 2-D finite volume mesh that includes more than 19,000 nodes, 38,000 elements (see Figure 7-15), and a spatially varying Manning's bottom friction roughness coverage to execute the hydrodynamic flood routing computations. Smaller elements were applied to capture details of critical flow way and flow obstruction such as roadways, ditches and embankments (see inset in Figure 7-15). Typical values of Manning's roughness co-efficient for the various land use segments within our study area were obtained from widely published USGS report on Manning's N co-efficient (USGS, 1989).

The mesh used for existing conditions was modified to reflect the LWC in the proposed conditions. For proposed conditions, the elevations of the mesh elements located along the proposed LWC were modified to represent a 300 feet wide LWC section at an elevation of 20.5ft-NAVD88. Note that because of limitations in model computation and availability of data, the model meshes do not reflect culverts and fire break trails in the project area. The exclusion of these structures does not significantly affect model results at flood rise and peak flow because the flow is negligible through these structures.



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MIKE 21 Model Mesh for Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-15
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DATE	JULY 2011

3. Two-Dimensional Model (MIKE-21) Boundary Conditions. The model boundary conditions applied inflow hydrographs from HC-SWMM model within the model domain (see Figure 7-14) and a land-boundary condition along the southern and western edges of the model domain. By specifying a land-boundary, the MIKE 21 model does not allow the water to leave the model domain boundary. Since the ground elevations at the northern and eastern boundaries are at significantly higher than the surrounding ground, it was assumed that water would not overtop the boundary. Hence, the northern and eastern boundaries do not require a land boundary condition. In spite of the ground elevations being lower than the surrounding ground along the southern and western edges of the model, a land boundary condition was applied since these model boundaries are far away from the LWC site and backwater effects can be neglected.

7.5.3 Model Results

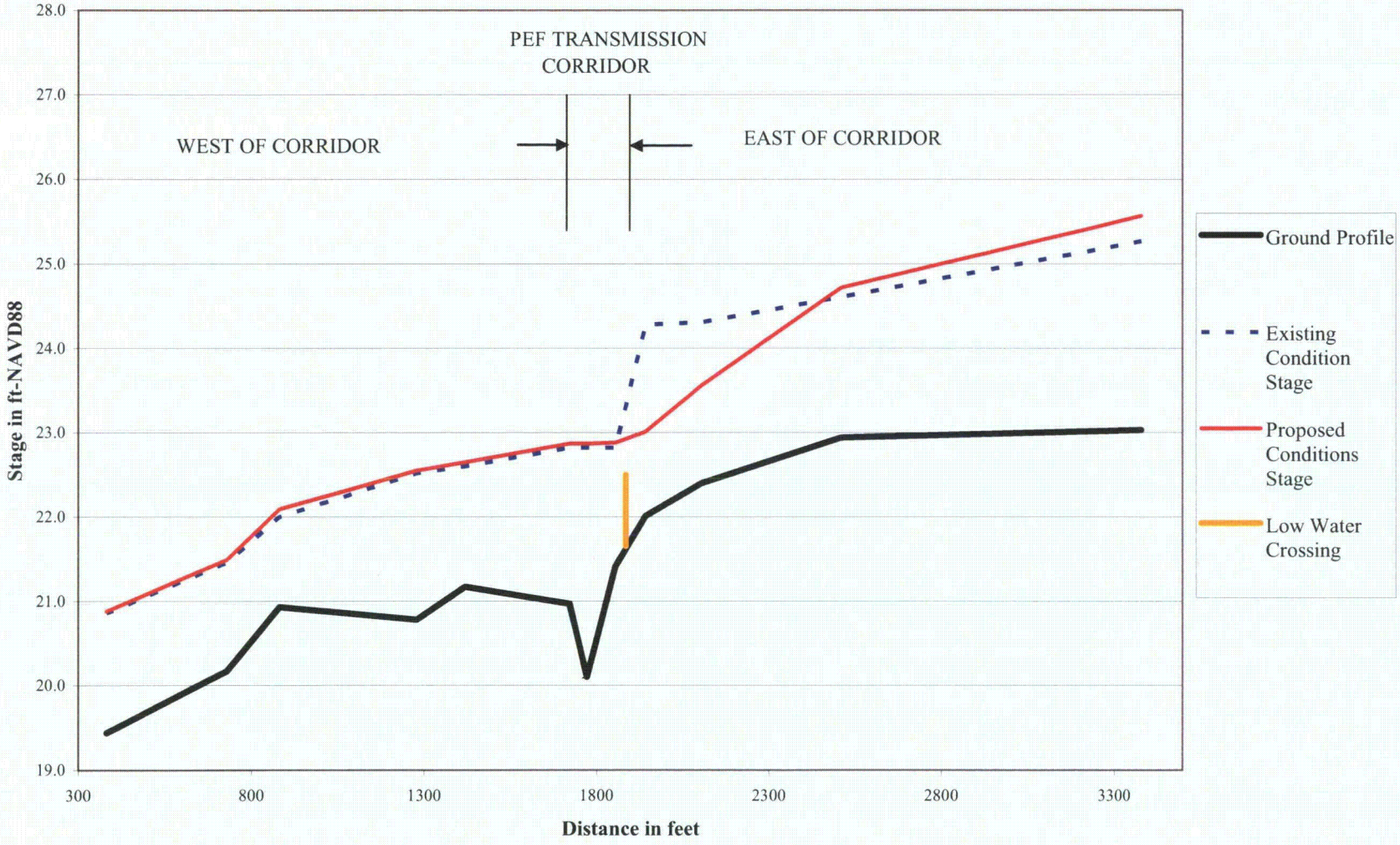
The HEC-RAS model was applied to the Brooker North LWC area for five rainfall events representing the 2.33-, 10-, 25-, 50-, and 100-year return periods. The MIKE-21 model was applied to the Brooker South LWC area for five rainfall events representing the 2.33-, 5-, 25-, 50-, and 100-year return periods. The model was applied to both existing (pre-construction) and proposed (post-construction) conditions. The post-construction conditions represent the proposed LWC at each site within the system (more details about the modifications are provided in the civil design section of this report). Comparison of the pre- and post-construction model results at each mitigation site demonstrate the improved flow conveyance gained from the construction of LWC. A detailed description of the results for each mitigation site is described in the following sections.

Brooker North LWC

Figures 7-16 through 7-20 shows the water surface profile for the 2.33-, 10-, 25-, 50-, and 100-year storm events in existing and proposed conditions. As seen from Figure 7-16, by constructing the LWC, the head loss across the road decreases from 1.5' to 0.1' for the 2.33-year storm event. The LWC allows for additional volume of water to pass over the road to restore the natural sheet flow along the historic Channel S and, thereby reducing the back-up of water upstream of the road. This increase in 2.33-yr event flow and decrease in head loss will better

represent historical conditions. As seen from figures 7-17 and 7-18, the model results for the 10- and 25-year storm events show similar decrease in head loss across the road. The model results show a negligible decrease in head loss across the road for the 50- and 100-year events.

2.33-year storm event - Profile of peak stages in Existing and Proposed Conditions



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Water Surface Profile in Existing and Proposed Conditions for 2.33-year Storm Event at Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-16
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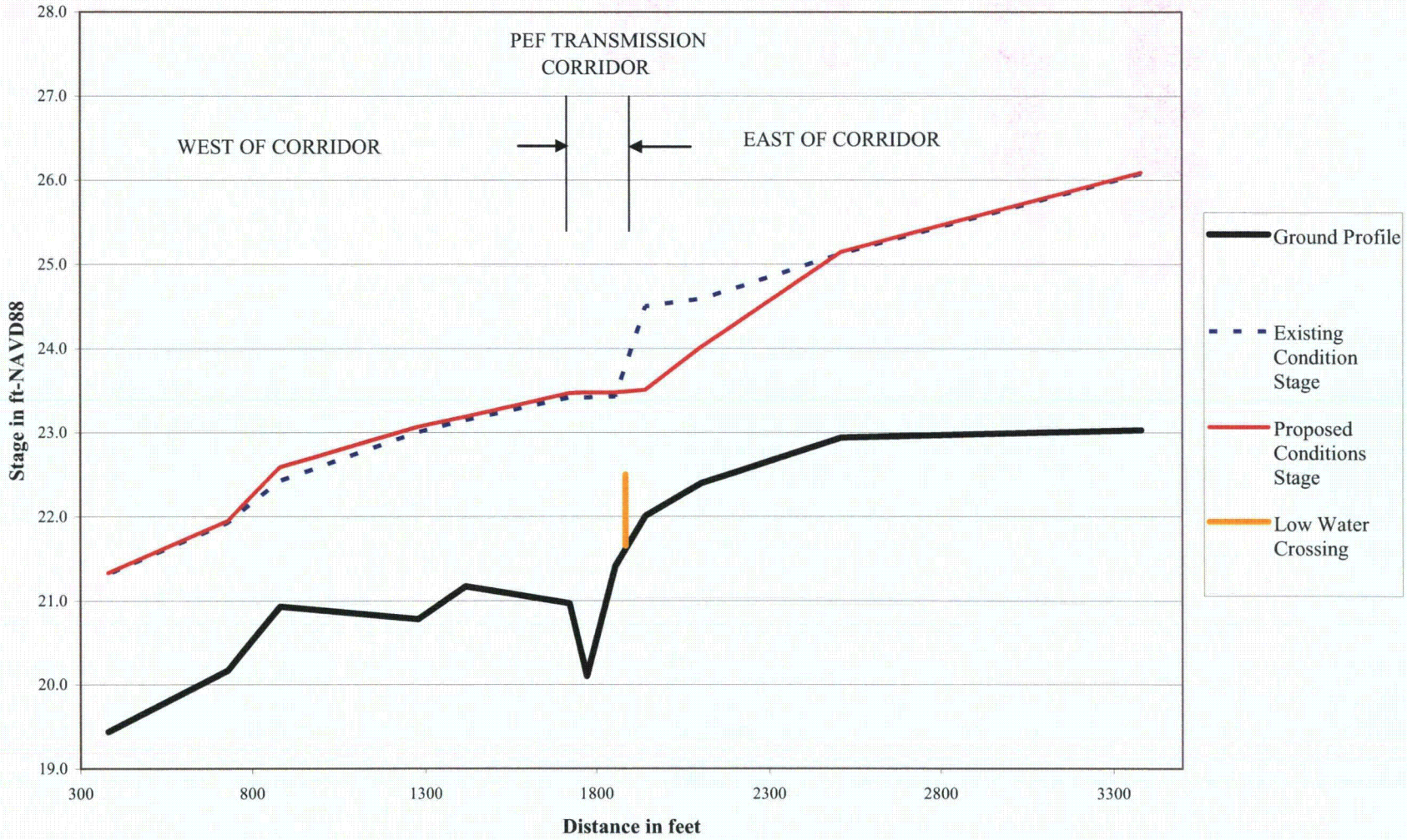
DATE	JULY 2011

10-year storm event - Profile of peak stages in Existing and Proposed Conditions



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Water Surface Profile in Existing and Proposed Conditions for 10-year Storm Event at Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-17
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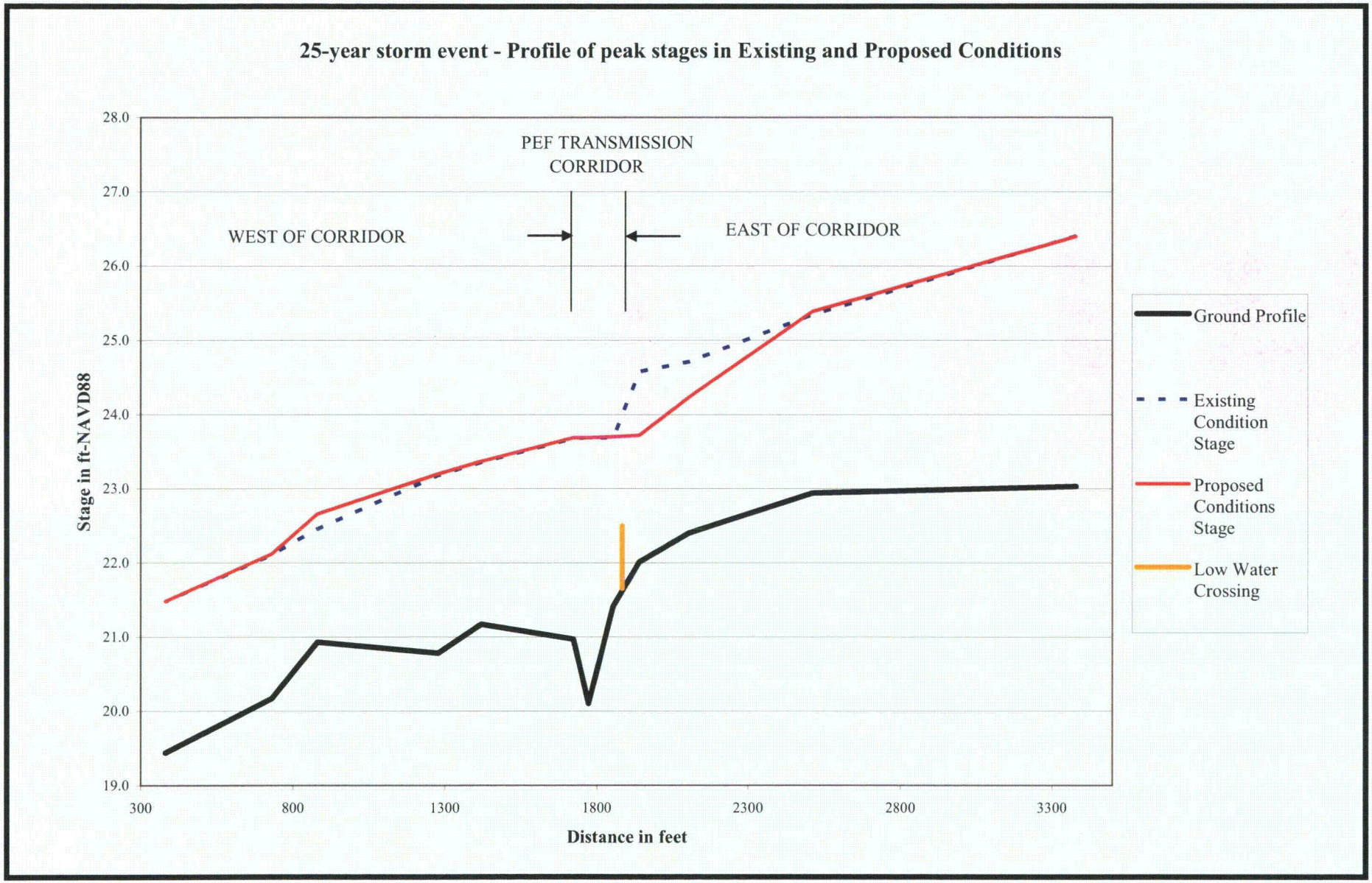
DATE	JULY 2011



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Water Surface Profile in Existing and Proposed Conditions for 25-year Storm Event at Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-18
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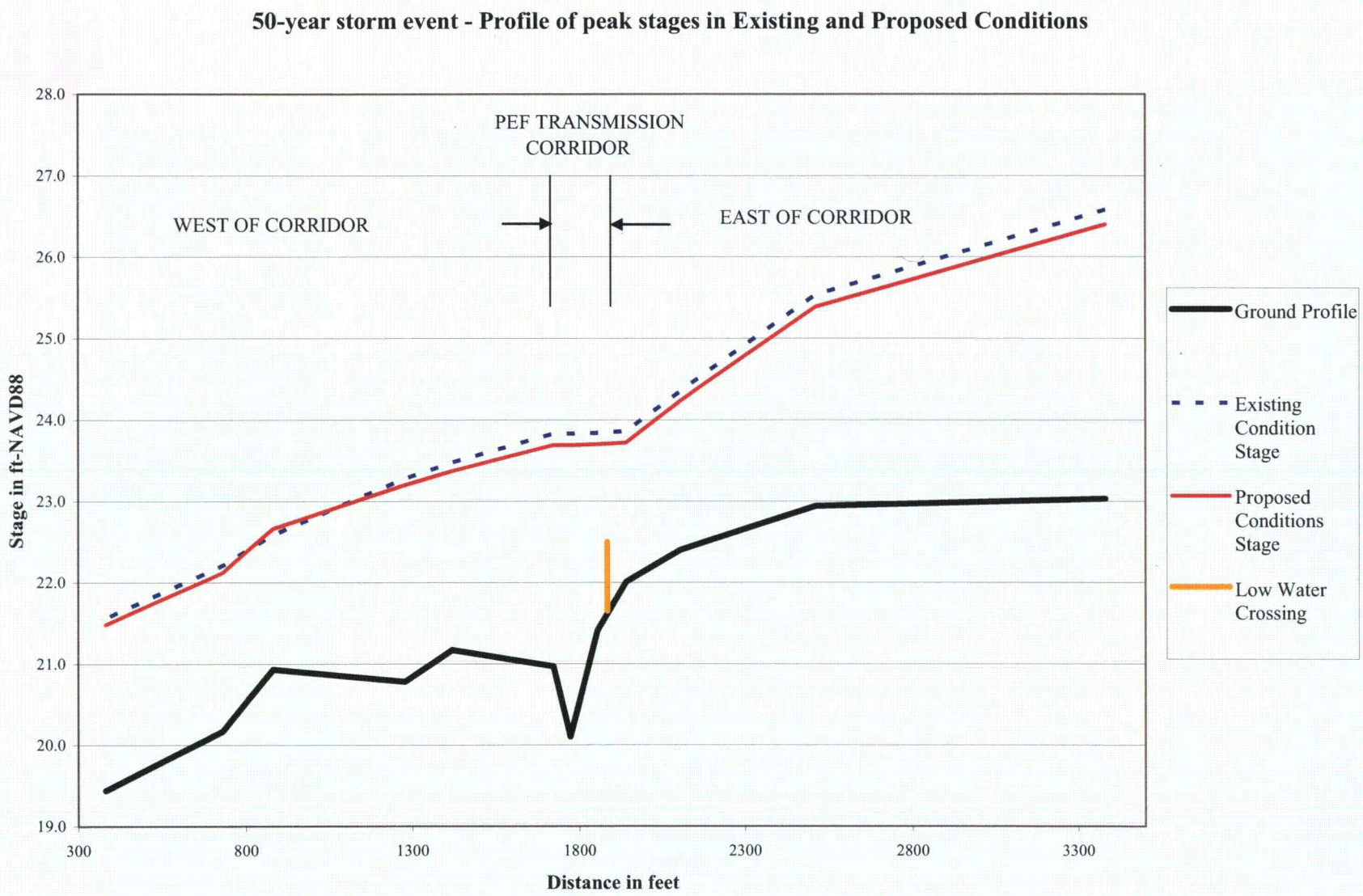
DATE	JULY 2011



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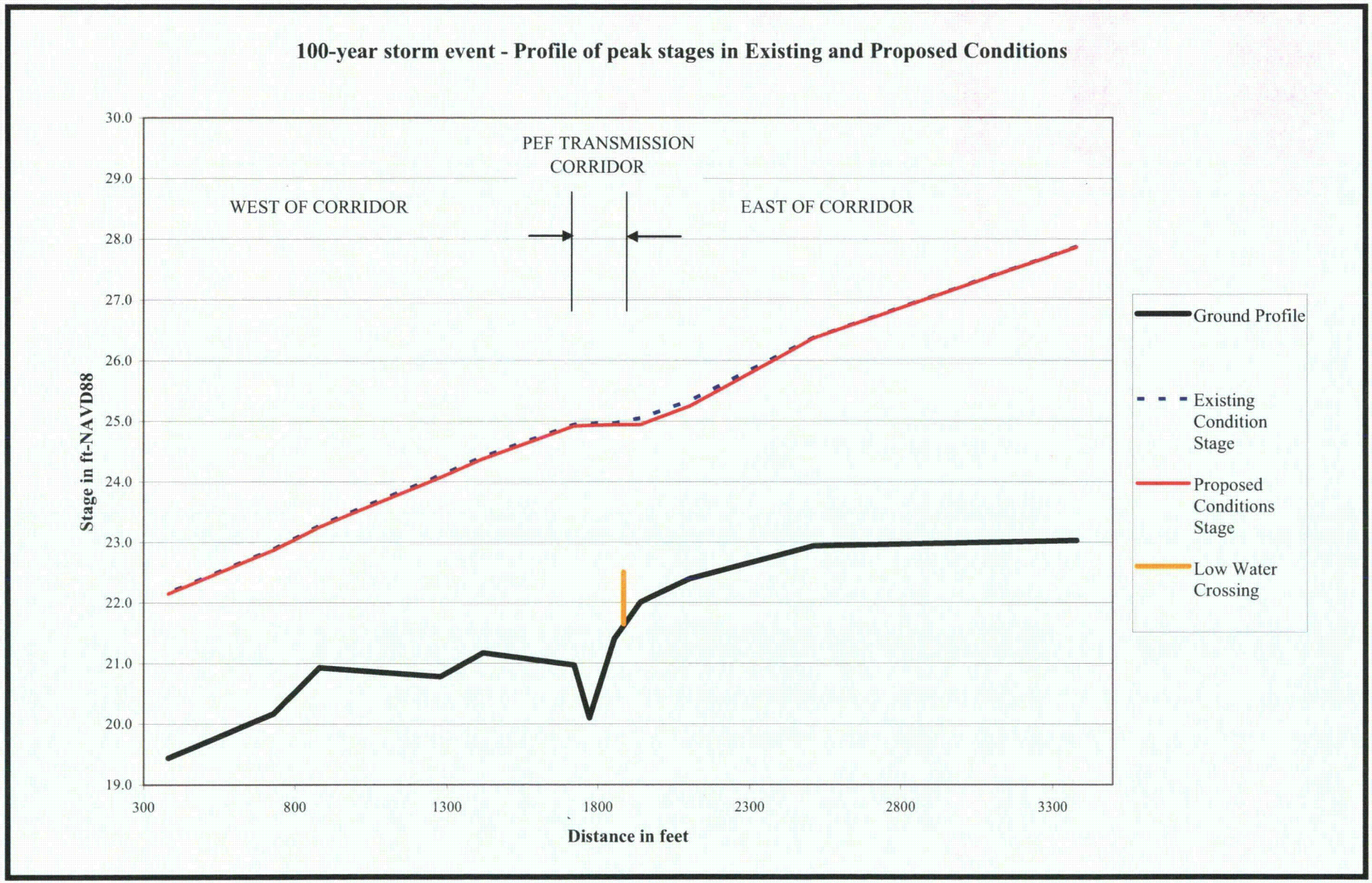
Water Surface Profile in Existing and Proposed Conditions for 50-year Storm Event at Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-19
DRAWN BY	RP
DATE	JULY 2011



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Water Surface Profile in Existing and Proposed Conditions for 100-year Storm Event at Brooker North LWC
Brooker Creek Preserve Site
Pinellas County, Florida

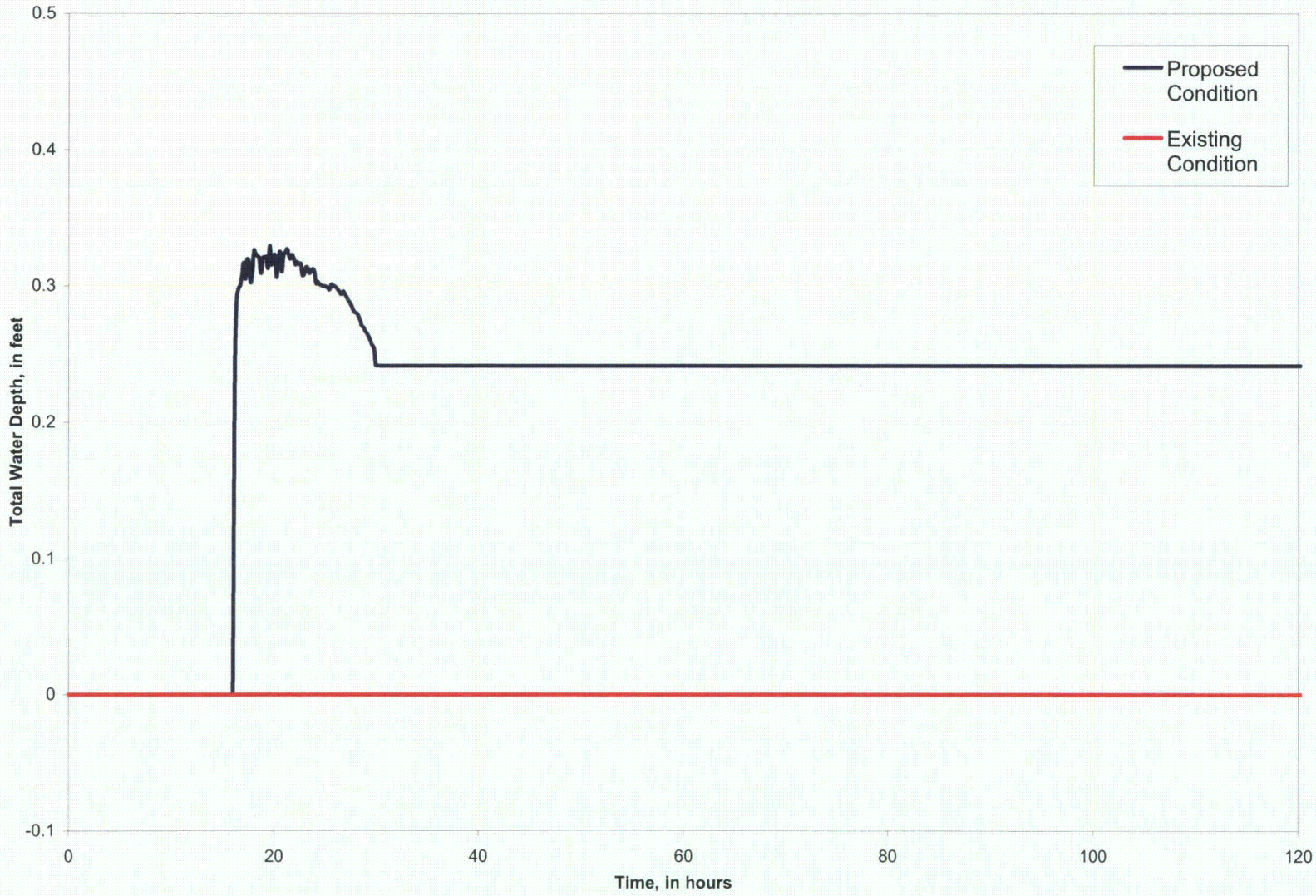
PROJECT	C2011-025
FIGURE	7-20
DRAWN BY	RP
DATE	JULY 2011

Brooker South LWC

For a 2.33-year storm event, the two-dimensional model result show the road is blocking the flow of water in the existing conditions. Model results for the proposed conditions, with the LWC, show a good connection between the east and west wetlands. Figure 7-21 shows a maximum water depth of 0.32 ft. over the road in proposed conditions for the 2.33-year storm event. Table 7-3 presents the peak flows along the proposed LWC in the existing and proposed conditions. As seen from this table, by constructing the low-water, the peak flow increases for by 767% for a 5-year storm event.

Table 7-3 Peak flows over the road in the existing and proposed conditions

	Peak flow for storm events (cfs)				
	2.33-year	**5-year**	**25-year**	**50-year**	**100-year**
Existing Conditions	0	9	102	148	342
Proposed Conditions	33	78	190	237	480
Increase	N/A	767%	86%	60%	40%



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Comparison of water depths for 2.33-year storm event in Existing and Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-21
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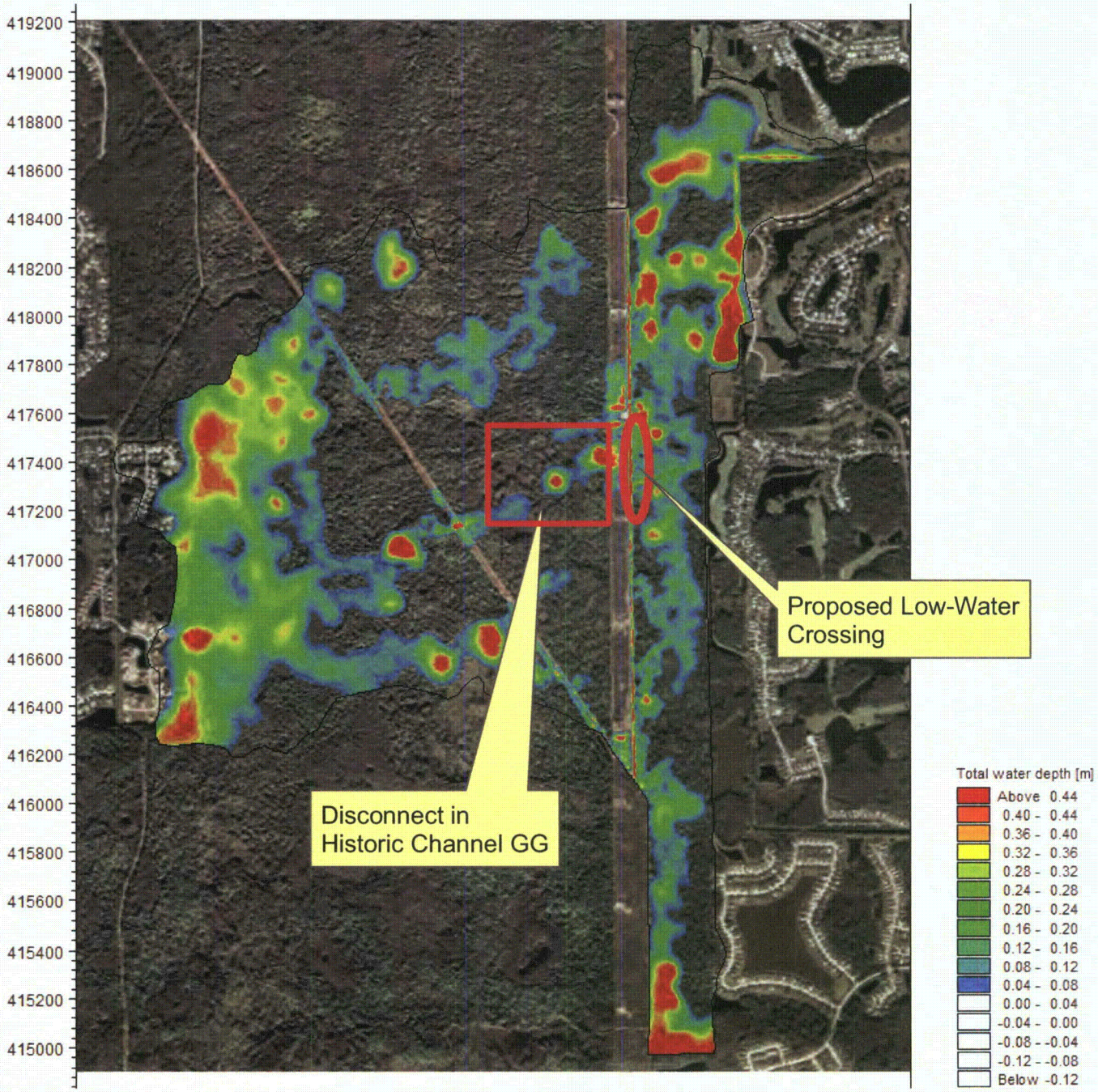
Figures 7-22 through 7-31 show the maximum water depth within the study area from 2.33-, 5-, 25-, 50-, and 100-year storm event model simulations for existing and proposed conditions. During a 2.33-year storm event the proposed conditions model with a LWC helps to re-establish the flow connection between the eastern wetlands with the historic Channel GG (see Figure 7-22). The existing conditions model simulation for the 2.33-year storm event shows the road blocking the flow of water from east to west (represented as velocity vectors in Figure 7-32). The proposed conditions model simulation for the 2.33-year storm event shows the flow passing over the LWC from east to the west (represented as velocity vectors in Figure 7-32).

The model simulations were also used to evaluate flooding impacts on the Eagles Golf Course Club. Figure 7-33 compares the water depths from the 100-year storm event model simulation for the existing and proposed conditions at the Eagles Golf Course Club. This figure shows that the water depths in the proposed conditions do not exceed the existing conditions water depths and thus proves that the LWC would not cause any flooding impacts at Eagles Golf Course Club.



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Maximum Water Depth for the 2.33-year storm event in Existing Conditions at Brooker South LWC
Brooker Creek Preseve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-22
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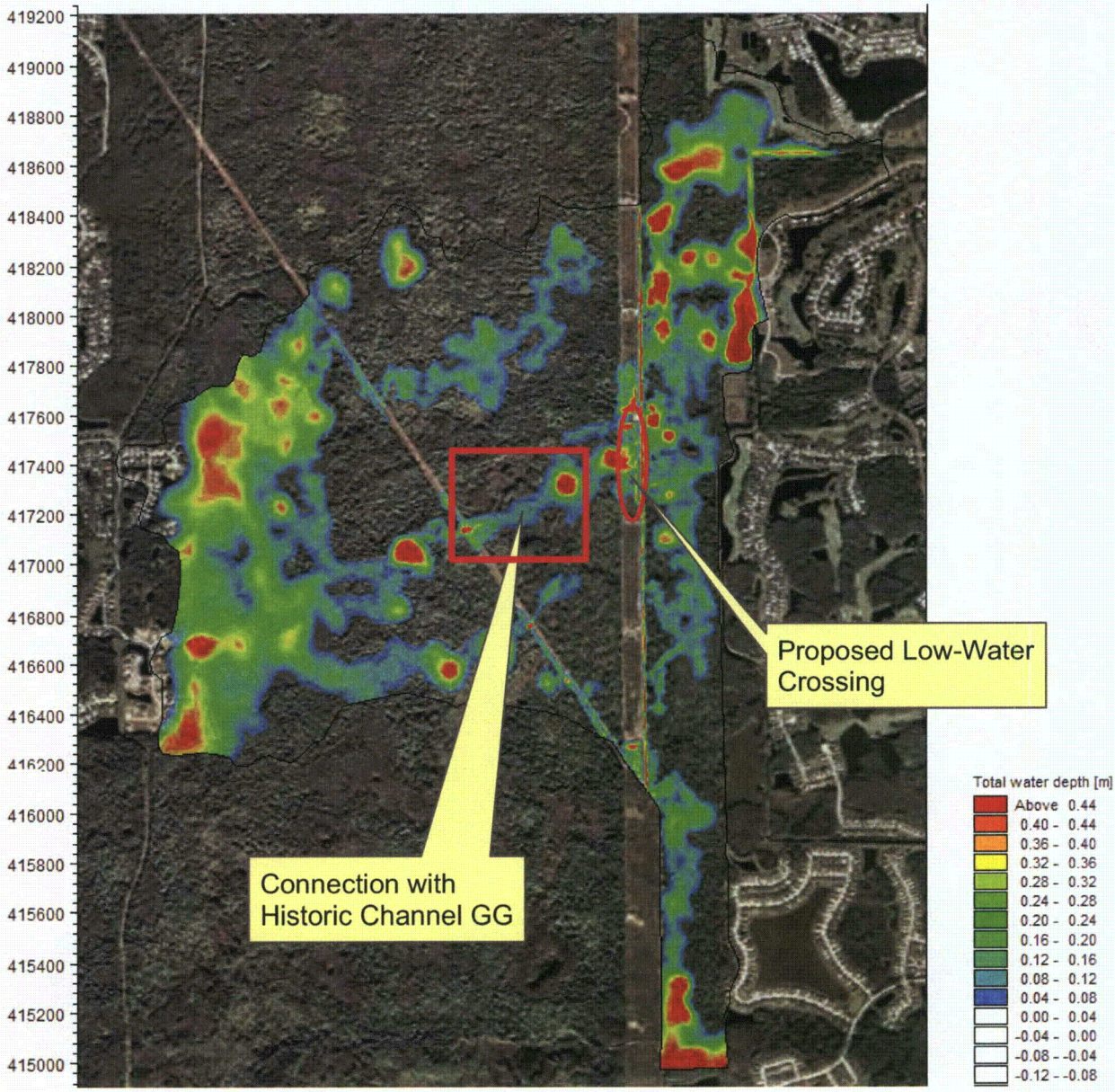
DATE	JULY 2011



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Maximum Water Depth for the 2.33-year storm event in Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-23
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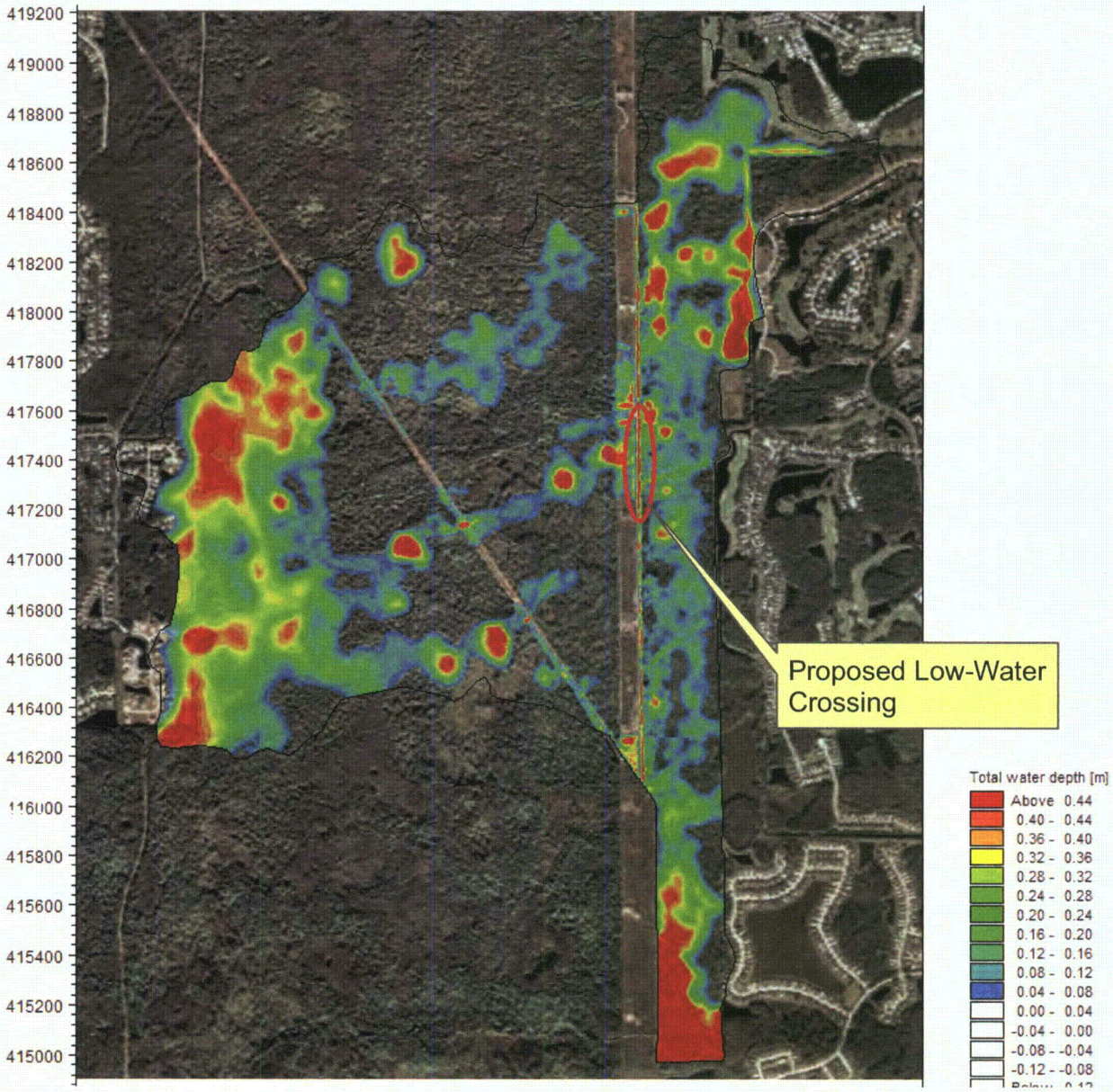
DATE	JULY 2011



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Maximum Water Depth for the 5-year storm event in Existing Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-24
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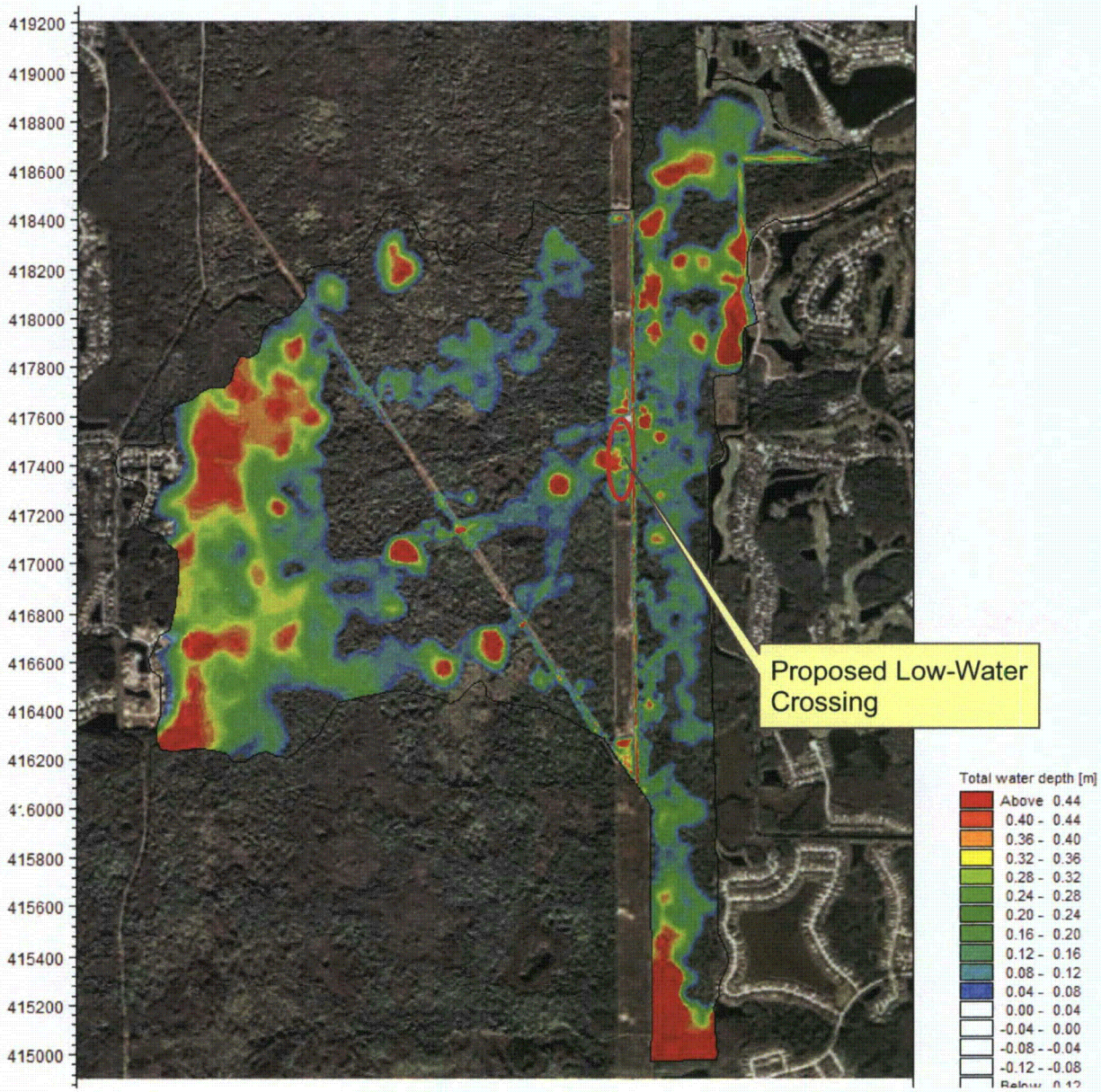
DATE	JULY 2011



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Maximum Water Depth for the 5-year storm event in Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-25
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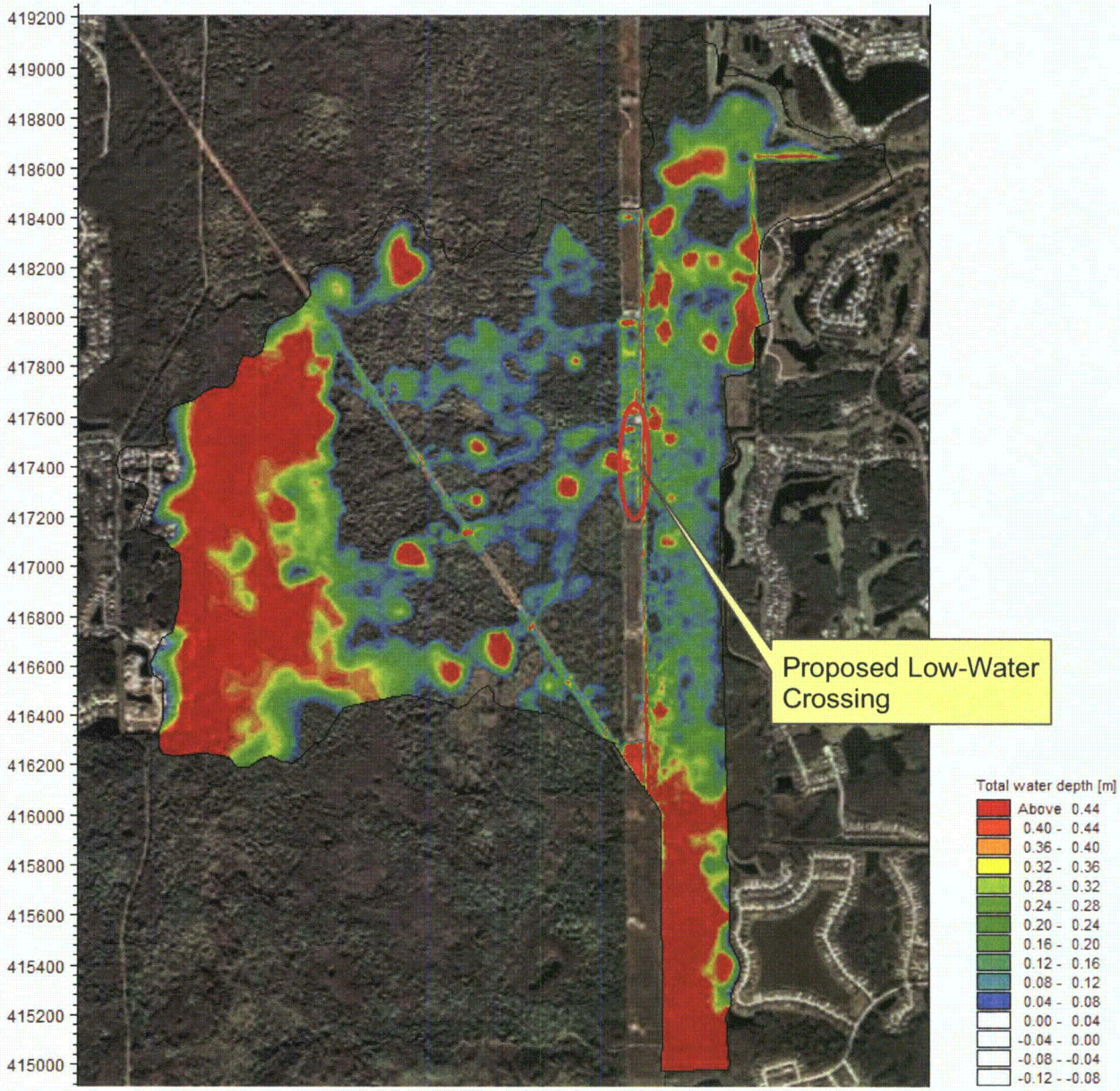
DATE	JULY 2011



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Maximum Water Depth for the 25-year storm event in Existing Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-26
DRAWN BY	RP
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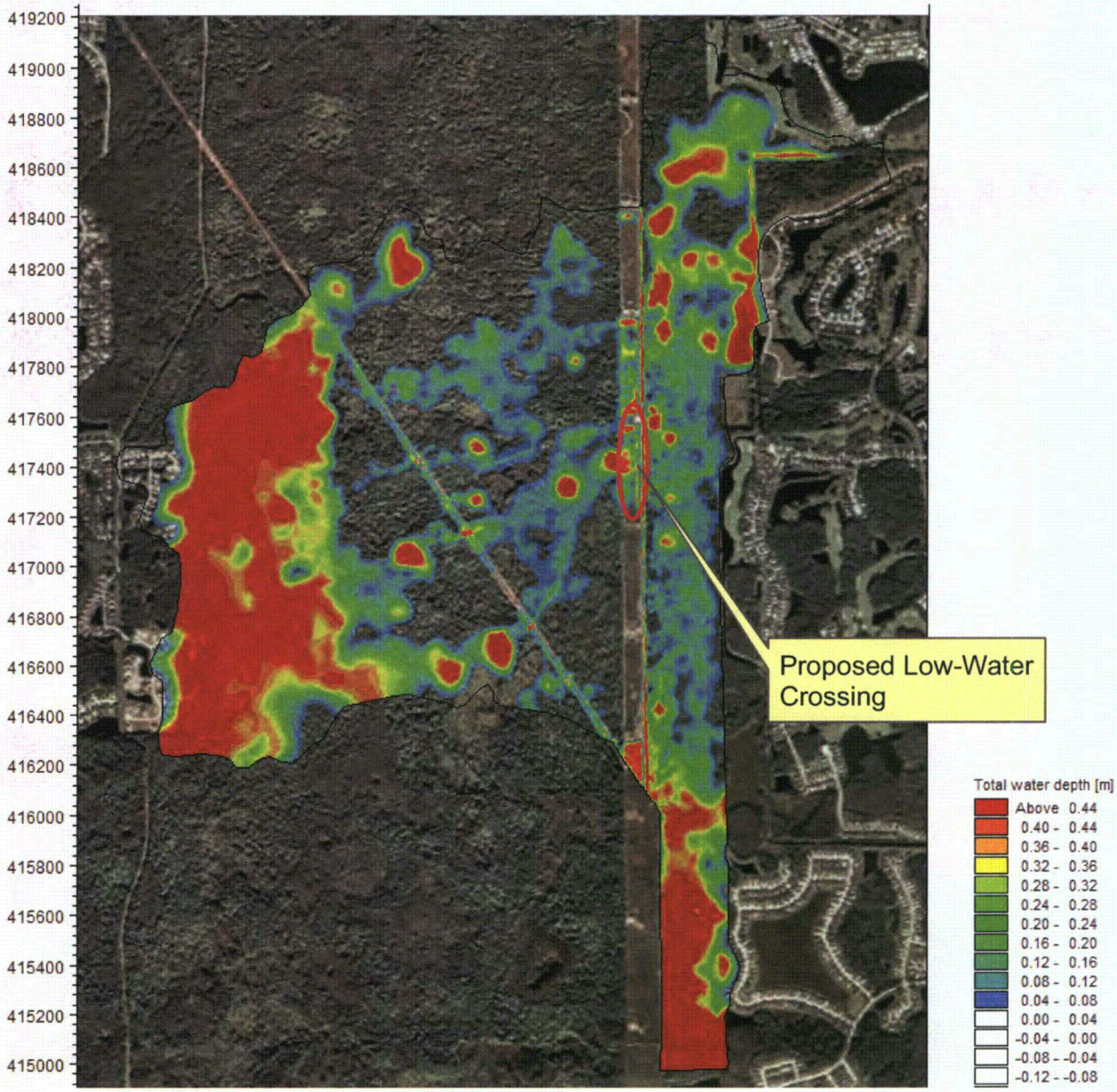

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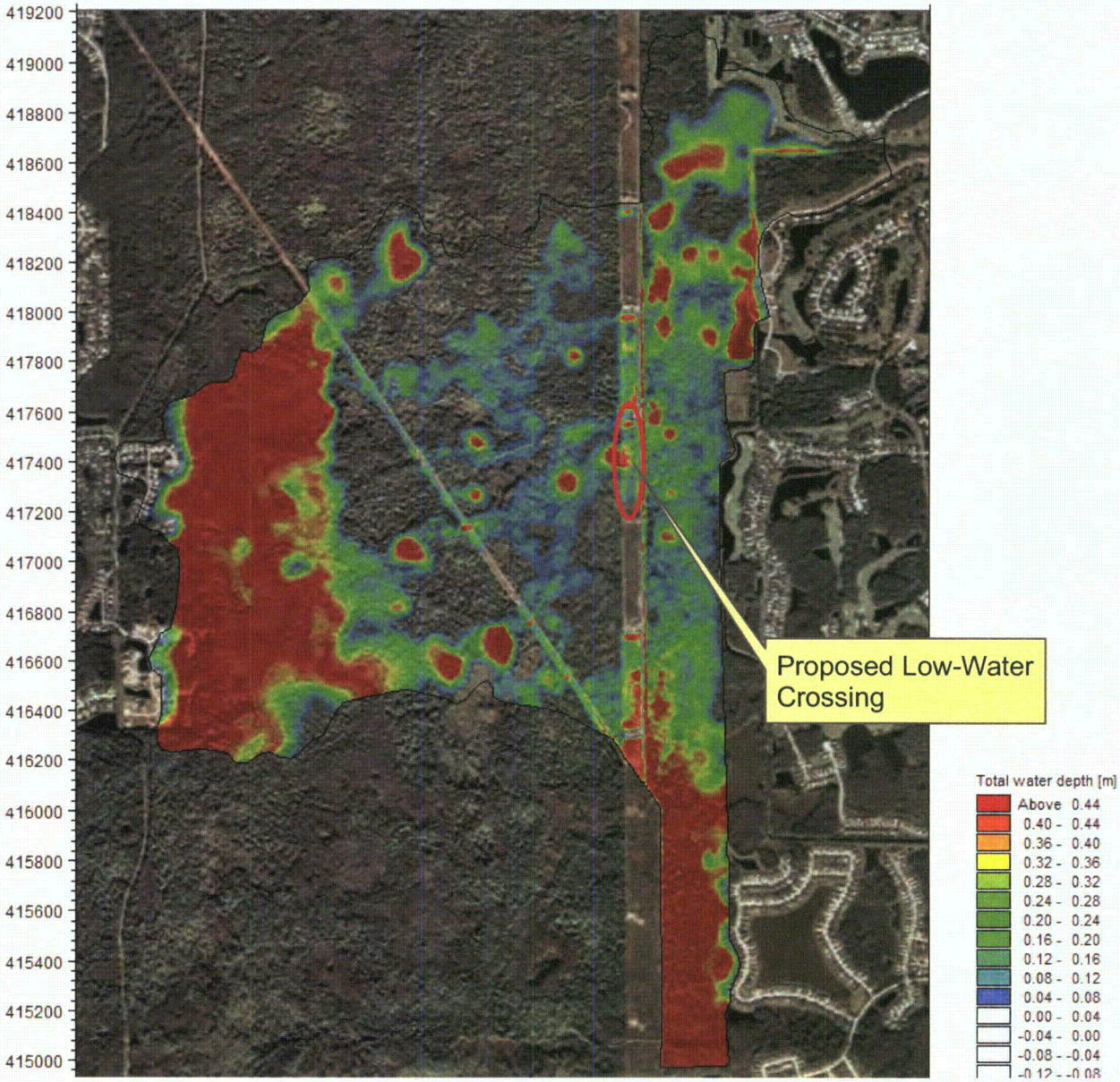
Maximum Water Depth for the 25-year storm event in Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

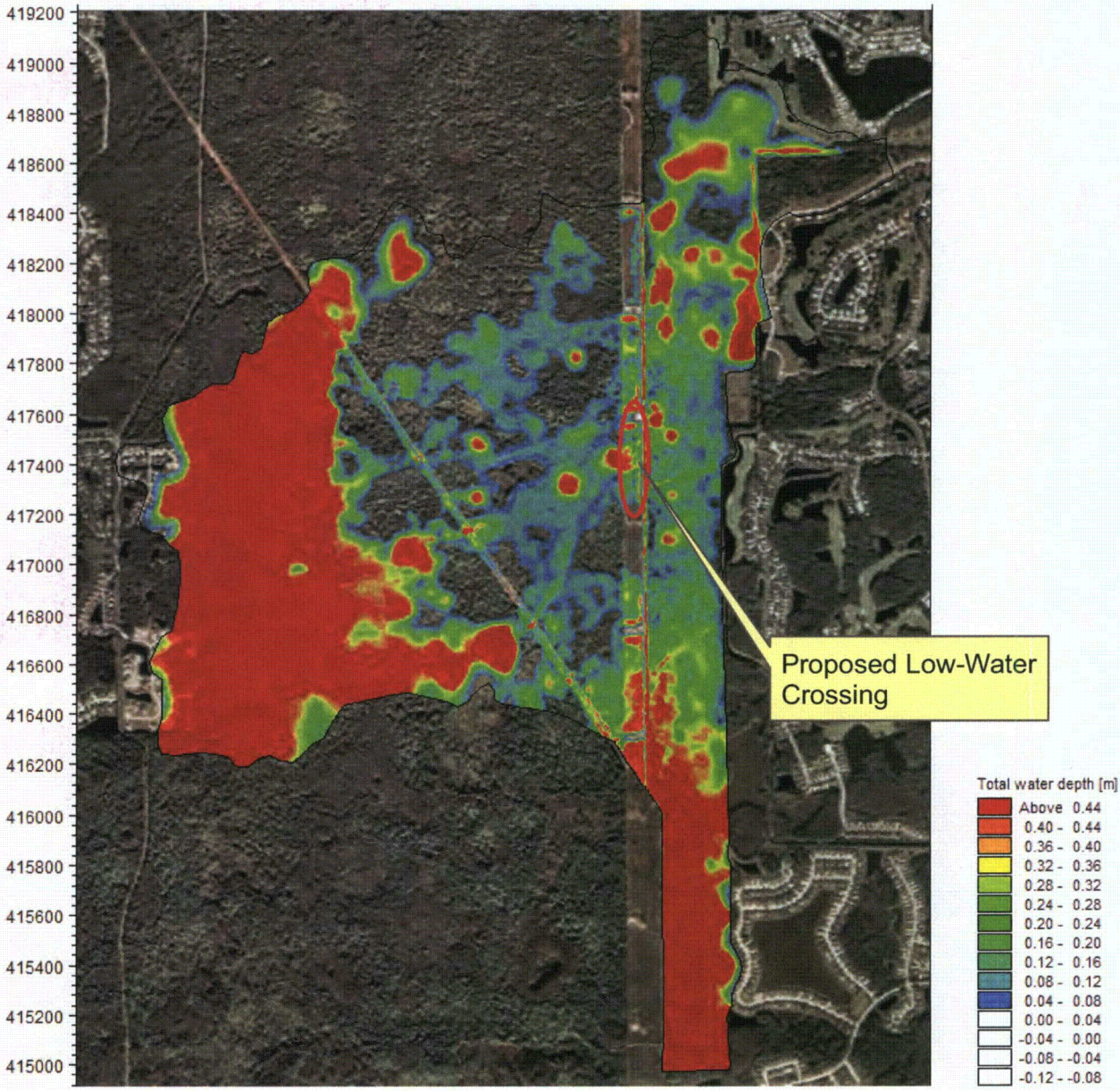
PROJECT	C2011-025
FIGURE	7-27
DRAWN BY	RP
DATE	JULY 2011



TAYLOR ENGINEERING, INC.

Maximum Water Depth for the 50-year storm event in Existing Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

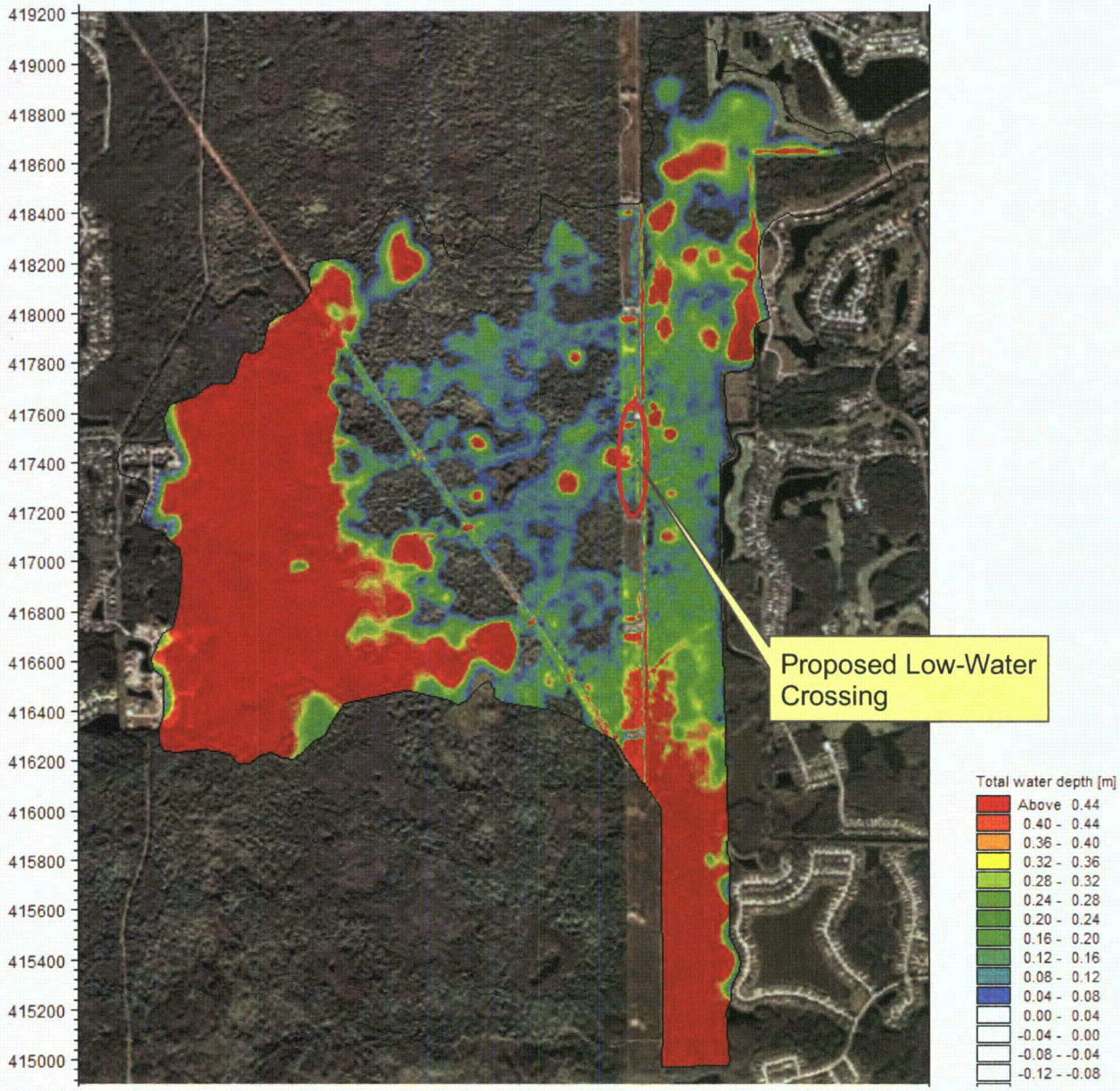
PROJECT	C2011-025
FIGURE	7-28
DRAWN BY	RP
DATE	JULY 2011



TAYLOR ENGINEERING, INC.

Maximum Water Depth for the 50-year storm event in Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

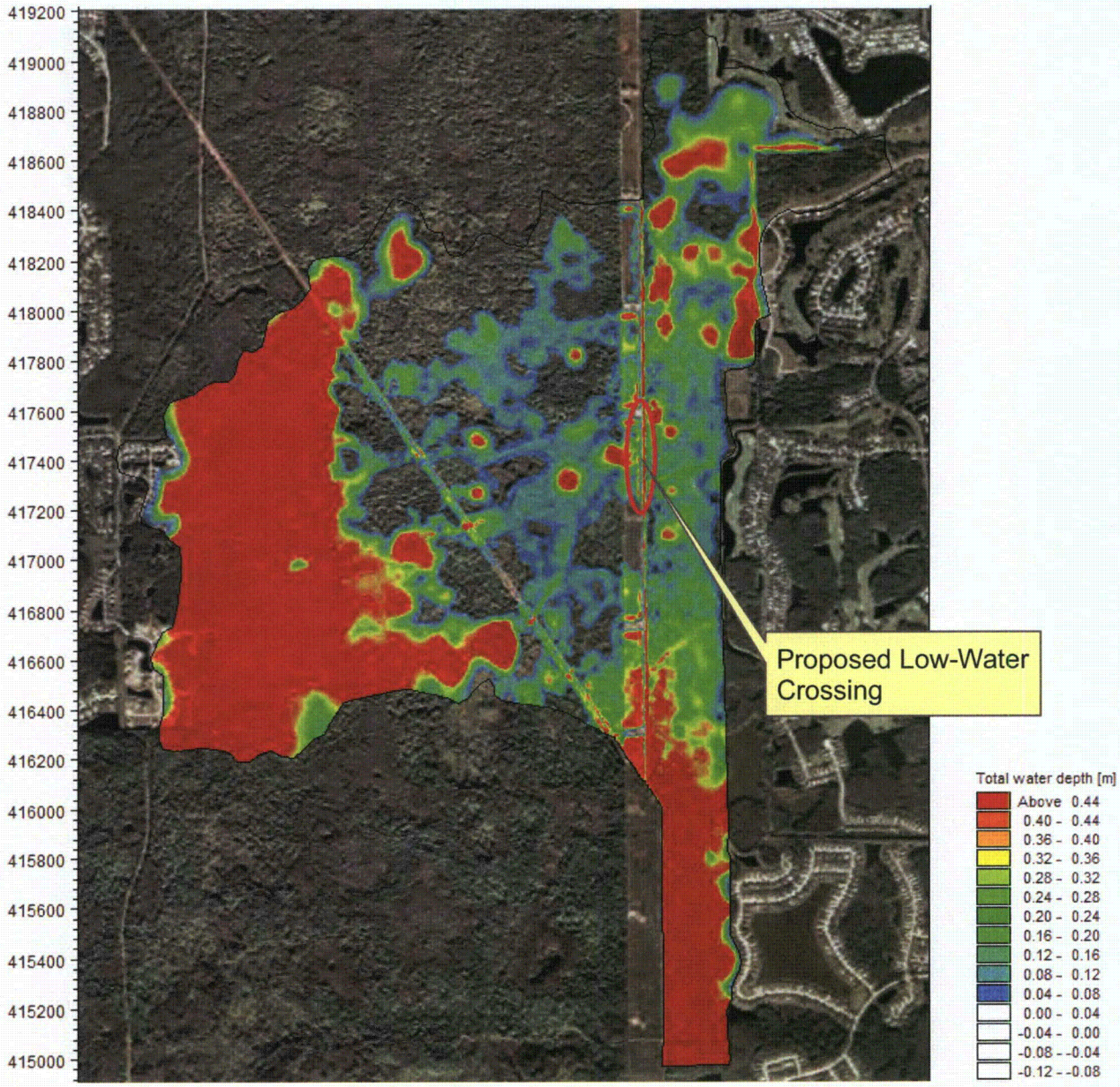
PROJECT	C2011-025
FIGURE	7-29
DRAWN BY	RP
DATE	JULY 2011



TAYLOR ENGINEERING, INC.

Maximum Water Depth for the 100-year storm event in Existing Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

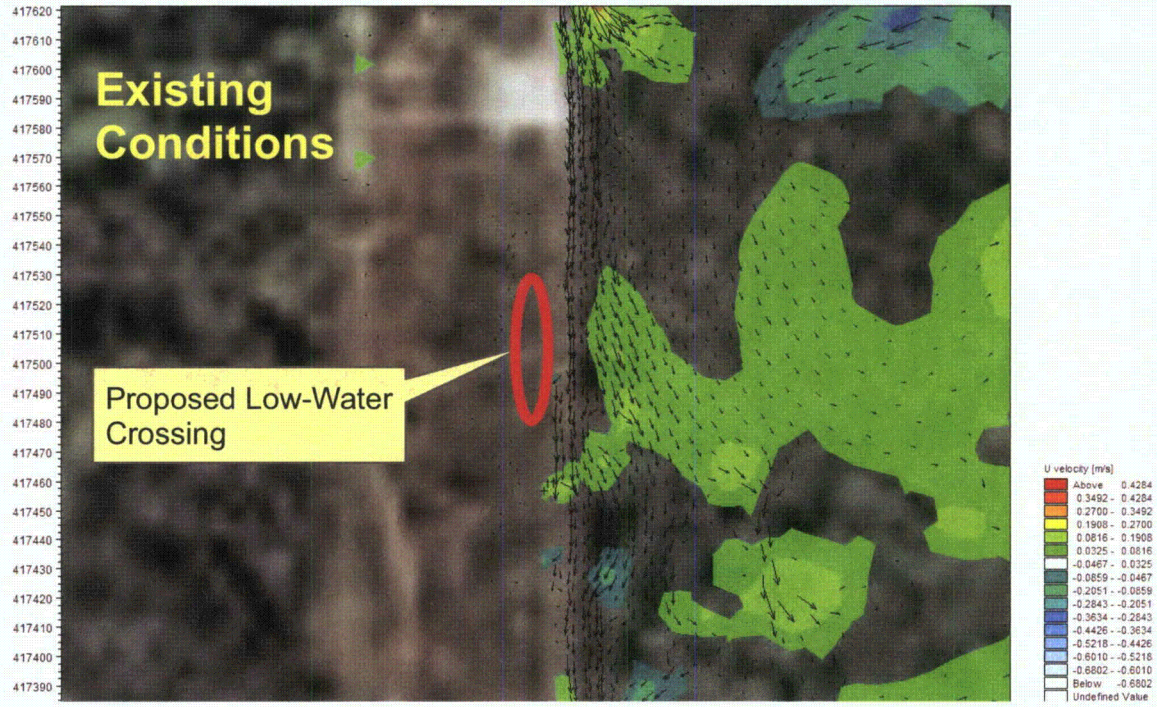
PROJECT	C2011-025
FIGURE	7-30
DRAWN BY	RP
DATE	JULY 2011



TAYLOR ENGINEERING, INC.

Maximum Water Depth for the 100-year storm event in Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

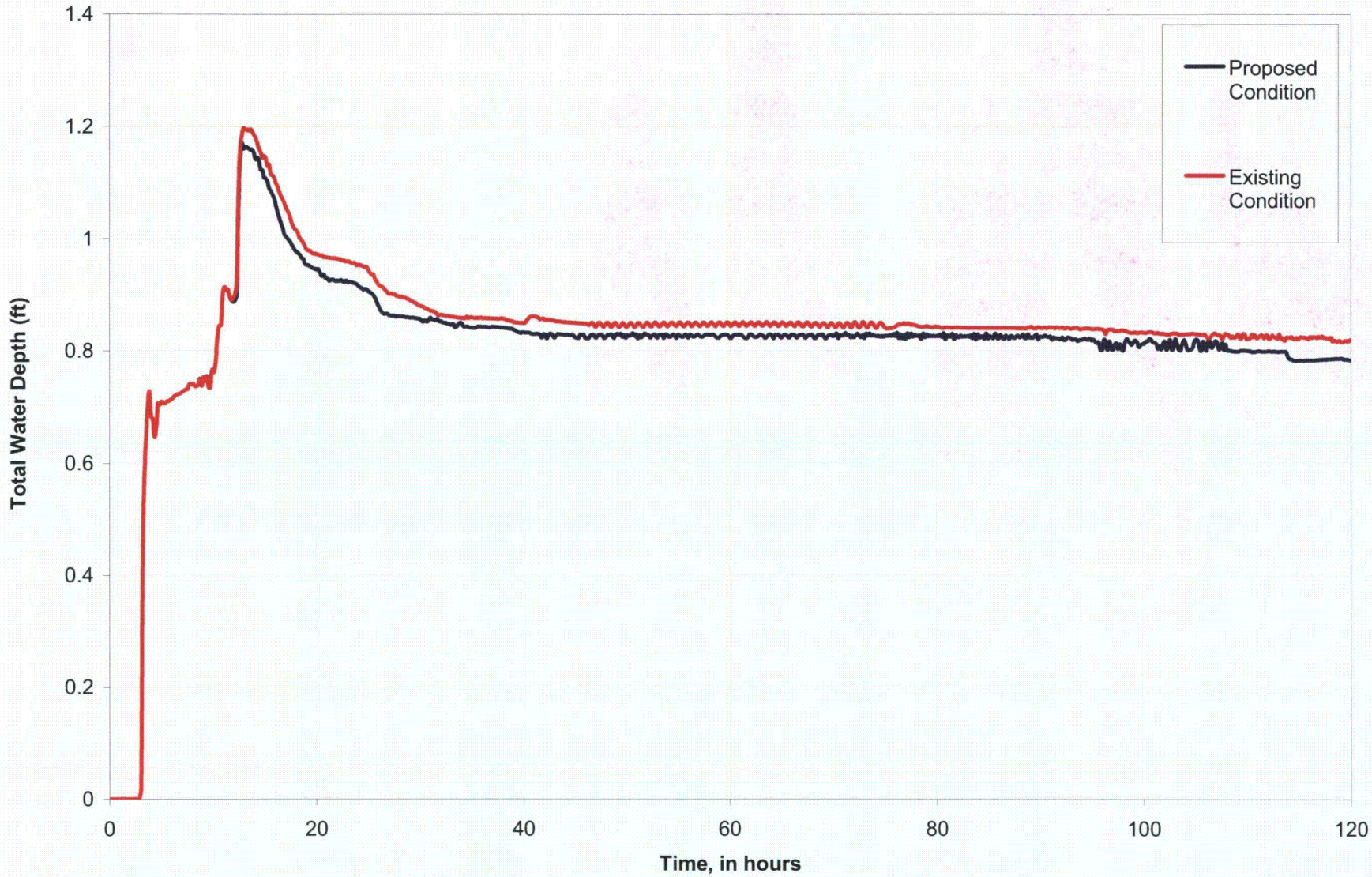
PROJECT	C2011-025
FIGURE	7-31
DRAWN BY	RP
DATE	JULY 2011



TAYLOR ENGINEERING, INC.

Velocity Vectors for the 2.33-year storm event in Existing and Proposed Conditions at Brooker South LWC
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-32
DRAWN BY	RP
DATE	JULY 2011



TAYLOR ENGINEERING, INC.

Comparison of water depths in Existing and Proposed Conditions at Eagles Golf Course Club for 100-year storm event
Brooker Creek Preserve Site
Pinellas County, Florida

PROJECT	C2011-025
FIGURE	7-33
DRAWN BY	RP
DATE	JULY 2011