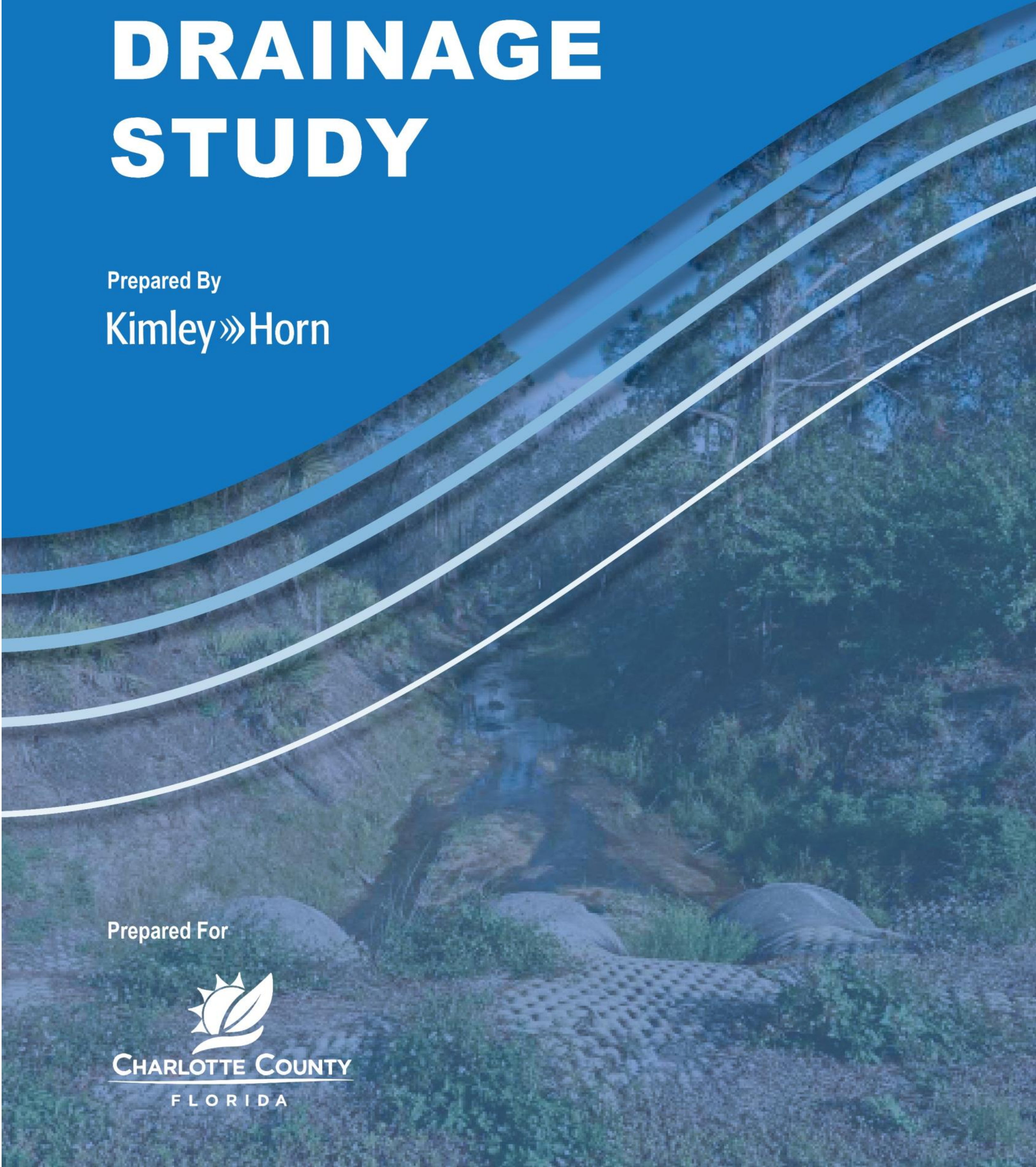
BURNT STORE DRAINAGE STUDY

Prepared By

Kimley»Horn



Prepared For

CHARLOTTE COUNTY
FLORIDA

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1. Introduction

1.1. Project Overview

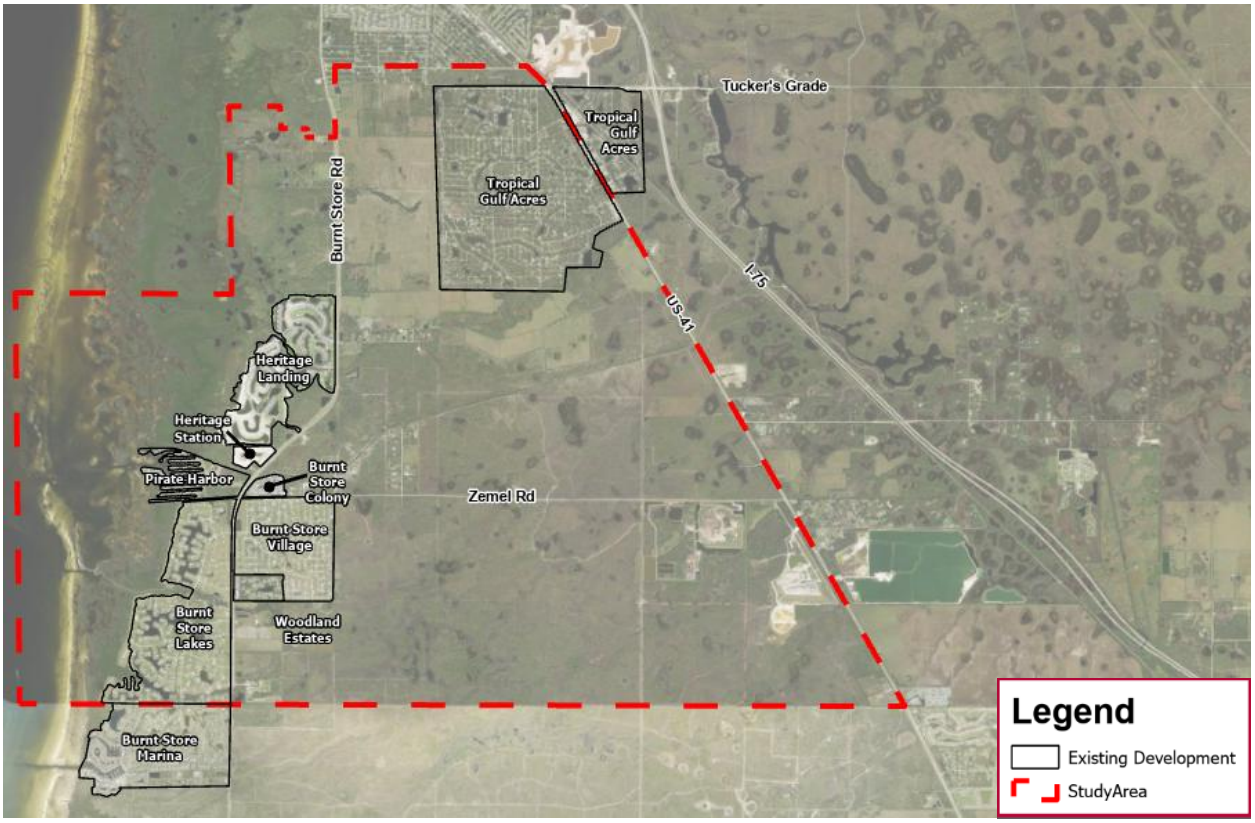
The Burnt Store Road drainage area within Charlotte County faces several unique challenges associated with flooding and stormwater management. These challenges include older infrastructure, limited historical stormwater management, and future growth. To address these challenges, Kimley-Horn was selected by the Charlotte County Board of County Commissioners to conduct a study of the Burnt Store Road drainage area. This study evaluated the existing conditions hydrologic and hydraulic characteristics of the Burnt Store Road drainage area, evaluated the effect of future conditions on the drainage area, and developed 3 concepts for proposed projects to address these concerns.

1.2. Project Goals & Approach

The Burnt Store Road corridor is a rapidly growing area of new and future development within Charlotte County. Several existing developments within the corridor have recorded flooding and other drainage concerns. There is additional concern from residents who live along Burnt Store Road that these concerns will worsen due to future development, more intense rainfall, and sea level rise. As a result, the goals of the drainage study were to evaluate the drainage of the study area in existing conditions, determine the changes to the drainage in future conditions, and identify improvements needed to address existing and future drainage concerns.

A study area was developed by the County to focus on seven key existing developments along Burnt Store Road. These developments included Tropical Gulf Acres, Burnt Store Village, Burnt Store Lakes, Heritage Landing, Burnt Store Colony, Pirate Harbor, and Woodland Estates. The study area was limited to Charlotte County and did not include neighborhoods along Burnt Store Road that are in Lee County (such as Burnt Store Marina). The study area and associated existing developments are shown in **Figure 1** below:

Figure 1: Study Area Map with Existing Developments



The approach of the study was to develop a hydrologic and hydraulic model to simulate existing and future conditions flooding. Three potential improvement projects were identified and implemented into the future conditions model to determine modeled Level of Service improvements. The proposed projects were scored based on cost and flooding improvement in different scenarios. This memorandum provides documentation of the study process, including methodology, results, and recommendations.

The study approach was broken down into eight tasks:

- **Task 1** Project Meetings
- **Task 2** Data Collection
- **Task 3** Public Involvement
- **Task 4** Existing Conditions Analysis
- **Task 5** Future Condition Model
- **Task 6** Alternatives Analysis
- **Task 7** Benefit-Cost Analysis
- **Task 8** Final Memorandum

Specific questions and concerns that the study is intended to address include:

- Are any finished floor elevations (FFEs) for existing homes and structures below the maximum stage elevations for a 100yr-24hr design storm?
- Are maximum stages for the 100yr-24hr design storm higher than pavement and road crown elevations along Burnt Store Road?

- What is the extent of nuisance flooding in the different communities within the Study Area?
- How does future development and potential changes to sea levels and rainfall impact these answers?

Note that this study is intended to only address rainfall-driven design storm events and does not evaluate storm surge or extreme tidal conditions.

1.3. Quality Control

Deliverables from each task were reviewed as part of the study's quality control process. Data was reviewed for accuracy. Accessible modeled structures were field verified. The developed models (existing condition, buildout condition, and alternatives) were reviewed both for inconsistencies and errors and for reasonableness in both inputs and results. Comments were provided to the project team and addressed before moving on to the next task. Along the way, the study approach and methodology were also reviewed. Significant modeling and study assumptions and methodology were coordinated with the County. The model was sent to the County for review and County comments were addressed. The modeling and report were each reviewed by a professional engineer at Kimley-Horn outside of the direct project team.

2. Project Meetings

Kimley-Horn conducted a kickoff meeting on January 21, 2025 to discuss project goals, available data, fieldwork procedure, and recurrence of additional meetings. Kimley-Horn held regular progress meetings with the County roughly 15 times over the course of the study. These recurring meetings served as a touchpoint to discuss a variety of topics including data collection and model creation, modeling assumptions, public coordination strategy, and updates on project milestones. These meetings typically occurred between the Kimley-Horn project team, the County Engineering Department, the County Survey Team, and the County public outreach group. Meetings were held either over Microsoft Teams or at the County's offices.

3. Data Collection, Review, and Processing

3.1. Summary of Data Collection, Review, and Processing

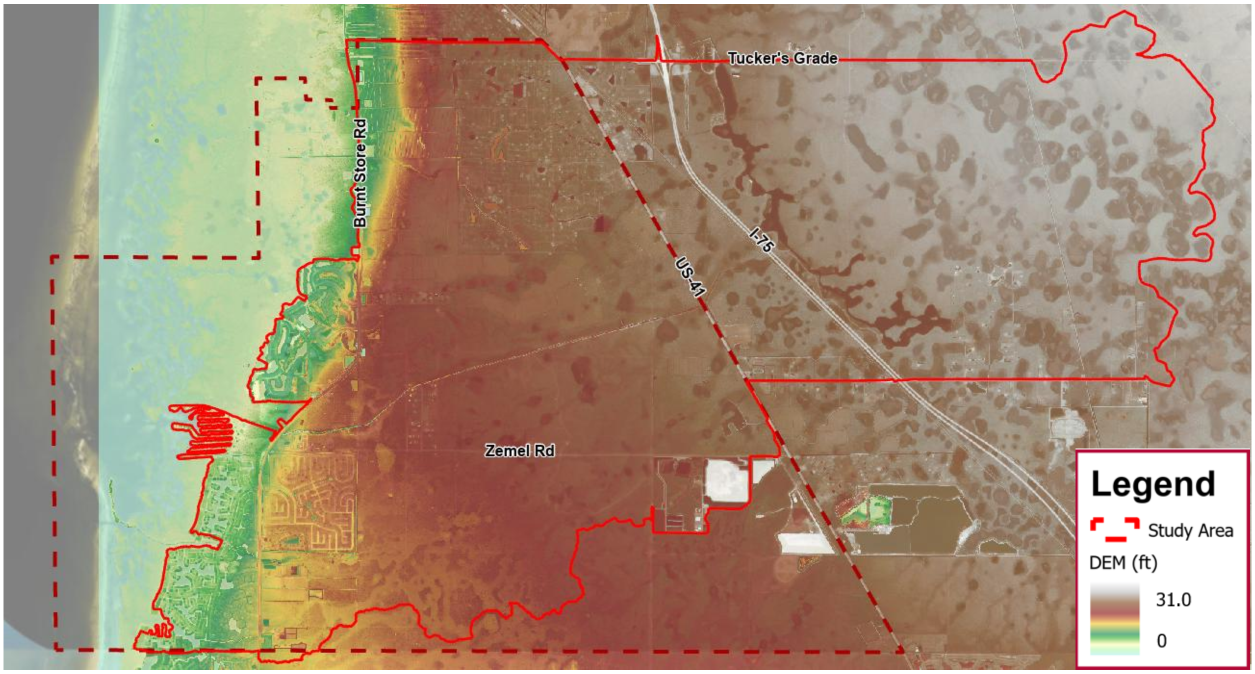
An extensive review of available data was performed as part of this study. This included collecting and reviewing existing infrastructure data, topographic conditions, soil data, existing land cover, documents from environmental resource permits, as-built survey, and other relevant hydrologic and hydraulic data. Additionally, data related to build-out conditions within the modeled area was obtained from the County and Southwest Florida Water Management District (SWFWMD). This includes locations of pending or planned future development and any associated site plans, modeling data, or other documents related to proposed stormwater management. Data was collected from readily available resources and agencies, such as the County, SWFWMD, NOAA, NRCS, FEMA, and other relevant agencies.

3.2. Topographic Data

Topographic data for the WQDS is based on existing conditions LiDAR imagery. LiDAR imagery in the form of a Digital Elevation Model (DEM) was downloaded from the Florida Geographic Information Office (FGIO) and clipped to the extents of the study area to simplify terrain processing. This DEM is dated 2018 and uses a vertical datum of NAVD88. The LiDAR obtained from FGIO did not include more recent improvements to Burnt Store Road. As-built elevation data for the Burnt Store Road improvements was provided by the County. This elevation data was converted into a DEM and used to append the LiDAR DEM. This combined DEM served as the effective topography for model parameterization.

The DEM was used to determine the watershed limits of the study area. This was used to revise the shape of the study areas provided by the County to a new study area that was developed by Kimley-Horn. This notably includes a large contributing drainage area east of I-75. Elevations within the study area generally range between sea level and 31 feet NAVD88, with water flowing from east to west. See **Figure 2** for a map of the DEM with the original and updated study areas limits included.

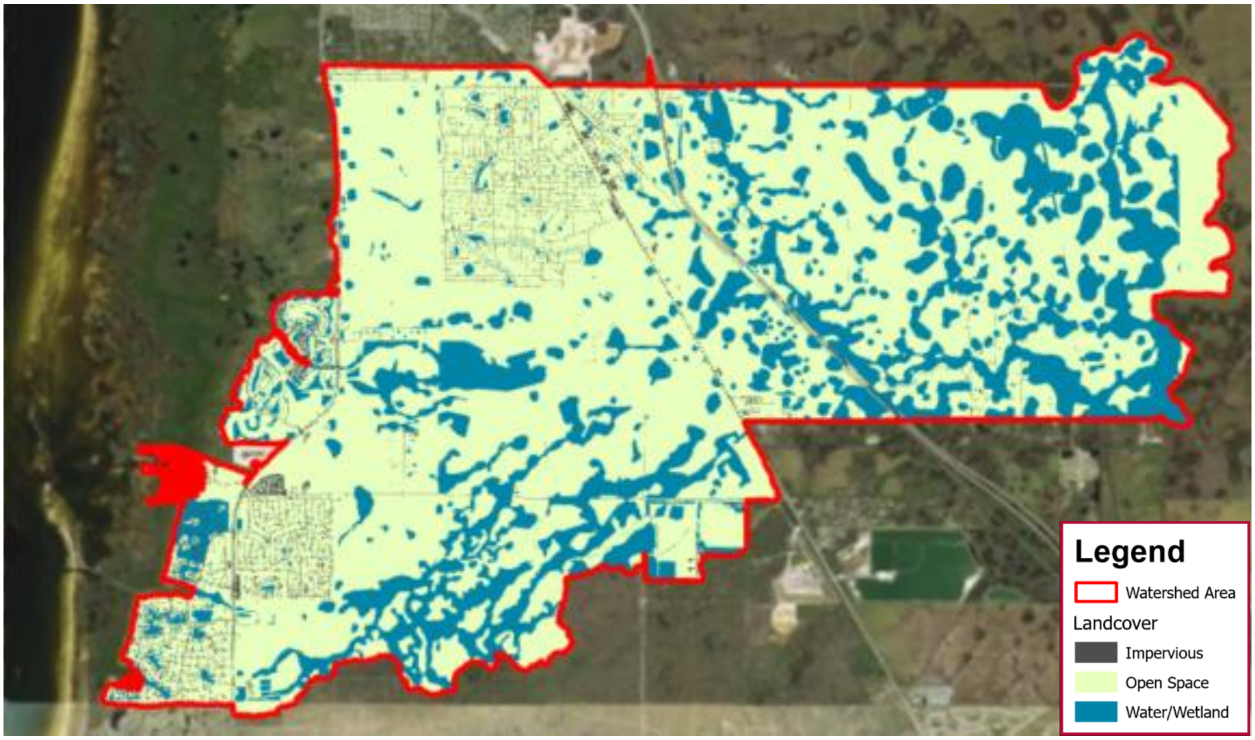
Figure 2: DEM Map



3.3. Land Cover

Land cover data was obtained from the National Oceanic Atmospheric Administration (NOAA), South Florida Water Management District (SFWMD), and SWFWMD. Impervious and open space areas were obtained as GIS layers from NOAA, while water body and wetland land covers were obtained as GIS data from the two water management districts. These GIS layers were combined into one land cover layer and reviewed manually against aerial imagery to confirm that land cover classifications were representative of existing conditions. In areas where aerial imagery conflicted with the developed land cover layer, the layer was updated to reflect the land cover associated with the aerial imagery. See **Figure 3** for a map of land cover classifications.

Figure 3: Land Cover Map



3.4. Soils

Soil data was obtained from the National Resources Conservation Service (NRCS) web soil survey. Soils within the study area primarily consist of Felda fine sand and Pineda fine sand, frequently ponded soil types. The existing conditions model utilized Green-Ampt as the rainfall excess method. The Green-Ampt parameters were obtained from the NRCS data.

3.5. Stormwater Infrastructure

Existing stormwater infrastructure data (pipes, weirs, control structures) was obtained through various means of data collection, including aerial review, Environmental Resource Permit (ERP) review, field reconnaissance, and survey.

Desktop Review

Initially, the DEM was reviewed for potential pipe crossings by identifying low areas, road intersections, and outfall areas. These locations were logged in ArcGIS and then reviewed using Google Street View to verify if stormwater infrastructure is present. Locations of identified structures were recorded for use during field visits and survey requests.

ERP Review

Available ERP data was obtained from SWFWMD and reviewed for existing permitted developments within the study area. Available as-builts, construction plans, and drainage reports were downloaded and reviewed. The existing infrastructure data within the reviewed documents, such as information on pipes or drop structures, was recorded with the permitted pipe parameters and ERP permit application number. These pipe and control structure locations were also field verified and surveyed. The ERP parameters were compared to the other two sources for accuracy. Infrastructure data from the ERP was converted from NGVD29 to NAVD88 as needed using a conversion factor of -1.125 feet.

Field Reconnaissance

Field reconnaissance was conducted for all accessible modeled structures to understand general drainage patterns and features of the study area, including infrastructure identified through DEM and aerial review. During field reconnaissance, Kimley-Horn took pictures of each structure as reference and documented culvert material, culvert size, weir lengths, link count, and culvert end type. This information, along with the condition of the structure, was logged using ArcGIS Field Maps. See **Figure 4**, **Figure 5,** and **Figure 6** for examples of structures documented in the field.

Figure 4: Site visit photo of typical Tropical Gulf Acres pipe crossing

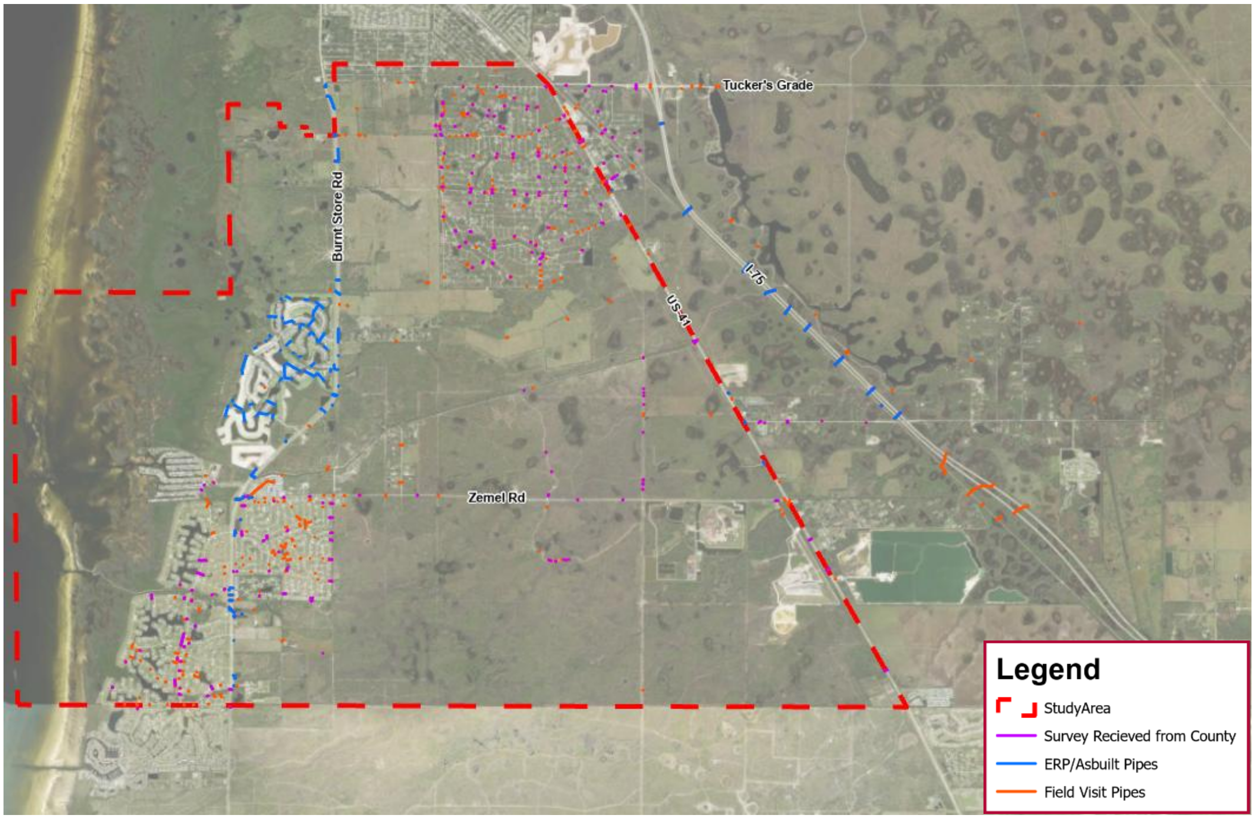
Figure 5: Site visit photo of large triple RCP crossing near Tropical Gulf Acres

Survey was performed by Charlotte County surveying crews to obtain inverts for 400 modeled structures in the study area. Kimley-Horn worked with the County to complete the surveying task by providing the GIS data of all structures from field reconnaissance efforts that would be included in the model. The surveyor visited each of these sites to collect structure information including culvert material, culvert size, culvert invert elevations, weir length, and weir elevations. Additionally, the County provided surveyed cross-section data at many of the modeled canals. This data was provided in NAVD88 as an Excel Spreadsheet in batches as data was collected.

Figure 6: Site visit photo of large RCP culvert crossing in Burnt Store Village

See **Figure 7** below for a map of collected stormwater infrastructure data with the associated source.

Figure 7: Collected Stormwater Infrastructure by Source

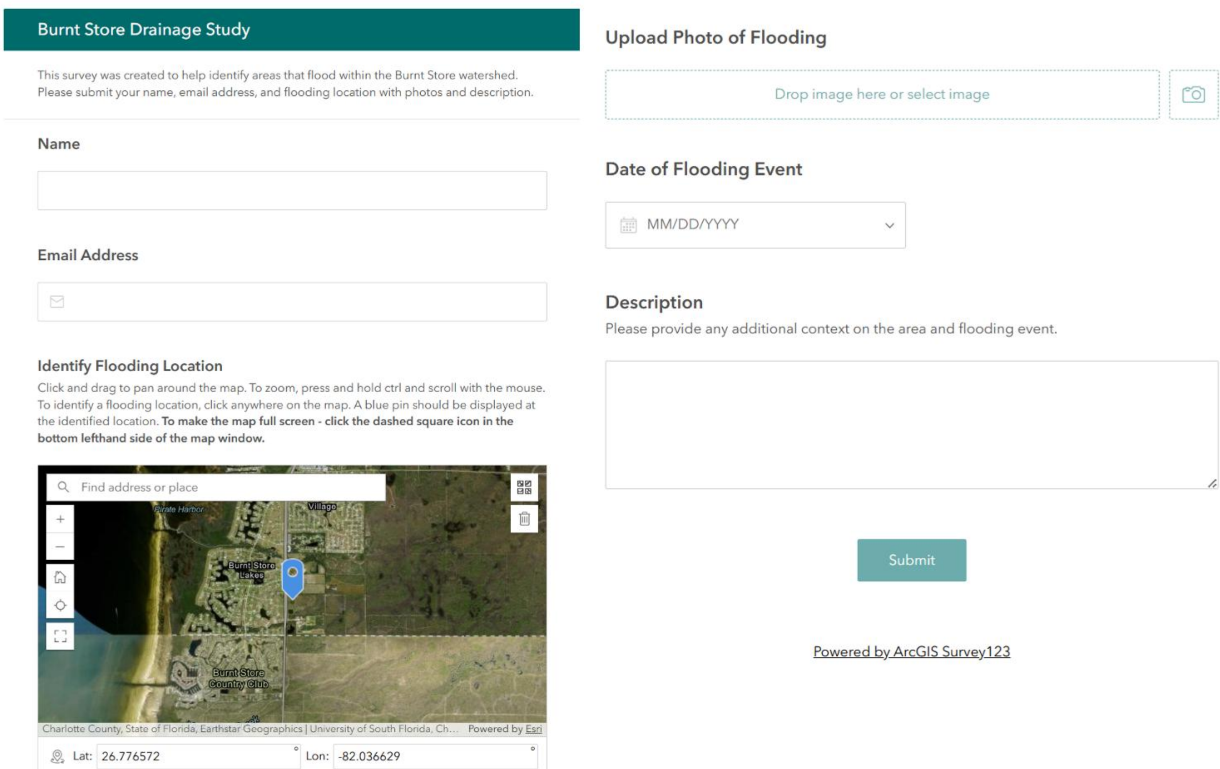


4. Public Involvement

4.1. Public Engagement Survey

A public engagement survey was created using ArcGIS Survey123 and included a site map with the capability of dropping location pins for known areas of flooding concern (See **Figure 8**). Comments and photos attached to the location pins were used to determine observed locations of flooding, dates when flooding occurred, types of flooding, and any other items that could be addressed during the public meetings. Pins were dropped at 56 locations, largely within Burnt Store Village, for a storm event in July 2025.

Figure 8: Public Survey for Flooding Concern



4.2. Public Meetings

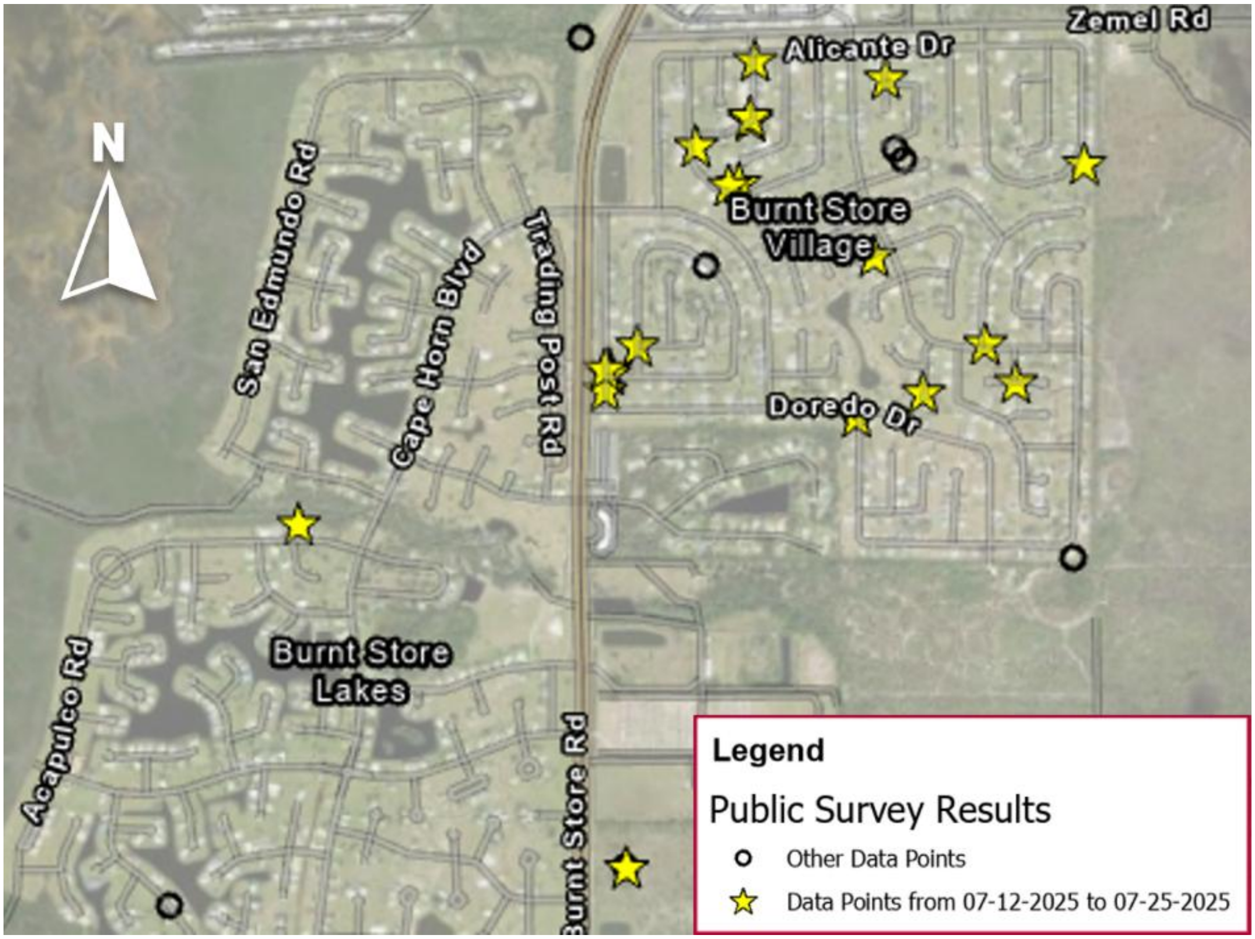
Public meetings were held for this study during model development, model validation, and as the study neared completion (See **Figure 9**). The three public meetings focused on both informing the public of the project and collecting data from the public. The Kimley-Horn team would typically include a 15-minute presentation with the project status, overall goals and objectives, analysis and results to date, and next steps. The public was given the opportunity to speak after the presentation, meet with the project team, and review the results using a variety of visual aids. Public input allowed Kimley-Horn to gain a stronger understanding of the study area, the public's concerns with the existing and future drainage, and the public's desires for project outcomes. The public concerns related to inadequate existing infrastructure, ongoing and future development, large amounts of sheet/overland flow from the east, and maintenance responsibilities. Members of the South Charlotte Stormwater Utility Unit, one of the Municipal Service Benefit Units (MSBU) within Charlotte County, attended the public meetings. Kimley-Horn coordinated with the County and MSBU to address specific concerns brought forth by MSBU advisory board members.

Figure 9: Public Meetings

Public Meeting 1 – Model Development

Public Meeting 1 was held on July 22, 2025, during the development of the existing conditions model. Major discussion points of the meeting include model inputs, initial model results, and areas of concern per the public survey. Public comments were largely focused around Burnt Store Village, Burnt Store Colony, and Woodland Estates, with the largest amount of concern regarding ongoing flooding along the Burnt Store Village rim ditch. Additionally, the meeting was used to share that the public survey was available for input. The main takeaway from this meeting was that while residents understand the desire to address flooding concerns associated with major storm events in the future, they are also concerned about flooding from typical "every-day" storm events, specifically in sections of Burnt Store Village that aligned with our survey results. This input resulted in a validation event being selected that represents a typical summer storm in July 2025. This strongly coincided with the findings from the public survey. See **Figure 10** for collected public survey locations by date of flooding.

Figure 10: Public Survey Results by Date



Public Meeting 2 – Model Validation

Public Meeting 2 was held on September 23, 2025, during model calibration/validation. The Kimley-Horn presentation included discussing public survey results, the validation event model result, and future/buildout conditions model methodology. The public survey included several photos and testimonials of flooding at Burnt Store Village. See **Figure 11**, **Figure 12**, and **Figure 13** for examples of flooding photos submitted by the public. This represented the best available data to calibrate/validate the model against, as detailed water level data was not available for the study area. The major takeaway from the validation event modeling was that flooding photos submitted by the public generally align with validation model results. This takeaway was shared at the meeting. More detail regarding the validation event is found in Section 5.8 of this report.

Figure 11: Burnt Store Village Flooding

Some of the public raised concerns about future development negatively impacting drainage across the study area. The public discussed specific future developments that they were concerned about, which all aligned with development areas that would eventually be included in the buildout conditions model. It was shared with the public that these developments would be included in the buildout conditions model. Another notable takeaway was the public's concern with existing drainage ditches not being well maintained and negatively impacting drainage. It was reiterated to the public that evaluation of maintenance procedures and responsibilities was outside of the scope of this study.

Figure 12: Burnt Store Village Flooding

Figure 13: Burnt Store Village Flooding

Public Meeting 3 – Final Public Meeting

Public Meeting 3 was held on May 19, 2025, upon completion of the modeling portion of the study model and focused primarily on sharing results with the public. Main discussion topics included discussing the difference between the evaluated scenarios, discussing the Level of Service goals for the conceptual improvements, and clarifying the conceptual nature of the project. Attendees had follow-up questions regarding proposed timelines, maintenance, and the involvement of regulatory agencies. Specific questions and other feedback raised by the public and the associated responses provided by the County and Kimley-Horn include:

- The public raised the question of when these projects would be implemented. The study does not include a timeframe for when potential projects would be implemented. It was shared that while this study may be used for future design and planning efforts, this study does not include an implementation plan component. It was discussed that while the future conditions planning horizon is not for several decades, these projects may be implemented alongside proposed road improvement projects that may occur much sooner.

- Some attendees suggested that projects should incorporate downstream improvements near Burnt Store Lakes and Pirate Harbor. It was discussed that if any of these projects were implemented, they would consider downstream improvements during design to prevent increased erosion of flood staging.
- Some attendees asked for clarification on the evaluated LOS criteria and which scenarios and how projects were evaluated. It was shared that improvements to building flooding and flooding along Burnt Store Road were evaluated during the future conditions 100-year, 24-hour event, and that local roads would be evaluated based on the validation event. Buildings were evaluated based on the future conditions storm event because there were more instances of estimated residential building elevations lower than the modeled 100-year, 24-hour floodplain elevations in this scenario. It was reiterated that the study does not evaluate storm surge.
- Some attendees raised concerns over the limitations of the LOS analysis and that additional storm events should be evaluated. It was shared that if any of these projects were to be implemented, they would be designed to meet more detailed criteria outside of the conceptual projects evaluated in this study.
- Many attendees were concerned about the maintenance responsibilities of the proposed improvements. It was reiterated that this is outside the scope of this study.
- Some attendees had questions on the permitting feasibility of the proposed projects. If implemented, proposed improvements would involve coordination with the Southwest Florida Water Management District before design begins.

It was reiterated that this is a conceptual, planning-level study. Recommendations for further uses of the study are listed in Section 9 of this report.

5. Existing Conditions Analysis

5.1. Existing Conditions Model Development

A model was developed to evaluate the existing conditions hydrologic and hydraulic (H&H) features of the study area. The model was developed using Stormwise (formerly known as ICPR4), an integrated H&H modeling software. Stormwise utilizes three main modeling components: basins, nodes, and links. Modeled basins are drainage areas within the overall watershed that assign runoff calculated by input hydrologic parameters (area, TC, unit hydrograph, landcover, soil) to a modeled storage location. These modeled storage areas are referred to as nodes, which can represent a ditch, link junction, wetland, lake, or other depressional area. The nodes are connected by links, which are modeled hydraulic connections between two nodes, such as pipes, channels, control structures, and overland weirs. Model parameters for the basins, nodes, and links were calculated and assigned based on available data from aerial imagery, DEM, survey, past flooding documentation, permitted plans, as-builts, and GIS information. Results in the model were in the form of a maximum stage (water elevation) for each node that were applied spatially to estimate the extent and depth of modeled flooding.

5.2. Model Schematic

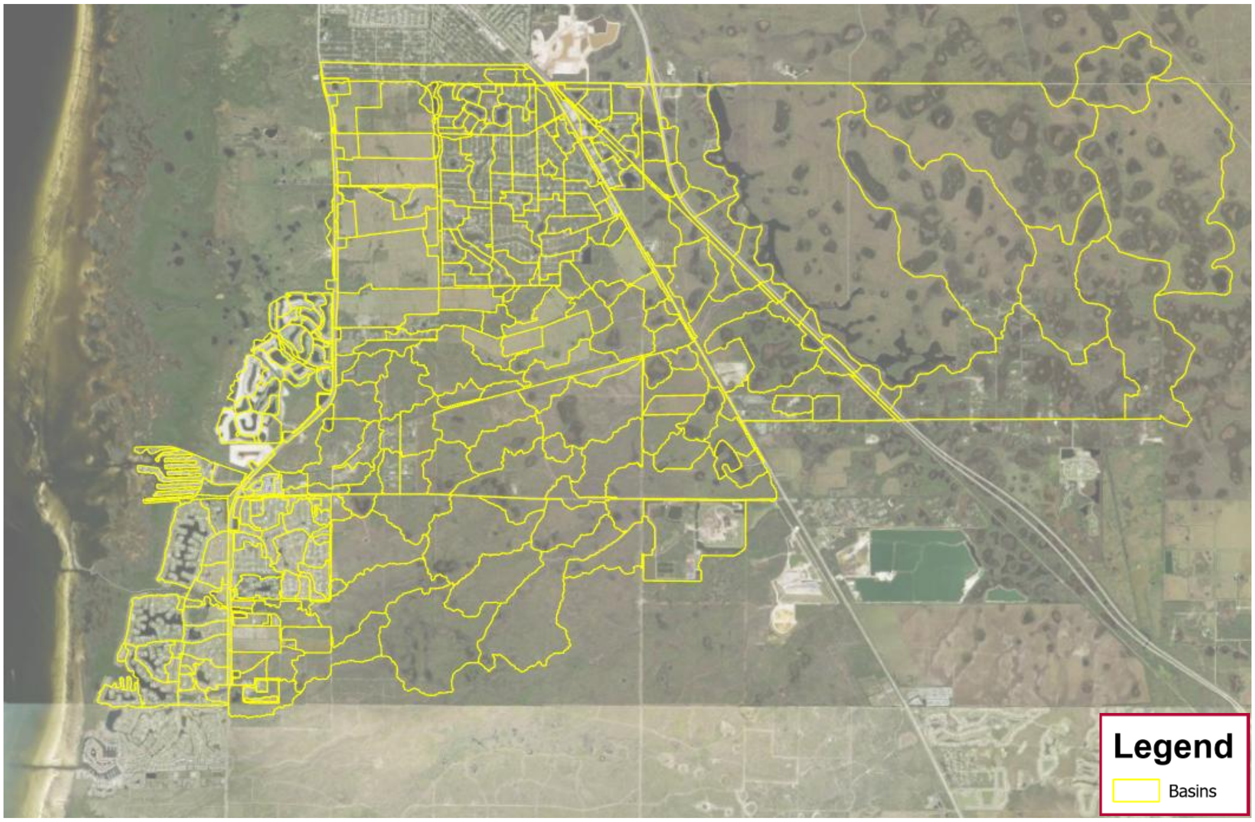
Model Scale

The level of detail of model features was determined by establishing a model scale. The model scale determines the size, configuration, and general intent of each basin, node, and link. For this model, the desired scale was detailed enough to accurately show modeled flooding for specific areas of interest within the County (streets, intersections, neighborhoods) without modeling every single pipe and storage area. As a result, a model scale was developed to a scale such that lakes, wetlands, roadway swale systems, and channels had an associated model component. The storage areas along Burnt Store Road and the evaluated development areas were typically modeled at a more detailed model scale than the contributing areas. The more detailed model scale is suitable for areas where detailed results are needed to propose potential improvements, while a more regional model scale is more suitable for determining the offsite drainage areas that contribute to the Burnt Store Road corridor. The local drainage features, such as roadside swales and driveway culverts, were not modeled. It is also worth noting that this is a planning-level study and not at a level suitable for FEMA map revisions or regulatory floodplain management programs. Additionally, the model was developed to reflect the conditions at the DEM. Because of this, in areas where the developed DEM reflected on interim conditions (such as Heritage Landing, which was being graded while LiDAR was taken), the existing conditions model schematic was based on the interim grading conditions.

Basins

Basins were delineated based on elevations from the developed DEM, infrastructure data, ERP permit data, and field investigations. Within the study area, the basins were reviewed against the DEM and modified as needed to reasonably represent how stormwater runoff is conveyed and stored. There are approximately 340 basins total within the model. Each basin was assigned a name, which was then referenced when assigning node and link names. See **Figure 14** for basins delineated for the study area.

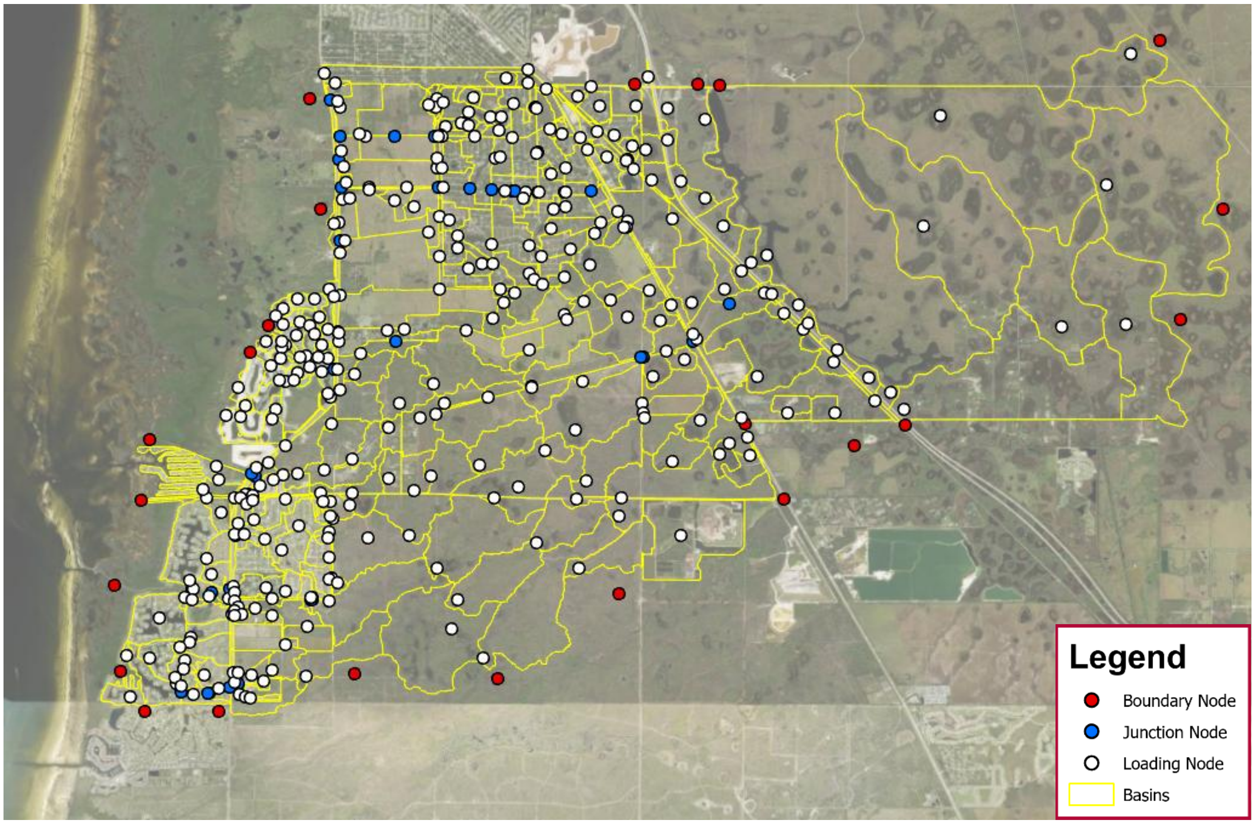
Figure 14: Existing Conditions Basin



Nodes

Two types of nodes were assigned within the model. These included stage-area (storage and junction) nodes and time-stage (boundary) nodes. Each basin was assigned to an associated storage node placed where the associated runoff and flow collected at the main storage area. Typical storage areas modeled as nodes were ponds, lakes, wetlands, large ditches, floodplain compensation areas, and other large storage areas. In addition to the storage nodes, junction nodes were used in the model to accurately represent hydraulic connectivity in channels. Boundary nodes were placed at the headwater and tailwater conditions around the basins to represent any inflow or outflow of water from the study area. There were approximately 375 stage-area nodes and 24 boundary nodes modeled. See **Figure 15** for the nodes modeled within the study area.

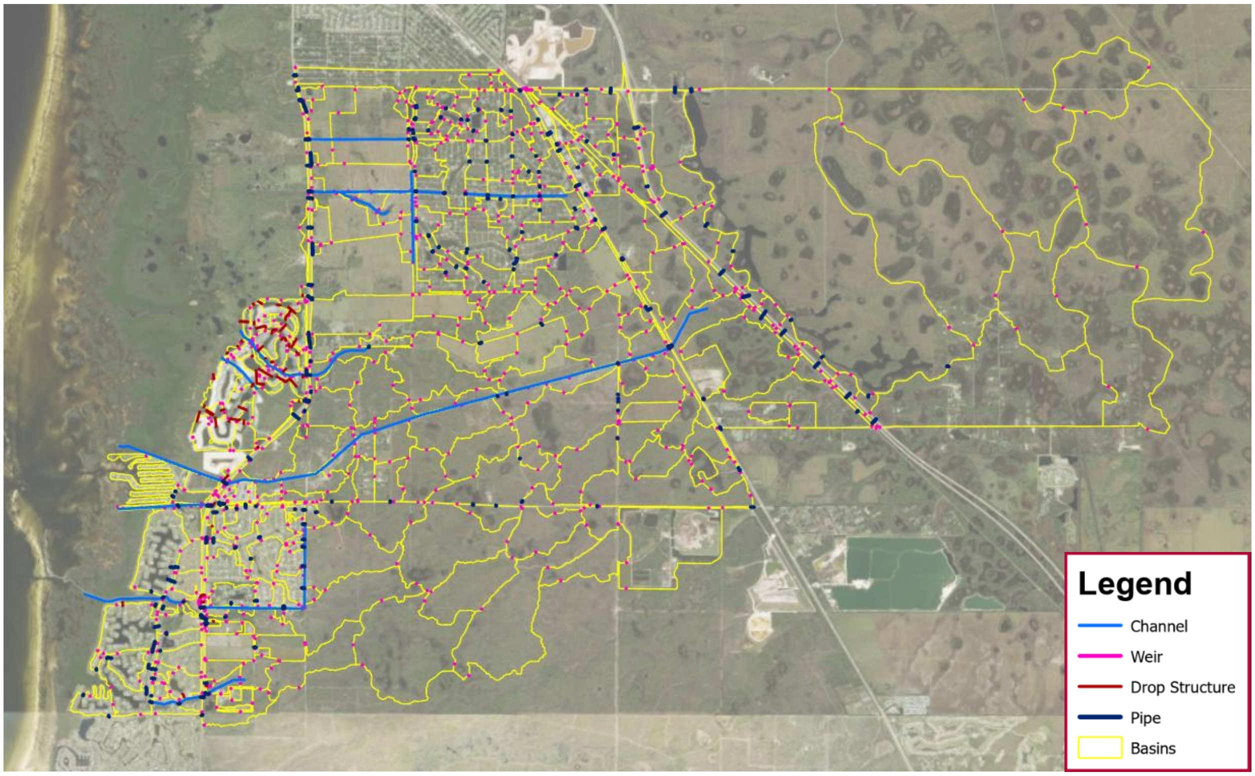
Figure 15: Existing Conditions Node Map



Links

Channels, pipes, drop structures, structural weirs, and overland weirs were placed between nodes. The model has 51 channel links, which represent large ditches or streams. Pipe and drop structure links represent primary pipes and control structures crossing basin boundaries; the model had approximately 332 pipe links and 65 drop structure links. Structural weirs and overland weirs are both modeled using a weir link, with structural weirs representing control structures without pipes and overland weirs representing overland flow between basins. The model had approximately 1,000 weir links. See **Figure 16** for links modeled within the study area.

Figure 16: Existing Conditions Link Map



5.3. Modeled Storm Events

The 100-year, 24-hour design storm was included in the existing conditions model. The Florida modified rainfall distribution curve was used for the design storm, and a rainfall amount of 11.3 inches was obtained from the NOAA Atlas 14 Precipitation Map.

5.4. Basin Parameters

Green-Ampt and Percent Impervious

Green-Ampt parameters are based on data collected from NRCS, such as hydraulic conductivity, effective porosity, capillary pressure, soil group and class, total porosity, and sample size. A soil layer containing these parameters was developed for the project area.

The developed landuse layer was intersected with each basin to determine the acreage of pervious area, impervious area, and water body/wetland for each basin. area. This acreage was used to calculate percent impervious, percent DCIA (directly connected impervious area), and percent direct (water/wetland) for each basin, which was assigned in the model using an impervious set table. It was conservatively assumed that all impervious area is DCIA. This was intersected with the soils layer to generate a table for each basin that assigned how much of a basin area was associated with each soil type. The model was then able to assign representative Green-Ampt and impervious parameters for each basin.

Time of Concentration and Unit Hydrograph

A time of concentration (Tc) was assigned to each basin. TC values were calculated for each basin by delineating the basin's longest flow path line and then calculating the total flow time along that path using the TR55 method. The longest flow paths were delineated from a combination of sheet flow and shallow concentrated flow, referencing visual flow paths created manually in GIS based on DEM elevations. The longest flow path started at the most hydraulically distant pervious point in the basin, then followed the flow path to the lowest point in the basin (usually to the node point), which was likely to represent the largest travel time. The flow paths consider the land cover types and the slope along the line, not just the distance. For example, a flow path through dense vegetation is going to take longer than flow going across pavement. Once the longest flow paths were drawn, the time of concentration was calculated. The first 100 feet of the longest flow path were designated as sheet flow. Manning's n coefficients for calculating sheet flow were assigned based on land cover. The rest of the flow path was designated as shallow concentrated flow until it reached a storage location or channel. Note that channel/pipe flow was not included in this analysis, as this travel time is typically relatively insignificant. Slopes for both sheet flow and shallow concentrated flow were calculated using the DEM. The calculated time of concentration for each of these flow types in a basin was added together for a total time of concentration for each basin. Any TCs of less than 10 minutes were assigned a minimum TC of 10 minutes. The calculated TCs in the model ranged from 10 to 263 minutes. A UH256 unit hydrograph was used in the model, with an associated peaking factor of 256.

5.5. Node Parameters

Stage-Area Nodes

Stage-area tables were generated in Stormwise based on DEM data. Stage-area extents are represented by stage-area polygons, which are the basin boundaries buffered in by 5 feet and channel storage areas excluded. The basin boundaries were buffered in by 5 feet because Stormwise counts all DEM cells intersecting with the boundary. The 5-foot buffer eliminates any partial cells from being counted towards total storage area. Channel storage exclusion areas were delineated to represent the channel volume extents to avoid double-counting channel storage volume. Nodes were processed starting at the lowest elevation within the stage/area polygon, with surface area being determined from the DEM in 0.1-foot vertical increments.

Time-Stage Nodes

A time-stage relationship was established for each time-stage node to simulate a tailwater condition based on established or assumed elevation data. See **Figure 17** for a map of the tailwater nodes with classification of how tailwater elevations were determined. Further discussion of each tailwater group is included below.

Tidal tailwater conditions (West Boundary Conditions) were assigned based on a review of the Port Manatee (8726348) and Fort Myers (8725520) tidal gauges. For each tidal gauge, the daily maximum tidal elevation was pulled for the past 5 years (August 30, 2020 to August 31, 2025), the "first" 5 years (January 1, 1999 to December 31, 2004), and the total time record (January 1, 1999 to August 31, 2025) for the daily Higher High Water Level. Based on this data, multiple percentiles of each dataset were calculated. The tailwater condition selected was the 95th percentile of the Port Manatee Tidal Gauge from the last 5 years (approximately 1.9’). The tailwater was selected to represent a realistic higher high tide scenario, such as a King Tide.

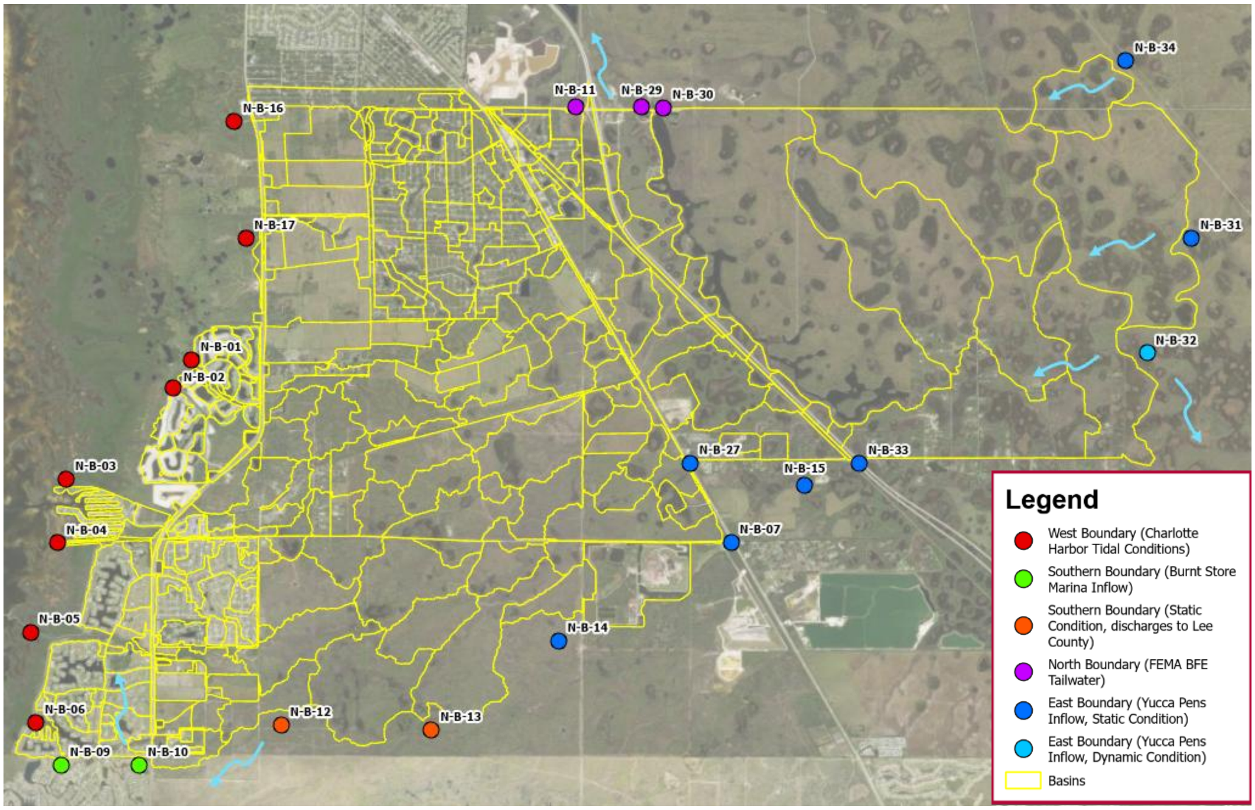
Tailwater conditions for the time stage nodes along the north side of the study area (North Boundary) were modeled as dynamic tailwater conditions determined by the nearest FEMA base flood elevations (BFE). For these nodes, an initial stage was set to the DEM elevation at a representative location, and the BFE was used as the stage at time 12 hours, which is the assumed peak hour of the storm. These nodes were assumed to recover to the initial stage at 72 hours.

Nodes along the eastern boundary of the study area (East Boundary) are modeled either at a static condition or with a dynamic tailwater condition set based on assumed inflow from the undeveloped Yucca Pens area. These were modeled with an initial stage at the DEM elevation at a representative location, and a maximum elevation was determined by the overland DEM elevation at which the inflow would start to discharge away from the study area (i.e. for Node N-B-32, the elevation at which the water would start flowing south and not west). The maximum elevation was assigned at the assumed peak time of 12 hours, and it was set to recover to the initial stage at 72 hours.

Time-stage nodes along the southern boundary (South Boundary) are modeled with a static tailwater condition representing clear discharge south into Lee County.

Conditions near the Lee County line and Charlotte Harbor account for tailwater coming into Burnt Store Marina across Burnt Store Road and then back into the study area before overflowing into Charlotte Harbor, as seen in **Figure 17**. The initial stage of the boundary nodes within Burnt Store Marina was set to 1.9’ NAVD88. The maximum stage was set to 5.75’ NAVD88, which is the overland elevation at which runoff from Burnt Store Marina will discharge into the Harbor based on available DEM elevations.

Figure 17: Existing Conditions Tailwater Node Map



Initial Conditions

To account for existing water within the modeled system, an initial stage (modeled water level at simulation time 0) was set for each node. Initial stage parameters for nodes were set based on a determination of static wet or dry conditions at each location. Wet conditions referred to areas with standing water, a lake, or wetland, regardless of a storm event. Dry conditions referred to all other areas. Nodes in dry condition areas had initial stages set based on the minimum DEM elevation. For nodes in wet conditions, the initial stage was set to the estimated control elevation of the water body or basin. Control elevations were estimated from a review of the DEM versus the extents of the waterbody while accounting for physical outfall parameters, including drop structure weir or pipe elevations.

For both wet and dry condition nodes, downstream links were then reviewed to represent a static condition at the start of the modeled storm event. Setting a model to static conditions at time 0 also removes initial flow in the model. For example, if a node's corresponding downstream link had an invert lower than that node's initial stage, then the model would flow at time 0. To address this, either that upstream node's initial stage was lowered to match the link invert or the node downstream of the link was raised to match the upstream node's initial stage (representing a submerged condition). This review of initial stages and flows was performed until there were no initial flows in the model and static conditions at time 0 were simulated.

5.6. Hydraulic Link Parameters

Links were parameterized based on review of data collected from aerials, DEM, ERPs obtained from SWFWMD, field visits, and survey data.

Pipes

Pipe links include the following model parameters: pipe size, shape, upstream invert, downstream invert, upstream end type, downstream end type, and Manning's roughness coefficient associated with the pipe material. Pipe sizes and shapes were obtained from field measurements taken by Kimley-Horn, survey data from the County, or available As-Built or ERP data. Modeled pipe sizes for circular and elliptical pipes were based on standard pipe sizes (15”, 18”, 24”, etc.) or the corresponding equivalent elliptical size. Pipe inverts were obtained from survey data or ERP plans/as-builts. Entrance and exit loss coefficients were obtained from the Stormwise Technical Manual as well and were based on upstream and downstream pipe end types and pipe outlet configuration. Manning’s roughness coefficients for the pipes were obtained from the Stormwise Technical Manual based on the material of the pipe. Note that it is assumed that pipes are fully functional in the model; changes to pipe parameters that would indicate blockage (such as clips) were not included.

Weirs

The modeled weirs included overland weirs and structural weirs. The parameters of overland weirs were the associated cross sections, weir invert, weir coefficients. Because each overland weir represents the interface between two basins, the overland weir cross sections were generated at each basin boundary and assigned elevations along the cross section based on the DEM. Each overland weir was assigned an invert that was equal to the lowest point along the cross section. Weir coefficients were set to a minimum of 2.8 for grass areas and up to a maximum of 3.2 for paved areas.

Structural weirs were modeled for any structure crossing a basin boundary intended to constrict flow that did not include a pipe. The parameters of structural weirs were the invert, geometry, width, depth, and weir coefficients. The only structural weirs within the model are for the bubbler structure downstream of the inverted siphon along Burnt Store Road. Weir inverts and geometry were obtained from as-built data provided by the County. While there was only one structural weir, there were several drop structure weir components that were parameterized in a similar manner as stated in the section below.

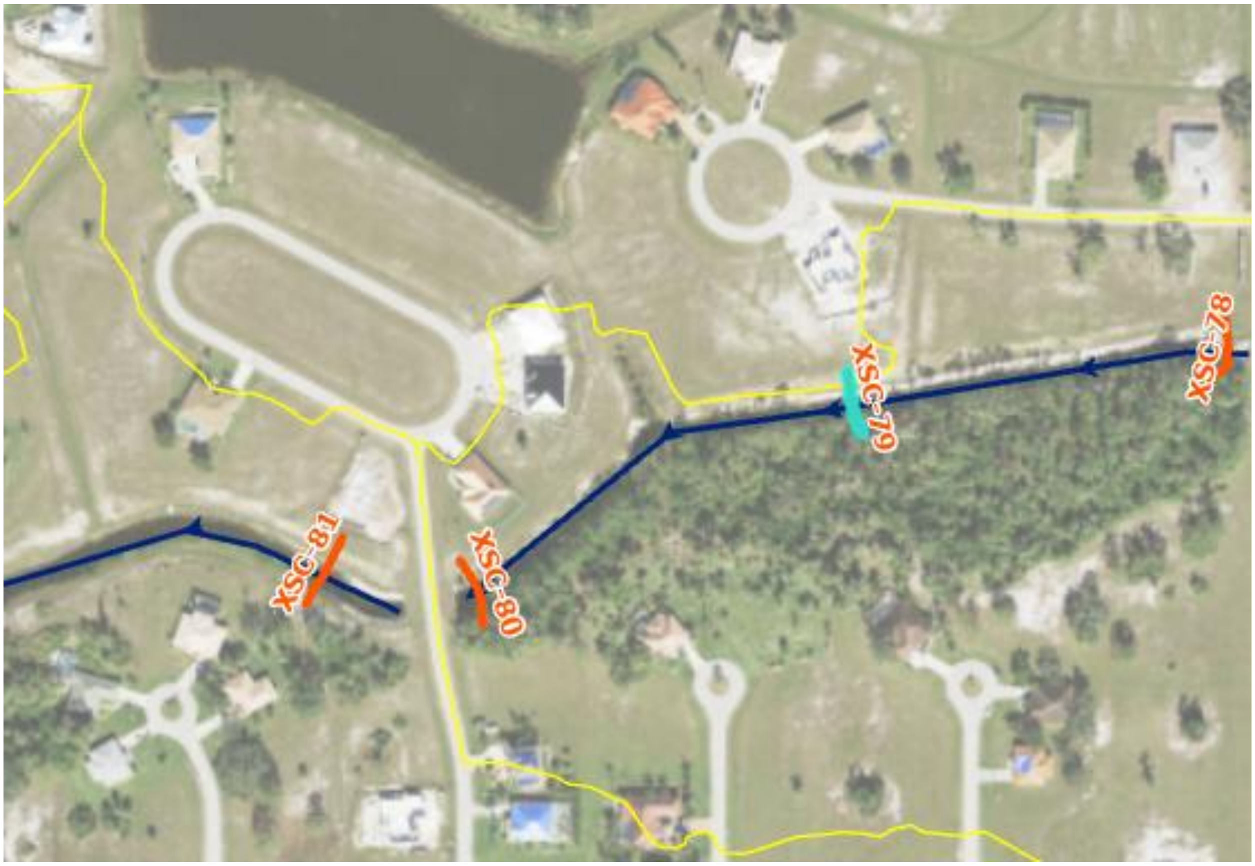
Drop Structures

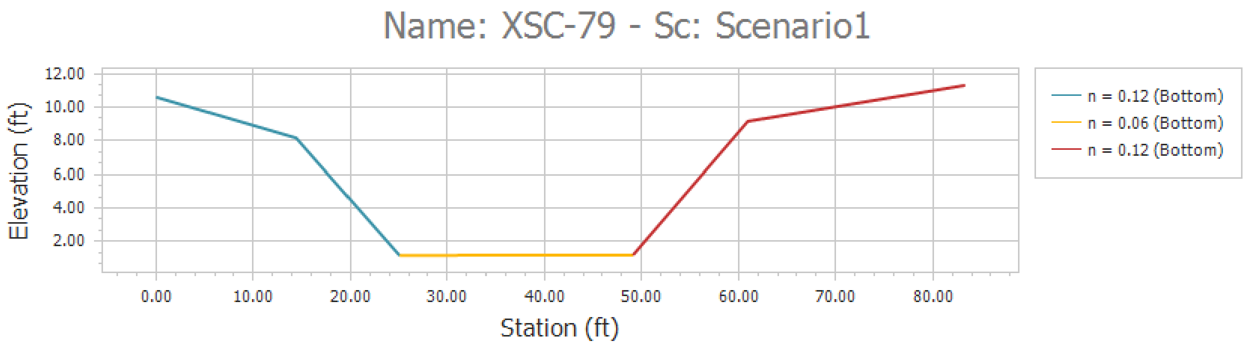
Each drop structure link consists of a weir component, which represents the openings of the box of the structure, and a pipe component, which represents the pipe outfall of the drop structure after water has entered the box. The pipe and weir component parameters were input using the same methodology for the pipe links and structural weir links included above.

Channels

Channel links included the following parameters: upstream and downstream cross sections, upstream invert, downstream invert, and loss coefficients. Channel cross-section elevations were assigned from collected survey data and supplemented from the DEM elevations at the location of that cross section. Mannings numbers were assigned at different stations along the cross-section based on the type of cover (overgrown or well maintained) and location (bottom of cross-section or side bank). Mannings numbers ranged between 0.03 and 0.20, with higher values along the side banks and in more overgrown areas and lower values at the channel bottom and in areas where channel flow is relatively unobstructed. See **Figure 18** below for example:

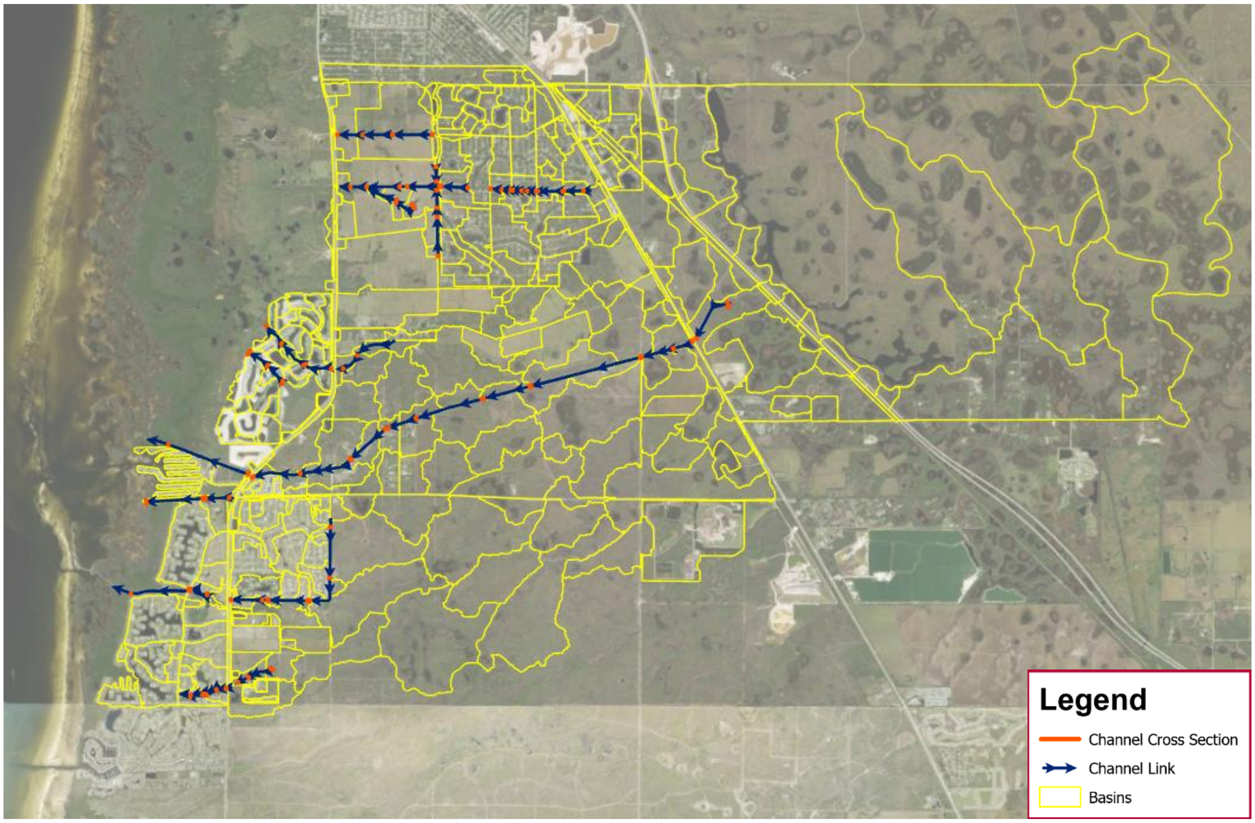
Figure 18: Typical Channel Cross Section





Cross section inverts were set to the lowest points along the corresponding upstream or downstream cross-sections. See **Figure 19** for a map of the modeled channels and cross section locations.

Figure 19: Existing Conditions Channels and Cross Sections

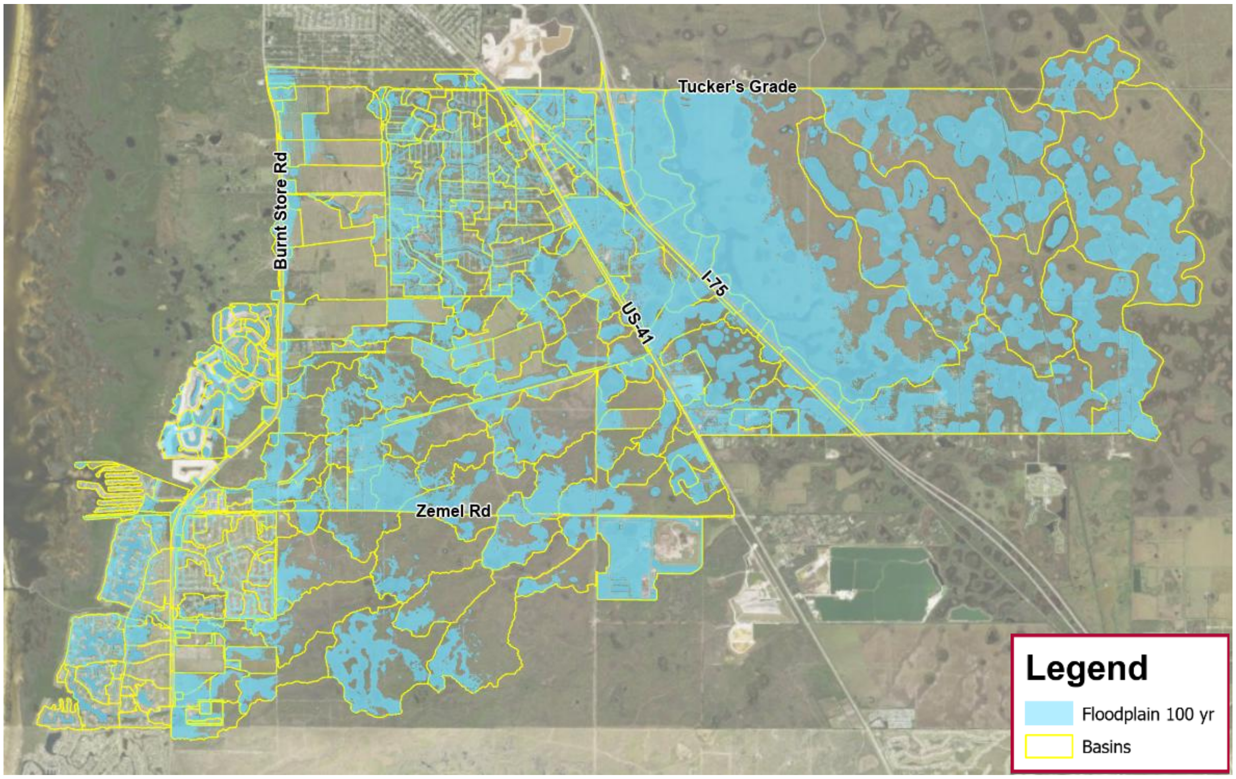


Cross-Section elevations were supplemented with available LiDAR data from the DEM as needed. The locations DEM data was used included locations where survey data was not obtained and in locations where the cross sections extended beyond the surveyed section (i.e. the overbank).

5.7. Model Results

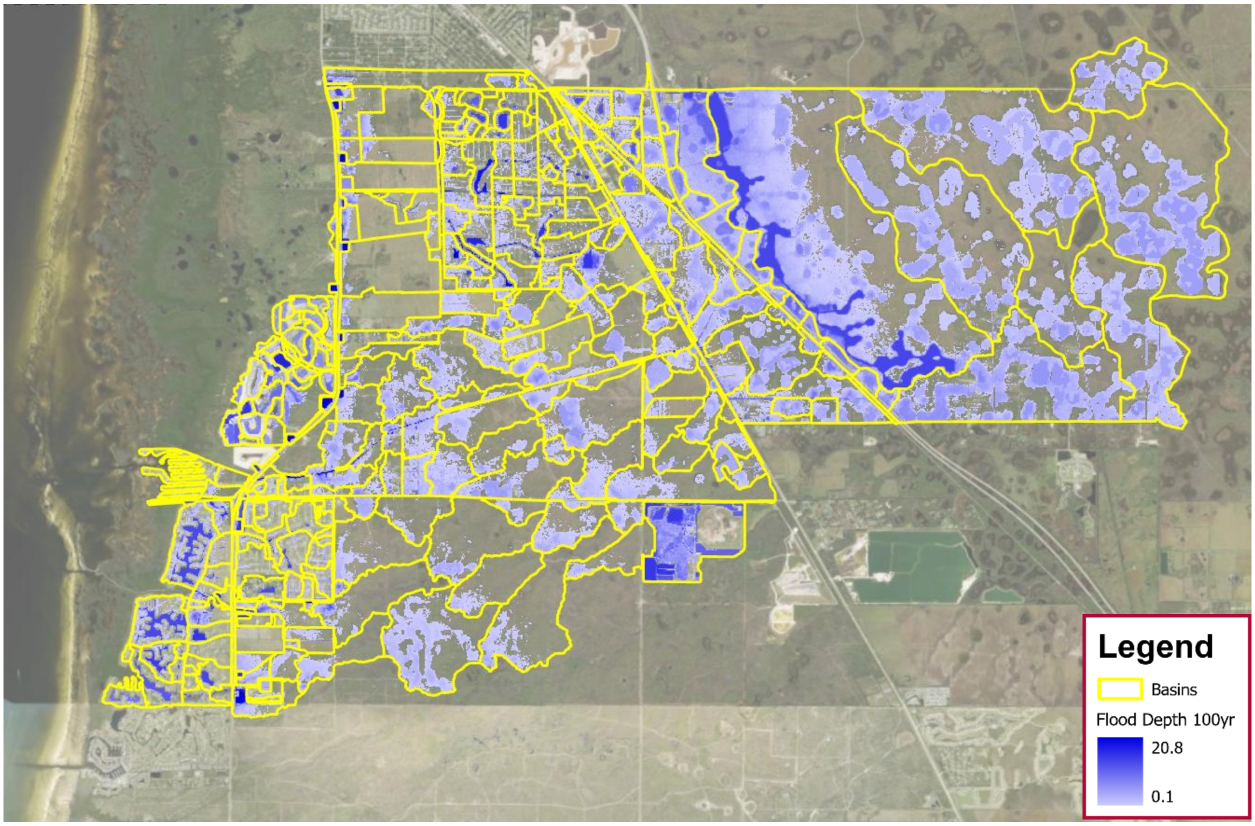
The model results were displayed in the form of level-pool floodplains to provide a visual representation of modeled flooding. These floodplains were generated based on the 100-year, 24-hour maximum stage results for each node. These node maximum elevations were compared to the DEM elevations of that node's associated basin. If a section of a basin had a modeled maximum stage higher than the DEM elevation at that section, it was classified as a modeled floodplain. A shape was generated for the modeled floodplains at every basin, see below in **Figure 20** for the floodplain extents within the study area.

Figure 20: Existing Conditions Modeled Floodplain Results



Within each floodplain, the flood depth (difference between ground elevation and modeled maximum stage) differs. Results were also displayed in the form of a flood depth raster to review variabilities in flood depth in areas of modeled flooding. The maximum flood depth within the study area was around 20.8 ft (associated with measurements from as-built Burnt Store Road ponds, which are below sea level and were provided representing a pond bottom elevation rather than a pond control elevation). Average flood depths were much lower. See results in the form of flood depth raster in **Figure 21** below.

Figure 21: Existing Conditions Modeled Flood Depth Results



5.8. Existing Condition Model Calibration/Validation

Model calibration/validation is typically performed to review the model accuracy by simulating flooding conditions of an actual storm event. Because available flood stage data was not available, and observational information was available from the results of the public survey, the model was validated based on the provided observational information. A storm event from July 7, 2025, through July 12, 2025, was selected as the model validation event for the existing conditions model based on the availability of recent flooding pictures and testimonials. This flood event represented a typical “nuisance storm” that flooded roads and lawns in Burnt Store Village, which was depicted in pictures included in the public survey response. This event serves as a contrast to the 100-year design storm and provides insight into what flooding may occur within the study area in a minor storm event.

To model this, NEXRAD data was obtained from SWFWMD. NEXRAD data contains location-specific rainfall data from a selected storm event. For the validation event, each basin was assigned a rainfall amount and distribution based on the NEXRAD spatial data from the selected storm event. Results in the form of level-pool floodplains with an associated flood depth from the validation event were compared with photos provided by residents of the study area.

Results from the validation event were used to evaluate if modeled results generally aligned with observed conditions. If they did not align, changes to the model were considered. Possible model changes that were evaluated included:

- **MODEL SCALE WITHIN BURNT STORE VILLAGE –** Additional detail was added to the Burnt Store Village area of the model to increase model scale to simulate observed flooding in the aera.
- **RUNOFF EXCESS METHOD –** Curve number and Green-Ampt rainfall excess methods were both utilized to determine if either method more closely matched results from flooding testimonials. Curve numbers were assigned based on selected land cover as described in the associated section above, with pervious area receiving a curve number of 80, impervious areas receiving a curve number of 98, and water/wetland areas receiving a curve number of 100. The model results between the curve number iterations of the model were relatively similar to the Green-Ampt model. The Green-Ampt version was used due to the additional soil-specific detail.
- **TAILWATER CONDITIONS/STORM SURGE EVALUATION –** Different tailwater conditions for Charlotte Harbor were evaluated to determine an appropriate tailwater condition. Most of the project area west of Burnt Store Road is lower than the FEMA Base Flood Elevation/historic storm surge. As a result, model results west of Burnt Store Road were heavily tied to the modeled tailwater condition. Conversely, model results east of Burnt Store Road were minimally affected by the evaluated tailwater condition. A static tailwater condition for Charlotte Harbor was eventually selected per the methodology described in the applicable section above so that modeled projects would be evaluated based on rainfall-driven conditions.
- **CHANNEL COEFFICIENTS –** Different channel coefficients were modeled to effectively simulate the limited flow condition of the rim ditch along Burnt Store Village.
- **UPSTREAM TAILWATER CONDITIONS –** Additional model area was added upstream of Tamiami Trail to improve simulated incoming flows under Tamiami Trail.

See **Figure 22**, **Figure 23**, and **Figure 24** for examples of results in the form of a flood depth raster from the modeled storm event compared to pictures provided by residents of the study area. Note that these validation results were shared at Public Meeting 2 held in September 2025 and do not reflect the final existing conditions model.

Figure 22: Burnt Store Village - 7/15/2025

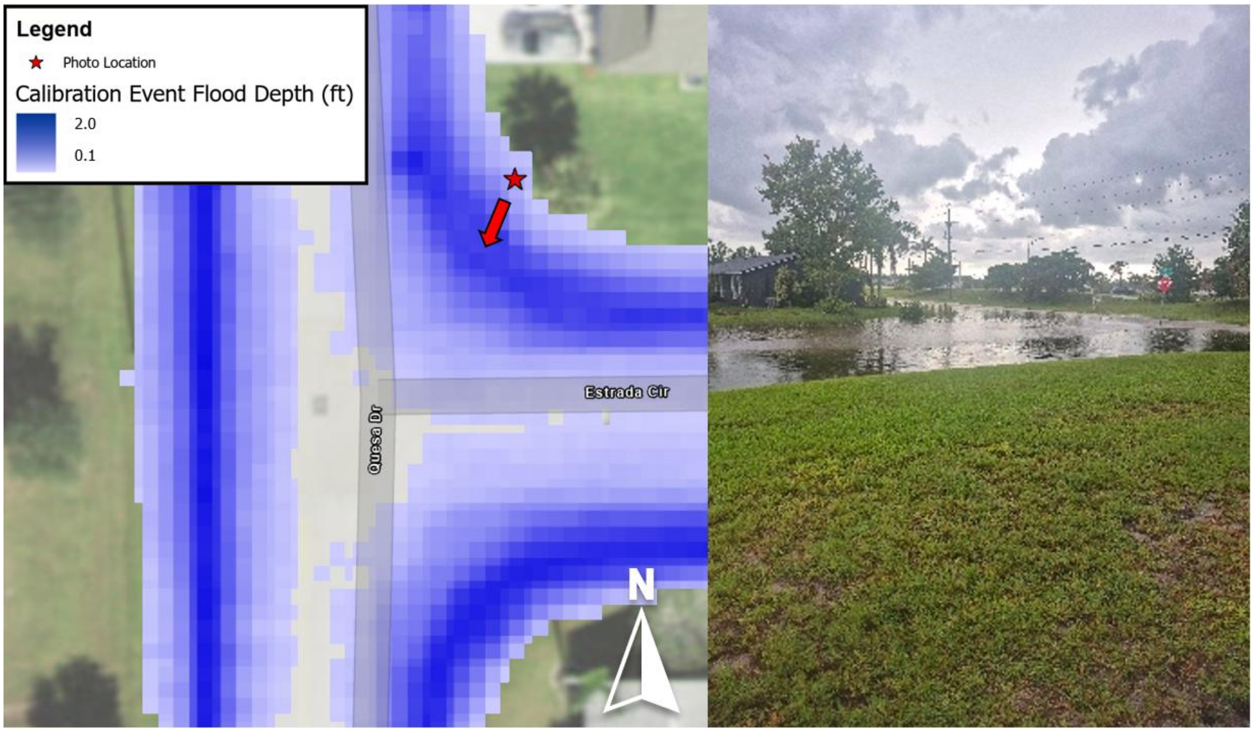


Figure 23: Burnt Store Village - 7/17/2025

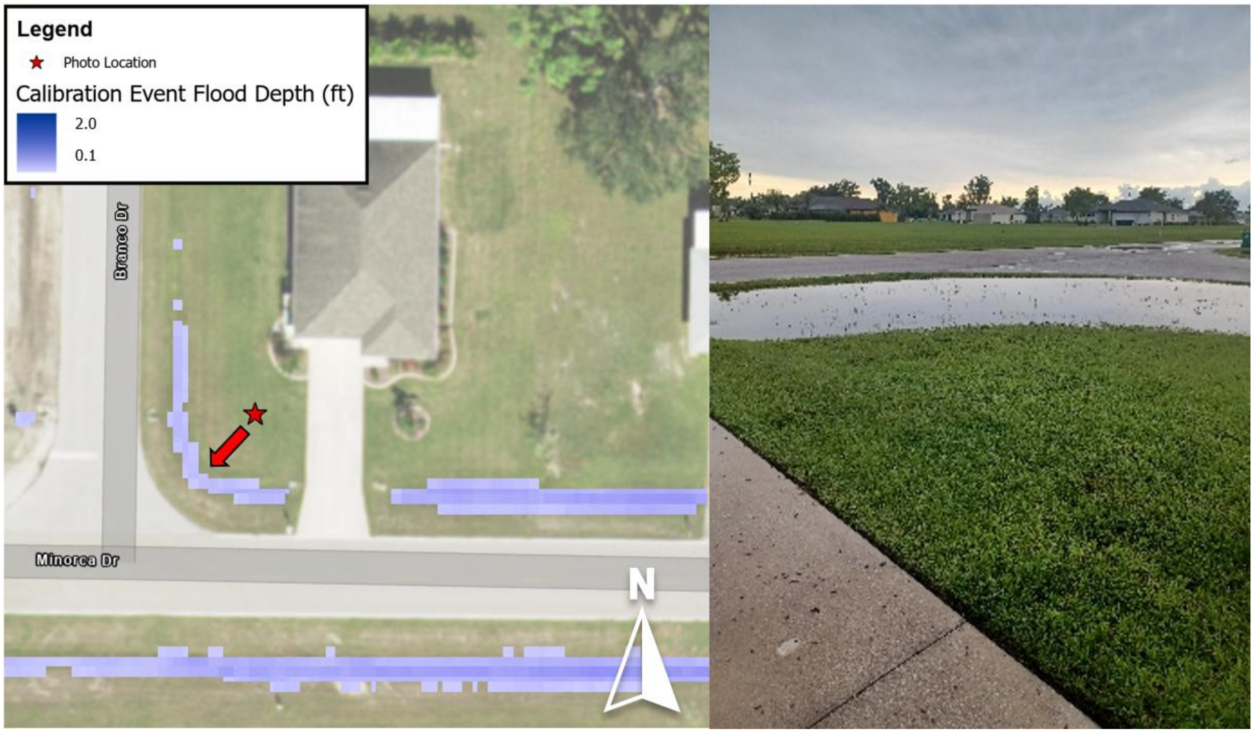
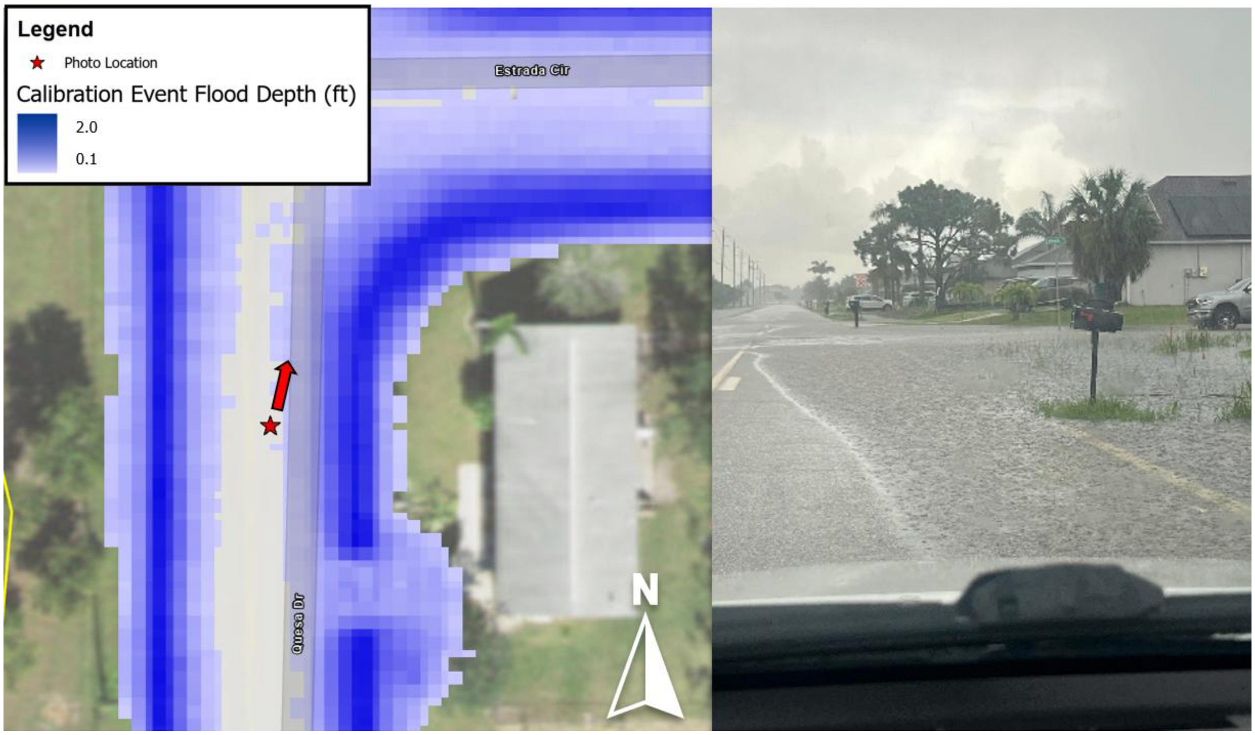


Figure 24: Burnt Store Village - 7/17/2025

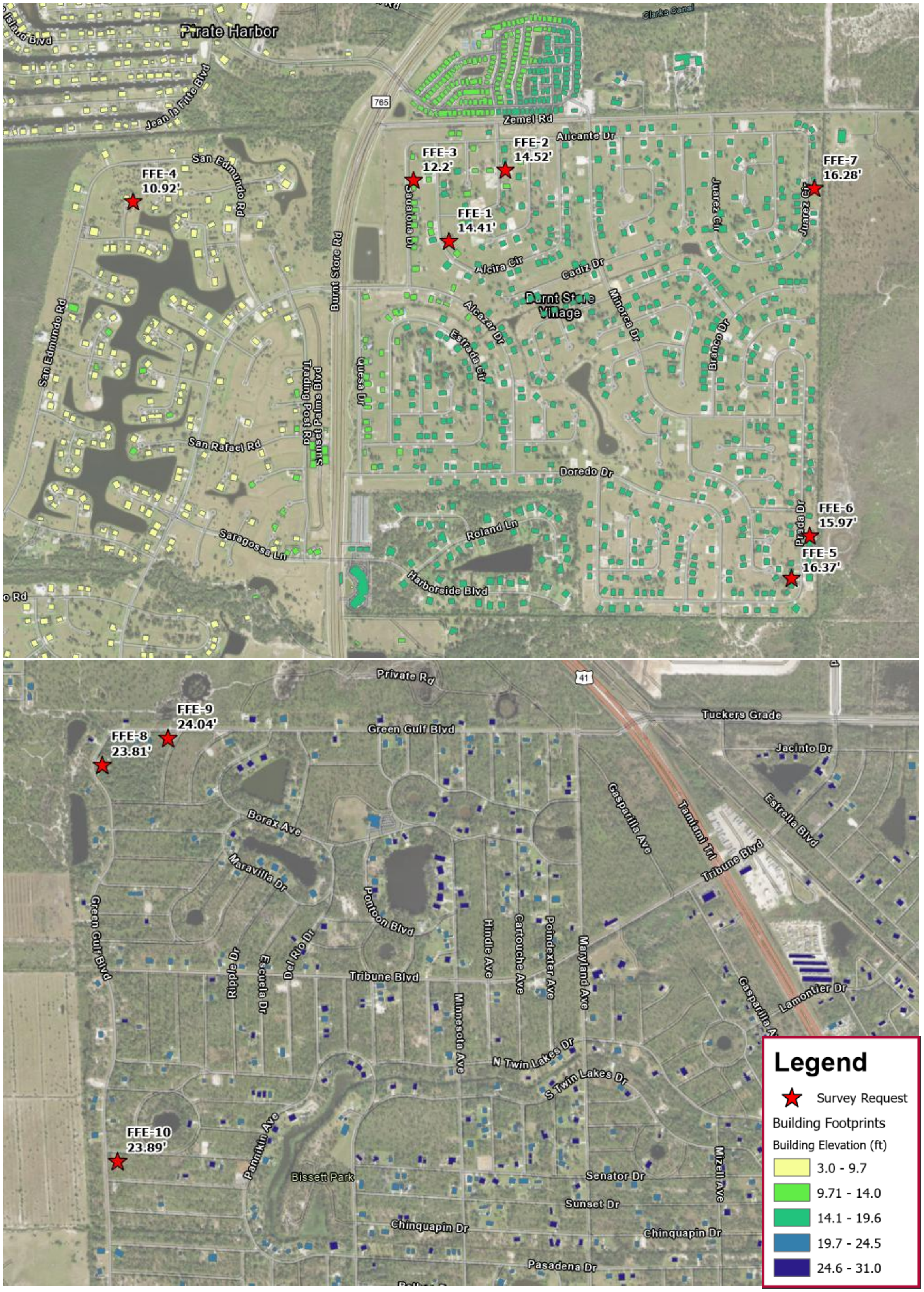


Final existing conditions calibration results were generally consistent with the figures shared at this meeting and at the locations of provided public input.

Findings

Findings of the existing conditions model were evaluated based on comparing the 100-year, 24-hour floodplains to assumed building elevations and Burnt Store Road elevations, as well as evaluating results of the validation storm. Based on the results of the model, assumed elevations of structures (homes and other buildings) within the study area were higher than the corresponding modeled floodplain elevation. This was evaluated by comparing assumed building elevation to the max stage of the basin corresponding with the structure location. Assumed building elevations were calculated as 1 foot higher than the average DEM elevation of the building footprints. This was determined by reviewing surveyed FFEs for representative structures that were obtained by Charlotte County survey crews, which were found to be generally 1ft higher than the mean DEM elevation. Note that the assumed building elevations used in this study are planning-level and are not meant to determine survey or design-level FFEs for buildings in the study area. Areas where assumed building elevations were lower than the corresponding basin max stage were typically areas where topographic voids were identified in the DEM and do not represent expected conditions. See **Figure 25** below for example of estimated building elevations provided by the County and general ranges for calculated assumed building elevations:

Figure 25: Surveyed FFEs and Estimated Building Elevation Ranges



This study was intended to address rainfall-driven design storm events and did not evaluate storm surge or extreme tidal conditions. Evaluation of existing structures that have elevations below a typical storm surge elevation for a 100-yr design storm or other high-surge event is not included in this study.

100-year, 24-hour storm maximum stages were reviewed against elevations of Burnt Store Road. To evaluate this, a warning stage was set for each node that represents a portion of Burnt Store Road. These warning stages were set to the minimum pavement elevation of the corresponding section of Burnt Store Road based on the developed DEM. Most maximum stages were below the corresponding warning stage, indicating that there is no flooding of pavement in this design storm. However, there were some instances where modeled 100-year, 24-hour maximum stages were higher than minimum roadway elevations. For example, at the crossing upstream of Jean Lafitte Canal south of Burnt Store Colony, the minimum as-built pavement elevation was 7.9’ NAVD88, while the modeled maximum stage was approximately 10.25’ NAVD88. There were no locations of Burnt Store Road where modeled flooding was higher than the road crown elevation.

For the validation event, areas of modeled flooding were reviewed against pictures provided in the public survey. After refinement of the model as part of the validation process, modeled flooding generally aligned with provided flooding pictures and testimonials. Preliminary results of the validation model were shared at Public Meeting 2, where citizens generally agreed that modeled flooding aligned with their experiences for this event.

6. Future Conditions Model

6.1. Introduction

This study evaluated the drainage concerns and potential improvements for not only existing conditions but future conditions as well. To accomplish this, a future conditions model was developed based on the existing conditions model and anticipated future conditions. These future conditions include future development (buildout) anticipated within the study area, rainfall intensification, and increases to the modeled tailwater. The buildout condition model was developed first. Rainfall and tailwater changes were then applied.

6.2. Buildout Conditions Model

A buildout conditions model was developed based on available planning and design data within the study area. This available data included models and stormwater management plans for permitted and pending development, future areas identified in the Burnt Store Area Plan, other areas of known improvement (provided by the County), and Future Development from Charlotte County Land cover. The intent of this model was to determine how buildout conditions would affect the modeled flooding within the study area without influence from sea level rise or rainfall intensification. This model updated model parameters based on this collected data but did not alter other future conditions model parameters such as rainfall and tailwater conditions.

6.2.1. Future Developments

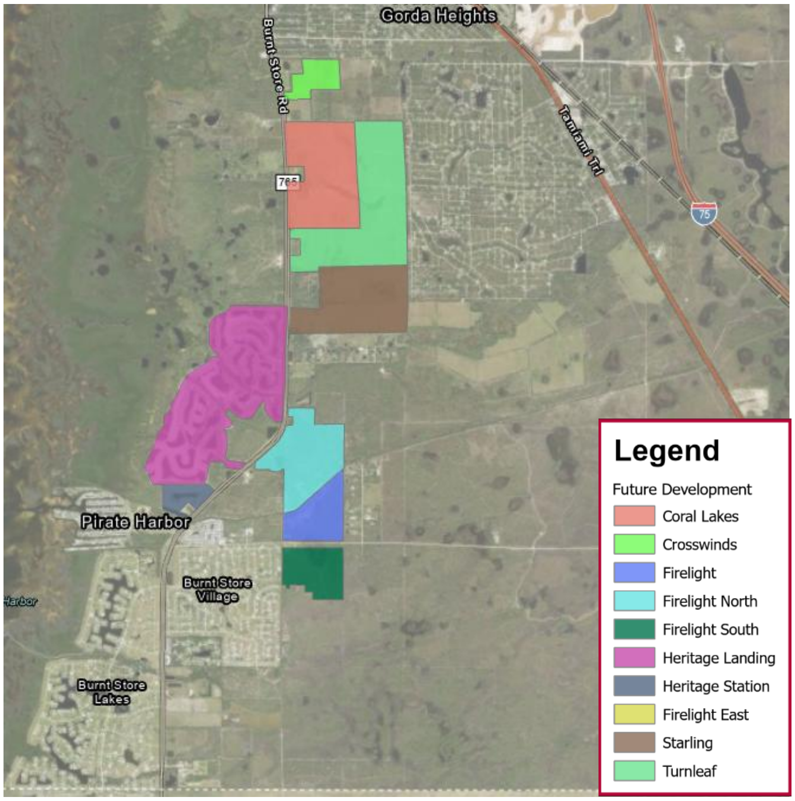
The buildout conditions model includes several future developments. These developments were based on one of four criteria:

A. Permitted and Proposed Developments. These areas include proposed developments with pending or recently completed SWFWMD ERPs and/or Charlotte County development permits. As of May 2026, these areas are either in the design phase, planned for construction, currently in constructed, or were constructed after the Lidar date of the effective DEM (2018 Lidar, with added data from Burnt Store Road As-Builts). These areas included:

- Coral Lakes
- Crosswinds
- Firelight, Including Firelight East, Firelight North, and Firelight South
- Heritage Landing full buildout
- Heritage Station
- Starling
- Turnleaf

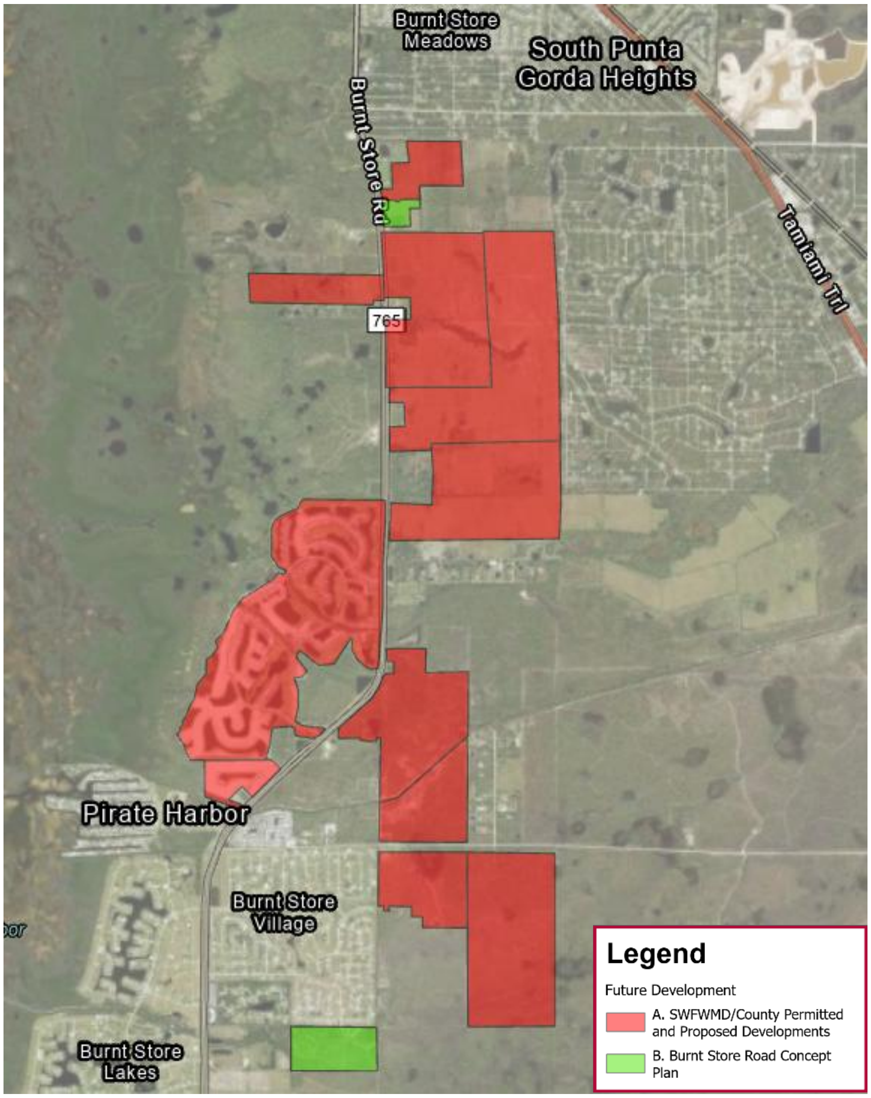
Kimley-Horn was able to obtain effective models, as-built data, plans, and other modeling data from these areas. See **Figure 26** below for a map of the Permitted and Pending Developments included in the assumed buildout conditions.

Figure 26: Permitted and Proposed Developments



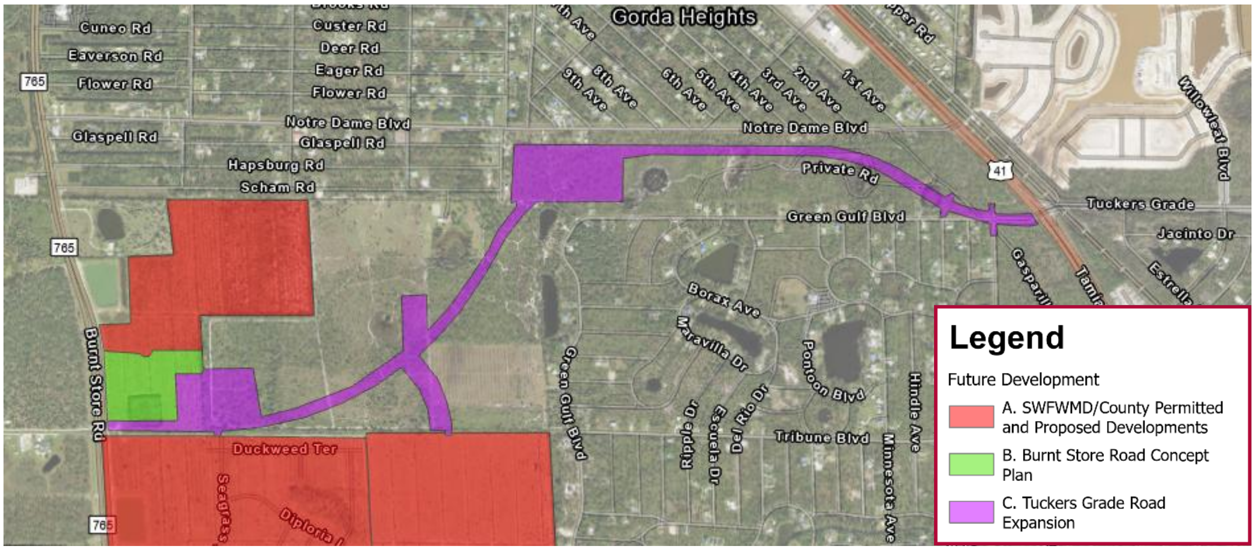
B. Burnt Store Area Plan Developments. These were areas of future development included in the Burnt Store Area Plan dated 11/25/2024 that do not have pending of recently completed ERPs. While most of the areas found in this plan already had an ERP, there were a few areas from the plan that were added to the model. See **Figure 27** below for a map of the areas.

Figure 27: Burnt Store Area Plan Developments



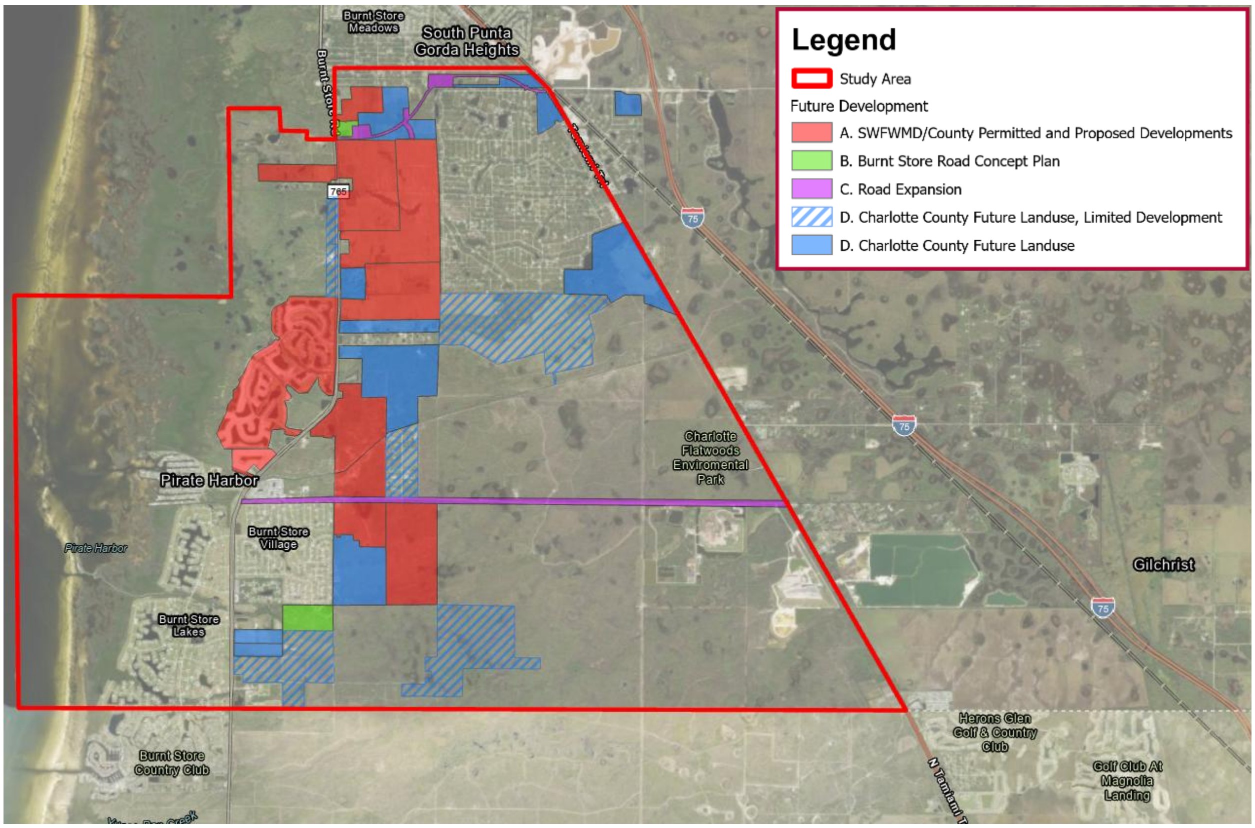
C. Additional Areas of Known Improvement. The only area that was included in this list is a proposed future connection between Burnt Store Road and Tuckers Grade. This area has a preliminary plan, provided by the County, that includes specific locations of anticipated stormwater improvement. Note that while Zemel Road and Burnt Store Road are anticipated to be potentially expanded at some point, these areas were not included as there was either not enough information to evaluate the associated potential stormwater management improvements or the improvements will have a negligible impact on existing drainage patterns within the project area (Zemel Road Roundabout). See **Figure 28** below for a map of the Areas of Known Improvement included in the assumed buildout conditions.

Figure 28: Additional County-Identified Areas



D. Areas of Future Development Landuse. These included areas identified as “Future Development” and “Future Development – Limited Development" in Charlotte County’s future landuse. See **Figure 29** below for a map of the Areas of Future Development Landuse included in the assumed buildout conditions separated into Future Development and Future Development – Limited Development.

Figure 29: Areas of Future Development Landuse



6.2.2. Model Parameters

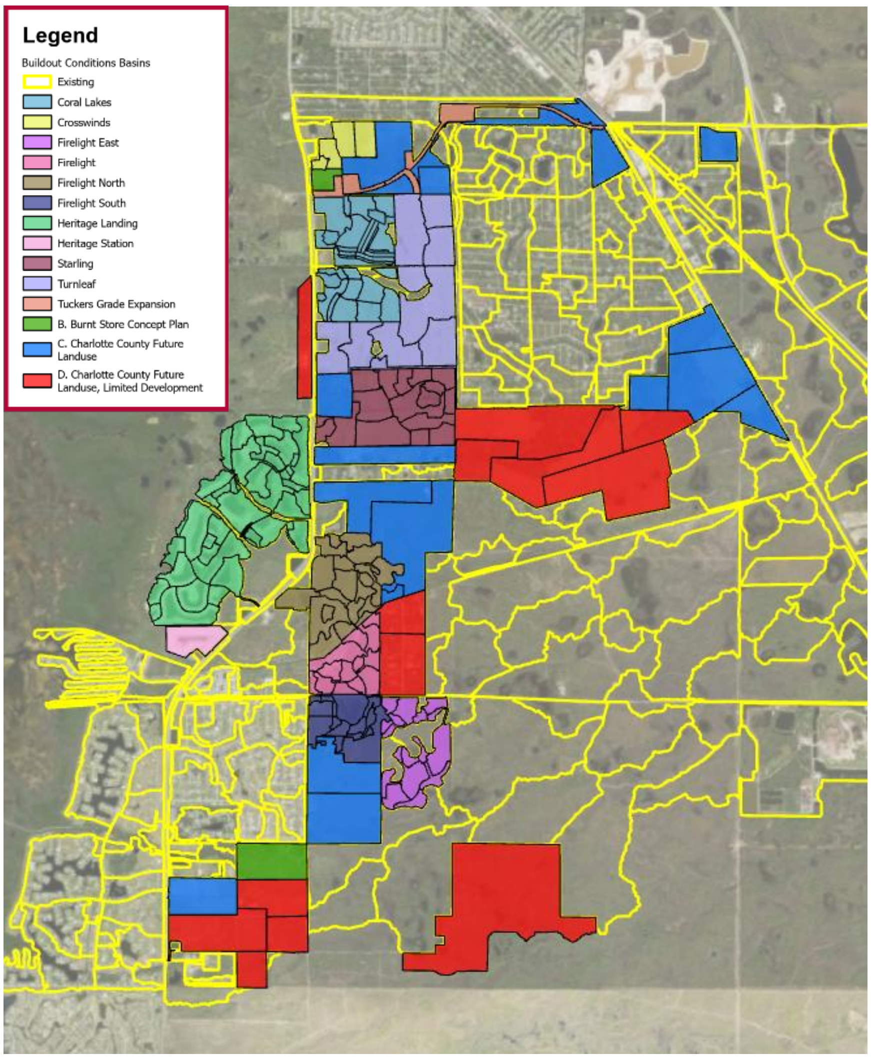
The model updates associated with the buildout improvements included changes to modeled basins, nodes, and links. For the above-listed future developments where modeling data (approved models or drainage reports) was available, more detailed model changes were made than in areas where proposed development is currently more conceptual.

Basins

Basins for future development were modeled using Curve Number rainfall excess method instead of Green-Ampt to maintain consistency with permitted values and typical methodology for new development. For Permitted and Proposed Developments, basin areas were generally derived from available models, drainage reports, or plans. Time of Concentration and Curve Number values were obtained from the existing available data. Note that some basin acreages were adjusted based on integration with the remaining existing conditions basins. Some Permitted and Proposed Developments were modeled at a more detailed scale than the existing conditions model and did not have available model files (Ex. Heritage Station). In these instances, the level of modeling detail for that development was reduced to be consistent with the rest of the model.

For Burnt Store Area Plan Developments and Areas of Future Development Landuse, each parcel identified in the Area Plan and County landuse was modeled as its own basin. Basins associated with the Tuckers Grade roadway expansion were generally delineated based on the preferred alternative developed by the County. Curve number, percent impervious, and time of concentration values were 80, 70%, and 10 minutes, respectively. For undeveloped basins with basin limits impacted by the proposed parameters, basin acreage, percent impervious, and soil coverage were recalculated. These basins were split if completely bisected by new development. Note that if an existing conditions basin was completely overlapped by future development limits, that basin was removed. See **Figure 30** below for visual of Buildout Conditions Basins.

Figure 30: Buildout Conditions Basins



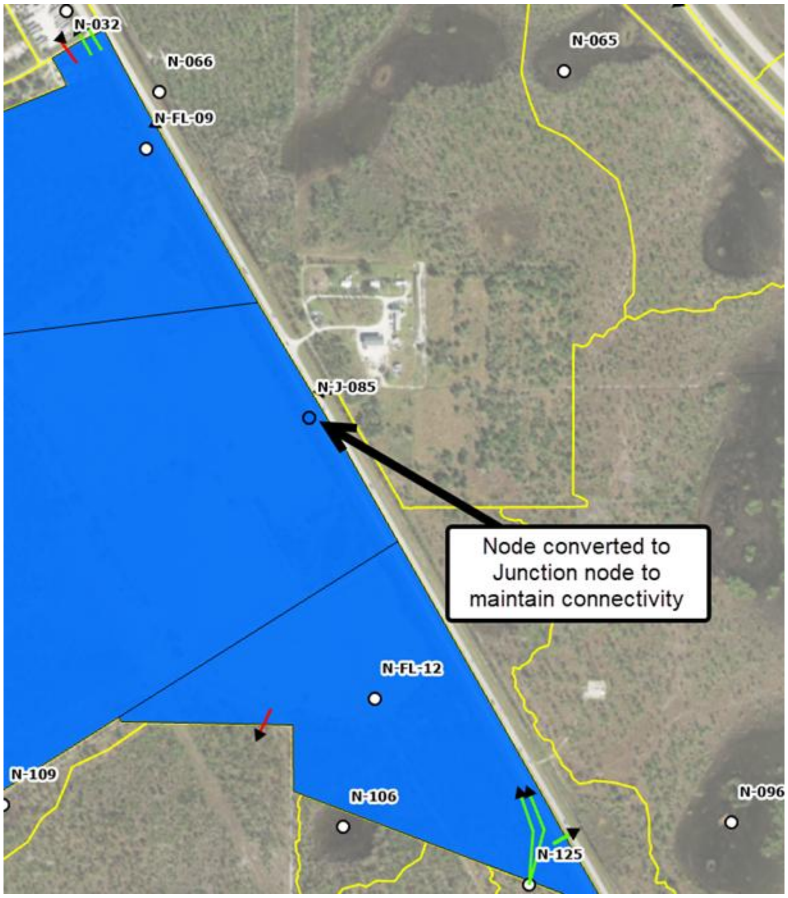
Nodes

For Permitted and Proposed Developments, node values such as initial stages, stage-area tables, and stage-volume tables, were derived from available models, drainage reports, or plans. There were areas from previous models that were modeled as undeveloped areas (such as wetland areas) were already modeled in existing conditions. In these areas, the stage-area of the existing node was revised based on the updated basin area instead of using the value from the ERP or associated model. Boundary nodes associated with the permit and proposed models and reports were not included, as these correspond with stage-area nodes in existing models. Link routing was revised to reflect the location changes to the basin and nodes.

For Burnt Store Area Plan Developments and Areas of Future Development Landuse, one node was placed at each basin to represent the overall conceptual stormwater management system. These nodes were assigned an initial stage based on the average existing grade of the conceptual development extents. This calculated initial stage was used to assign an assumed control elevation of the conceptual stormwater management system. Stage-area values were assigned based on an assumed pond depth of 4ft below control elevation to a maximum storage elevation. Assumed areas at initial stage and pond top related to the percent of the overall basin/conceptual development area (15% of the basin area at initial stage and 20% at the maximum storage elevation).

For undeveloped basins with basin limits impacted by the proposed parameters, stage-area values were updated based on the revised basin limits. Note that while some existing conditions basins were completely removed from the model due to overlap with development areas, the corresponding node was kept and converted to a junction node if it represented a connection between two pipes would not be impacted. This was utilized for nodes that represent roadside swales that are included in future development footprints. See **Figure 31** below for example:

Figure 31: Example of Stage-Area node converted to junction node



Drop Structures

For Permitted and Proposed Developments, drop structure parameters were derived from available models, drainage reports, or plans. Drop structures routed to boundary nodes from the ERP models were instead routed to the associated existing condition model stage area nodes.

For other areas of future development without available model and design data, a standalone model was created to develop assumed design parameters. It is assumed that for these developments, the design discharge out of the drop structure will be less than the 25yr-24hr existing conditions discharge. To evaluate this, the standalone model included a corresponding existing conditions basin for each future development area to determine the existing 25yr-24hr runoff (assigned a TC from a representative basin from the overall existing conditions model, a curve number of 80 based on TR55 value for open space type D-equivalent soil, and a basin area equal to the future development footprint). Then, a representative drop structure was modeled from the development's node (modeled per the above section) to a static boundary node. The drop structure was modeled with assumed design parameters such as:

- A 6' wide by 3' deep slot weir set at the control elevation. Detailed weir/bleeder sizing was not considered as part of this effort, and therefore the weir sizes included in the buildout model may not meet standard water quality requirements. This weir size was used as a starting point for conceptual modeling of these structures considering discharge only.
- A Type 'H' grate set to 3.5' above the control elevation

- A 48” pipe set 6’ below the control elevation

The slot weir size, grate size, and structure count were iteratively updated until the flow from each of these drop structures was less than the discharge rate from the corresponding pre-development basin, but greater than 50% of that discharge rate. For example, if a 50 cfs pre-development discharge rate was calculated for a basin, the proposed discharge rate would be between 25 cfs and 50 cfs. These assumptions are extremely conceptual and are used to develop conceptual estimates for future development flows. If these parcels were to be developed, there would likely be multiple outfalls, different stormwater management areas at different control elevations, and different weir elevations resulting in different discharge values.

Pipes

For Permitted and Proposed Developments, pipe parameters were derived from available models, drainage reports, or plans. Pipes routed to boundary nodes from the ERP models were instead routed to the associated existing conditions model stage area nodes. Existing pipes with outfalls that are partially impacted by buildout development were assumed to remain and the corresponding upstream and downstream nodes were adjusted as needed. Existing pipes completely within an area of buildout development were removed.

Weirs

For Permitted and Proposed Developments, structural and overland weirs from the permitted models and reports were added to the buildout conditions model. In many instances, the perimeter berm of the permitted developments was not modeled, as design stages were lower than those berm elevations. Because the storms modeled in this project were typically more intense (100-year, 24-hour) than the standard design storms (25-year, 24-hour storm) of some of the developments, weirs were added to each node from the Permitted and Proposed Development models to the neighboring existing conditions node. These weirs were set to an assumed perimeter berm elevation based on review of permitted data. These weirs represent overland flow between the development areas and the rest of the existing conditions model. Weirs internal to Permitted and Proposed Developments were not added and included only if modeled already.

For all other areas of future development, overland weirs were modeled to account for overtopping of proposed berms. These weirs were set to the greater of two potential design elevations:

- 100yr-24hr node elevation of the standalone model developed to evaluate the drop structure parameters rounded up to the nearest tenth.
- 3.5 ft above control elevation

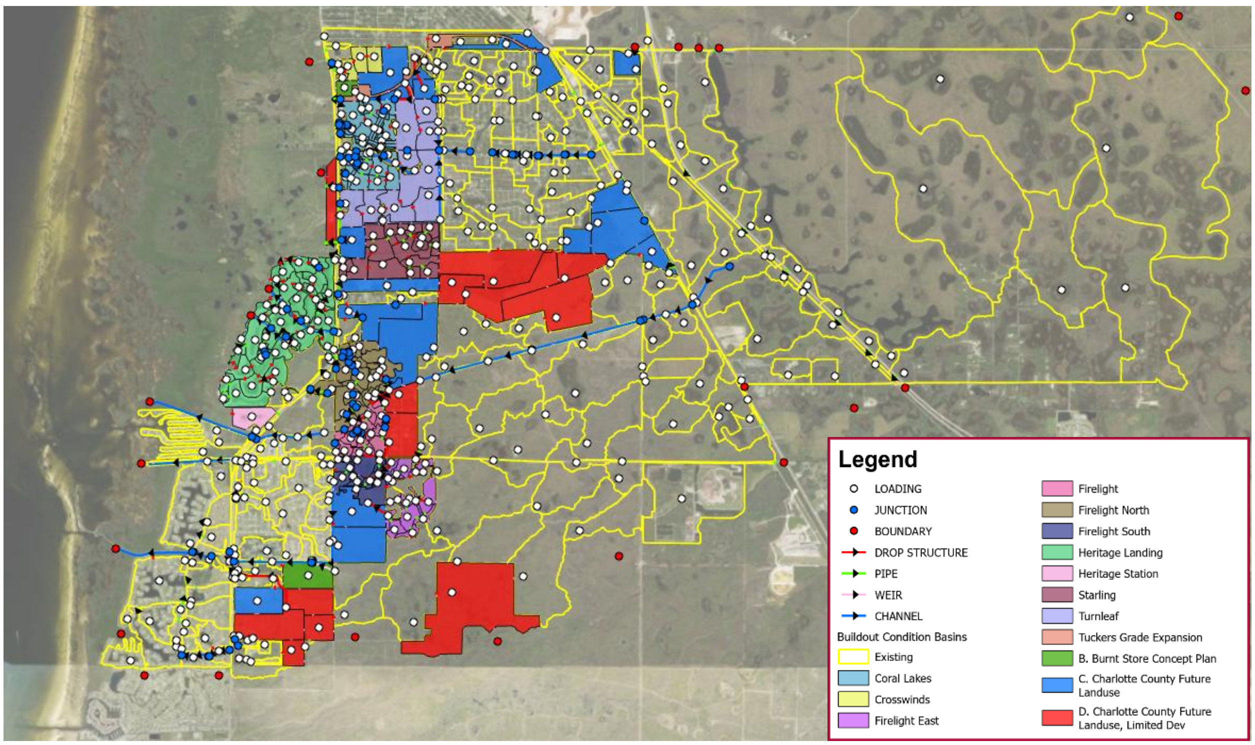
This assumes that these areas will be designed to not overtop in the existing conditions 100yr-24hr storm and will have a pond depth of at least 3.5 ft (based on a typical reviewed pond depths of 3-4ft), but may overtop in a more intense design storm.

Many future development footprints impact areas with significant overland flow. Existing weirs that were located completely within areas of new development were largely deleted. However, it is assumed that conceptual future developments will be required to maintain offsite flows to prevent significant increases in upstream stage. Therefore, in areas of conceptual future development without permitted plans, it was assumed that there would be a bypass link to maintain existing overland flow. This assumption was not made for Proposed and Permitted Developments since plans were available to determine if offsite flow ways were maintained. In areas where existing basins were modified to accommodate future development, the corresponding weirs and weir cross-sections were modified accordingly.

Channels

The permitted developments were assumed to not impact existing conditions channel flow based on review of the proposed plans. Based on overland flow areas that would be impacted in areas of future developments, assumed bypass channels were added using the cross-section of the impacted weir to mimic an assumed bypass area. These bypass channels were modeled with a length of 5 to represent overland flow and not add artificial channel storage. Bypass links were limited to 1 per area of impacted overland flow. See **Figure 32** below for a map of the complete buildout conditions schematic.

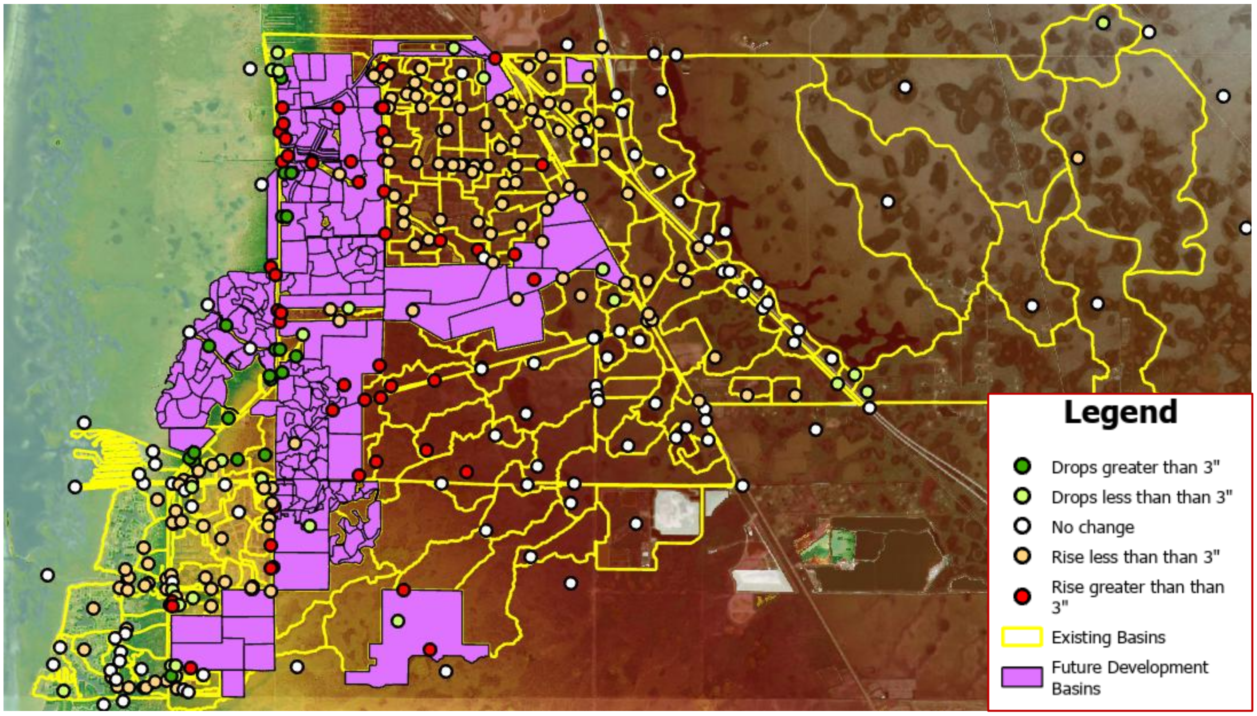
Figure 32: Buildout Conditions Map



6.2.3. Findings

Results from the buildout conditions model were evaluated by checking for “rises” (increases in the 100-year, 24-hour maximum stage in modeled nodes from existing conditions) and “drops” (decreases in the 100-year, 24-hour maximum stage in modeled nodes from existing conditions). The average rise across all nodes was relatively minimal, as the buildout condition does not add any rainfall and does add storage that compensates for the additional runoff generated by the development areas. However, since these storage/berm elevations are typically higher than existing conditions overland flow elevations, rises typically occurred in nodes directly upstream of areas of future development. These rises typically occur in undeveloped areas upstream of the existing and planned development within the study area and east of Tamiami Trail. Conversely, drops typically occur in undeveloped areas along Burnt Store Road, where historic overland inflow is blocked by modeled development. See **Figure 33** below for map of rises and drops from the buildout conditions model.

Figure 33: Buildout Conditions Rises and Drops



Results of the buildout conditions model are heavily dependent on assumed parameters, such as location, routing, and model parameters of the assumed bypass areas and assumptions for overland flow from the development areas. Based on the results of the buildout conditions model, it is recommended that as additional development occurs within the study area, the County reviews if proposed developments are considering and accommodating offsite flows from the east. As-built data for future developments was not available for this study. As these developments are constructed, it may be beneficial to add the finished developments to the existing model based on as-built parameters or an updated DEM. This could be done as part of regularly scheduled model maintenance (such as on an annual basis using as-built data) or periodically as updated DEMs become available.

6.3. Baseline Future Condition Model

To assess future conditions within the Study Area, the buildout conditions model was updated with parameters associated with rainfall intensification and future conditions.

6.3.1. Rainfall Intensification

The buildout conditions model was updated with a more intense rain event to assess potential rainfall intensification within the Study Area. To assess this, a change factor was determined based on the CORDEX dataset from the FIU Updating the Statewide Extreme Rainfall Projections report published by Obeysekera dated June 1, 2021. A value of 1.53 was chosen from the 83rd percentile dataset and considers a future planning period from 2069 to 2099 for a 100-year 24-hour storm event. The 100-year 24-hour rainfall of 11.3 inches was multiplied by this change factor to get a future conditions 100-year 24-hour rainfall value of 17.29 inches.

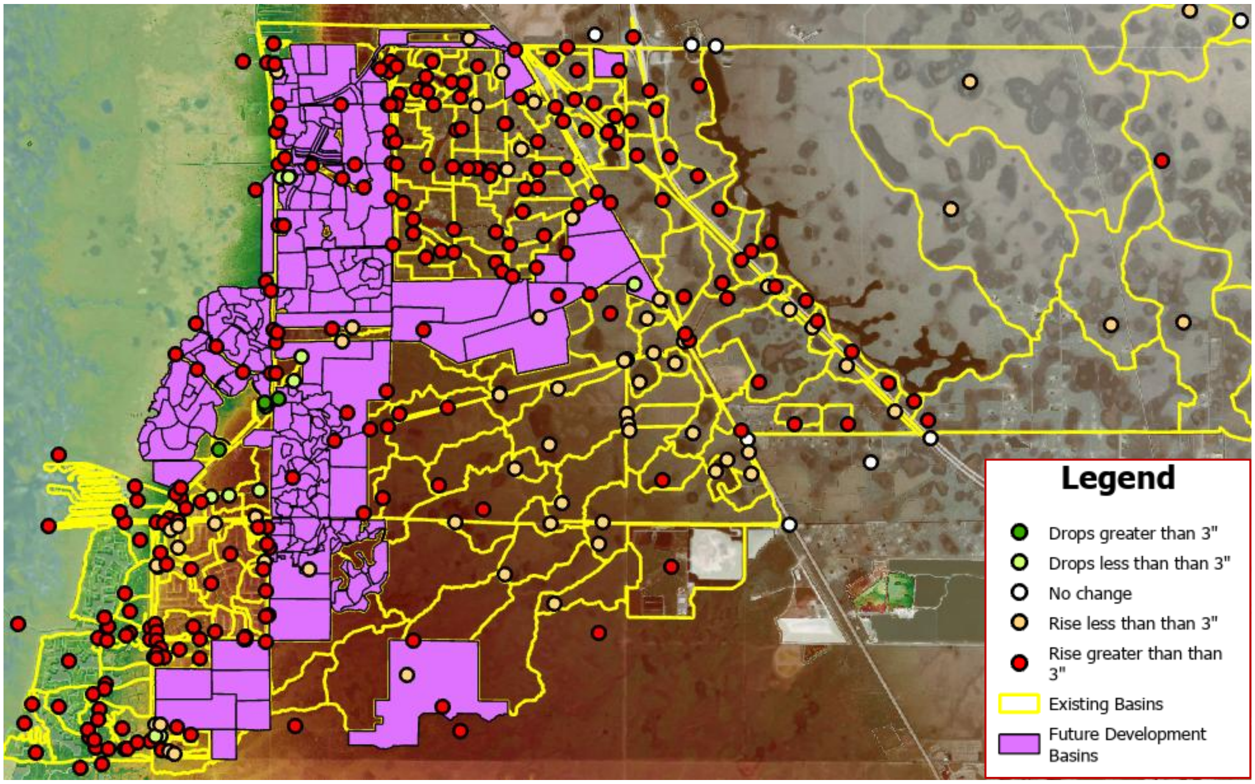
6.3.2. Tailwater Changes

Future tidal conditions were input based on NOAA's 2022 Sea Level Rise Technical Report, considering a future planning year of 2100. The difference between the current mean sea level and future mean sea level was added to the existing tailwater value, resulting in a future tailwater value of 6.59 feet NAVD88, which became the new modeled static tidal condition. As in existing conditions, storm surge elevations greater than the modeled static tidal condition were not included in this study. Tailwater conditions for boundary nodes not associated with tidal conditions at Charlotte Harbor were left unchanged from existing and buildout conditions.

6.4. Conclusions

Similarly to the buildout conditions model, findings of the Baseline Future Conditions Model were evaluated based on rises and drops within the project area. This model had consistent rises in the study area due to higher rainfall. Model results for the portion of the study area west of Burnt Store Road were extremely sensitive to the increased tailwater condition, with many nodes having a maximum stage equal to that tailwater condition. See **Figure 34** below for map of rises and drops from the baseline future conditions model.

Figure 34: Baseline Future Conditions Rises and Drops



Unlike in existing and buildout conditions, there were several buildings with an estimated building elevation lower than the modeled 100yr-24hr storm elevations, and some portions of Burnt Store Road were completely inundated with the modeled flooding. The parts of the study areas with rises that result in existing building Estimated building elevations below the 100yr-24hr stages include the southeast corner of Burnt Store Village, the western portion of Burnt Store Colony, and the eastern portion of Tropical Gulf Acres. See **Figure 35**, **Figure 36**, and **Figure 37** below for figures of buildings with estimated building elevations lower than the associated baseline future conditions maximum stage (note that estimated building elevations are labeled using white text with black outline and maximum node stages are labeled using black text with white outline):

Figure 35: Estimated Building Elevations below Future Condition Modeled Elevations in Burnt Store Village

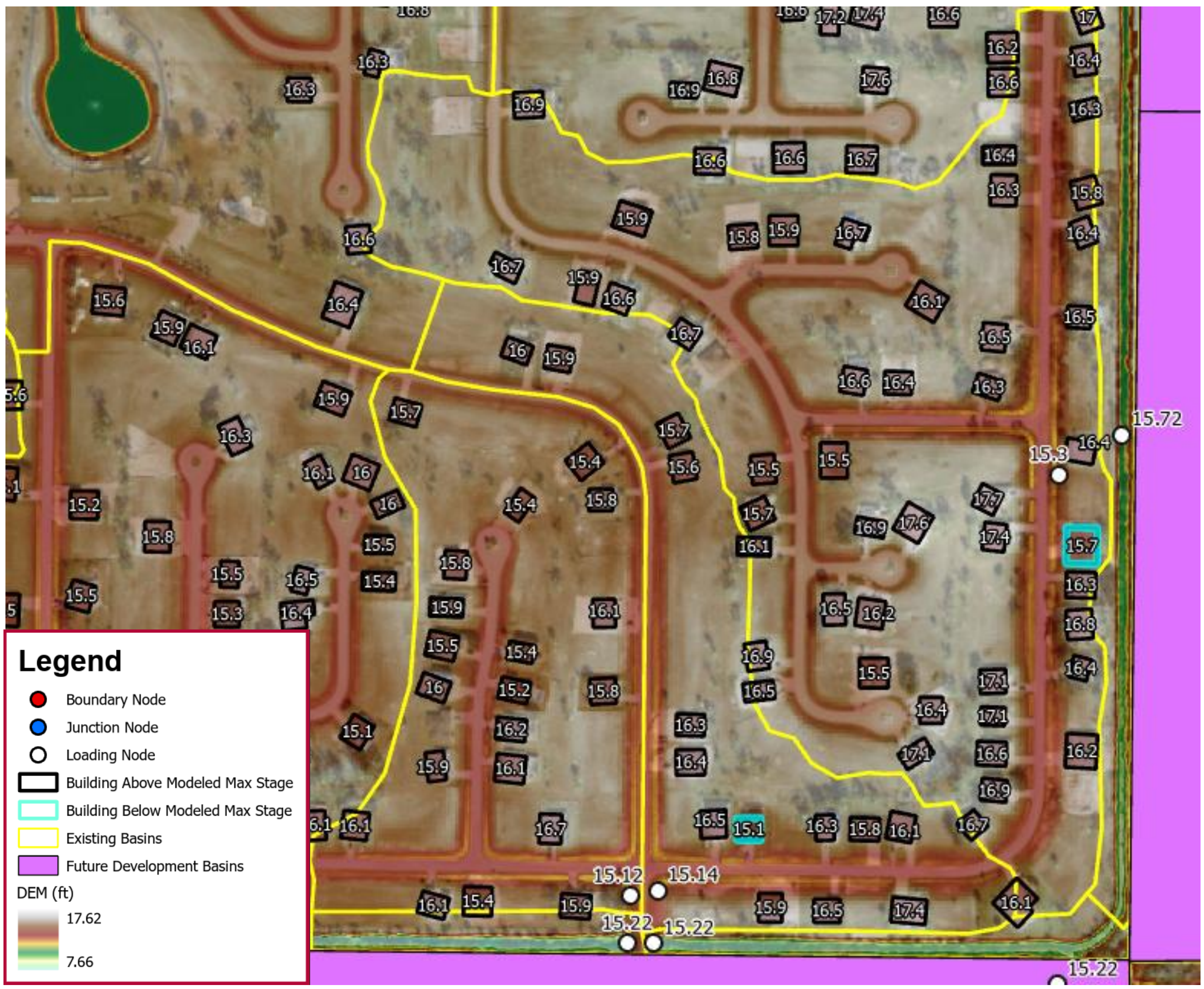


Figure 36: Estimated Building Elevations below Future Condition Modeled Elevations in Burnt Store Colony

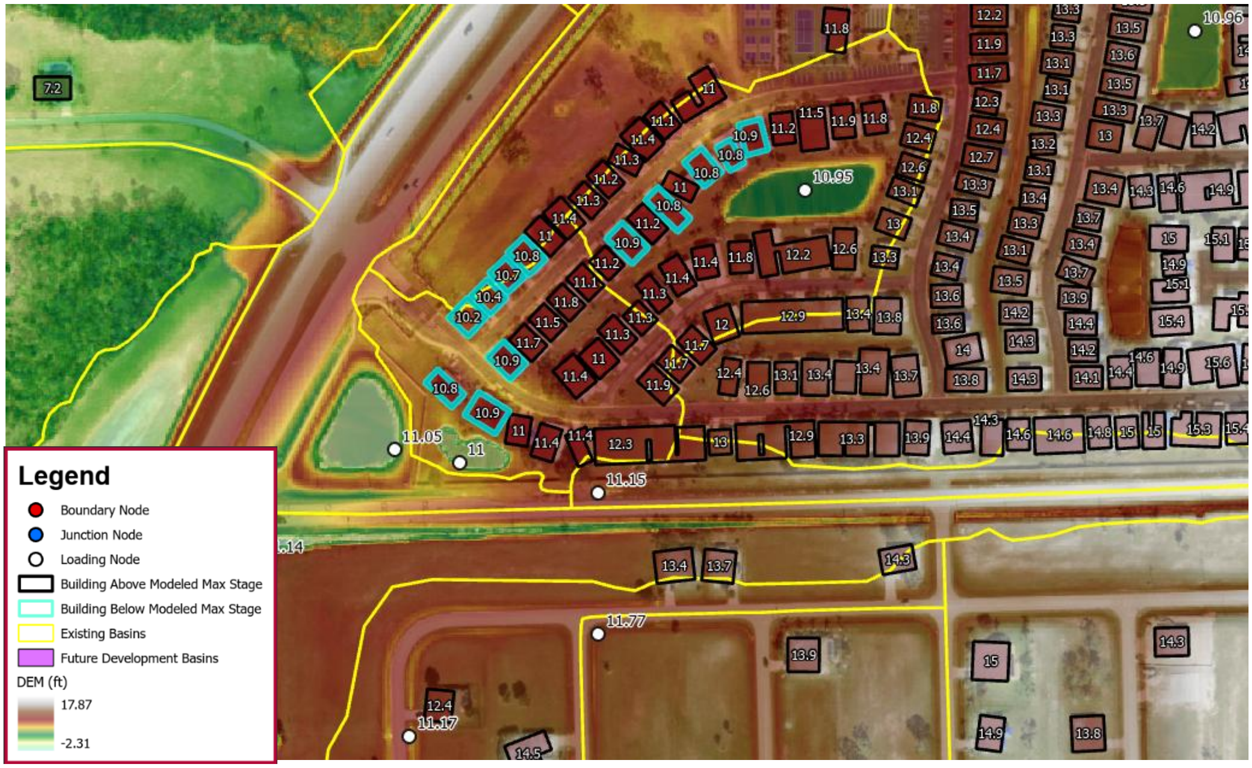


Figure 37: Estimated Building Elevations below Future Condition Modeled Elevations in Tropical Gulf Acres

7. Alternatives Analysis

7.1. Initial Project Selection

Kimley-Horn reviewed the results of the future conditions model and met with the County to discuss potential projects. Proposed projects were generally selected based on the following criteria:

- Results from Existing Conditions, Buildout Condition, and Future Conditions Models
- Input from County Staff
- Ability for a proposed project to improve flood conditions in multiple existing development areas
- Ability to phase proposed projects
- Alignment with current County planned improvements

Based on the above criteria, three conceptual projects were developed.

Project 1: Burnt Store Village Rim Ditch Improvements: The intent of this project was to lower modeled flooding at the southeastern corner of Burnt Store Village along the rim ditch by improving capacity of the rim ditch and downstream capacity as needed.

Project 2: Burnt Store Colony Crossing: The intent of this project was to lower modeled flooding at the western side of Burnt Store Colony and northeast corner of Burnt Store Village by increasing capacity of the existing Burnt Store Road Crossing.

Project 3: Tropical Gulf Acres Improvements: The intent of this project was to develop an additional outfall from the Tropical Gulf Acres Rim Ditch and tie in areas that are vulnerable in future conditions.

7.2. Desired Level of Service

To evaluate results from the modeled alternatives, a desired Level of Service (LOS) was established. The LOS represents a performance metric for which the County can assess both private and public assets and is typically based on asset elevations compared to modeled maximum flood elevations in specific design storms. Based on coordination with the County, the desired LOS was established as follows.

- **LOS Criteria 1:** Estimated building elevations should be above the 100yr-24hr future conditions modeled flood elevation. Any estimated building elevation below the 100yr-24hr future flood elevation would not meet the desired LOS.
- **LOS Criteria 2:** Paved travel lane of Burnt Store Road should be above the 100yr-24hr future conditions modeled flood elevation. Any paved travel lane elevations of Burnt Store Road below the 100yr-24hr flood future elevation would not meet the desired LOS.
- **LOS Criteria 3:** Elevations of local roads should be above the existing condition modeled flood elevation from the validation event. Note that the typical design storm for local roads in Charlotte County is the 5-year design storm event. As this design storm is more intense than the validation event and was not evaluated as part of this study, it is assumed that any road elevations below the validation event maximum stages would also not meet the LOS for a 5-year storm and would therefore not meet the desired LOS.

Based on conclusions made from the future conditions model results, the first two LOS criteria were evaluated by modeling the projects in future conditions (buildout, rainfall intensification, and tailwater change), as this is the scenario where more areas do not meet the desired LOS. The third LOS criterion was based on implementing the proposed projects in the existing conditions validation scenario.

7.3. Project Development

Refinement of alternatives was centered around improvements to the three LOS criteria, instead of realizing general flood improvement. As a result, projects are not intended to remove all modeled flooding within a development area and are instead targeted to remove LOS violations by targeted reduction of modeled flooding.

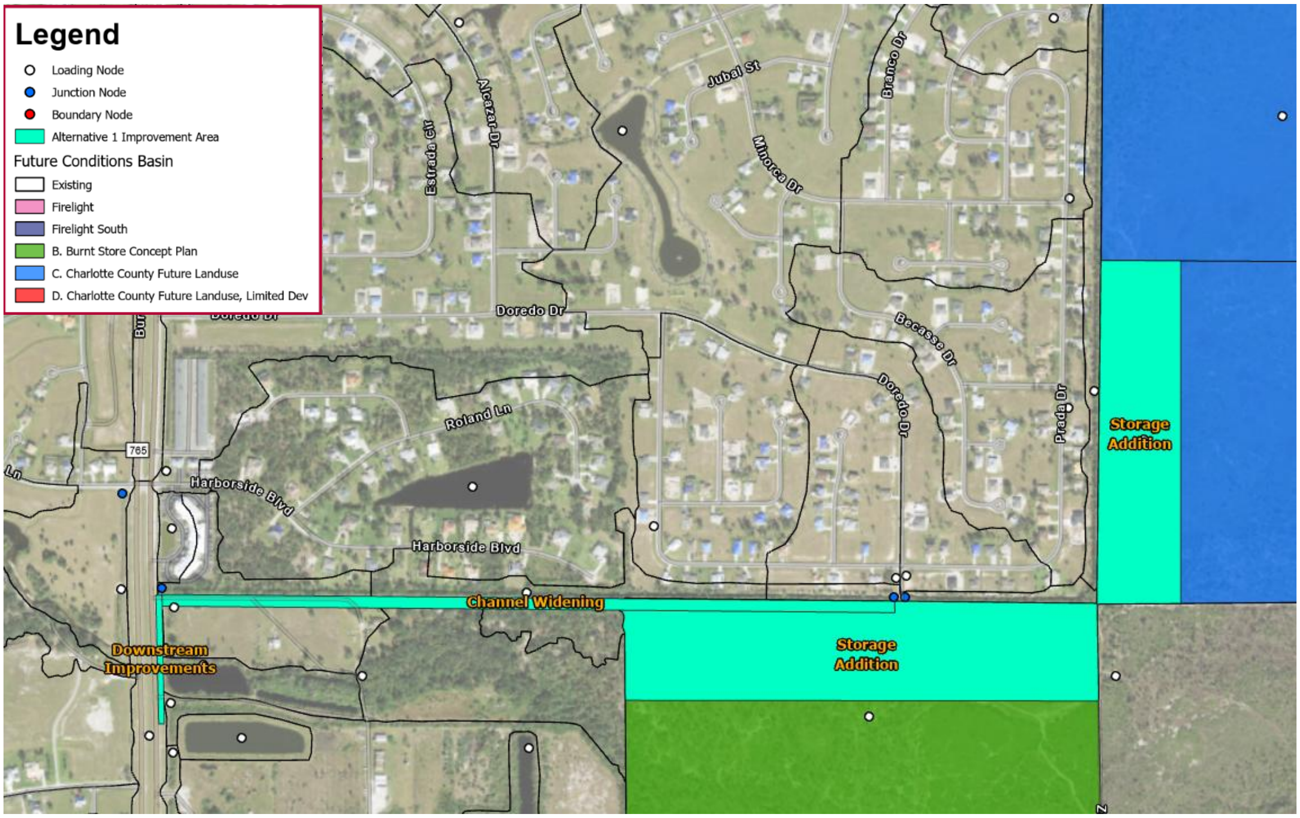
7.3.1. Project 1: Burnt Store Village Rim Ditch Improvements

Project 1 evaluates storage improvements of the Burnt Store Village Rim Ditch. In existing conditions, the rim ditch circles around the east and south sides of Burnt Store Village and the southern portion of Woodland Estates before discharging through a crossing under Burnt Store Road. The rim ditch receives runoff from the existing development and the adjacent eastern undeveloped area. In buildout conditions, it is anticipated that the rim ditch will continue to receive runoff from the eastern area even as that area becomes built-out. Results from the existing conditions model indicate that stages in the rim ditch are higher than the stages within the southeast corner of Burnt Store Village. Modeled flooding in this corner occurs in not only the 100-year, 24-hour storm but also the validation event. Due to the modeled flooding observed in the 100-year, 24-hour future conditions and validation storms, the proposed improvements are designed to improve LOS Criteria 1 and 3. See **Figure 38** below for a conceptual schematic of Project 1.

Proposed improvements that were evaluated as part of Project 1 included:

- Additional areas of floodplain storage. This included adding stage-area nodes that were directly interconnected with the rim ditch to provide storage in a dedicated flood storage area.
- Channel widening and clearing of the rim ditch. This included widening the cross-section of the channel link and lowering the modeled channel Manning's numbers to represent clearing of channels.
- Upsizing the existing culverts under Doredo Drive at the south end of Burnt Store Village that connect the rim ditch towards the west to Burnt Store Road.
- Adding additional capacity at the Burnt Store Crossing at the downstream end of the rim ditch.
- Additional channel improvements west of Burnt Store Road.

Figure 38: Project 1 Conceptual Schematic



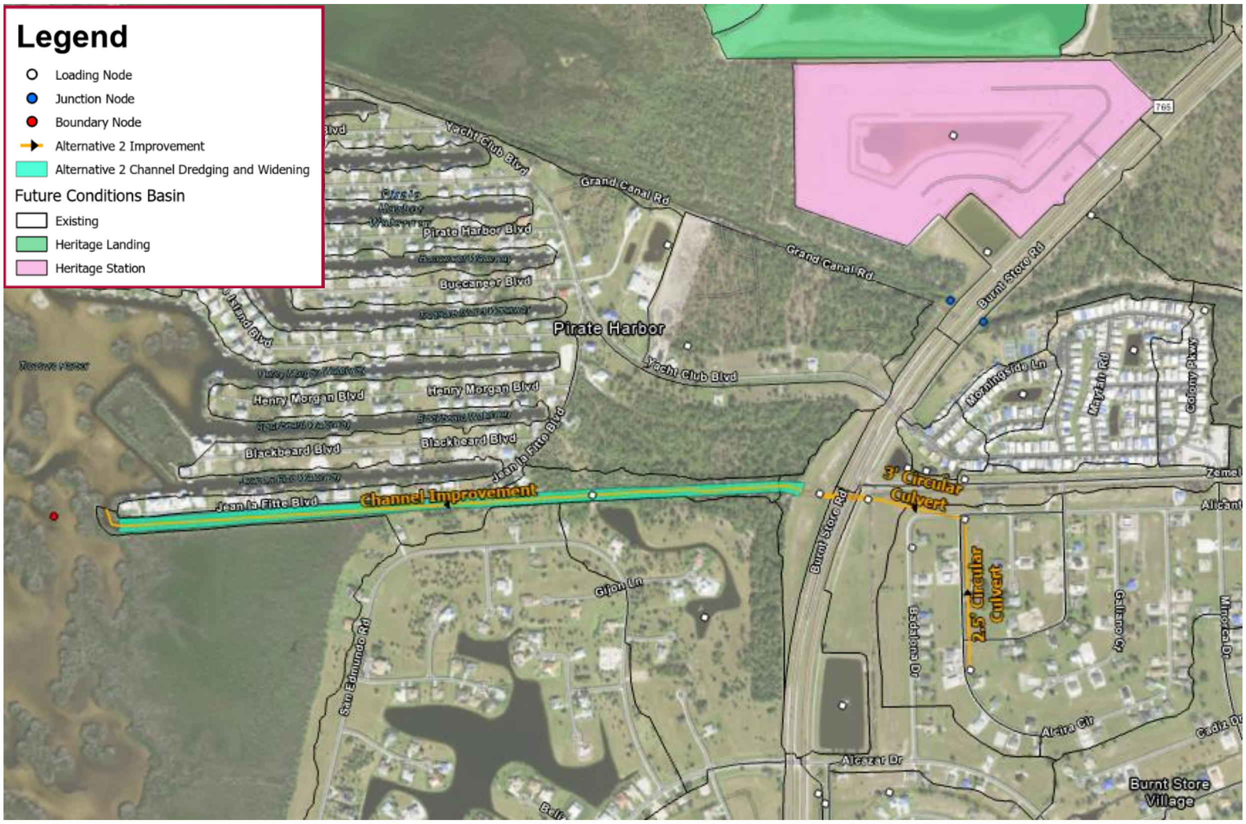
7.3.2. Project 2: Burnt Store Colony Crossing

Project 2 evaluated several alternatives for crossing improvements near Burnt Store Colony. In existing conditions, this crossing does not meet the desired Level of Service for Burnt Store Road. This area upstream of the crossing receives runoff from several developed areas before ultimately discharging to Jean Lafitte Canal. In future conditions, the 100-year, 24-hour modeled stages at this crossing increase to cause several estimated building elevations to be below the modeled stage in Burnt Store Colony. There are several areas at the northwestern corner of Burnt Store Village that experienced modeled flooding in the validation event upstream of the potential crossing improvement. See **Figure 39** for a conceptual schematic for Project 2.

Proposed improvements that were evaluated as part of Project 2 included:

- Improvements to the Burnt Store Road Crossing upstream of Jean Lafitte Canal. This involved upsizing of the four existing 54” culverts underneath Burnt Store Road to three 12’ x 6’ box culverts to match the Clark Canal Crossing.
- Improvements to the Clark Canal Crossing.
- Improvements to the Inverted Syphon crossing Burnt Store Road.
- New crossings at Burnt Store Road near the Burnt Store Road stormwater management area west of Burnt Store Village.
- Widening and dredging of the Jean Lafitte Canal to accommodate upstream crossing improvements.
- Proposed pipe improvements at Burnt Store Village

Figure 39: Project 2 Conceptual Schematic



7.3.3. Project 3: Tropical Gulf Acres Improvements

Project 3 targets decreasing the number of Tropical Gulf Acres structures in the Future Conditions 100-year, 24-hour floodplain by improving the hydraulic connections within Tropical Gulf Acres to the western rim ditch and the associated outfall under Burnt Store Road. In existing conditions, runoff from Tropical Gulf Acres discharges through existing channels and overland flow from the western rim ditch to various crossings under Burnt Store Road. While this channel flow is anticipated to be maintained in Future Conditions, this overland flow will be impacted by future development. The Future Conditions Model assumes that there will be a connection from the stormwater management area of Tropical Gulf Acres under the Tuckers Grade Expansion that will mimic overland flow from Tropical Gulf Acres to the west in that area. In existing conditions, this area only overflows during a major storm, but may be beneficial as a design outfall in future conditions. See **Figure 40** below for a conceptual schematic for Project 3.

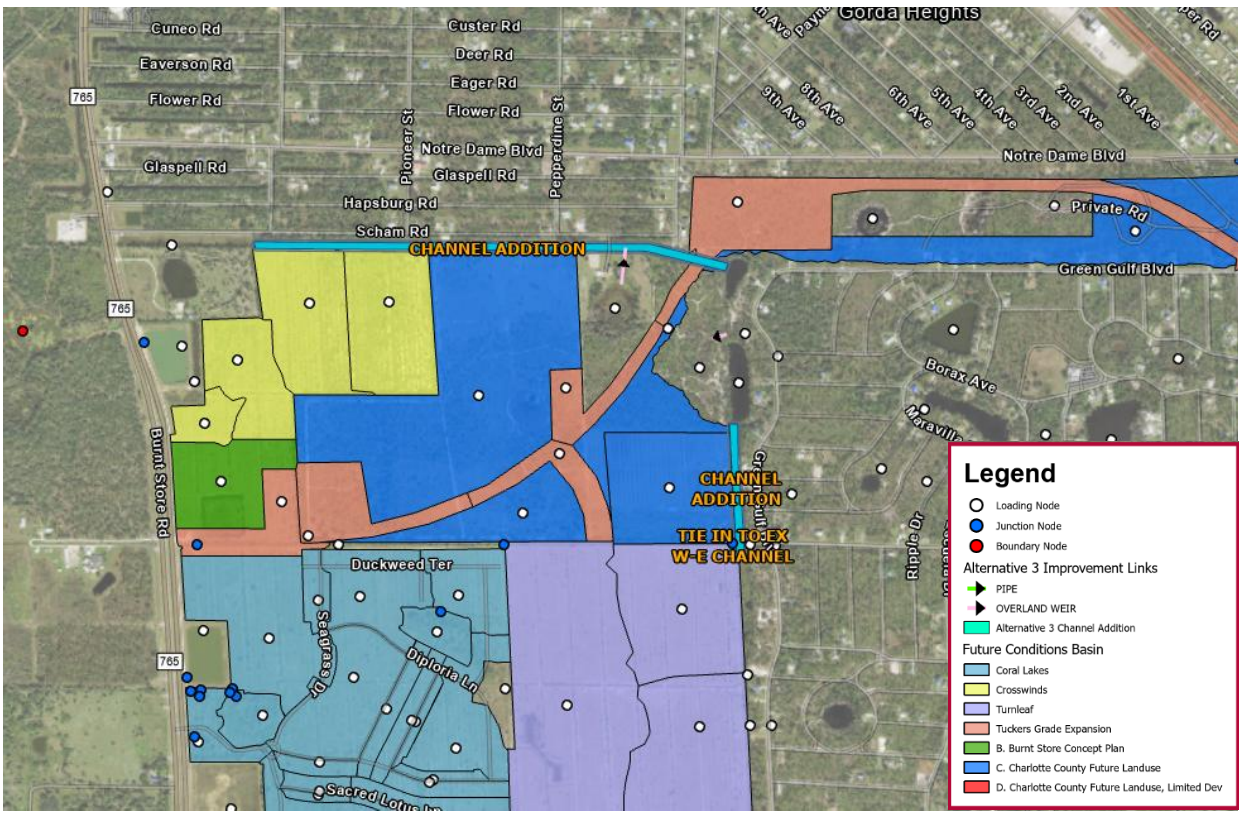
Potential Improvements that were evaluated as Project 3 included:

- Adding another channel outfall from Tropical Gulf Acres to Burnt Store Road. This would connect the Tropical Gulf Acres stormwater management areas to a crossing under the Tuckers Grade Expansion and then parallel to the existing channels that connect Tropical Gulf Acres to the Burnt Store Road crossings.
- Improving hydraulic connections within Tropical Gulf Acres to the rim ditch. This included pipe upsizing and the addition of new channels to alleviate runoff going to existing channels along the west side of Tropical Gulf Acres. Multiple iterations were performed to configure the sizing of the

new channels and to determine appropriate upsizing of pipes upstream and downstream of the additional storage areas.

- Proposed channel improvements located west of Green Gulf Boulevard, running south from Mandalay Drive north to the existing ponds adjacent to Green Gulf Boulevard bend. This channel provides a connection to the existing channels to allow flow to bypass the existing channels' intended outfall. The second additional channel connects from these existing ponds and runs west to Burnt Store Road. One of the pipes upsized with this alternative is the crossing under Burnt Store Road that the proposed channel will discharge through.
- Connections from Green Gulf Boulevard to the existing channels discharging to Burnt Store Road.
- Additional improvements to the crossings under Burnt Store Road downstream of the new outfall from Tropical Gulf Acres. This would potentially be needed to accommodate additional proposed flow from Tropical Gulf Acres.

Figure 40: Project 3 Conceptual Schematic



7.4. Alternative Model Results

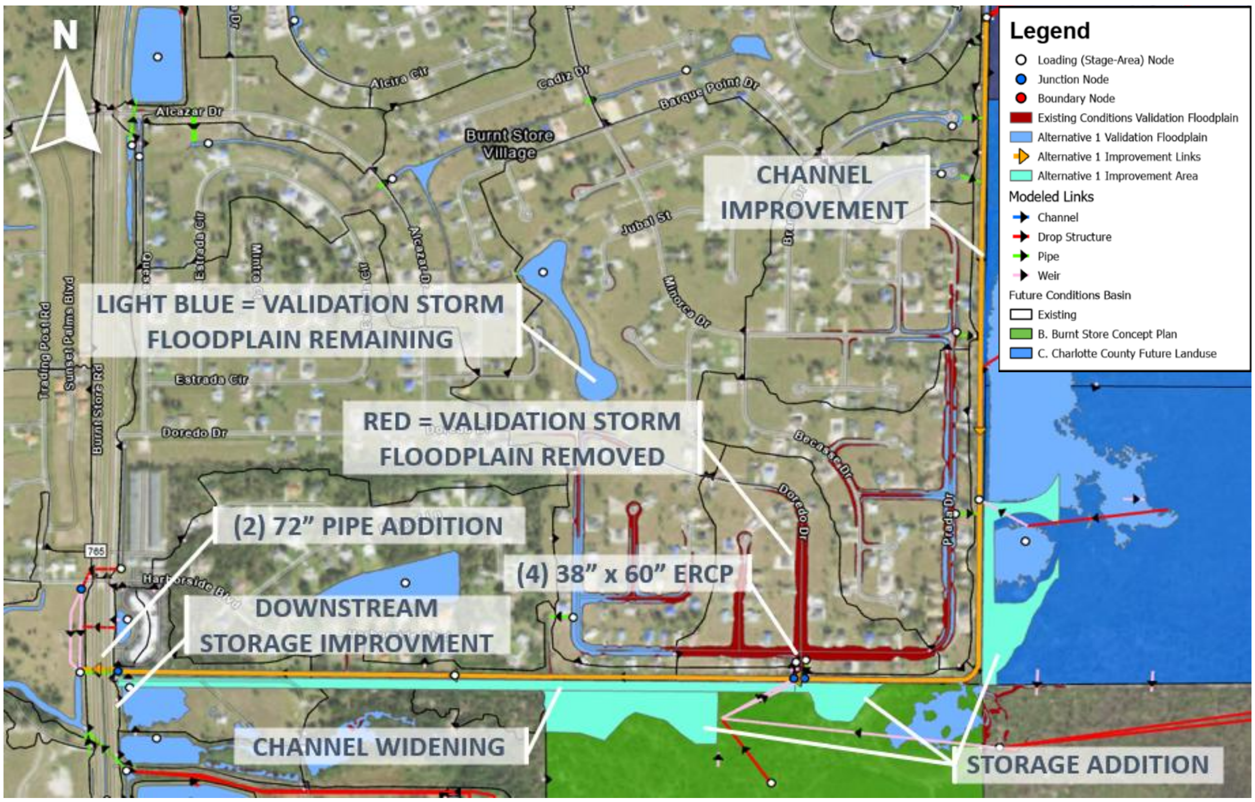
A summary of model results for each proposed project is included below. Additional recommendations for the conceptually proposed projects are included in Section 9.

7.4.1. Project 1 Results

Project 1 lowered modeled stages of the rim ditch between approximately 3" and 6" in the Future Conditions 100-year, 24-hour model. This removed each of the homes with an estimated building elevation lower than the modeled floodplain. This project did not remove any local roads from the Future

Conditions 100-year, 24-hour floodplain, and Burnt Store Road was not flooding in this scenario. Widespread reductions in modeled flooding occurred when the project was plugged into the validation storm event, which resulted in flooding in this scenario being largely limited to the roadside swales. Note that reductions in modeled floodplain extent were much greater in the validation storm than in the Future Conditions 100-year, 24-hour storm. As a result, improving additional connections from Burnt Store Village into the rim ditch were not proposed, as this may cause more water to discharge from the rim ditch into the neighborhood in a major storm event. In future conditions, the 100-year, 24-hour max stage of the crossing (13.5’ NAVD88) is slightly higher than the minimum pavement elevation (13.3’ NAVD88), so this project will remove a portion of Burnt Store Road from the future conditions floodplain. See **Figure 41** for validation model results for Project 1.

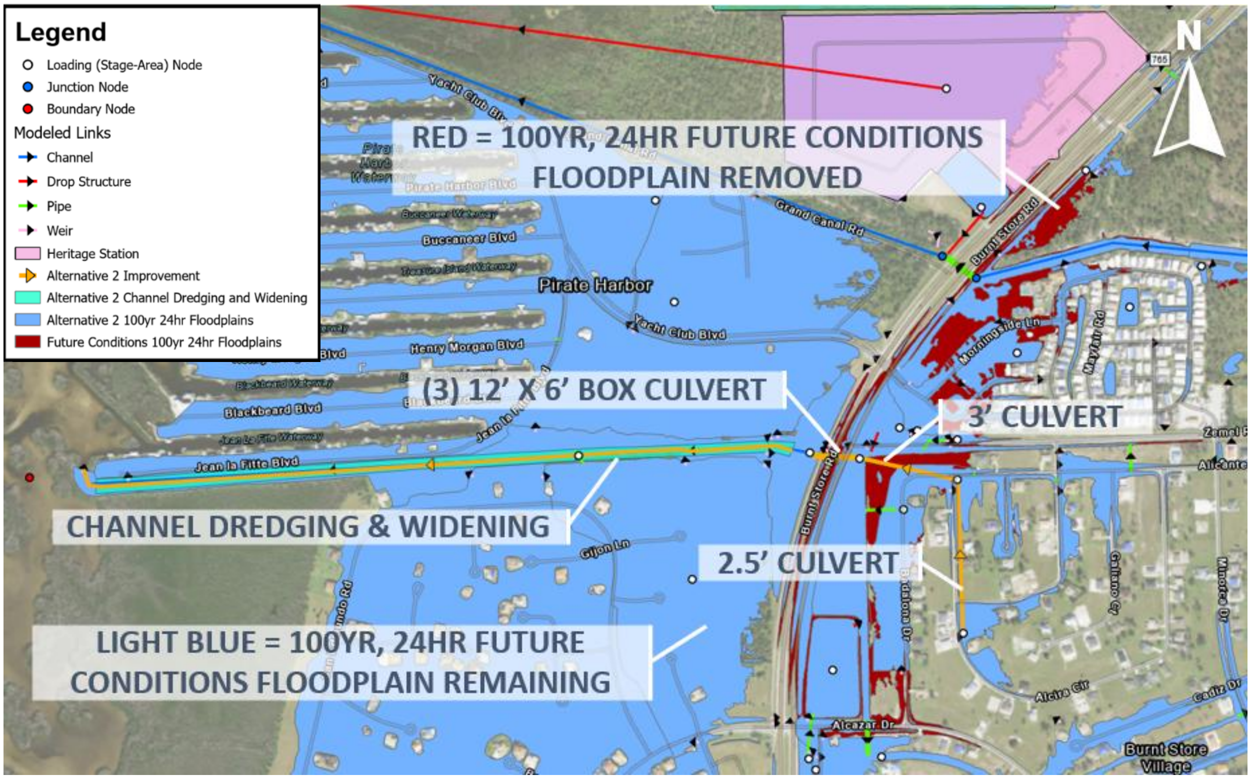
Figure 41: Validation model results for Project 1



7.4.2. Project 2 Results

Results from Project 2 indicated that the proposed project was largely effective in improving Future Conditions LOS for residences in the Burnt Store Colony neighborhood and for the portion of Burnt Store Road. The largest stage decrease was observed upstream of the proposed channel improvements and upsized culvert underneath Burnt Store Road (N-230). A minor stage increase was observed directly downstream of the upsized culverts (N-227, node directly east of Jean Lafitte Canal), but modeled staging along Jean Lafitte Canal did not increase due to modeled channel improvement. The maximum stage elevation at this node remains below the associated pavement elevation of Burnt Store Road and does not represent a significant flood risk increase resulting from this project. Improvements to the Clark Canal Crossing and proposing new crossings under Burnt Store Road were ultimately not included in the final project. Improvements to the inverted syphon showed some minor improvements in the validation storm. See **Figure 42** for 100-year, 24hr future conditions model results for Project 2.

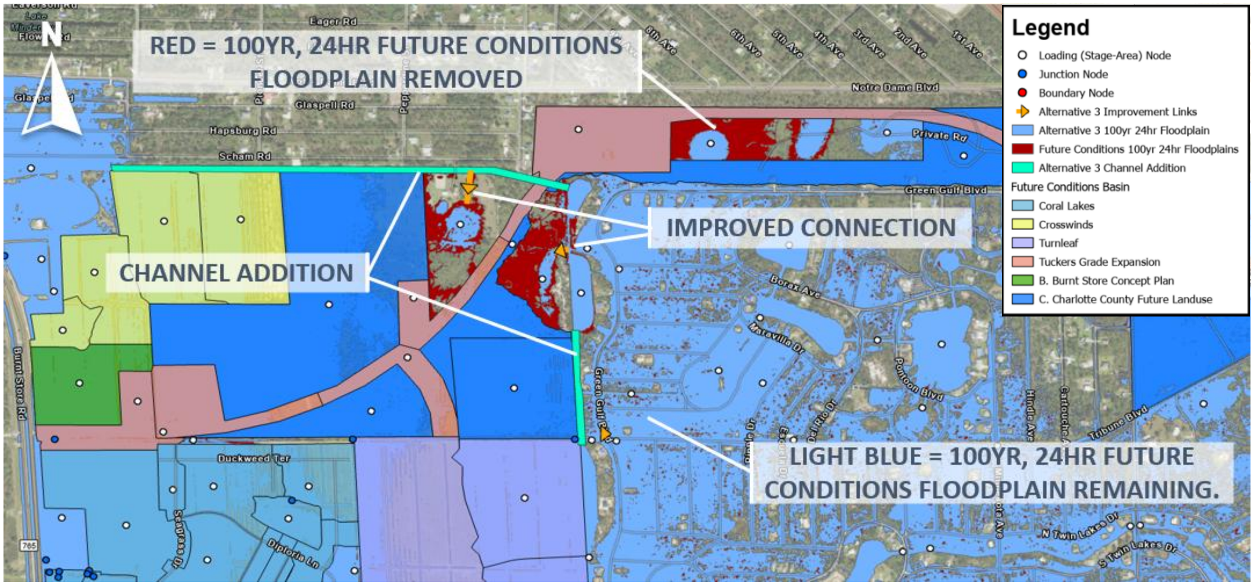
Figure 42: 100-yr, 24-hr future conditions model results for Project 2



7.4.3. Project 3 Results

Results from Project 3 indicate that some of the residences in the Tropical Gulf Acres neighborhood were removed from the Future Condition 100-year, 24-hour floodplain. The largest stage decreases were all located within the areas of improvement for this alternative. A large stage decrease was observed upstream of the proposed channels, where the existing channels directed west to outfall, which was the intent of the proposed improvements. Another large stage decrease was noted in the existing ponds adjacent the Green Gulf Boulevard. Other significant stage decreases were located within basin storage areas near the proposed improvements. Additional stage decreases were also observed within the Tropical Gulf Acres community and surrounding areas. These stage increases were not significant (a few inches), but did remove homes from the future conditions 100-year, 24-hour floodplain. If this project is implemented, additional design refinement is recommended to show greater stage decreases. See **Figure 43** for 100-year, 24hr future conditions model results for Project 3.

Figure 43: 100-yr, 24-hr future conditions results for Project 3



Detailed additional recommendations for the conceptually proposed projects are included in Section 9.

8. Benefit and Cost Analysis

8.1. Decision Support Matrix

To determine a priority ranking list of the projects, a decision support matrix was created to rank each project based on a project score. The project score was developed by evaluating four different scoring criteria and categorizing these scores as either a Benefit or a Cost. Each Benefit scoring criterion was assigned an associated point value, with the total maximum point values for all benefits totaling 100. The only Cost criterion used for this project was the calculated cost of the project.

8.2. Benefit Scores

Benefit scores were associated with the desired LOS improvements associated with each project. See **Table 1** for a list of evaluated criteria, a brief description of the criteria, and associated weighting value:

Table 1: Project Benefit Scoring Methodology

Criteria	Description	Scoring Methodology	Available Points
Structures Removed from FC 100-yr floodplain	Number of structures (homes) removed from the 100-year future conditions floodplain	The project that removes the most structures from the floodplain will receive a score of 40. A project that does not remove any structures from the floodplain would have a score of 0. All other projects will be given a score based on buildings removed from floodplain with respect to the highest value and 0.	40
Burnt Store Rd FC LOS improvement	Linear feet (LF) of Burnt Store Road removed from 100-year future conditions floodplain	The project that removes the most LF of floodplain from Burnt Store Road will receive a score of 30. A project that does not remove any LF of Burnt Store Road would have a score of 0. All other projects will be given a score based on LF of floodplain removed from Burnt Store Road with respect to the highest value and 0.	30
Roads Removed from Validation Event Flooding	Linear feet (LF) of road removed from validation event conditions floodplain	The project that removes the most LF of floodplain from all roads will receive a score of 30. A project that does not remove any LF of any road would have a score of 0. All other projects will be given a score based on LF of floodplain removed from all roads with respect to the highest value and 0.	30

Table 2 below shows the values of each project for each benefit criterion:

Table 2: Benefit Criteria Values

Project	Structures Removed from FC 100-yr Floodplain	Burnt Store Rd FC LOS improvement (LF)	Roads Removed from Validation Event Flooding (LF)
Burnt Store Village Rim Ditch Improvements	4	0	6,800
Burnt Store Colony Crossing	19	650	400
Tropical Gulf Acres Improvements	7	100	0

The values of the individual benefit criteria were converted to scores using the project benefit scoring methodology. The individual scores for each benefit were summed to calculate a Total Benefit Score.

$$Total\ Benefit\ Score = Sum\ of\ Individual\ Benefit\ Criteria\ Scores$$

Table 3 below shows the individual and total benefit scores for each project.

Table 3: Benefit Scores

Project	Score from Structures Removed from FC 100-yr floodplain	Score From Burnt Store Rd FC LOS improvement	Score From Roads Removed from Validation Event Flooding	Total Benefit Score
Burnt Store Village Rim Ditch Improvements	7.3	4.6	30	41.9
Burnt Store Colony Crossing	40	30	1.8	71.8
Tropical Gulf Acres improvements	21.8	0	0	21.8

8.3. Conceptual Opinion of Probable Cost

A Conceptual Opinion of Probable Cost (COPC) was estimated for each alternative. Costs for each alternative include Stormwater, Earthwork, Land Acquisition, Wetland Mitigation, Miscellaneous, and Contingency. Costs were estimated using the FDOT Cost Index unless otherwise noted.

Stormwater improvement costs include proposed pipes and structures such as inlets and manholes. Pipe lengths were estimated from existing modeled lengths for upsized pipes or from conceptually drawn lengths for new pipes. The number of structures was estimated manually by placing structures at storm crossings, low areas where water would be collected, and changes in pipe size. For Project 1, it is assumed that the proposed pipes will be jack-and-bored under Burnt Store Road.

Earthwork costs include the reconstruction of disturbed areas, excavation, embankment construction, and clearing and grubbing. Reconstruction costs for stormwater infrastructure were estimated to include restoration of roads and landscaping that have been impacted by the installation of proposed improvements. Costs for reconstruction of disturbed areas were estimated as $/SY value, combining Sod+Grading for "Non-Road" and Grading+Base/Subbase+Asphalt for "Paved Road". Disturbed areas were estimated based on pipe length multiplied by an estimated disturbed width. The assumed disturbed width was 10’ plus the proposed pipe width (e.g. for a 4’ pipe, 10’+4’=14’ disturbed width). Excavation areas were measured as an average depth of excavation of 2’ multiplied by the area of a proposed pond, buffered by 10’. Embankment costs were calculated as an average height of 2’ multiplied by the remaining 10’ width of a proposed pond. Ditch excavation was also assumed at an average depth of 2’ and 10’ wide for the length of a ditch.

Land acquisition costs were based on the Charlotte County Property Appraiser's Just Market Value. For areas where ponds are proposed, it is assumed that the whole parcel will need to be bought. For areas where a pipe crosses through a parcel, it is assumed that only an easement will need to be established, with a $/sf value calculated for the parcel and applied to an estimated easement size.

Wetland mitigation costs were based on the FDEP Uniform Mitigation Assessment Method, where a standard value is multiplied by the acreage of wetland conflict potential. See Section 8.1.3 for details on how wetland conflict potential was determined. Detailed UMAM assessment was not performed as part of this project.

Miscellaneous costs include erosion control, geotechnical and survey, maintenance of traffic (if applicable), demolition and site preparation, mobilization and demobilization, dewatering, design and permitting, and CEI costs. These are lump sum costs that were calculated as a percentage of the sum of Earthwork, Stormwater, and Land Acquisition costs. Ongoing costs such as maintenance were not considered in this evaluation.

A 30% contingency was applied to the sum of the Earthwork, Stormwater, Land Acquisition, and Miscellaneous costs. The estimated total construction cost was then the sum of Earthwork, Stormwater, Land Acquisition, and Miscellaneous, plus the 30% contingency.

See Appendix B for a full breakdown of COPC line items. The Consultant has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Consultant at this time and represent only the Consultant's judgment as a design professional familiar with the construction industry. The Consultant cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs. Additionally, costs can and will likely increase in the time between this study and a project being implemented. If the County does move forward with any of these projects, it is recommended that the opinions of probable cost be revisited and updated prior to beginning design and throughout the design process.

8.4. Benefit-Cost Score

Table 4: Project Cost Score

Project Cost Score			
Criteria	**Description**	**Scoring Methodology**	**Available Points**
Project Cost Score	Lump Sum construction costs for projects based on current industry information with applicable contingencies. Costs were evaluated in 2026 US Dollars.	The project that is the most expensive will receive a cost score of 100. A project with that has a cost of $0 would have a cost score of 0. All other projects will be given a score based on cost with respect to the highest cost and $0.	100

The calculated total benefit score and project cost score were used to develop an overall benefit/cost score

$$Benefit/Cost\ Score = \frac{Total\ Benefit\ Score}{Project\ Cost\ Score}$$

Based on the scoring matrix developed for this project, the calculated final relative benefit/cost scores are shown below. These benefit/cost scores are based on scoring criteria that are relative to one another, so scores are intended to represent how well the projects score when considering the benefit criteria and cost criteria in relation to one another.

Table 5: Benefit/Cost Score

Project Number	Project	Project Cost Score	Project Benefit Score	Benefit/Cost Score
1	Burnt Store Village Rim Ditch Improvements	$10,250,000	41.9	0.42
2	Burnt Store Colony Crossing	$3,700,000	71.8	2.01
3	Tropical Gulf Acres improvements	$1,700,000	21.8	1.36

Note that project benefit/cost scores are not a determination on if a project should or should not be implemented or a recommendation of sequencing of implementation of projects.

9. Conclusions and Recommendations for Future Analysis

The proposed projects were generally able to provide targeted LOS improvement within the study area. However, due to the conceptual nature of this study, additional consideration should be made prior to design or other next steps for these projects.

9.1. Project-Related Conclusions and Recommendations

- **Project 1:** For the Burnt Store Village Rim Ditch, it was concluded that the conceptual project modeled as part of this project showed general improvements to LOS criteria. It is recommended that if this project were to progress, additional refinement of the rim ditch improvements or other related improvements should be evaluated. This may include evaluating additional storm events and scenarios in project design.
- **Project 2:** For the Burnt Store Colony Crossing, it was concluded that the conceptual improvement was able to reduce Future Conditions 100yr-24hr staging along Burnt Store Road. Due to the large physical size of the conceptual improvements, it is recommended that additional refinement of sizes for these improvements be performed. Similarly, it is recommended that upstream storage, conveyance, and roadway improvements (upstream sump, downstream channel improvement, elevating roadway pavement) be evaluated. It is also recommended that additional consideration be made to tie-in areas of Burnt Store Village to the proposed crossing improvements.
- **Project 3:** For Tropical Gulf Acres, it was concluded that this area is close to meeting the LOS in existing conditions. However, this area is susceptible to increased modeled flooding in future conditions. It is recommended that an additional outfall parallel with Scham Road be evaluated

for future conditions. It is understood that the Tuckers Grade expansion will bisect this potential connection, so as that connection is fully designed, it is recommended that any crossings under that expansion be evaluated in a future condition scenario. This outfall will eventually discharge to an existing Burnt Store Road Crossing. Sizing of this crossing would need to be further evaluated if this outfall were to be implemented. Additional improvements within Tropical Gulf Acres to tie into this crossing would include new and upsized pipes and new channel connections.

9.2. General Conclusions and Recommendations

- Due to the conceptual nature of this study and limitations of the scope of the study, additional refinement of the conceptually proposed projects is recommended during design to both improve modeled benefits and optimize design and associated costs.
- Since many of these projects include multiple improvements targeted toward very different design scenarios (Future Conditions 100yr-24hr versus existing conditions validation event), it is recommended that phasing for these projects be evaluated. For example, the rim ditch storage improvements for Project 1 could be prioritized over the crossing improvement at Burnt Store Road. Phasing considerations were not evaluated as part of this study.
- For many of these projects, additional easement and property acquisition are likely required for design. It is recommended that the feasibility of acquiring these easements or properties be further explored prior to project implementation.
- For any implemented project, it is recommended that meetings with the appropriate permitting agencies (SWFWMD, FDEP, others) occur before project design to discuss environmental considerations.
- It is recommended that downstream impacts and improvements be evaluated alongside any implemented projects. For example, Burnt Store Road crossing improvements and upstream ditch widening may require downstream improvements at existing developments west of Burnt Store Road (Pirate Harbor, Burnt Store Lakes, others). This is conceptually discussed in the applicable project narratives but should be further evaluated during design.
- It was concluded that in buildout conditions, future developments modified flow patterns in the study area mainly because of their proposed berms. The future developments caused many modeled areas to see an increase in the modeled stage upstream of these developments. While these increases were typically observed in undeveloped areas, it is recommended that as additional development occurs within the watershed, upstream contributing flows should be considered during design for the 100yr-24hr and other more intense storm events. It is recommended that the County consider the upstream contributing flows and bypass needs as proposed developments are reviewed.
- If recent development is desired to be incorporated in a design-level project, it is recommended that as-built survey data obtained after construction is substantially completed be used to update the model for these projects.
- As these developments are constructed, it may be beneficial to add the constructed developments to the existing model based on as-built parameters or an updated DEM. This could be done as part of regularly scheduled model maintenance (such as on an annual basis using as-built data) or periodically as updated DEMs become available.

- It is understood that building elevations estimated in this report are estimated and not survey-level FFEs. These assumed building elevations are not intended to be used for comparison to established floodplains, design-level analysis, or in any other future analysis.
- Modeled rises in the 100yr-24hr storm from existing conditions to buildout conditions were less than modeled rises from buildout conditions to future conditions. It is therefore concluded that modeled flooding in the watershed is more sensitive to changes in modeled tidal elevations and rainfall intensification than the additional modeled development.
- This study does not evaluate potential funding sources for these conceptual projects. It is recommended that grants or other potential funding sources be evaluated prior to designing and during future phases of these projects.
- This study does not evaluate any maintenance considerations associated with existing and future drainage infrastructure. It is recommended that additional coordination with stakeholders (other County departments, MSBUs, SWFWMD) occur to discuss maintenance considerations or other relevant next steps for the proposed projects.