Attachment D – Lake Alice Watershed – Stormwater Modeling Report

Prepared for

Wetland Solutions, Inc.

May 2024

Prepared by

JonesEdmunds

YEARS 1974-2024

TECHNICAL MEMORANDUM

JonesEdmunds 50 YEARS 1974-2024

Lake Alice Watershed Management Plan

TO:	**Scott Knight, PhD, PE; Amy Gooden, PE**
FROM:	**Austin Wood, PE; Justin Gregory, PE**
DATE:	May 16, 2024
SUBJECT:	ICPR Model Update Jones Edmunds Project No. 23140-003-01

1 INTRODUCTION

The University of Florida (UF) selected Wetland Solutions, Inc. (WSI) to develop a watershed management plan (WMP) for the Lake Alice watershed. As part of the Lake Alice WMP, WSI contracted with Jones Edmunds to update the campus-wide hydrologic and hydraulic (H&H) model we developed for UF Facilities Services in 2018. This technical memorandum details the updates we made to the UF campus-wide model for the Lake Alice WMP.

2 MODEL UPDATES

2.1 Base Data

Jones Edmunds used the following datasets when updating parameters for the ICPR 4 model:

- Light Detection and Ranging (LiDAR)-based Digital Elevation Model (DEM) developed by the US Geological Survey (USGS) in 2018.
- US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) Database for Alachua County.
- 2014 St. Johns River Water Management District (SJRWMD) landcover mapping.
- National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP) impervious cover mapping.
- UF Stormwater Inventory.
- 2010 UF Master Stormwater Permit and 2023 UF Master Stormwater Permit Renewal Application prepared by Chen-Moore & Associates, which included updates to the 2018 Jones Edmunds campus-wide model.
- Environmental Resource Permits (ERPs) from SJRWMD.

- Construction drawings and as-built drawings provided by UF.
- City of Gainesville Stormwater Inventory.
- Aerial Imagery:
  - Alachua County aerial imagery (2023).
  - Near Map Ltd. aerial imagery (October 2023).

2.2 Basins and Subbasins

The UF main campus was previously divided into four primary basins. The basins were delineated to identify areas that drain to:

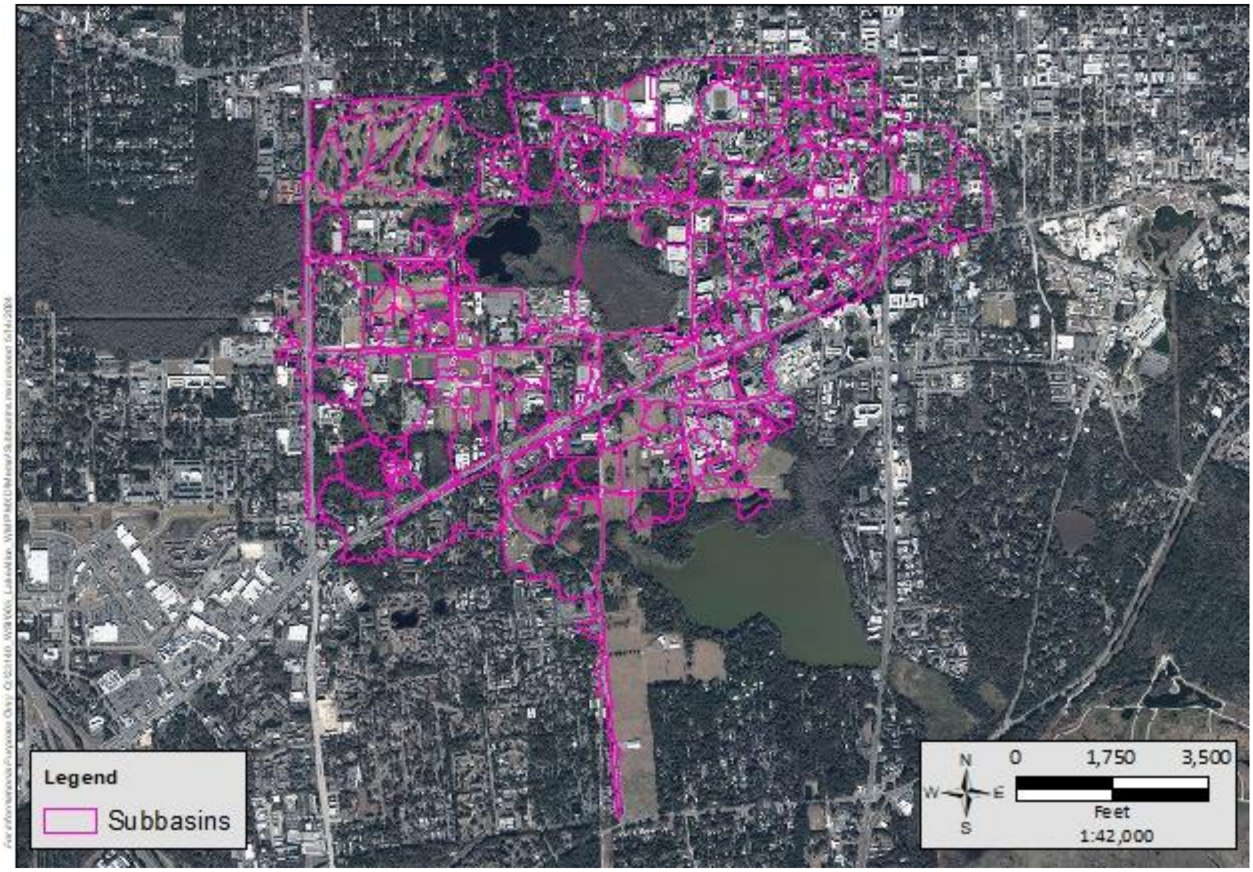
- Lake Alice.
- Hogtown Creek.
- Tumblin Creek.
- Internally drained depressional basins that do not discharge off-campus.

Jones Edmunds originally developed ICPR subbasins for each basin. We updated and refined the subbasin delineations using a combination of automated geographic information system (GIS) basin delineation techniques and manual delineations developed using the following datasets:

- LiDAR-derived 2018 DEM.
- UF Stormwater Inventory.
- Aerial imagery collected in October 2023 by Near Map Ltd.
- ERPs from SJRWMD; construction drawings and as-built drawings from UF.

The updated basins range from 0.1 to 93.5 acres, with a median basin size of 5.3 acres. A total of 210 subbasins were used to represent the main campus drainage system, an increase of 46 subbasins compared to the 2018 H&H model. Figure 1 is a map of the updated subbasin boundaries.

Figure 1 Subbasin Boundaries



The model scale was originally established to ensure that the primary stormwater infrastructure, such as stormwater ponds, control structures, primary trunk lines, and significant culverts, were modeled hydraulically. Local-scale infrastructure such as driveway culverts or roadway drainage systems were typically not modeled hydraulically but were accounted for in the basin hydrology. Smaller basins were delineated and refined in areas with significant stormwater structures or historical flooding, such as the northeast portion of the UF campus and the Surge Area. Larger basins were delineated for areas outside the study area that contribute stormwater to the UF campus or that were used to establish off-campus boundary conditions. During the model updates, we also refined several stream basins to add additional detail and updated basin delineations to account for new developments that have occurred since 2018.

Jones Edmunds retained the original naming convention we developed for model schematic features based on their location within the watershed. We assigned a prefix to features corresponding to the primary watershed basin in which they originate. We also assigned a second prefix that describes the type of feature. We used the following prefixes in developing the stormwater model:

- LA – Lake Alice Basin
- UF – Depressional Basin
- UFH – Hogtown Creek Basin
- UFT – Tumblin Creek Basin
- N – Node
- R – Reach (Link)
- X – Cross Section

2.3 Curve Number (CN), Directly Connected Impervious Area (DCIA), Unconnected Impervious Area (UCIA), and Direct Area

The campus-wide model Jones Edmunds developed in 2018 used the multi-layer Green-Ampt infiltration option in ICPR 4 to calculate the infiltration and rainfall excess for each subbasin. However, during the current master stormwater permit renewal process, Chen-Moore converted the model to use CN infiltration due to SJRWMD permitting requirements. For this study and to align with future permitting needs, we also updated the model to use the CN infiltration method. CNs developed for the updated model represent the pervious areas, and we explicitly calculated the percent DCIA, percent UCIA, and percent direct for each basin.

2.3.1 Curve Number

We developed CNs for the updated model subbasins using NRCS soil mapping, SJRWMD land cover mapping, and USDA-NRCS Technical Release (TR)-55 (1986). We determined the pervious-area CN for each basin by creating response units using an intersection of the NRCS hydrologic soil group (HSG) and FLUCCS code. Soils classified by the NRCS as dual HSG (A/D, B/D, and C/D) were assumed to be in a natural, wet season condition and respond like a HSG D soil. Basins were then assigned a pervious-area CN based on an area-weighted average of the CNs for each soil and land cover combination within the subbasin. Table 1 summarizes the land cover and CN combinations used in the updated model.

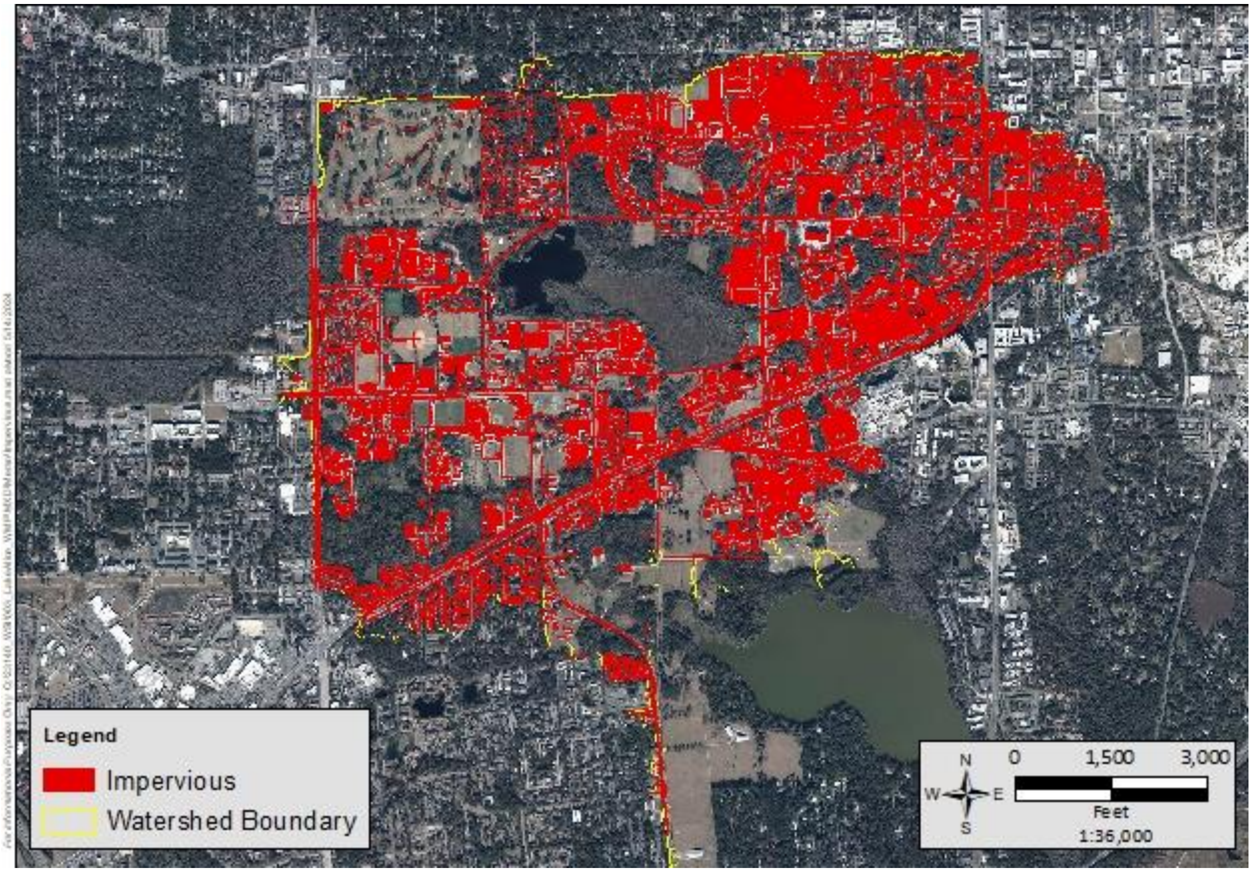
Table 1 CN Classifications

Land Cover	Curve Number			
Description	A	B	C	D
Open Space/Woods/Brush	39	61	74	80
Mixed Scrub-Shrub Wetland	100	100	100	100
Mixed Wetland Hardwood	100	100	100	100
Wet Prairie	68	79	86	89

2.3.2 UCIA and DCIA

NOAA produces national standardized land cover and change products for the coastal regions of the United States. In 2023, the C-CAP released high-resolution impervious mapping for Florida, representing impervious areas from 2020 through 2021. This mapping is based on high-resolution (30 centimeter or better) aerial imagery. Jones Edmunds used the NOAA C-CAP impervious cover mapping to calculate DCIA and UCIA characteristics for the updated watershed model. We reviewed the NOAA impervious mapping and updated it to include impervious areas associated with new development. For this study, we assumed that impervious areas were 90% directly connected due to the prevalence of drainage systems on campus. Figure 2 shows the impervious areas used in the updated model.

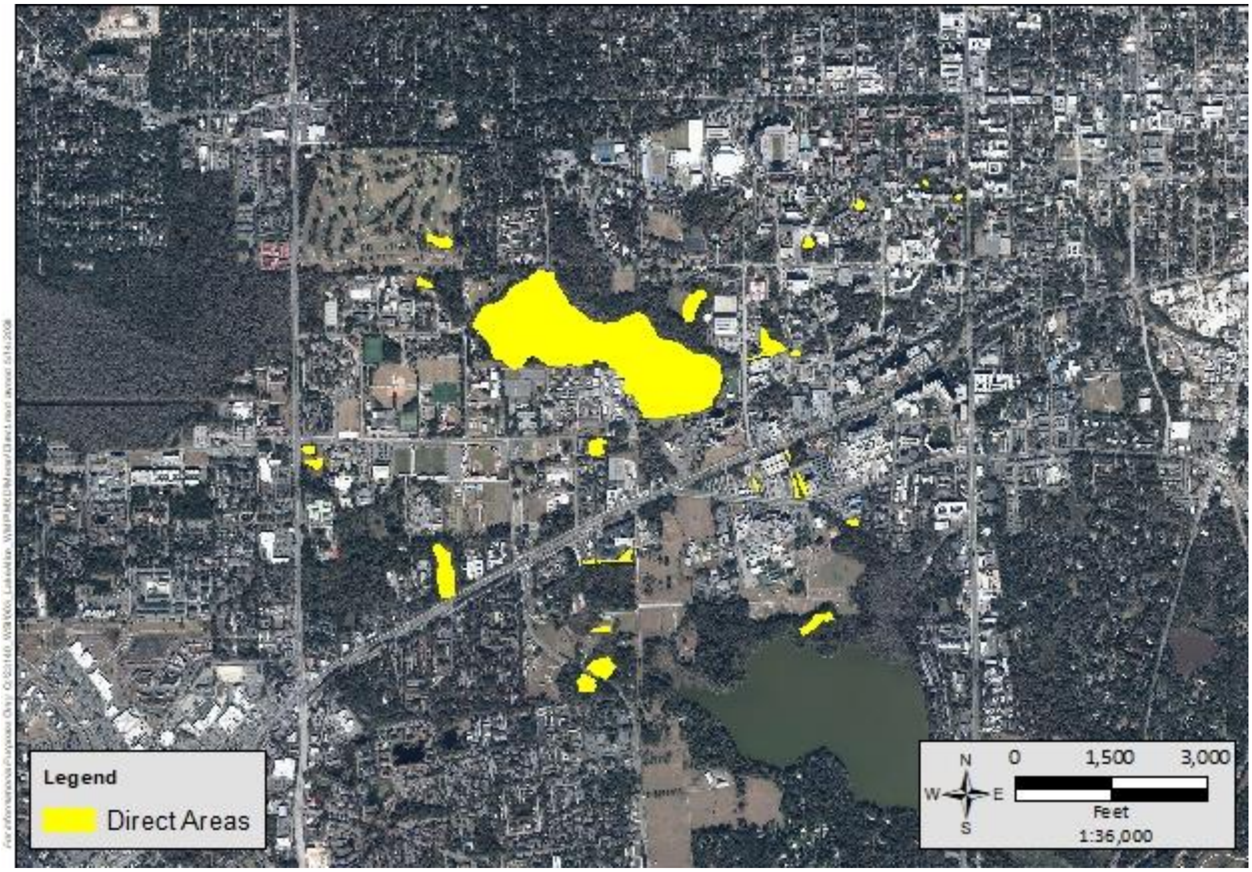
Figure 2 Impervious Area



2.3.3 Direct Area

The percent direct area is the percentage of the subbasin area where rainfall is applied directly to the basin outlet and bypasses any type of basin hydrograph routing. This applies to portions of the subbasin where rainfall occurs directly on the surface area of a pond or wetland. Figure 3 shows the direct areas used in the updated model.

Figure 3 Direct Areas



2.4 TIME OF CONCENTRATION

Jones Edmunds calculated the time of concentration for each subbasin using the methods outlined in USDA-NRCS TR-55. We determined each subbasin's longest representative flow path using GIS techniques and manual review. To avoid double-routing flow in both the hydrologic and hydraulic components of the model, Jones Edmunds excluded any storage or conveyance areas in the hydraulic model from the time of concentration analysis. We reviewed the watershed and determined that sheet flow would be limited to a maximum of the first 100 feet of a flow path, the maximum sheet flow length recommended by the NRCS. We considered the rest of the flow path shallow concentrated flow and classified the sheet flow as pervious or impervious. We then assigned roughness values to the shallow concentrated portion of the flow path. We calculated the time of concentration using the methods described in TR-55 with a minimum travel time of 6 minutes.

2.5 UNIT HYDROGRAPH

Jones Edmunds used a unit hydrograph with a 484 peaking factor for the updated model based on the watershed characteristics and to align with SJRWMD permitting requirements.

2.6 NODE STORAGE

Jones Edmunds updated the model's stage-area relationships for each storage node using the 2018 USGS LiDAR-based DEM and an automated procedure within GIS. The interval of the stage-area relationship was varied to accurately represent the volume of storage in the subbasin. We used a minimum stage interval of 0.1 foot and a maximum stage interval of 1 foot. Nodes representing drainage structures such as manholes, curb inlets, and ditch bottom inlets were manually assigned nominal storage relationships to account for the elevation difference between the bottom of the structure and the lowest point on the LiDAR-based DEM. Nodes representing underground storage vaults were assigned stage-volume relationships based on the permitted design drawings.

Jones Edmunds delineated channel-storage exclusion polygons to exclude storage modeled within a channel from the node stage-area relationship to avoid double-counting storage within the modeled channel links. We also delineated storage exclusion polygons for areas not accurately represented by the LiDAR-based DEM. We then checked each node for general consistency.

2.7 Starting Water Levels (Initial Conditions)

Jones Edmunds retained the initial stages used in the original 2018 model for stormwater management areas and ponds. We developed initial conditions for new nodes added during the model update based on the best available information such as ERP documents, control-feature data, orthophotography, LiDAR-based DEM, or seasonal high-water table (SHWT) levels when control-feature data were not applicable.

For Lake Alice, we assumed the water surface elevation started at the control elevation of R-1, the regulated recharge well that controls the normal lake elevation. The existing Master ERP for the UF campus states the elevation of R-1 was artificially elevated by 0.5 foot for the permit due to the "current obstructed condition of the R-1 well grate." However, for this study a maintained condition was assumed for all hydraulic infrastructure.

2.8 Overland Irregular Weirs and Channels

Jones Edmunds used irregular overland weirs or channels to connect modeled nodes that stage up out of the primary conveyance features. The inverts and cross-sections for the overland weirs and some channels were determined from the LiDAR-based DEM. A survey was collected for the remaining channel cross-sections and incorporated into the model as part of the Lake Alice WMP update.

2.9 Culverts, Stormwater Pipes, and Control Structures

Jones Edmunds retained the originally collected structure inverts, pipe shapes, and pipe dimensions for modeled stormwater structures obtained from the following sources:

- UF Stormwater Master Plan.
- SJRWMD ERPs.
- City of Gainesville Stormwater Infrastructure Database.
- Stormwater inventory completed earlier in the project.
- Rim measure downs combined with LiDAR estimates of rim elevations.
- Real Time Kinematic Global Positioning System survey of structure inverts.

Data for new structures added as part of the model update were obtained from SJRWMD ERPs, construction drawings, as-built drawings provided by UF, and survey performed as part of the Lake Alice WMP.

Jones Edmunds documented the source of elevations and structure characteristics in the ICPR 4 model and the associated geodatabase. We converted all elevations to the North American Vertical Datum of 1988 (NAVD88). For the UF campus, the conversion factor is 0 feet NGVD = -0.84 foot NAVD88.

2.10 PUMP STATIONS

Jones Edmunds originally identified several stormwater pumps associated with the UF stormwater system during the inventory phase of the project. Most of the pumps we identified were sump pumps used to handle localized drainage. However, two pumps were identified on the south boundary of the Mark Bostick Golf Course that we included in the stormwater model. We represented these pumps using rating curves in ICPR 4, with flow rates set based on the ERP construction plans obtained from SJRWMD. No changes were made to the modeled pumps during the update process.

2.11 BOUNDARY STAGES

Jones Edmunds originally developed time series boundary stages to represent the model boundaries. Boundary conditions representing waterbodies (Sugarfoot Prairie and Bivens Arm) are at elevations significantly lower than the contributing watershed. Therefore, they are not expected to produce a tailwater influence on the UF stormwater model. The following summarizes the boundary conditions used in the model:

- Hogtown Creek (Sugarfoot Prairie, NZ3000) – Representative elevation derived from LiDAR-based DEM.
- Tumblin Creek (Bivens Arm, NZ1000) – Estimated 25-year/24-hour return period storm event water surface elevation based on Log Pearson Type III analysis.
- Lake Alice recharge wells (NZ7000 and NZ8000) – Elevation sufficient to allow free-flow conditions simulating sink.
- Offsite Node at northeast corner (NZ6000) – Representative elevation derived from LiDAR-based DEM.

No changes were made to the boundary stages during the model update process.

2.12 DESIGN STORMS AND RESULTS

Jones Edmunds ran and submitted model simulations for the following storm events:

- 2.33-year/24-hour
- 10-year/24-hour
- 25-year/24-hour
- 100-year/24-hour

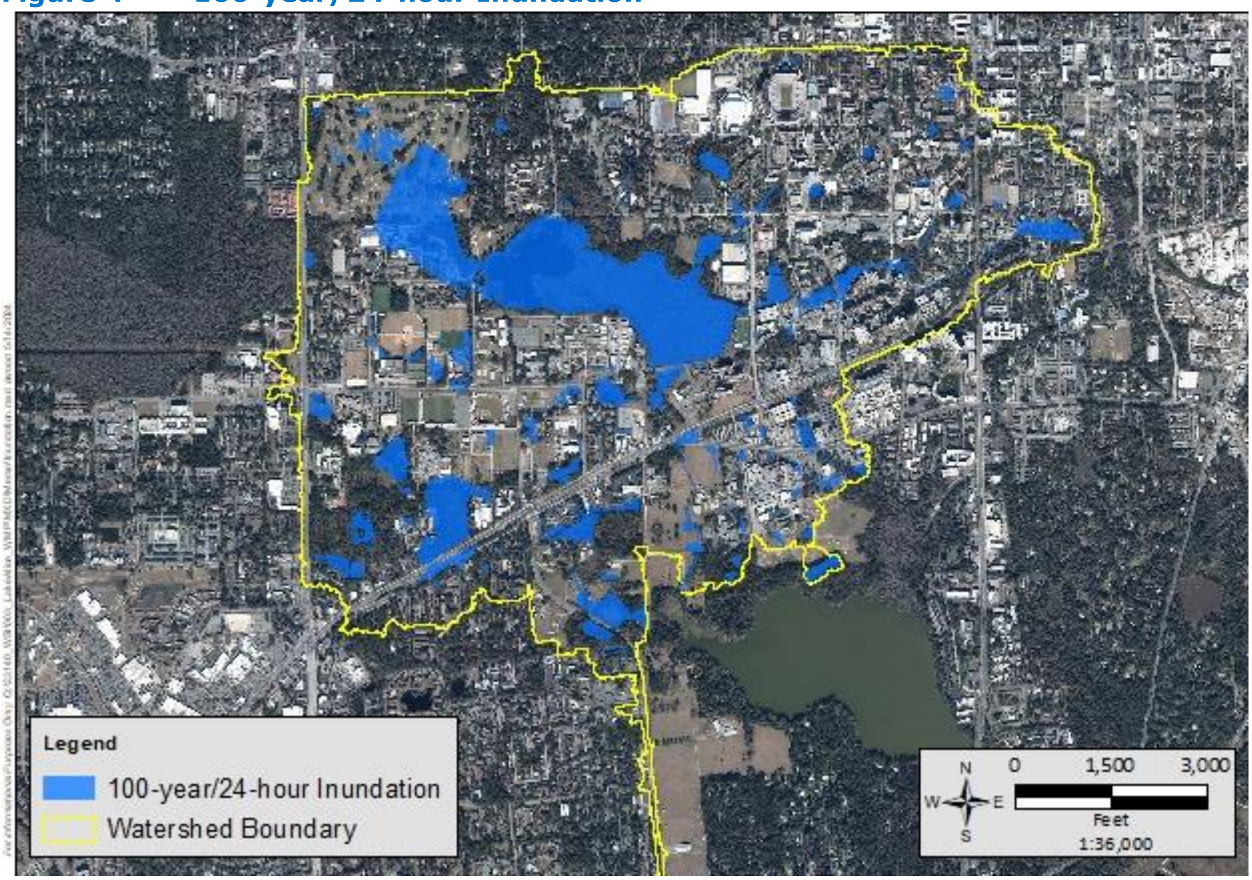
Jones Edmunds retained the NOAA rainfall depths used in the original UF stormwater model. Table 2 summarizes the rainfall depths that were used. We used the Florida-modified rainfall distribution for these design rainfall storms.

Table 2 University of Florida Watershed Estimated Rainfall Depths

Frequency	NOAA Depth (inches)
2.33-year/24-hour	4.26 (interpolated)
10-year/24-hour	5.88
25-year/24-hour	7.24
100-year/24-hour	9.79

The ICPR4 model contains results for all simulations. In addition, we mapped inundation areas for the 100-year/24-hour storm event within GIS using a grid (raster) calculation technique. These feature classes are stored within the *Watershed* feature class in the "LakeAlice_WMP.gdb" database provided with the final deliverables. Figure 4 shows the 100-year/24-hour inundation areas.

Figure 4 100-year/24-hour Inundation



In addition to the four design storms listed above, we also simulated two multi-day storm events (100-year/72-hour and 100-year/168-hour) to determine the watershed's sensitivity to larger volumes of rainfall over multi-day storm events. Generally, a 1-day event using the NRCS Type II Florida-Modified distribution should be adequate for accurately identifying flood risks in dendritic systems (i.e., systems with positive outfalls) that are relatively small. Flood risks in closed subbasins can be more affected by larger but possibly less intense rainfall volumes over longer durations, and areas with much larger contributing areas may be more affected by larger volumes over longer durations due to the lag times involved in the timing of flows from multiple parts of the watersheds.

Ideally, measured hydrologic data for a watershed will contain high water marks and/or gauge data at multiple locations from large storm events under similar hydrologic conditions. These data help determine the sensitivity of flood risks to rainfall volumes and durations in various parts of the watershed. No measured hydrologic data in the UF campus watershed could be used to determine the sensitivity of flood risks to rainfall volumes and durations.

A comparison of model results shows that 28 nodes in the UF campus watershed have a peak stage of more than 0.5 foot higher for one of the 100-year multi-day storm events than the 100-year/24-hour storm. Most of these are depressional basins on the west side of campus and Lake Alice. The maximum difference between the 24-hour and multi-day storms was nearly 2 feet. The sensitivity of the UF campus watershed to the multi-day events is due to the significant number of internally drained basins that do not have an outfall. Jones Edmunds cautions that care should be taken when using the 100-year/24-hour model results to analyze the 100-year flood risk at these nodes since the 100-year/multi-day and 100-year/24-hour design storms all have the same exceedance probability. We recommend that UF further review this sensitivity before using the 100-year/24-hour design storm results to set the 100-year flood stage. Since no long-term water level data are available in the watershed, developing a long-term continuous simulation using a representative rainfall record to determine a 100-year flood stage at one or more of the duration-sensitive nodes may be helpful; however, this was beyond this project's scope.

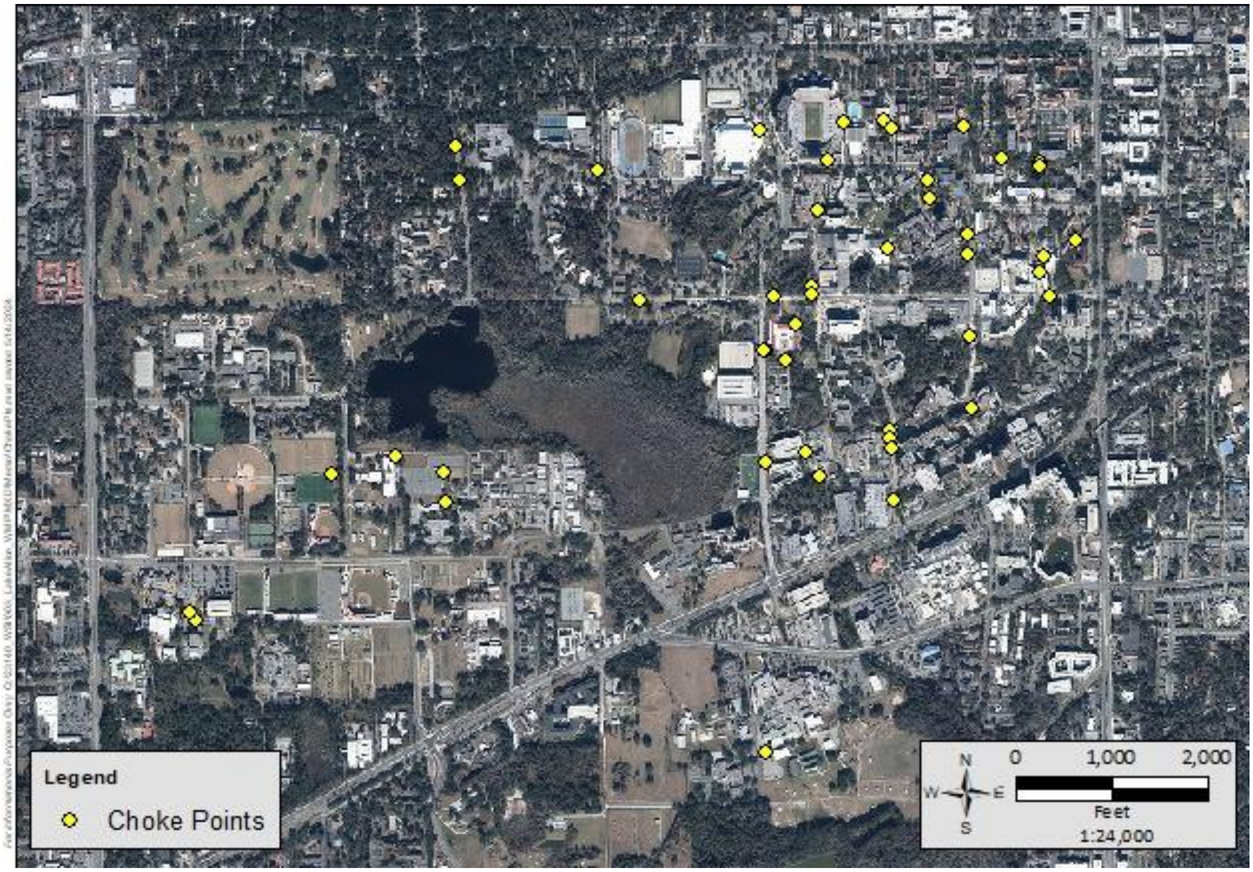
3 STORMWATER NETWORK – CHOKE POINT ANALYSIS

As part of the Lake Alice WMP, Jones Edmunds performed an updated analysis of the stormwater inventory network developed during the previous project and maintained since by UF. The stormwater network was again reviewed to locate points in the system with outflow capacities that were less than what was contributing to that point from upstream hydraulic infrastructure. These ‘choke points’ can result in surcharging manholes and upstream flooding during storm events, contributing large amounts of runoff to the storm sewer system.

We used the inventory data to estimate the flow capacities of all pipes within the UF stormwater system. Because the desktop analysis was performed on the entire system instead of only pipes included in the H&H model, we assumed that all pipes had a slope of 1 percent, and pipes of unknown material were reinforced concrete for flow capacity calculations. No detailed hydraulic modeling was performed for this analysis, and all pipes were assumed to be flowing full. In addition, pipes of unknown diameter or beginning/end point were excluded from the analysis, along with all pipes smaller than 8 inches in diameter.

Figure 5 shows junction locations with a difference greater than 20 cubic feet per second (cfs) in flow capacity between the upstream and downstream hydraulic infrastructure. The deliverable also includes a shapefile with the locations shown in the figure.

Figure 8 Choke-Point Analysis



Currently, many areas flagged as choke points are not shown as flooding hazards in the H&H model. Some pipes may have been intentionally oversized for exfiltration purposes or installed because the materials were available during construction. However, further development may result in additional runoff being routed through the system in the future, which could result in flooding. Additionally, many of these points may not be explicitly modeled due to the model scale not capturing all hydraulic features. Therefore, we recommend further investigation of these points, including additional survey and hydraulic modeling, to ensure proper capacity is available in the stormwater system.