Summary Memorandum
Hook Street Study

January 22, 2021

1.0 INTRODUCTION AND BACKGROUND

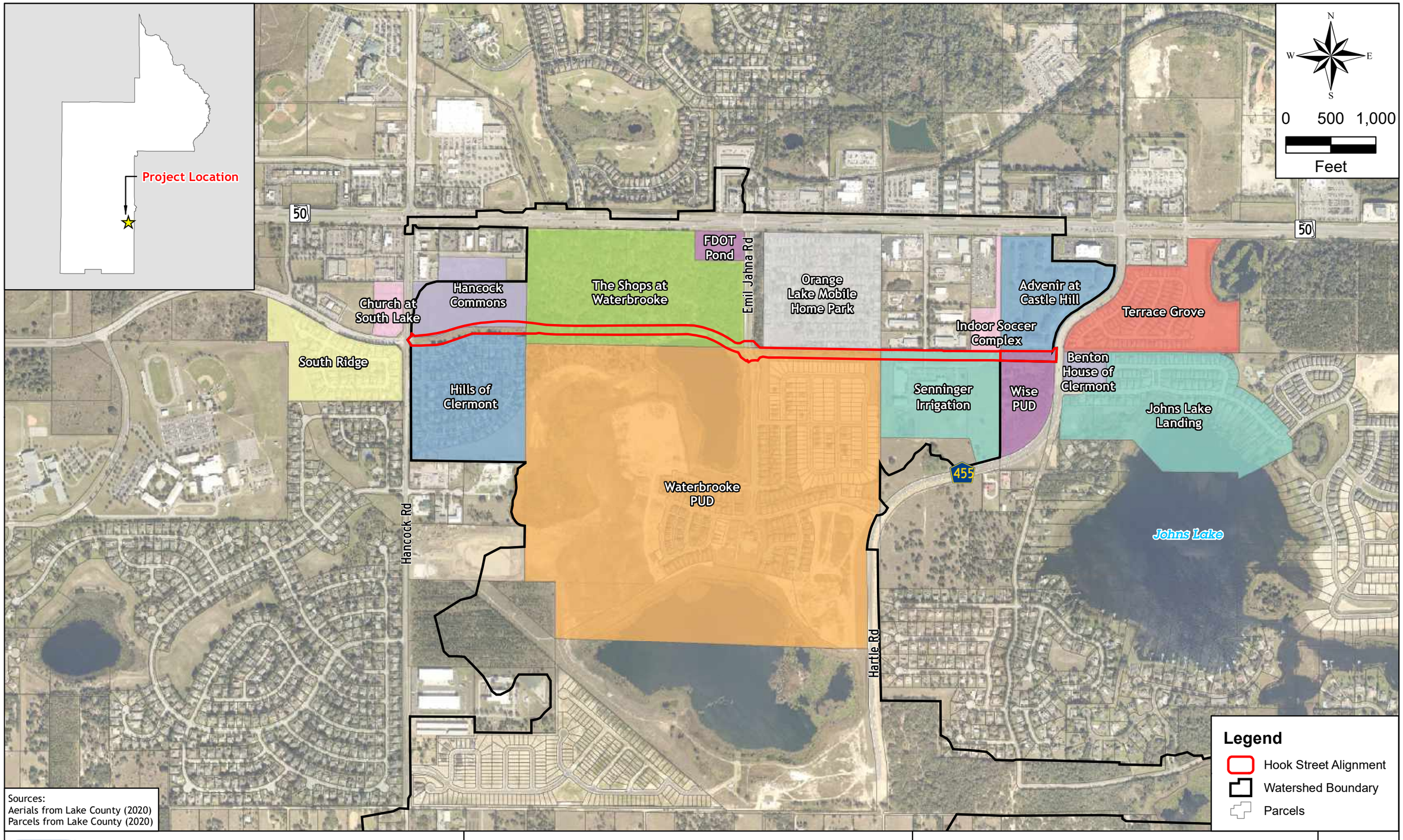
Singhofen & Associates, Inc. (SAI) was contracted to provide stormwater management services in support of an Alternative Corridor Evaluation (ACE) for extension of Hook Street in Lake County, Florida. The study was conducted by Metro Consulting Group, LLC. (Metro). The project includes extending the existing Hook Street from its current termination point at Hancock Road to Hartle Road, roughly 1.4 miles in length. See **Figure 1** for a Vicinity Map that depicts the project location. The new roadway is being proposed as a two-lane road with landscaped median and buffered bike lanes and sidewalk along both sides of the street. A new roundabout is being proposed at the Emil Jahna Road intersection.

The roadway will be primarily located adjacent to residential developments to the south and commercial areas to the north with the exception of the Orange Lake Mobile Home Park at the northeast intersection of the proposed Hook St. and Emil Jahna Road. Adjacent properties to the south of the project are comprised of existing neighborhoods or sites that are currently under design or construction. This includes the Waterbrooke PUD which has an existing entrance road at the Emil Jahna Road intersection. The commercial parcels located along the northern side of the project are also under design and permitting to varying degrees. There are also several vacant properties towards the eastern end of the roadway extension that are under differing levels of planning for future development.

Drainage within the project area is generally divided into two primary basins. The western portion of the project includes the majority of the roadway from Hancock Road to the western boundary of the Wise PUD site (See **Figure 1**). The eastern portion includes the remainder of the project site along the northern side of the Wise PUD to Hartle Road.

Runoff within the west basin for the Hook Street project was included in the design and permitting of the Waterbrooke PUD Master Plan, however, the proposed alignment will impact and eliminate existing stormwater ponds located along the north side of the Senninger Irrigation property (See **Figure 1**). This lost pond storage was not included in the Waterbrooke design/permit and will need to be mitigated by the Hook Street drainage system. The western basin is a closed basin and currently drains to an existing land-locked pond located on the northern part of the Waterbrooke property, just south of the proposed Hook Street extension. Design and permitting for this section of the new road will be designed according to St. Johns River Water Management (SJRWMD) criteria.

The eastern basin currently consists of open space that slopes north to south to an existing sink hole located near the center of the Wise property. Runoff volumes generated by the roadway improvements in excess of that under existing conditions will need to be retained by the project. This eastern basin is part of the Johns Lake drainage basin which is located within the Lake Apopka and Ocklawaha Hydrologic Basins. Permitting through SJRWMD will generally consist of demonstrating runoff from the site for the design does not exceed the existing conditions runoff. The Lake Apopka Basin also has phosphorus/pollutant loading criteria that shall be met for any new improvements.



Sources:
Aerials from Lake County (2020)
Parcels from Lake County (2020)

SINGHOFEN & ASSOCIATES, INC. PHONE: (407) 679-3001 FAX: (407) 679-2691	**HOOK STREET DESIGN**	**VICINITY MAP**	**FIGURE:** **1**

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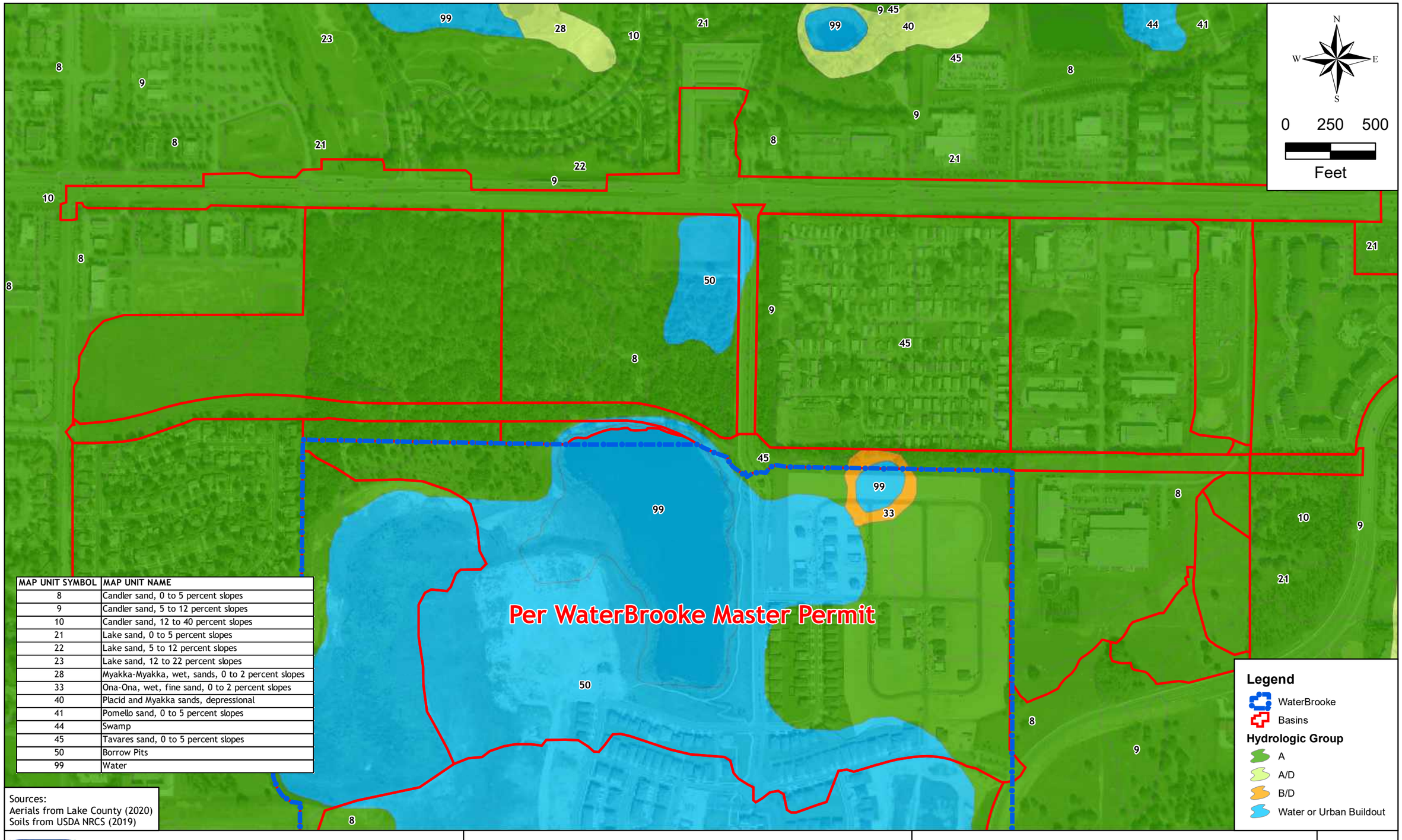
2.0 PERMITTED AND PROPOSED CONDITIONS

2.1 Existing Conditions: SAI collected data from a number of sources in support of the required analyses. This included permitting information, reports, aerial photography, and terrain data. Soils in the area are primarily well-drained (i.e., hydrologic soil group A) with a small area of hydrologic group B/D (**Figure 2**). The roadway project area is currently vacant/wooded area with a future land use designation of transportation/roadway (**Figure 3**). Runoff generally slopes from north to south across the project area. Capacity for this stormwater will be provided through the project corridor. The west basin currently drains to the existing lake on the Waterbrooke property while the east basin drains towards the sink hole on the Wise property.

There are several retention ponds located along the north and west side of the Senninger property. The ponds along the north boundary are proposed to be impacted/eliminated for the new Hook Street right-of-way and roadway. Alternatives to address these impacts are discussed in **Section 3**.

2.2 Permitted Conditions: Runoff from the Hook Street extension to a point approximately 600 feet west of Hartle Road was accounted for in the Waterbrooke PUD Master Plan. The PUD permit also includes capacity for development of the parcel at the northeast corner of the Emil Jahna intersection and SR50 runoff that drains to the existing pond on that parcel. The Waterbrooke design did not, however, account for elimination of the existing Senninger ponds. Runoff for the east basin currently drains south to a sink hole on the Wise property, however, additional runoff generated by the new roadway and impervious areas cannot exceed pre-development discharge (rate and volume) for the project area. A permitted conditions basin map is shown below in **Exhibit 1**.

Exhibit 1 – Permitted Conditions Basin Map



MAP UNIT SYMBOL	MAP UNIT NAME
8	Candler sand, 0 to 5 percent slopes
9	Candler sand, 5 to 12 percent slopes
10	Candler sand, 12 to 40 percent slopes
21	Lake sand, 0 to 5 percent slopes
22	Lake sand, 5 to 12 percent slopes
23	Lake sand, 12 to 22 percent slopes
28	Myakka-Myakka, wet, sands, 0 to 2 percent slopes
33	Ona-Ona, wet, fine sand, 0 to 2 percent slopes
40	Placid and Myakka sands, depressional
41	Pomello sand, 0 to 5 percent slopes
44	Swamp
45	Tavares sand, 0 to 5 percent slopes
50	Borrow Pits
99	Water

Sources:
Aerials from Lake County (2020)
Soils from USDA NRCS (2019)

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HOOK STREET DESIGN

DESIGN CONDITIONS
NRCS SOILS MAP

FIGURE:
2

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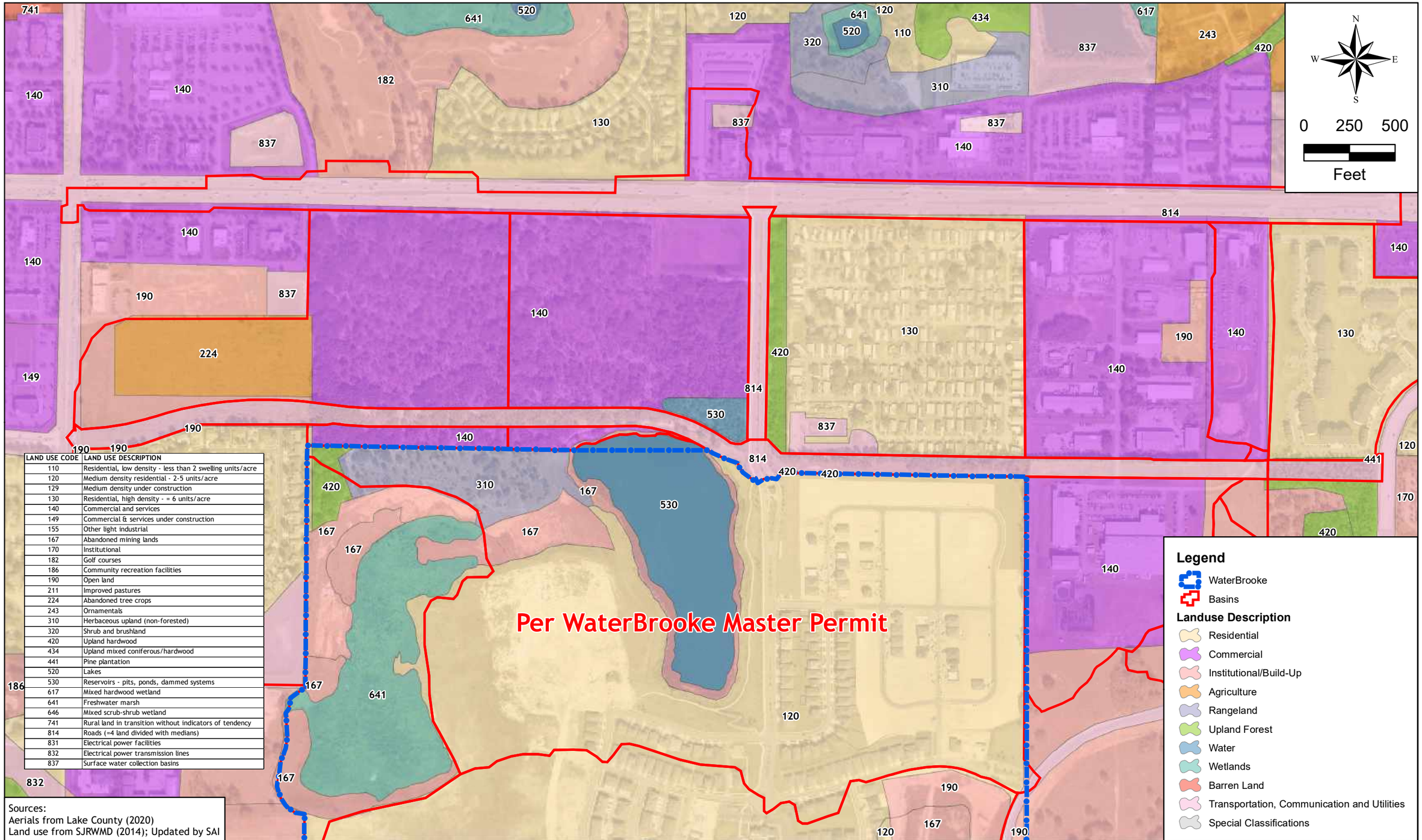

LAND USE CODE	LAND USE DESCRIPTION
110	Residential, low density - less than 2 swelling units/acre
120	Medium density residential - 2-5 units/acre
129	Medium density under construction
130	Residential, high density - = 6 units/acre
140	Commercial and services
149	Commercial & services under construction
155	Other light industrial
167	Abandoned mining lands
170	Institutional
182	Golf courses
186	Community recreation facilities
190	Open land
211	Improved pastures
224	Abandoned tree crops
243	Ornamentals
310	Herbaceous upland (non-forested)
320	Shrub and brushland
420	Upland hardwood
434	Upland mixed coniferous/hardwood
441	Pine plantation
520	Lakes
530	Reservoirs - pits, ponds, dammed systems
617	Mixed hardwood wetland
641	Freshwater marsh
646	Mixed scrub-shrub wetland
741	Rural land in transition without indicators of tendency
814	Roads (=4 land divided with medians)
831	Electrical power facilities
832	Electrical power transmission lines
837	Surface water collection basins

Sources:
Aerials from Lake County (2020)
Land use from SJRWMD (2014); Updated by SAI

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HOOK STREET DESIGN

DESIGN CONDITIONS LAND USE MAP

FIGURE: 3

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SJRWMD Permit No. 146214-2 (Waterbrooke PUD – Master Drainage Plan) was issued on 11/21/2017 for the master stormwater plan of the Waterbrooke development. This permit included anticipated runoff for future development of the Hook Street extension. This consists of runoff generated by the construction of new impervious area (pavement, sidewalks, etc.) within the west basin of the Hook Street project. This permit allows runoff from the Hook Street project up to 11.78 ac-ft to discharge to the existing Waterbrooke pond based on the assumptions made during permitting of the Waterbrooke mater plan. **Table 1** includes the assumptions and runoff calculations included in the master plan permit.

Table 1 – Waterbrooke PUD Permitted Runoff for Hook Street

PERMITTED BASIN DATA			
Basin ID	POST-HOOKS		
Total Basin Area	15.53	acres	
NDCIA Area	5.05	acres	
DCIA Area	10.48	acres	
Composite CN	54		
Comp. DCIA	67%		
Rainfall Depth (P)	11.2	inches	25-year / 96-hour storm

PERMITTED RUNOFF VOLUME CALCULATIONS

Soil Storage (S) = $\frac{1000}{CN} - 10$

Runoff Depth (R) = $\frac{(P - 0.2S)^2}{P + 0.8S}$

Runoff Volume (V) = $\frac{(R * Area)}{12}$

NonDCIA Runoff		
Soil Storage (S) =	8.52	inches
Runoff Depth (R) =	5.01	inches
Runoff Volume (V) =	2.11	ac-ft

DCIA Runoff		
Soil Storage (S) =	0.10	inches
Runoff Depth (R) =	11.08	inches
Runoff Volume (V) =	9.68	ac-ft

Total "Credit" Included in Waterbrooke PUD Permit

Total Runoff Volume =	**11.78**	**ac-ft**
Total Runoff Volume =	513263	CF

The Waterbrooke design did not, however, anticipate impacts to the Senninger ponds. As a part of the Hook Street improvements, the loss of storage at the Senninger property will be mitigated by the roadway project. Permitted pond volume for the Senninger ponds were obtained from SJRWMD Permit No. 42214-4. The pond volume that will be eliminated as a result of the new Hook Street alignment was then calculated from GIS data obtained from Lake County. The Senninger property is anticipated to see a loss of 6.45 ac-ft of pond volume as demonstrated in **Table 2** below.

Existing Ponds Per ERP				Pond Area Removed for Hooks Street R/W				Remaining Pond Area			
Stage	Area	Inc. Volume	Cum. Volume	Stage	Area	Inc. Volume	Cum. Volume	Stage	Area	Inc. Volume	Cum. Volume
(ft)	(ac)	(ac-ft)	(ac-ft)	(ft)	(ac)	(ac-ft)	(ac-ft)	(ft)	(ac)	(ac-ft)	(ac-ft)
118	0.42	0.00	0.000	118	0.32	0.00	0.000	118	0.10	0.00	0.000
119	1.13	0.78	0.78	119	0.99	0.66	0.66	119	0.14	0.12	0.12
120	1.78	1.46	2.23	120	0.96	0.98	1.63	120	0.82	0.48	0.60
121	2.08	1.93	4.16	121	1.13	1.05	2.68	121	0.95	0.89	1.49
122	2.38	2.23	6.39	122	1.21	1.17	3.85	122	1.17	1.06	2.55
123	2.71	2.55	8.94	123	1.30	1.26	5.10	123	1.41	1.29	3.84
124	3.08	2.90	**11.84**	124	1.40	1.35	**6.45**	124	1.68	1.55	5.39
Permitted Pond Volume =		**11.84**	**ac-ft**	*Stage-area calculated from GIS data				**Revised Pond Volume =**		**5.39**	**ac-ft**
*Stage-area obtained from ERP No. 42214-4											

Permitted Runoff Volume (ERP No. 42214-4)		
25-yr / 96-hr storm =	**11.78**	ac-ft

Table 2 – Senninger Existing Pond Calculations

2.3 Proposed Conditions: The ACE report prepared by Metro evaluated three alignment alternatives and a two-lane typical section. Metro also included some discussion on a four-lane option to accommodate future widening if deemed necessary. The recommended (i.e., Green Alternative) alignment and two-lane typical section will generate 10.85 ac-ft of runoff for the western portion of the project (**Table 3**). This assumes approximately 56% imperviousness. The four-lane option increases imperviousness to approximately 78% and would generate an additional 1.79 ac-ft of total runoff volume for a total of 12.64 ac-ft for the western portion of the project.

The east basin is anticipated to generate 1.02 ac-ft of runoff which is 0.44 ac-ft greater than the 0.58 ac-ft generated under existing conditions. Storage volume will need to be provided to account for the additional runoff associated with the new road as listed in **Table 4**.

RUNOFF VOLUME CALCULATIONS

Soil Storage (S) = $\frac{1000}{CN} - 10$

Runoff Depth (R) = $\frac{(P - 0.2S)^2}{P + 0.8S}$

Runoff Volume (V) = $\frac{(R * Area)}{12}$

GREEN ALIGNMENT - 2 Lane		
Total Basin Area	15.57	acres
Pervious Area	6.97	acres
DCIA Area	8.61	acres
Curve Number	54	
% DCIA	56%	
Pervious Area Runoff		
Soil Storage (S) =	8.52	inches
Runoff Depth (R) =	5.01	inches
Runoff Volume (V) =	2.91	ac-ft
DCIA Runoff		
Soil Storage (S) =	0.10	inches
Runoff Depth (R) =	11.08	inches
Runoff Volume (V) =	7.95	ac-ft
Total Runoff based on Design		
Total Runoff Volume =	**10.85**	**ac-ft**
Total Runoff Volume =	472722	CF

GREEN ALIGNMENT - 4 Lane		
Total Basin Area	15.57	acres
Pervious Area	3.43	acres
DCIA Area	12.15	acres
Curve Number	54	
% DCIA	78%	
Pervious Area Runoff		
Soil Storage (S) =	8.52	inches
Runoff Depth (R) =	5.01	inches
Runoff Volume (V) =	1.43	ac-ft
DCIA Runoff		
Soil Storage (S) =	0.10	inches
Runoff Depth (R) =	11.08	inches
Runoff Volume (V) =	11.22	ac-ft
Total Runoff based on Design		
Total Runoff Volume =	**12.64**	**ac-ft**
Total Runoff Volume =	550783	CF

Table 3 – Hook Street Design Runoff Calculations for West Basin

RUNOFF VOLUME CALCULATIONS

Soil Storage (S) = $\frac{1000}{CN}$ - 10

Runoff Depth (R) = $\frac{(P - 0.2S)^2}{P + 0.8S}$

Runoff Volume (V) = $\frac{(R * Area)}{12}$

EXISTING CONDITIONS		
Total Basin Area	1.39	acres
Pervious Area	1.39	acres
DCIA Area	0.00	acres
Curve Number	54	
% DCIA	0%	

Pervious Area Runoff		
Soil Storage (S) =	8.52	inches
Runoff Depth (R) =	5.01	inches
Runoff Volume (V) =	0.58	ac-ft

DCIA Runoff		
Soil Storage (S) =	0.10	inches
Runoff Depth (R) =	11.08	inches
Runoff Volume (V) =	0.00	ac-ft

Total Runoff

Total Runoff Volume =	**0.58**	**ac-ft**
Total Runoff Volume =	25314	CF

PROPOSED CONDITIONS - 2 Lane		
Total Basin Area	1.39	acres
Pervious Area	0.53	acres
DCIA Area	0.87	acres
Curve Number	54	
% DCIA	56%	

Pervious Area Runoff		
Soil Storage (S) =	8.52	inches
Runoff Depth (R) =	5.01	inches
Runoff Volume (V) =	0.22	ac-ft

DCIA Runoff		
Soil Storage (S) =	0.10	inches
Runoff Depth (R) =	11.08	inches
Runoff Volume (V) =	0.80	ac-ft

Total Runoff

Total Runoff Volume =	**1.02**	**ac-ft**
Total Runoff Volume =	44451	CF

Additional Volume Req'd for Design = 0.44 ac-ft

Table 4 – East Basin Runoff Calculations

3.0 DESIGN ALTERNATIVES

3.1 Design Considerations: As discussed in **Section 2**, the Hook Street west basin is permitted to discharge 11.78 ac-ft to the Waterbrooke pond. The 2-lane section generates 10.85 ac-ft which increases capacity in Waterbrooke by 0.93 ac-ft. Thus, the removal of 6.45 ac-ft from the Senninger ponds leaves a net deficit of 5.52 ac-ft that must be provided for runoff volume from the west basin.

The four-lane typical section, if selected, generates runoff volume for Hook Street of 12.64 ac-ft which exceeds the permitted capacity of the Waterbrooke system. This option would yield a net deficit of 7.31 ac-ft created by the Senninger pond impacts and new Hook Street runoff. **Table 5** provides a summary of the permitted and project condition runoff volumes for both the two-lane and four-lane options.

WEST PROJECT AREA - 2 LANE		
SMA-NORTH		
Permitted Runoff for Hooks St.	11.78	ac-ft
Conceptual Design Hooks St. Runoff	10.85	ac-ft
Available Volume Remaining	0.93	ac-ft
Senniger Ponds		
Permitted Senniger Pond Storage	11.84	ac-ft
Revised Senniger Pond Storage	5.39	ac-ft
Pond Volume Removed	6.45	ac-ft
Additional Storage Required		
Available - Removed	**-5.52**	ac-ft

WEST PROJECT AREA - 4 LANE		
SMA-NORTH		
Permitted Runoff for Hooks St.	11.78	ac-ft
Conceptual Design Hooks St. Runoff	12.64	ac-ft
Available Volume Remaining	-0.86	ac-ft
Senniger Ponds		
Permitted Senniger Pond Storage	11.84	ac-ft
Revised Senniger Pond Storage	5.39	ac-ft
Pond Volume Removed	6.45	ac-ft
Additional Storage Required		
Available - Removed	**-7.31**	ac-ft

Table 5 – West Basin Runoff Calculations Summary

3.2 Design Alternative 1: This alternative proposes to discharge all runoff in the west basin to the Waterbrooke pond, as permitted, in addition to stormwater from the impacted portions of the ponds at the Senninger site. **Table 6** shows permitted and modified conditions in the Waterbrooke facility. It includes permitted maximum stages for multiple storm events including back to back 25-year 96-hour storms, a 100-year 24-hour storm (for FEMA purposes) and 100-year 72-hour event. As shown in the table, the net increase of 5.52 acft would increase the peak stage in the pond between 2 and 3 inches depending upon the storm event (See **Table 6**). While the runoff generated by Hook Street along with the Senninger pond modifications will exceed the permitted volume to the Waterbrooke pond, there is sufficient freeboard included in the Waterbrooke design to accommodate the additional runoff.

New stormwater inlets and pipes along the road would collect runoff and discharge to the existing pond. The road drainage system would also include capacity to direct runoff from the Senninger property to the Waterbrooke pond to mitigate the lost pond storage. This alternative would be the most cost effective as there is no need to acquire additional land to mitigate the lost storage at the Senninger site and no significant impacts to the Waterbrooke system would occur. A permit modification to the Waterbrooke master plan will be required through SJRWMD. This alternative will also require approval from the Waterbrooke developer/landowner to modify the permit. Coordination and negotiations are reportedly underway in this regard. This alternative will meet both the two-lane and four-lane options under consideration with the latter increasing pond stages in Waterbrooke about 1 more inch than the 2-lane typical section.

Permitted and 2-lane Design Calculations			
Waterbrooke Permitted Volume	11.78	acft	
Hook Street - West Basin Runoff	10.85	acft	
Senninger impacted pond volume	6.45	acft	
Net Additional Volume to Waterbrooke	5.52	acft	
Waterbrooke Storm Event	**Permitted Stage**	**Stage with Additional Volume**	**Stage Increase (in)**
25-Year, 96-Hour (1 of 2)	90.72	90.96	2.9
25-Year, 96-Hour (2 of 2)	94.42	94.65	2.7
100-Year, 24-Hour (FEMA)	88.60	88.85	3.0
100-Year, 72-Hour	92.80	93.03	2.8
	*Stages in ft NGVD		
Permitted and 4-Lane Design Calculations			
Waterbrooke Permitted Volume	11.78	acft	
Hook Street - West Basin Runoff	12.64	acft	
Senninger impacted pond volume	6.45	acft	
Net Additional Volume to Waterbrooke	7.31	acft	
Waterbrooke Storm Event	**Permitted Stage**	**Stage with Additional Volume**	**Stage Increase (in)**
25-Year, 96-Hour (1 of 2)	90.72	91.04	3.8
25-Year, 96-Hour (2 of 2)	94.42	94.72	3.6
100-Year, 24-Hour (FEMA)	88.60	88.93	4.0
100-Year, 72-Hour	92.80	93.11	3.7
	*Stages in ft NGVD		

Table 6 – Design Alternative 1 Summary

To account for runoff in the eastern basin, a linear retention swale will be constructed along the south side of Hook Street with an outfall structure to the existing sink hole. A conceptual layout plan of this design is provided as **Exhibit 2**. A 20-ft easement across the storm pipe is required to allow for access and maintenance of the pipe. The proposed alignment of the new pipe minimizes impacts to future development of the Wise property based on a recent site plan provided for that property. However, it is understood that the applicant for the Wise property has withdrawn their application. In general, the actual route of the new pipe is not crucial so long as it provides the necessary connection from the swale to the sink hole. Input from the landowner will be sought during final design to identify the most optimal placement and route of the new pipe and associated easement. The swale would also require acquisition a 50-ft wide parcel of land parallel to the right-of-way.

Exhibit 2 – New Swale for East Basin

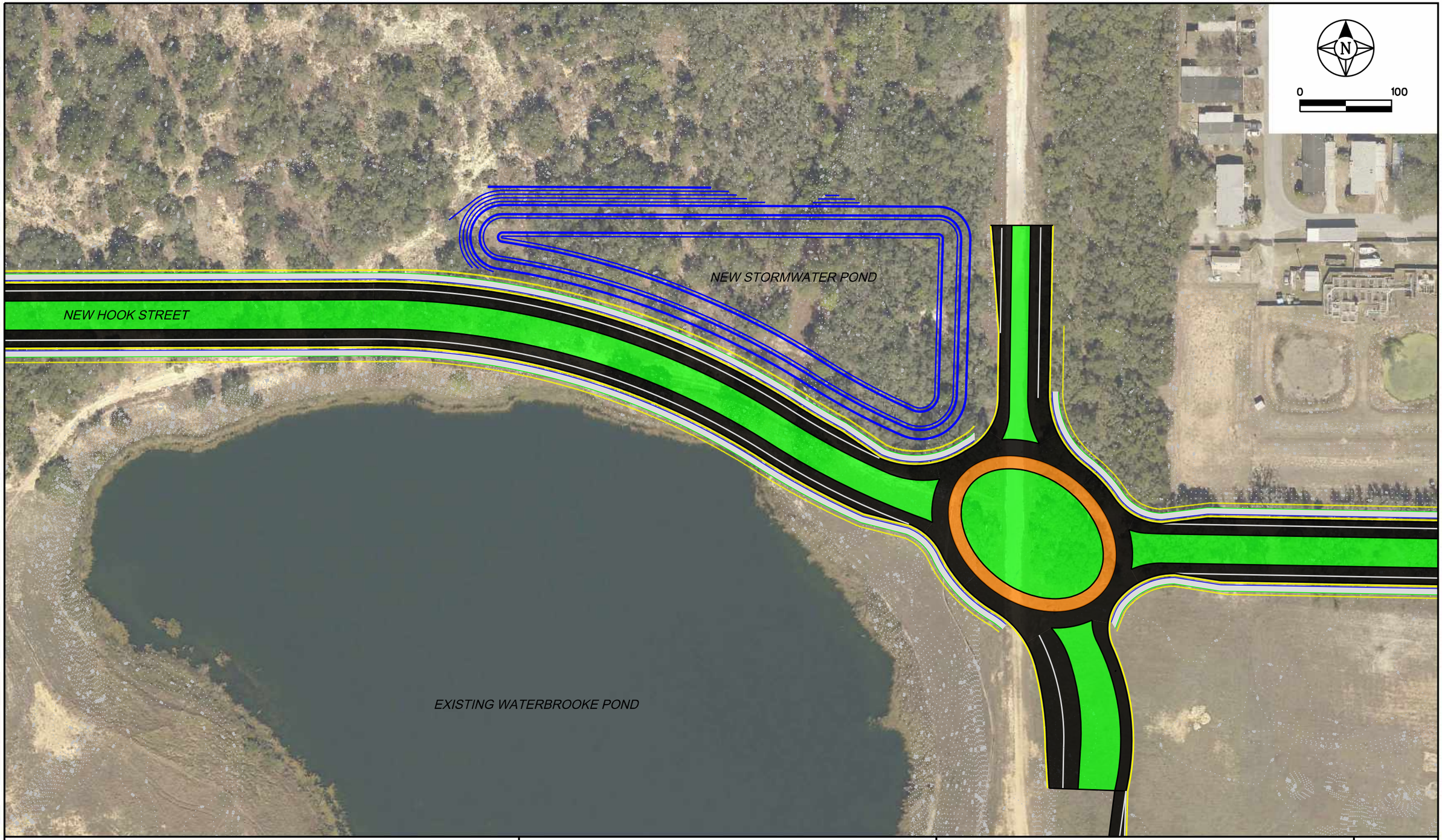
3.3 Design Alternative 2: This alternative is designed to mitigate the Senninger pond impact if modifications of the Waterbrooke permit to accept the additional stormwater are not possible. It includes discharge of the permitted volume of runoff to the Waterbrooke pond as well as construction of a new stormwater pond to capture the excess volume required to mitigate the net lost storage of 5.52 ac-ft (**Table 5**). The new pond will be located at the northwest corner of the proposed roundabout at Hook Street and Emil Jahna Road. Terrain in this area varies significantly, ranging from elevation 107-ft to elevation 92. Groundwater is anticipated to be around elevation 87 and the new pond is proposed to function as a dry pond with a bottom elevation of 89-ft and top of bank at elevation 95-ft which will provide for 1-ft of freeboard. Storage volume from the pond bottom to elevation 94 is 5.57 ac-ft which exceeds the required volume (**See Table 7**). This design also includes a 10-ft wide maintenance berm with 1:4 side slopes. Land acquisition for the new pond site will be required and is anticipated to be roughly 2.3 acres. A layout of this design alternative is included as **Figure 4**. As with Design Alternative 1, the road drainage system would also include capacity to direct runoff from the Senninger property to

the Waterbrooke pond and/or the proposed pond to mitigate the lost pond storage. In addition, drainage design for the east basin is identical to that described for Design Alternative 1 as shown in **Exhibit 2** above.

WEST PROJECT AREA - 2 LANE		
SMA-NORTH		
Permitted Runoff for Hooks St.	11.78	ac-ft
Conceptual Design Hooks St. Runoff	10.85	ac-ft
Available Volume Remaining	0.93	ac-ft
Senniger Ponds		
Permitted Senniger Pond Storage	11.84	ac-ft
Revised Senniger Pond Storage	5.39	ac-ft
Pond Volume Removed	6.45	ac-ft
Additional Storage Required		
Available - Removed	**-5.52**	ac-ft
Additional Storage Provided		
New Stormwater Pond	**5.57**	ac-ft
EAST PROJECT AREA		
Total Runoff		
Existing Conditions Runoff	0.58	ac-ft
Design Conditions Runoff	1.02	ac-ft
Additional Runoff from Design	0.44	ac-ft
New Stormwater Swale	0.48	ac-ft

Table 7 – Design Alternative 2 Summary

Design Alternative 2 will be sufficient for the two-lane typical section; however, it does not work for the four-lane option. Implementation of further design solutions (**Section 3.4**) will be required to provide additional storage if the four-lane option were deemed necessary.



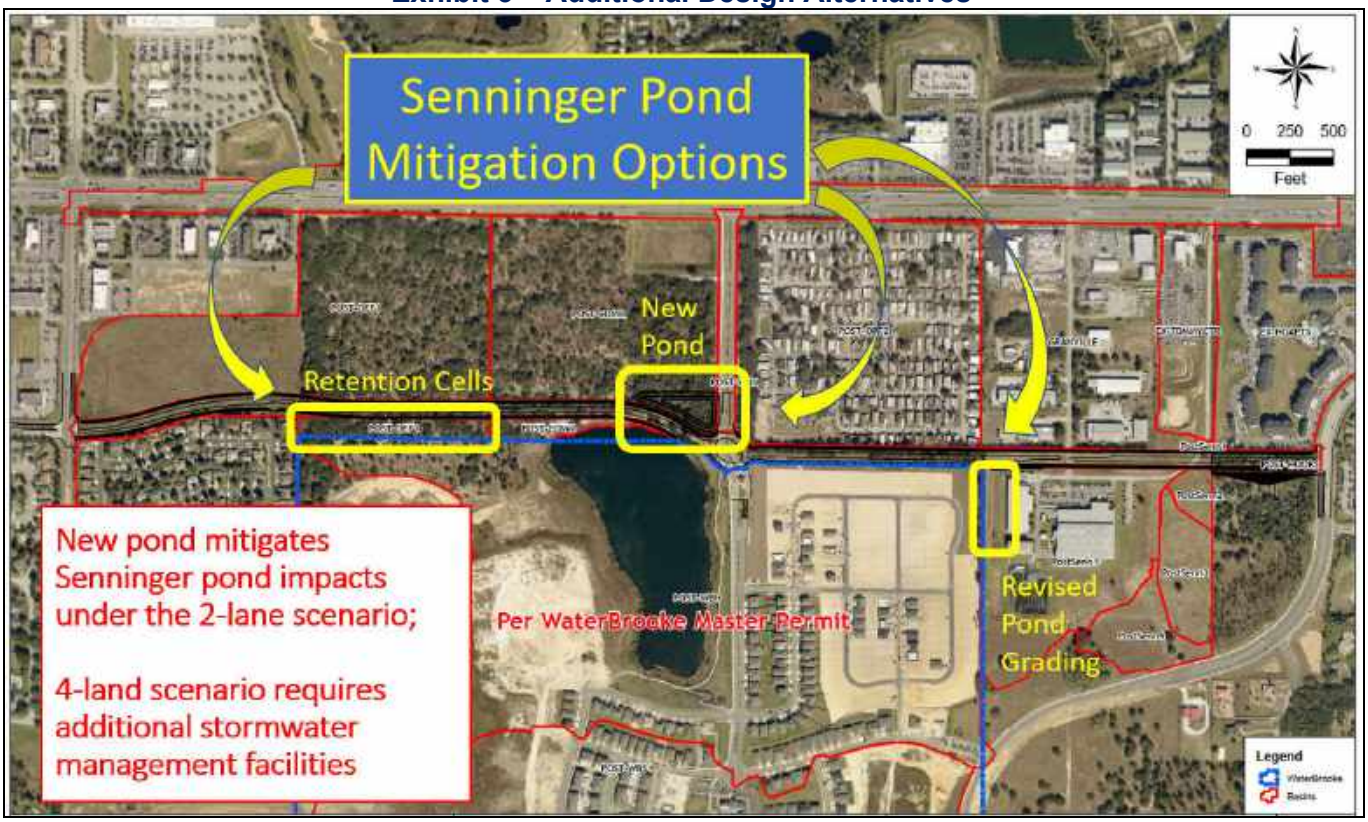
SAI SINGHOFEN & ASSOCIATES, INC. STORMWATER MANAGEMENT AND CIVIL ENGINEERING	HOOK STREET DESIGN	DESIGN ALTERNATIVE 2 CONCEPTUAL LAYOUT PLAN	FIGURE 4

SCALES
DATES

3.4 Future Four-Lane Option: The following discusses additional design alternatives that could be considered to provide additional stormwater capacity should the four-lane typical section be deemed necessary. As mentioned previously, the four-lane typical section increases the project's stormwater capacity deficit to 7.31 acft. If the option to discharge the additional runoff to the Waterbrooke pond is not allowed and the four-lane section is selected, additional stormwater capacity is required.

Additional options were evaluated to address the increased deficit includes constructing a multi-cell retention area along County-owned property and/or modifications to the remaining portion of the Senninger ponds. Refer to **Exhibit 3** for an overview of these additional alternatives.

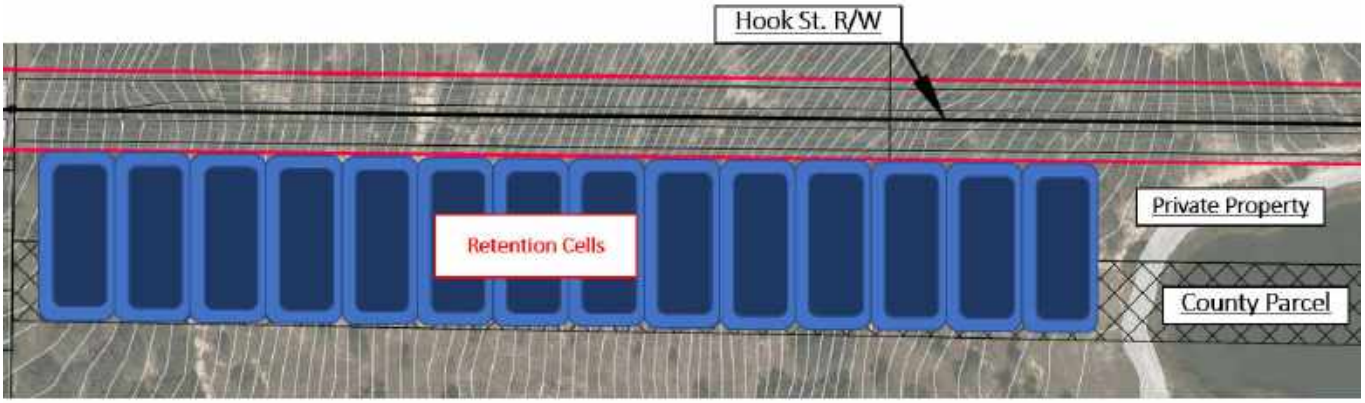
Exhibit 3 – Additional Design Alternatives



3.4.1 Construction of a larger new stormwater pond (i.e., adjustment of Design Alternative 2) is the simplest option, however, it comes with higher land acquisition costs to accommodate the larger pond.

3.4.2 There is an existing County owned sliver of land that parallels the Hook Street extension located west of the Waterbrooke pond. With the new roadway alignment, there will be approximately 100-ft between the right-of-way and the County owned parcel. This area was initially considered for construction of a linear pond, however, the land slopes significantly from west to east making construction of a pond there unfeasible. A system of retention cells would provide a portion of the required stormwater capacity. Preliminary calculations suggest approximately 1.25 ac-ft of storage could be realized which would mitigate a portion of the deficit. This would require acquisition of private land located between the County property and the new right-of-way (**Exhibit 4**).

Exhibit 4 – Retention Cells Conceptual Plan



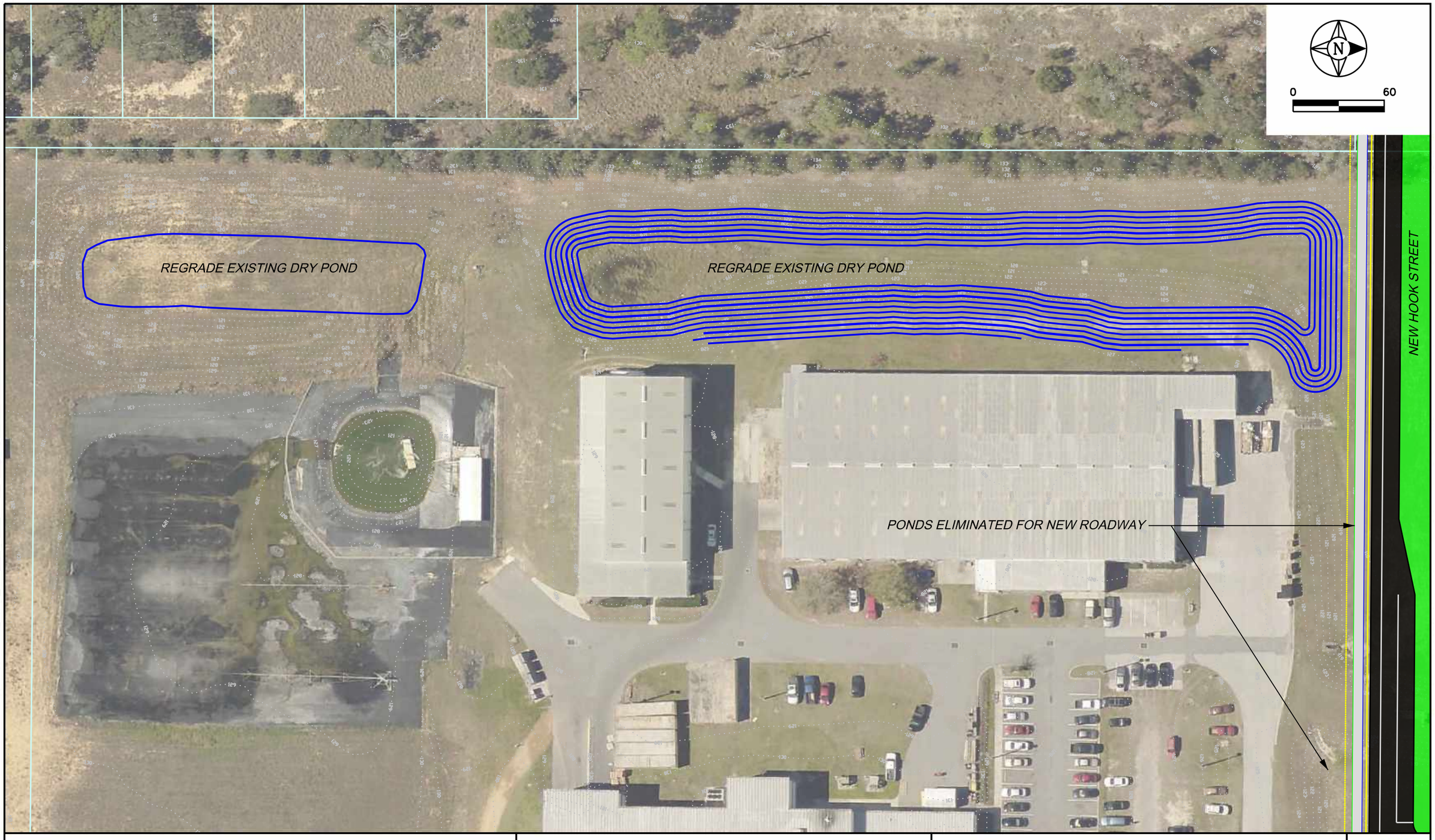
3.4.3 During discussion with representatives of the Senninger property, it was suggested that possible improvements at that location could be considered. Alternate pond sites were evaluated but future plans for development of the property limited those options. Subsequently, it was determined that there is a potential to modify the remaining portions of the impacted ponds to increase storage.

There is approximately 40-ft of separation from the northwest building to the existing top of bank that could allow for pond expansion. Existing side slopes on the pond appear to be roughly 1:3.5 which would be maintained for the modification work. A conceptual layout plan for the Senninger pond expansion is included as **Figure 5**. This modification will provide an additional 0.60 ac-ft of storage to the Senninger site.

The retention cell alternative and the Senninger pond modification, in combination, will provide the additional capacity required by the four-lane option. Neither alternative will, however, provide the necessary capacity by itself. Furthermore, modifications of the Senninger pond would require work in close proximity to an existing building which adds a certain amount of risk to that alternative.

WEST PROJECT AREA - 4 LANE		
SMA-NORTH		
Permitted Runoff for Hooks St.	11.78	ac-ft
Conceptual Design Hooks St. Runoff	12.64	ac-ft
Available Volume Remaining	-0.86	ac-ft
Senniger Ponds		
Permitted Senniger Pond Storage	11.84	ac-ft
Revised Senniger Pond Storage	5.39	ac-ft
Pond Volume Removed	6.45	ac-ft
Additional Storage Required		
Available - Removed	**-7.31**	ac-ft
Additional Storage Provided		
New Stormwater Pond	5.57	ac-ft
Retention Cells	1.25	ac-ft
Senniger Modifications	0.60	ac-ft
Total Additional Storage	**7.42**	ac-ft

Table 7 – Summary of Additional Measures for Stormwater Management



SINGHOFEN & ASSOCIATES, INC. STORMWATER MANAGEMENT AND CIVIL ENGINEERING	**HOOK STREET DESIGN**	**DESIGN ALTERNATIVE 3** **SENNINGER POND MODIFICATIONS**	**FIGURE** **5**

SCALES
DATES

4 Conclusion: Much of the runoff from the proposed Hook Street project is accounted for in the Waterbrooke PUD. The PUD also includes capacity for development of a commercial tract north of the proposed road corridor, a portion of SR50 that drains to an existing pond on that tract and existing runoff coming from other areas along the north side of the propose Hook Street. This stormwater will be conveyed through the Hook Street R/W.

While the Waterbrooke PUD is permitted to provide capacity for much of Hook Street, additional storage is required to mitigate for impacts to existing ponds that are located within the proposed road alignment at the Senninger Irrigation facility as that storage was not included in the Waterbrooke design. The required storage is offset slightly as a result of the reduced imperviousness of the two-lane typical section, but additional stormwater capacity is still required to mitigate the pond impacts completely. The problem is exacerbated should the four-lane section be deemed necessary.

The existing Waterbrooke pond has capacity for the additional required storage without significant impacts to its performance. Use of that facility to provide the additional volume would, however, require modification of its permit and agreement from the owner. Should this not be possible, a new pond (approximately 2.3 acre tract) would be required to provide the necessary retention storage. If the four-lane typical section is required, the pond would need to be expanded. The expansion could be reduced by incorporation of a gallery of retention cells on County owned property near the project and/or pond expansion on the Senninger Irrigation site. The retention cells would, however, also require land acquisition to be cost-effective. In addition, pond expansion on the Senninger site includes some risk due to proximity of the work to an existing building.

Runoff from a small portion at the east end of the project will require construction of a linear swale to mitigate the additional runoff. Overflows will drain to an existing sinkhole on the adjacent property. The outfall pipe will require an easement for construction and maintenance.