DRAFT BIOLOGICAL ASSESSMENT

COLLIER COUNTY
COMPREHENSIVE WATERSHED IMPROVEMENT PLAN
COLLIER COUNTY, FLORIDA

APPENDIX F: VEGETATION EFFECTS HYDROLOGY ANALYSIS

Appendix F

Collier County Comprehensive Watershed Improvement Plan

Vegetation Hydrology Effects Analysis

Introduction

Project Purpose and Need

The Collier County Watershed Improvement Project (CWIP) proposes of restoration hydrologic conditions in the natural area immediately east of Naples, FL between I-75 and US-41 by withdrawing water from the Golden Gate Canal and diverting it to the Picayune Strand State forest **(Figure 1**). The project area was once part of a much larger watershed draining from the north. Development of the Golden Gate Estates subdivision and the associated network of canals cut off the northern third of the watershed. The runoff from that northern area was diverted into the Golden Gate Canal (GGC) as well as other ditches and drained to Naples Bay. The bay's' estuarine ecosystem has been degraded from excessive freshwater. The redirection of flows has also dehydrated of the area south of I-75, with attendant changes in vegetation communities due to the changed hydrologic conditions. Collier County now proposes to return a portion of that diverted water to the project area. Due to other permitted water uses of the GGC flows, development within the project area for recreational and some residential/commercial uses, bordering urbanization, and the importance the habitat area for listed species, especially Red Cockaded Woodpecker and Florida Panther, Collier County proposes hydrologic restoration that will not adversely affect the ecosystem, impinge on other water uses, or adversely affect developments bordering the project area.

The project effects are focused in approximately 9,000 acres of the western Picayune Strand State Forest (PSSF) east of Naples FL (**Figure 2**: Core Rehydration Area and Flowway Extent). Outside that area the project will increase hydroperiod, wet season average water elevation and dry season groundwater elevations to a much lesser extent or not at all. Landscape boundaries of the hydration area include the I-75 corridor to the north, and city of Naples development to the west. To the south, the 6Ls Agricultural Area creates a boundary to project effects. To the east, the SFWMD CERP (Comprehensive Everglades Restoration Program) Picayune Strand Forest Restoration creates a hydrologic condition that the CWIP accounts for in evaluation of project effects in order to avoid negative hydrologic impacts. The total assessment area within those boundaries includes about 22,000 acres.

Project Description

Water will be diverted from the Golden Gate Canal through pumps located upstream of the GG-3 weir (**Figure 1**). Based on a GG-3 flow duration analysis and permitted water diversions from the canal, the project proposes to divert 100 cfs when the discharge through the structure exceeds 450 cfs (~ 55 days/year) and 50 cfs when the discharge is between 200 cfs and 450 cfs (~ 83 days/year). Diversions will occur most often during the wet season however; sufficient water is expected to be available during early dry season to allow for smaller (i.e. 50 cfs) diversions. The diverted water will flow southwards via a proposed ditch that discharges water directly into the I-75 north canal. An operable gate structure is

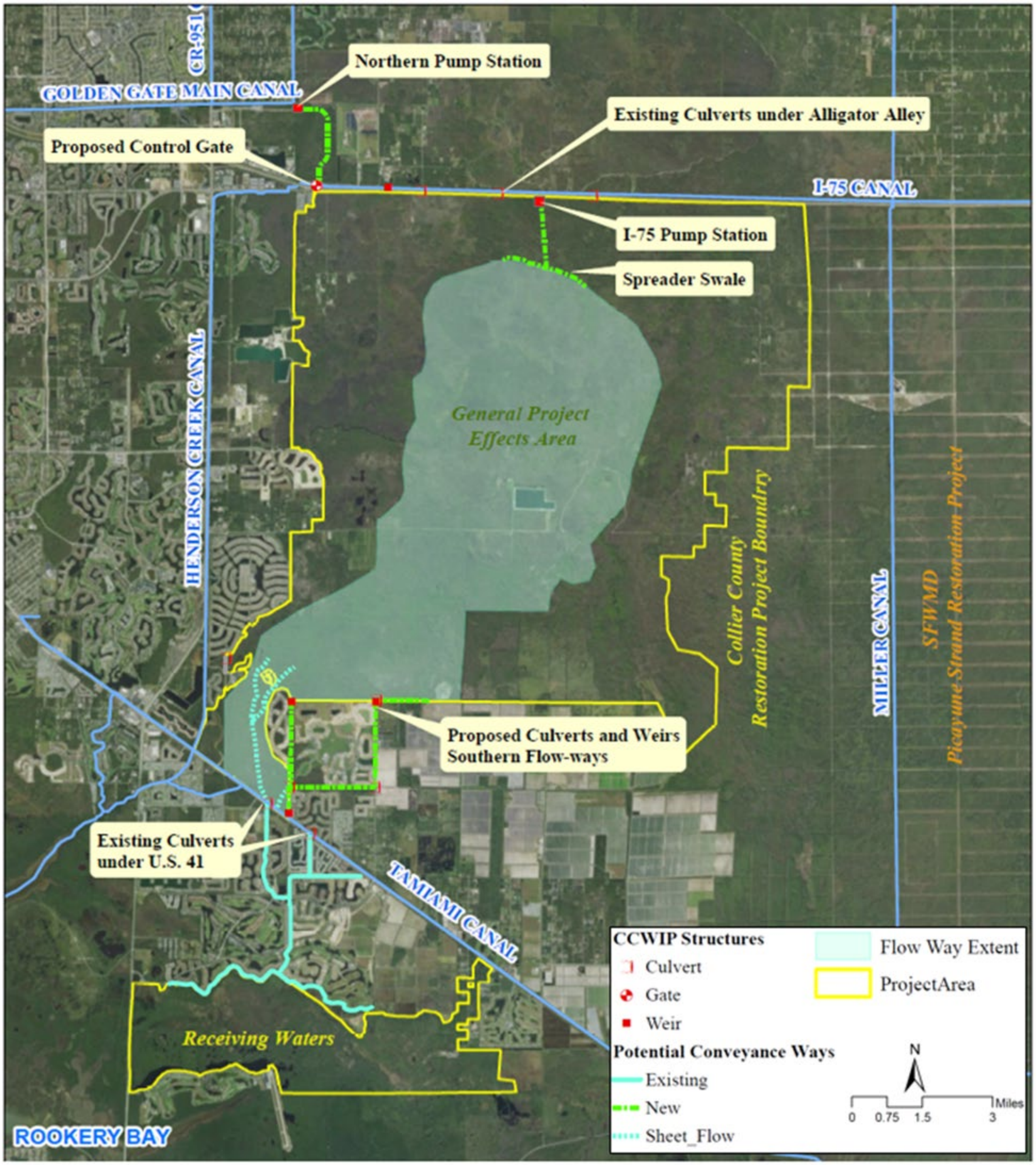

Figure 1. CWIP Restoration Project Overview

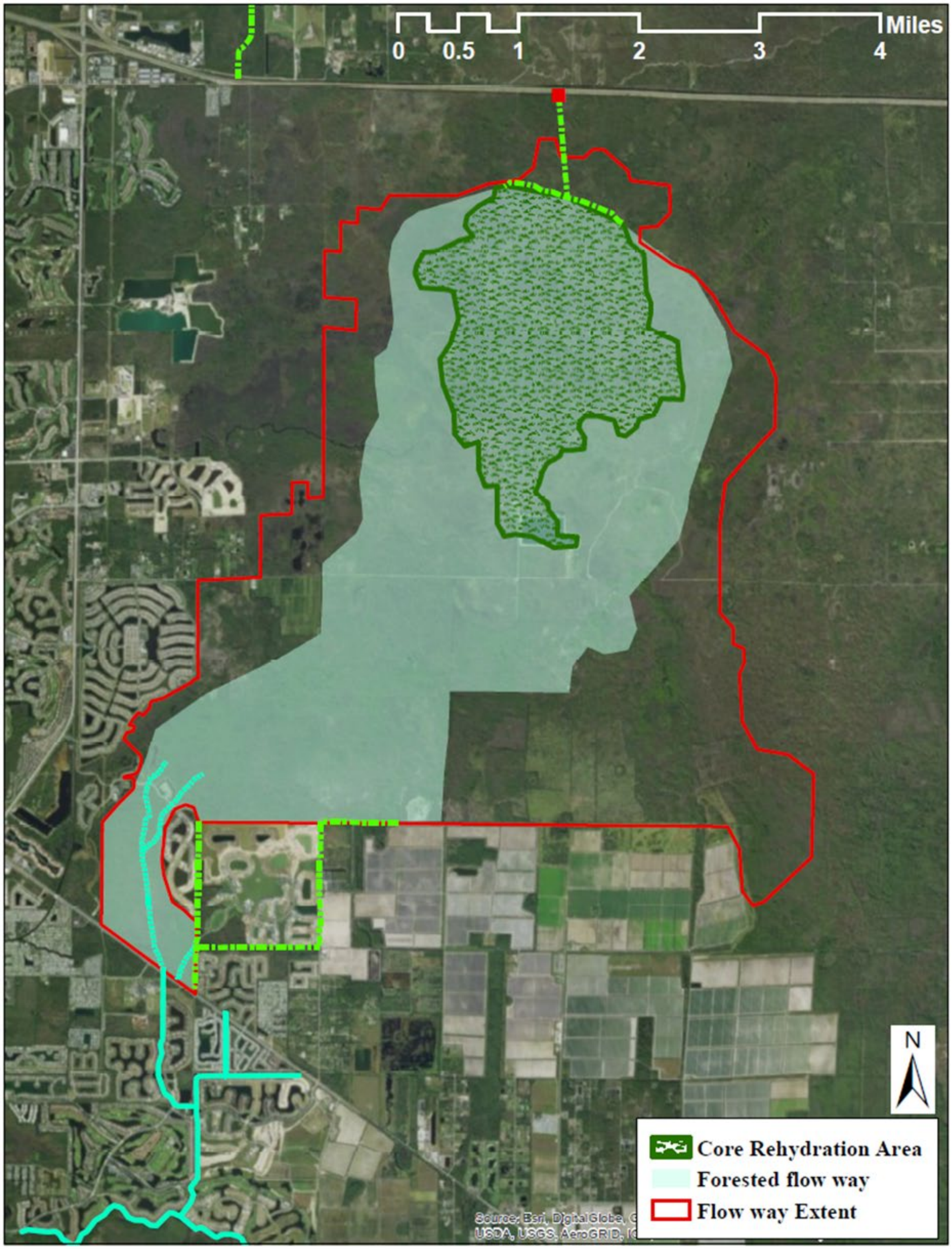

Figure 2. CWIP General Project Effects Area, about 9,000 acres.

proposed on the I-75 north canal to force water to move eastwards and hence restrict discharge into Henderson Creek. The water will continue to flow south into the I-75 south canal through existing culverts under I-75, where it will be pumped into a proposed flowway located south of the canal, which will serve as an in-line water treatment facility providing settlement of solids to treat runoff from I-75. The spreader swale will have fixed weirs controlling water elevations in the entire flowway system as well as releasing water into Belle Meade Forest as sheet flow. Once released into the forest, the flow of water is driven by forest topography which slopes gradually from northeast to southwest. After infiltration and evapotranspiration losses, the remaining water will reach the southwest end where a collector ditch will receive the majority of the water near the eastern edge of Naples Reserve subdivision. The flow will be routed around the residential developments by means of proposed canals and will be discharged into U.S. 41 canal. A small portion of the forest water will continue to flow southwest as gravity sheet flow under Winding Cypress Drive. The water will continue to flow south under Tamiami Trail through existing culverts. The water will be routed through the Fiddlers Creek residential developments using two existing canals both of which discharge into a linear lake bordering the southern boundary of Fiddler's Creek. The water will spill over the southern bank of the lake into wetlands fringing Rookery Bay as sheet flow. The sheet flow will continue to flow south and southwest towards Rookery Bay. A small fraction of the flow will make its way westwards under existing S.R. 951 culverts.

The reader is referred to **Supplemental Information Attachment 7 Hydrologic and Hydraulic Modeling** section 2.2.1.2, provided as part of the USACE permit application, for details of the project drainage system and design details.

The project infrastructure will impact about 36 acres of wetlands and alter a total of about 60 acres of natural habitat. The habitat improvements over more than 9,000 acres provided by the rehydration will also provide the mitigation necessary to offset wetland impacts.

The project evaluation area, about 22,000 acres, includes the western side of the Picayune Strand State Forest (PSSF) and other natural lands between the PSSF western boundary and the eastern edge of the Naples Florida development. The main effects of the project will occur in approximately 9,000 acres (Figure 2) identified as the Core Rehydration Area and Flowway Extent, dominated by four vegetation communities described by the Florida Land Use Cover and Classification Forms System (FLUCCS) as Cypress (FLUCCS 621), Cypress Pine Cabbage Palm (FLUCCS 624), Hydric Pine (FLUCCS 625), and Pine Flatwood (FLUCCS 411) (**Table 1, Appendix 1:** FLUCCS community acres by zone, percent FLUCCS communities by zone). Pine flatwoods are classified as uplands; the other dominant communities are wetlands. A similar community dominance occurs outside the 9,000-acre main effects area. **Appendix 2** describes the development of the FLUCCS map by combining the most recent FNAI mapping of the Picayune Strand State Forest and the most recent SFWMD FLUCCS map for areas outside the state forest. The appendix also describes the FLUCCS – FNAI community crosswalk used to convert all shapes to FLUCCS codes.

Ten-year hydrologic simulations suggest that only minor and negligible hydrologic changes will occur outside the core rehydration area and flowway extent. The project will enhance the hydrology of the forest without creating conditions that would drive large vegetation community changes.

Methods

Hydrologic Simulation and FLUCCS Vegetation Shapefile Creation

Ten-year hydrologic simulation methods and development of FLUCCS shapefile maps used in this analysis are briefly summarized in **Appendix 1**. As explained there, shapefiles >32.3 acres in size were used to assess existing and with project to best characterized community hydrology for each of the dominant FLUCCS vegetation types.

Definition of Vegetation Shapefile Hydrology

The hydrologic simulations results were estimated for each vegetation shape by weighting the hydrologic values in the grid cells intersecting each shape by the fraction of the shape associated with each intersecting grid cell (**Appendix 3**). Each hydrologic model grid cell had an area of 3.23 acres. Polygons used in the hydrologic analysis had areas > 32.3 acres.

Within the landscape, vegetation patches express the elevation and related hydrology at those locations. Smaller vegetation patches within larger, dominant vegetation communities are associated with surface elevations that are small in area but sufficiently uniform to allow development of a community associated with a different hydrology than the surrounding community or communities. The hydrology of the numerous small vegetation patches (**Table 1**) could likely be misrepresented by the weighting scheme used to calculate shape hydrology. Since reducing the simulation model cell size to accommodate small shapes (many an acre or less) was infeasible due to the related increase in computational time, vegetation patches over 32.3 acres (large patches) were selected to represent expected hydrology for each of vegetation communities, regardless of patch size. These large patches were most likely to include all or most of multiple grid cells for calculation of vegetation shapefile hydrologic values. The hydrologic values obtained using this subset of the data were considered representative of all patches of a community type. Note that about 2,000 acres of the project evaluation area are accounted for by various other land uses including disturbed lands, mines, open waters, development, etc.

Table 1. Area Relationships of Dominant Natural Community Patches in the Project Area

Vegetation Community	Total Area (acres)	n	Patches >32.3 acres	% of Area > 32.3 acres	n
Hydric Pine (FLUCCS 625)	2,253	381	1,034	46%	13
Cypress-Pine Cabbage Palm (FLUCCS 624)	7,472	222	6,878	92%	26
Cypress (FLUCCS 621)	7,156	242	6,183	86%	23
Wet Coniferous Forest (FLUCCS 620)	1,102	13	402	83%	5
Pine Flatwoods (FLUCCS 411)	2,619	397	1,473	56%	12
Totals	20,602	1,255	15,970	78%	79

Vegetation Community Hydrology Estimated Averages

Duever (2004) identified average hydrologic ranges for several wetland communities crosswalked to FLUCCS codes 411 (Pine Flatwood), 625 (Hydric Pine), 621 (Cypress), and 620 (Wet Coniferous Forest) for the PSRP project. The averages were based on several years of hydrologic data collected from locations east of the project area and existing technical literature (**Table 2**). FLUCCS code 624 (Cypress-Pine-Cabbage Palm) was not included in that analysis, due to the lack of that community in the locations where measurements were collected. Duever (personal communication 2019) associated hydrology of Cypress Pine Cabbage Palm, a dominant community in the CWIP project area with that of hydric pine, based on the presence of hydric pine in that (FLUCCS 625) vegetation association. Wet Coniferous Forest, identified as a significant wetland community for one of the zones, was assumed to have hydrology comparable to Cypress.

Table 2. Duever-Estimated Community Hydrology

Hydrologic Statistic	Pine Flatwood	Hydric Pine	C-P-CP*	Cypress
Hydroperiod (months)	0 - 1	1 - 2	1 - 2	6 - 8
Average Wet Season Depth (inches)	0 - 2	2 - 6	2 - 6	18 - 24
Average Annual Dry Season Water Table (inches)	-46	-30	-30	-16
1 in 10 yr. low water depth (inches)	-76	-60	-60	-46

*C-P-CP = Cypress-Pine-Cabbage Palm – Placed into the Hydric Pine category by Duever, personal communication 2019.

The elevation data for large (greater than 32.3 acres) vegetation polygons in the project area (**Figure 3**) indicated that cypress-pine cabbage palm (C-P-CP) community typically occurred at a lower landscape elevation than hydric pine; and is thus likely to include hydrologic conditions more aligned with cypress than with hydric pine. The analysis uses the hydric pine standard for C-P-CP hydrology comparison purposes but focuses on the elevation and hydrologic data for this community compared to Hydric Pine and Cypress communities when reaching conclusions regarding project impacts. Wet coniferous forest, with a single shapefile greater than 32.3 acres was at an elevation (5.4 ft) lower than the cypress shapefiles; cypress hydrologic standards were used for assessment of this community.

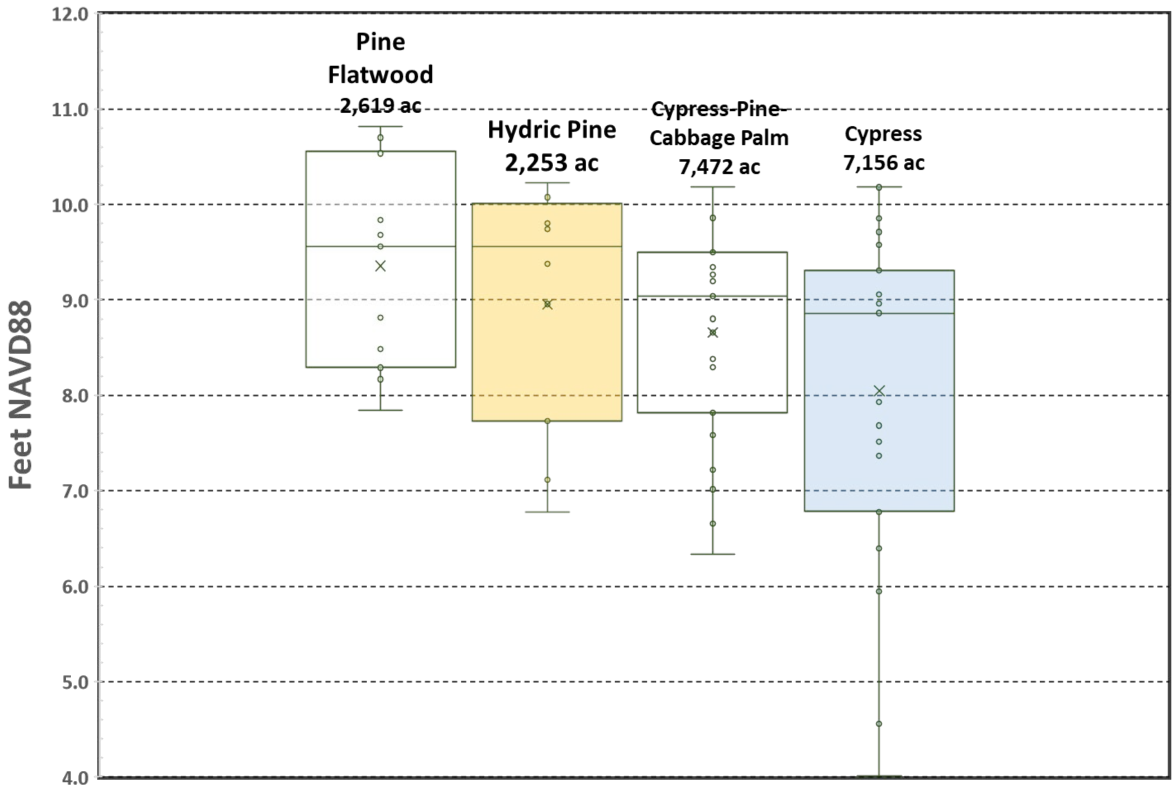

Figure 3: Box and Whisker Plot Summary of Elevation Characteristics of Large Vegetation Patches. The "Whiskers" display the interquartile range for each dataset

Hydrologic Effects Assessment

Assessment of potential hydrologic impact of project natural communities compared the data to Duever estimates of average hydrology: hydroperiod, wet season water elevation above ground surface, and dry season water table elevation below ground surface. Two datasets were used: The hydrology of the large vegetation polygons and 21 individual simulation cell locations selected by state and federal agency stakeholders. Polygon data were summarized by community – Pine Flatwoods (FLUCCS 411), Hydric Pine (FLUCCS 625) Cypress-Pine-Cabbage Palm (FLUCCS 624), and Cypress (FLUCCS 621). The simulations cells were characterized by the FLUCCS community they located within. The specific cell (about 3.2 acres) was selected within the desired location by identifying a cell that was covered at leasd90% by a single FLUCCS community.

Results

<u>Vegetation Shapefile Hydrology Compared to Duever (2004) Estimated Average Hydrology</u>

The FLUCCS land uses in the 22,131-acre project assessment area include about 17,484 acres of wetland, 1,519 acres of various types of development and 2,763 acres of uplands, dominated by Pine Flatwoods (FLUCCS 411). **Appendix 1** provides a full accounting of all FLUCCS land uses in the project assessment area and receiving waters.

For vegetation analysis purposes, the project assessment area is divided into four zones (**Figure 3-6)**:

- Core rehydration area (CRA 2,390 acres), the deepest of the project zones where the water diverted from the Golden Gate Canal is distributed by the spreader ditch into the Picayune Strand State Forest
- Flowway Extent (FE 6,607 acres): that area outside the Core Rehydration Area where the rehydration effects are strongest.
- Outside area (OC 13,134 acres): the remainder of the natural area within the 22,000 acre project assessment aera. Hydrologic effects are minor or none.
- RCW Habitat Areas (1,971 acres and 1,892 acres) associated with RCW Core Foraging Areas outside of the Core Rehydration Area and Flowway Extent. These polygons were analyzed separately from the others in the Outside Area because of their importance to the RCW.

Receiving Waters (2,921 acres) include the tidal estuarine wetlands south of US-41 where the water from the project area flows (currently and in the with-project condition). As that area has a shortage of wet season freshwater flows, the additional freshwater will benefit that area as well; however, because the area is tidal, project effects are difficult to assess; in any case, the changes are expected to be minimal or not detectable.

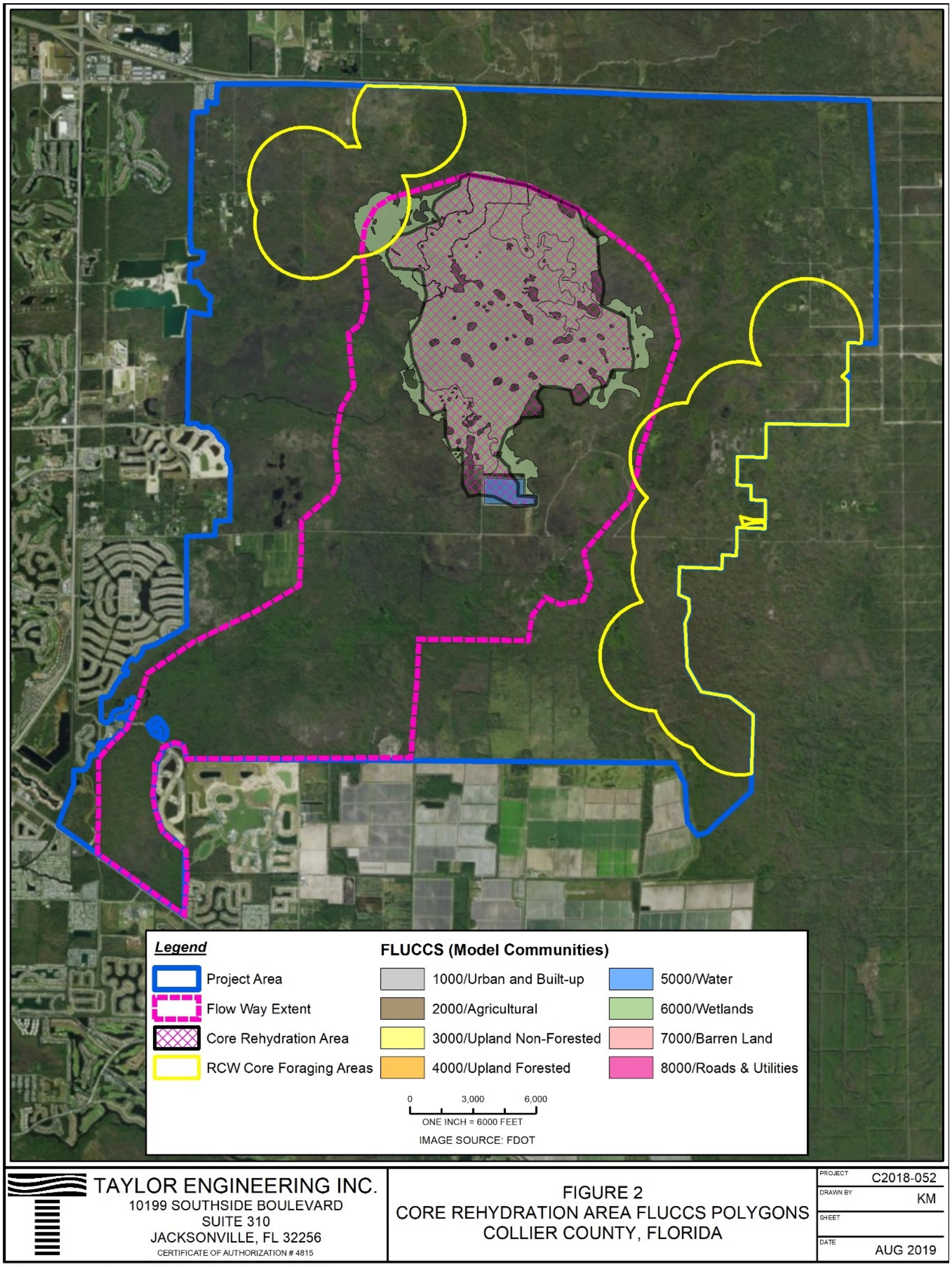

Figure 3. Core Rehydration Area: Large Polygons Used for Vegetation Hydrology Effects Analysis

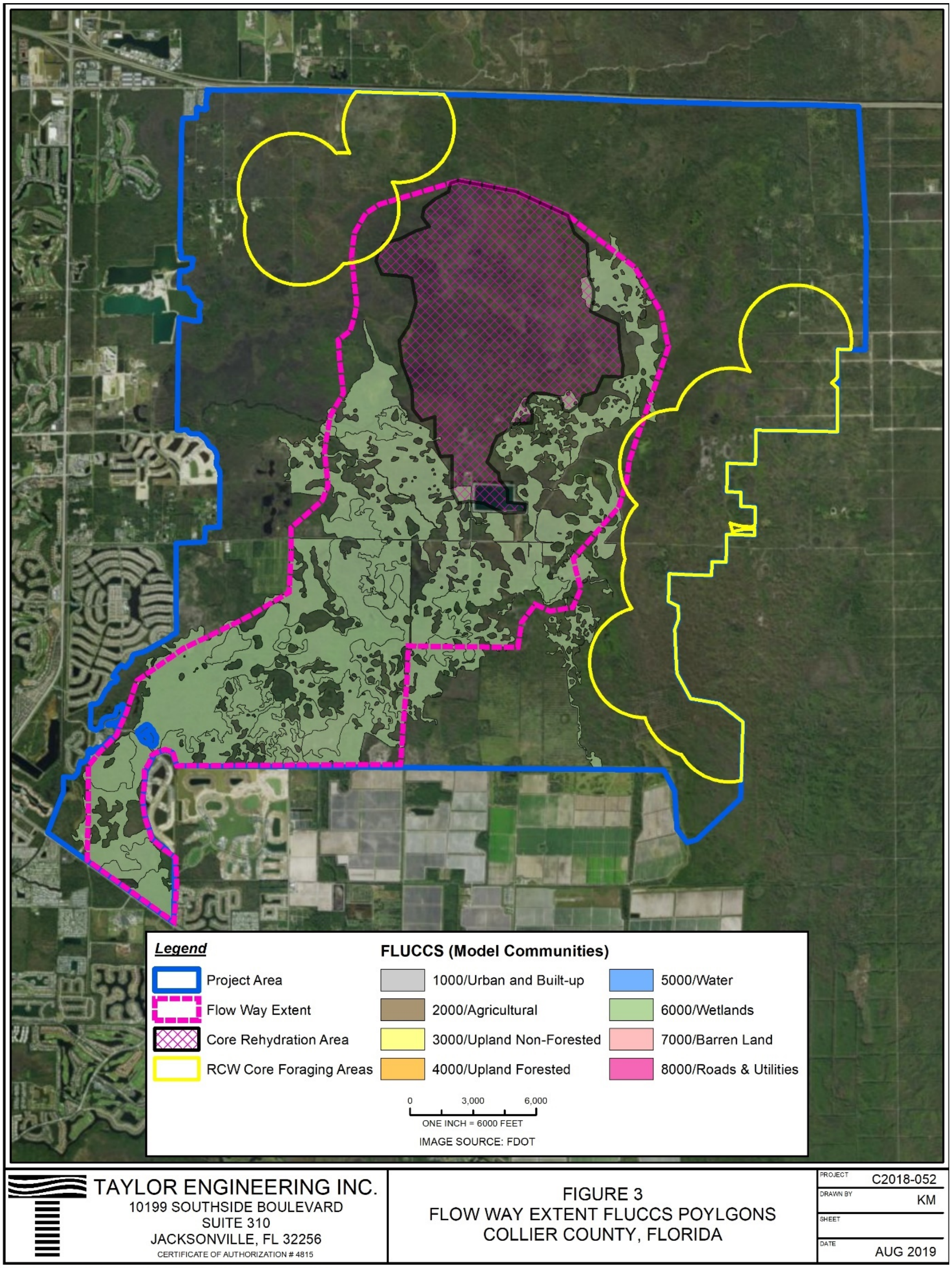

Figure 4. Flowway Extent Area: Large Polygons Used for Vegetation Hydrology Effects Analysis

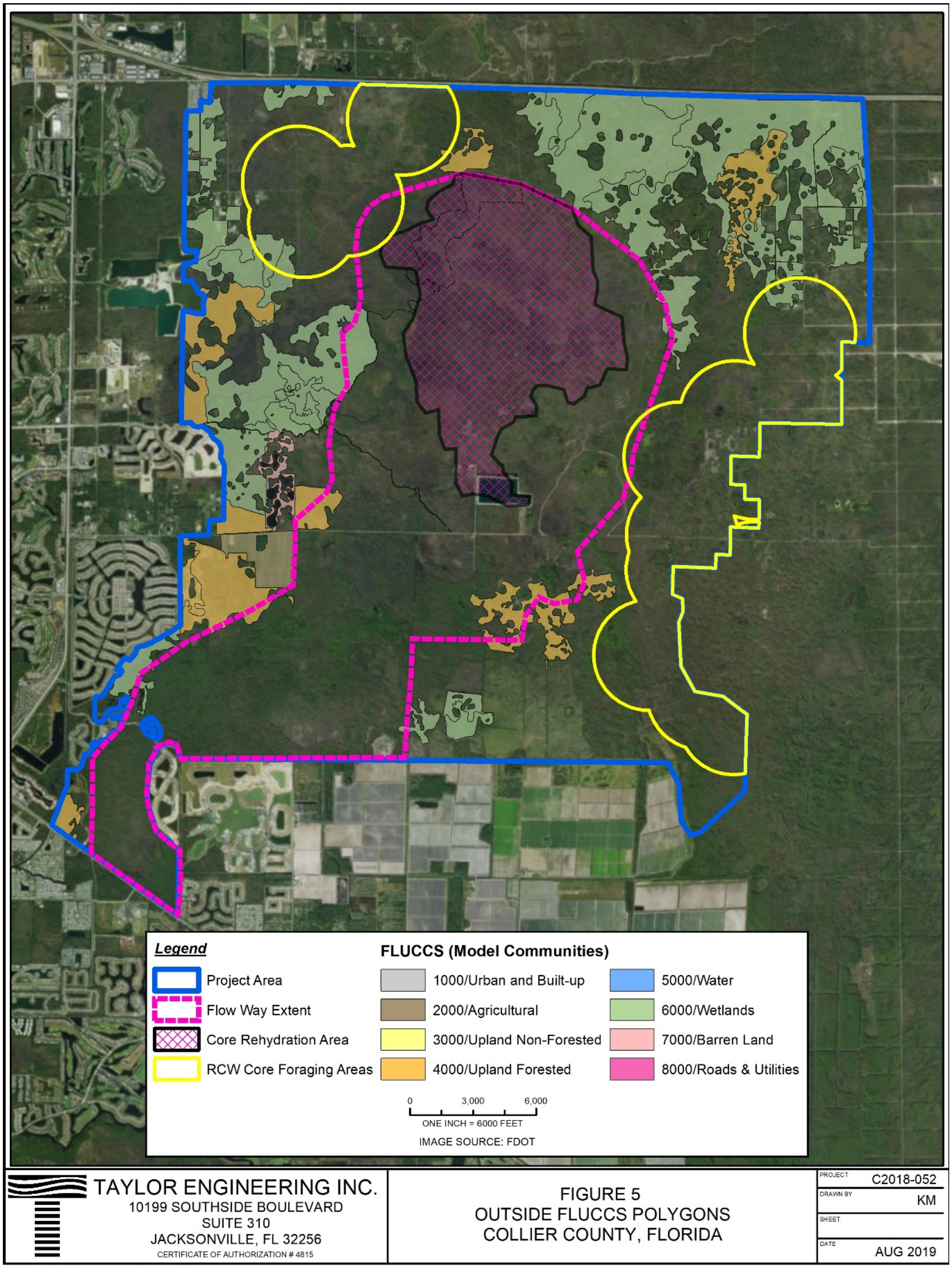

Figure 5. Outside Area: Large Polygons Used for Vegetation Hydrology Effects Analysis

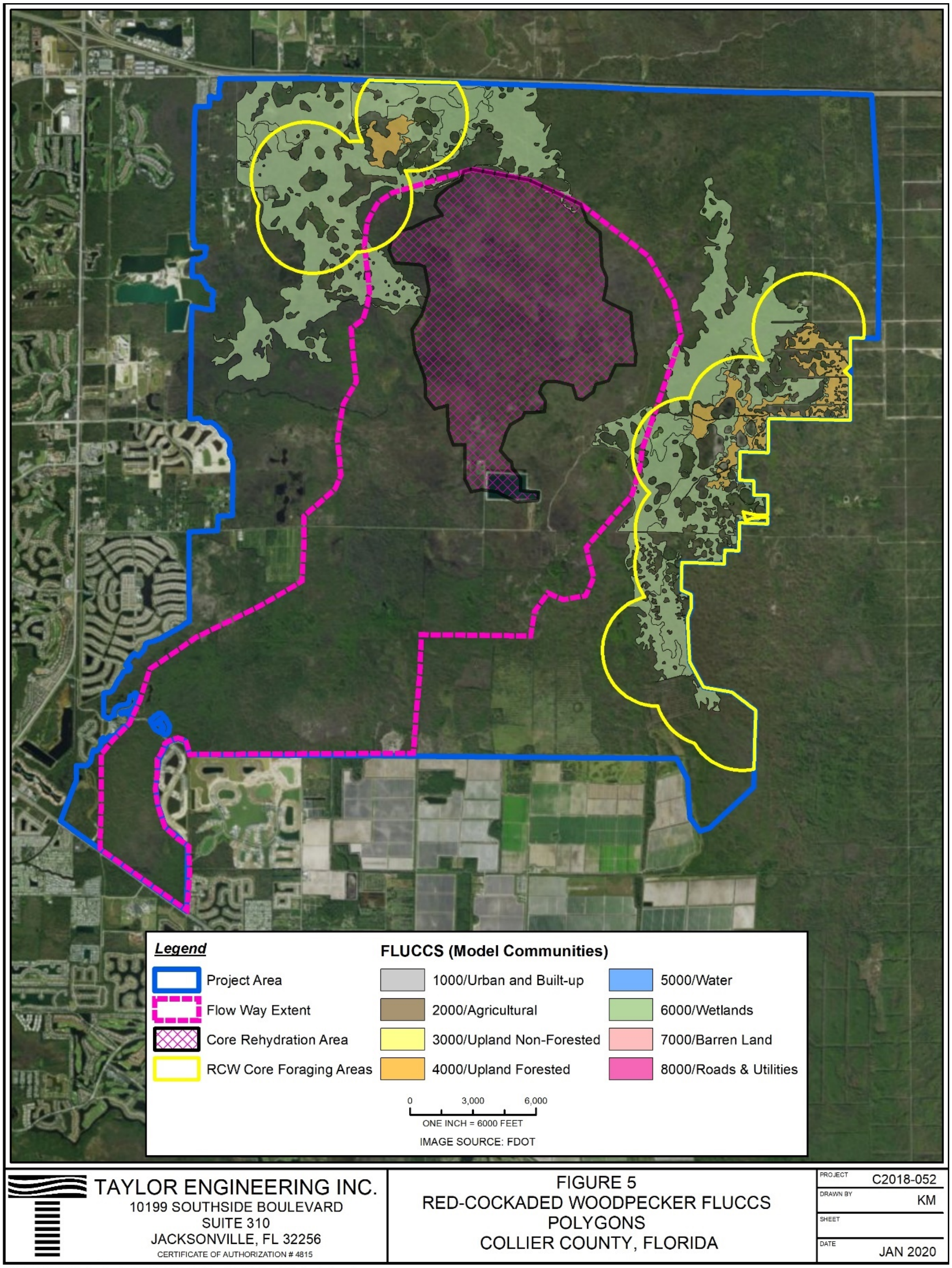

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Figure 6. RCW Habitat Area: Large Polygons Used for Vegetation Hydrology Effects Analysis

Wetland communities dominate all zones (**Table 3**). The CRA includes the greatest percent area of wetlands, and lowest amount of development (disturbed lands and roads). The greatest area of upland natural community (primarily pine flatwood) occurs in the Other Area, outside the CRA and FE zones.

Table 3. Acres of Wetland and Upland in Each Project Zone

Zone	CRA wetland	FE wetland	OC wetland	RW Wetland	CRA Upland	FE Upland	OC upland	RW Upland
Acres	2,328	5,898	12,853	2,872	28	602	281	22
% of Zone Area	97.4%	89.3%	97.9%	98.3%	1.2%	9.1%	2.1%	0.7%

Summarizing the data for all polygons, there were only small differences between median values of with-project and existing condition hydrologic data for each of the dominant FLUCCS types for shapefiles >32.3 acres (**Table 4**). In general, differences were greatest in the communities lower in landscape.

Table 4. Differences Between Median With-Project and Existing Condition Hydrologic Statistics

FLUCCS ID	Description	Hydroperiod (Months)	Dry Season Water Table Elevation (inches)	1 in 10 year Dry Season Water Table (inches)	Wet Season Water Level (inches)
411	Pine Flatwoods	0.1	1.8	0.2	0.1
625	Hydric Pine	0.4	0.5	0.3	0.1
624	Cypress-Pine-Cabbage Palm	0.7	0.9	0.3	0.8
621	Cypress	0.7	3.7	0.2	1.3

<u>Comparison of Project Zone Hydrology to Duever Averages</u>

Comparison of the Duever (2004, Personal Communication 2019) estimated average community hydrology was compared to simulation-estimated hydrology for dominant communities in each of the zones and shapefiles as defined above. Values for simulation results are medians of values within a set; median was selected rather than mean to avoid average value biases associated with wide variability within the relatively small datasets. Note that the RCW habitat area was analyzed separately from the rest of the area outside the Flowway Extent and Core Rehydration. The data presented here for the RCW areas are also used in the RCW analysis.

Graphic comparisons of simulated hydrology by project zone with Duever's average values indicated that for the majority of the comparisons, the with-project condition remained within or below the Duever average values (**Appendix 4**). Significant deviations from this occurred in the Cypress-Pine Cabbage Palm (C-P-CP) community, for both the existing and with project condition. See in particular the **Appendix 4** hydroperiod graphs for each zone. Dry season depths for C-P-CP are also in line with the cypress communities, which straddle Duever's average dry season water table depths. The other unusual result was the dry season water table depths for hydric pine in the Outside Area; both existing and with project simulations showed average groundwater table values above the Duever prediction. The RCW Areas (Appendix 4 Figures 4A-10 through 4A-12) are the "driest" of the various areas and almost all the data remain within or below Deuver averages.

Summarized, the comparisons of community hydrology with Duever (2004) average values suggest that:

1. Existing and with project conditions are consistent with or drier than Duever estimates, assuming the C-P-CP community has hydrology conditions closer to Cypress than Hydric Pine.
2. Hydroperiods show clear existing and with-project differences; C-P-CP shows the greatest change between existing and with project conditions, as might be expected if the landscape placement of that community was more like Cypress than Hydric Pine. Average wet season depths are consistent with landscape elevation differences.
3. All dry season water table elevations are below Duever average values. Average dry season depths are very similar, with only small differences between vegetation communities.
4. Considering by vegetation community and together as a habitat area, average differences between existing and with project conditions are small; not indicative of large hydrologic shifts that could imply major vegetation changes.

In summary, assuming that the C-P-CP community hydrology is most similar to that of the Cypress community in this area, the analysis suggests that the project is well-behaved with respect to hydrologic changes – the project will create slight increases in the hydrologic indicators but will not create major changes that would impact vegetation.

Stage Duration Curve Comparisons

Stage-duration curves provide another way to summarize project-related hydrologic changes. Model outputs of the combined groundwater-surface water model used to simulate project hydrology over a 10-year period were used to produce the stage duration curves for 21 locations within the project assessment area.

Locations for assessment were selected to assess the effects of the CWIP project alone and in conjunction with a fully functional Comprehensive Everglades Restoration Program Picayune Strand Restoration Project (PSRP) immediately east of the CWIP project area with a focus on those vegetation communities most commonly used by RCW or identified by USFWS and Florida Forestry Service as potential RCW habitat (**Figure 5**). The RCW desirable habitat area shape was developed by and provided to Collier County by Kim Dryden, USFWS and Mike Knight, Florida Forest Service.

At each location, the simulation results from a single hydrologic simulation cell (3.2 acres) wholly or nearly completely contained within one vegetation type was selected for analysis. One objective of the CWIP project is to avoid negative hydrologic changes on the eastern project border when added to hydrologic changes created by the PSRP; that project is already in progress, although not yet complete. With-Project PSRP hydrologic simulations results provided by the South Florida Water Management District added to results at the same locations from the CWIP hydrologic simulations estimated the combined projects' changes.

Stage duration curves (**Appendix 5**) were plotted and the plot data used to calculate related hydrologic statistics including hydroperiod (the period when the water table exceeded the ground elevation), average water depth during that period, average water table elevation during the SFWMD-defined wet season (may 15 – October 15) and dry season (October 16 – May 14). Statistics were calculated for existing and with project conditions for single simulation grid cells within the dominant communities, with an emphasis on Pine Flatwood and Hydric Pine (**Table 5, Appendix 5**). The average water table elevations are always below the ground elevation because the calculated hydroperiods are always much shorter than the SFWMD wet and dry season periods (5 and 7 months long, respectively) and even during the wet season the water elevations above the ground surface do not offset the below-ground depths of the water table during the rest of the wet season. We calculated the average water elevation for the period that the water was above the ground surface to provide another dataset for comparison to the Duever average values for the PSRP wetland communities; the actual "wet season" period used for those calculations was not clearly defined.

The **Table 5** data indicate that for those simulation grid cell data, the average values almost always fell below or within the Duever (2004) expected average values Since soil water table elevations are strongly influenced by site-specific soil conditions it is not surprising the data show some variability; there does not appear to be sufficient variability to suggest any pattern of exceedences of the Deuver averages; in fact most of the data are less than the Duever estimates. The exceptions to this general conclusion, locations IR-6 and (R-7, mapped as pine flatwood and cypress pine cabbage palm communities. At an elevation of 7.8 ft NAVD88, IR-6 lies well below the pine flatwood community and within the Hydric Pine and Cypress-Pine-Cabbage Palm elevations (**Appendix 5:** Compare elevations for the various pine flatwoods locations). Since the vegetation communities at the select locations were not verified by observation, it is very possible that the identified community at IR-6 is incorrect. IR-7 lies at the same elevation as IR-6 and while Duever (Personal Communication 2019) identified Cypress-Pine-Cabbage Palm communities as likely having hydrologic characteristics similar to Hydric Pine, the data collected for this project suggest that the C-P-CP community in the project area occurs in landscape elevations more typical of Cypress and the hydrologic conditions of the two

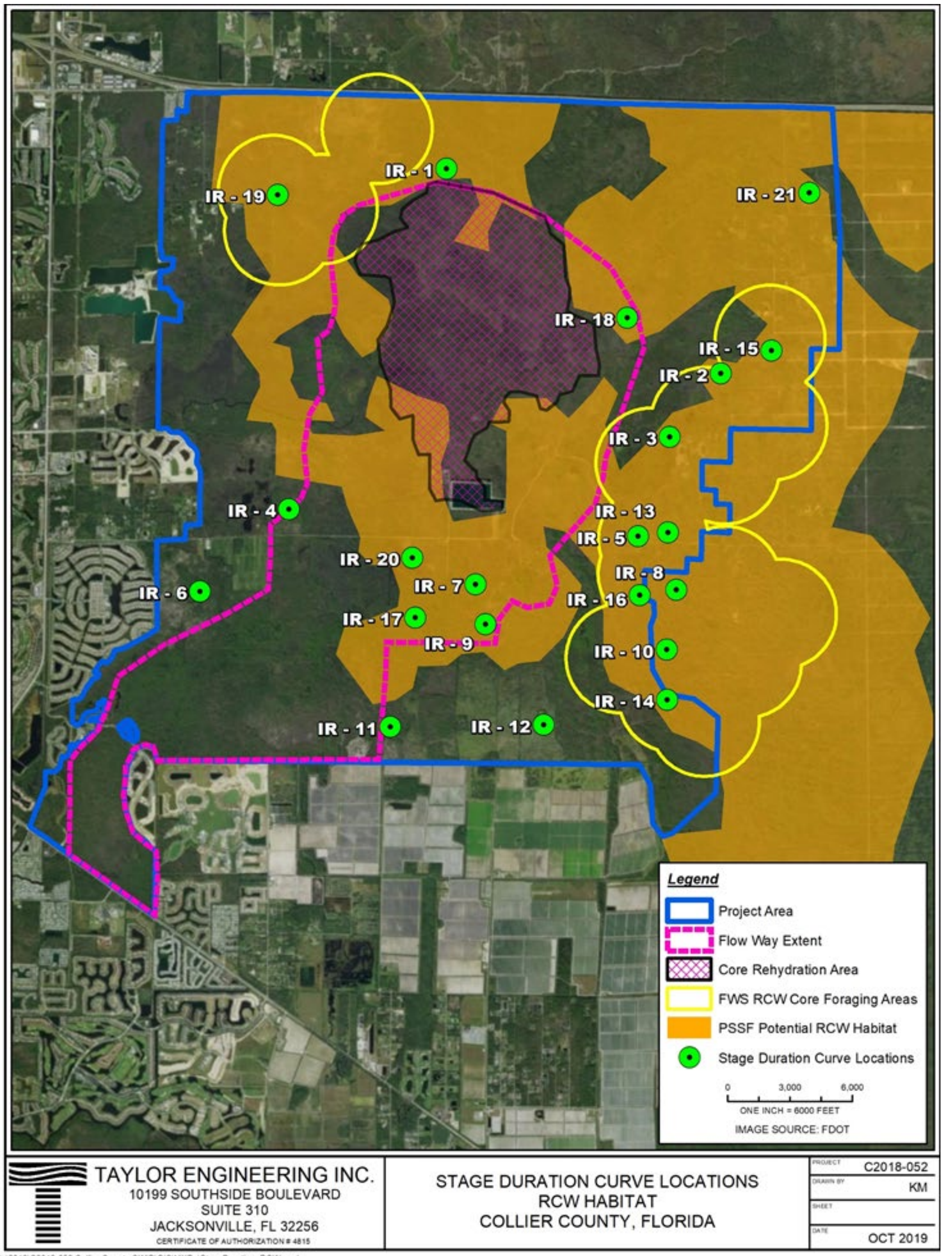

Figure 5. Location of Stage Duration Curve Data, RCW SuperClusters (within and without of Project Assessment Area) and Estimated Areas of Possible RCW Habitat

communities are similar. Therefore, the anomalies in the dataset do not suggest that the project may produce extreme hydrologic conditions in general for those communities; almost all the rest of the data suggest the opposite; that in fact the project has only a minor effect within the area of primary hydrologic change, and inconsequential hydrologic effects outside that area, where the current RCW colonies are located and where the appropriate vegetation communities occur in the same general area.

Hydrologic average values were not calculated for stage duration curves of combined CWIP and PSRP simulations shown in several **Appendix 6** figures. It is clear from the presented figures that the combined project water elevations create only slightly greater change than the CWIP alone.

Summary

The analysis of vegetation hydrology in the various project assessment zones indicate that the amount and seasonal distribution of additional water proposed to rehydrate the area will enhance the project hydrology while remaining protective of the desirable vegetation communities and Red Cockaded Woodpecker habitat. However, these are the results of simulations; the performance of the project is yet to be seen. Collier County has a monitoring program underway to provide measurement of baseline conditions over multiple years and after the project is constructed and operating. This monitoring program, described elsewhere in the permit application, will provide the basis for adaptive management to ensure that the expected with project conditions are realized.

Table 5. Average Hydrologic Values for 21 locations within the Project Assessment Area for Existing and With Project Simulations.

						Water Table Depths From Soil Surface			
Location ID*	**FLUCCS ID**	**Hydrologic Condition**	**Simulation Hydroperiod (months)**	**Duever Hydroperiod (months)**	**Simulation Hydroperiod Average Water Depth Above Surface (Inches)**	**Average Simulated Wet Season Water Depth (inches)**	**Duever Average Wet Season Water Depth (inches)**	**Dry Season Average Water Table depth (inches)**	**Duever Average Dry Season Depth (inches)**
IR-1	411	Existing	0.0	0 - 1	0.17	-36	0 - 2	-45	-46
		With-Project	0.1		0.11	-30		-41	
IR-2	624	Existing	2.4	1 - 2	0.32	-24	1 - 2	-36	-30
		With-Project	2.6		0.38	-23		-34	
IR-3	411	Existing	0.0	0 - 1	0.04 (one value)	-41	0 - 2	-51	-46
		With-Project	0.0		0.06 (one value)	-39		-49	
IR-4	411	Existing	0.0	0 - 1	0.14	-30	0 - 2	-37	-46
		With-Project	0.0		0.14	-29		-35	
IR-5	625	Existing	1.2	1 - 2	0.24	-30	0 - 1	-41	-30
		With-Project	1.9		0.3	-28		-39	
IR-6	411	Existing	2.2	0 - 1	0.2	-25	0 - 2	-32	-46
		With-Project	2.5		0.24	-24		-31	
IR-7	624	Existing	3.7	1 - 2	0.26	-18	1 - 2	-27	-30
		With-Project	4.3		0.55	-17		-24	
IR-8	624	Existing	1.4	1 - 2	0.11	-28	1 - 2	-39	-30
		With-Project	1.7		0.13	-27		-37	

						Water Table Depths From Soil Surface			
Location ID*	FLUCCS ID	Hydrologic Condition	Simulation Hydroperiod (months)	Duever Hydroperiod (months)	Simulation Hydroperiod Average Water Depth Above Surface (Inches)	Average Simulated Wet Season Water Depth (inches)	Duever Average Wet Season Water Depth (inches)	Dry Season Average Water Table depth (inches)	Duever Average Dry Season Depth (inches)
IR-9	624	Existing	0.2	1 - 2	0.11	-30	1 - 2	-39	-30
		With-Project	0.6		0.1	-28		-37	
IR-10	624	Existing	1.1	1 - 2	0.06	-26	1 - 2	-37	-30
		With-Project	1.4		0.075	-26		-36	
IR-11	621	Existing	3.7	6 - 8	0.54	-13	18 - 24	-27	-16
		With-Project	4.0		1.25	-11		-24	
IR-13	625	Existing	1.0	1 - 2	0.14	-33	2 - 6	-44	-30
		With-Project	1.3		0.14	-32		-43	
IR-14	625	Existing	0.6	1 - 2	0.14	-25	2 - 6	-36	-30
		With-Project	0.8		0.14	-24		-36	
IR-15	411	Existing	0.0	0 - 1	0.09	-37	0 - 2	-50	-46
		With-Project	0.0		0.07	-37		-50	
IR-16	411	Existing	0.5	0 - 1	0.06	-28	0 - 2	-38	-46
		With-Project	0.7		0.07	-27		-37	
IR-17	625	Existing	1.0	1 - 2	0.14	-27	2 - 6	-36	-30
		With-Project	2.5		0.19	-24		-33	
IR-18	411	Existing	0.1	0 - 1	0.11	-31	0 - 2	-41	-46

						Water Table Depths From Soil Surface			
Location ID*	**FLUCCS ID**	**Hydrologic Condition**	**Simulation Hydroperiod (months)**	**Duever Hydroperiod (months)**	**Simulation Hydroperiod Average Water Depth Above Surface (Inches)**	**Average Simulated Wet Season Water Depth (inches)**	**Duever Average Wet Season Water Depth (inches)**	**Dry Season Average Water Table depth (inches)**	**Duever Average Dry Season Depth (inches)**
		With-Project	0.1		0.09	-29		-38	
IR-19	411	Existing	0.0	0 - 1	0.03 (one value)	-41	0 - 2	-49	-46
		With-Project	0.0		0.03 (one value)	-39		-48	
IR-20	411	Existing	0.1	0 - 1	0.15	-29	0 - 2	-37	-46
		With-Project	0.4		0.11	-26		-34	
IR-21	625	Existing	0.0	1 - 2	0.03 (one value)	-42	2 - 6	-55	-30
		With-Project	0.0		0.03 (one value)	-42		-55	
IR-12**	fallow cropland	Existing	1.7	na	0.45	-24	na	-37	na
		With-Project	2.8		0.6	-22		-35	

* See Figure

** Duever (2004) did not provide average hydrologic values for this FLUCCS code.

References

Duever, Michael. 2004. Southwest Florida Pre-Development Vegetation Map. Appendix B in: Zahina John G., Winifred Park Said, Rachelle Grein and Michael Duever 2007. Pre-Development Vegetation Communities of Southern Florida. Technical Publication HESM-02. South Florida Water Management District, West Palm Beach FL. June 2007.

Appendix 1.

Definition of Vegetation Community Shapefiles

Florida Land Use/Cover Classification System - Florida Natural Areas Inventory Crosswalk

Vegetation Community Shapefile Creation and Data Summary

Definition of Vegetation Community Shapefiles

The 10-year hydrologic simulation results used in this assessment were the product of a combined surface groundwater continuous simulation model. The model used a 375 ft x 375 ft (3.23 acre) grid as the basis for reporting simulation results. Each grid cell produced one simulation value for each day of the simulation period. Daily grid cell results for SFWMD-defined wet season (DATE _ DATE) and dry season (DATE _ DATE), and hydroperiod (days when the water level was above the ground surface for the cell) were averaged over the 10 year simulation period to provide the data for the analysis.

A shapefile depicting the vegetation communities within the project area was created by merging the most recently created Picayune Strand State Forest (PSSF) Florida Natural Areas Inventory (FNAI) shapefile provided by the Florida Forest Service (FFS 2018), the South Florida Water Management District (SFWMD) Land Cover Land Use 2014 – 2016 shapefile (SFWMD 2018), and FLUCCS vegetation communities delineated within outparcels of the PSSF using aerial imagery and vegetation community signatures and polygon definitions from defined polygons on outparcel boundaries.

The PSSF FNAI shapefile defines vegetation communities only within the boundaries of the PSSF and as such does not include any information for the private outparcels within the forest bounds (Figure 1). These outparcels range in size from 0.25 acres to 525 acres. In order to create a seamless shapefile for the project area, the communities within these boundaries were delineated within ESRI's ArcMap® version 10.5.1 (ESRI 2016) using 2018 aerial imagery for Collier County provided through the Florida Department of Transportation (FDOT) Aerial Photo LookUp System (FDOT 2018). The vegetation communities within the outparcels were attributed using the FNAI classification scheme (FNAI 2010), tied into the PSSF FNAI shapefile, and attributed using the FNAI classification scheme. The data were clipped to the project area. The PSSF vegetation communities were tied into the SFWMD Land Cover 2016 shapefile (Figure 3). However, as the vegetation communities within the SFWMD shapefile were attributed using the Florida Land Cover Classification System (FLUCCS) (FLUCCS 2018) rather than FNAI, a crosswalk was used to attribute each of the shapefiles using both FLUCCS and FNAI classification systems. This crosswalk was created using the Habitat Classification and Field Reconnaissance table provided by the Florida Fish and Wildlife Conservation Commission (FWC 2018), adjusted to include all the communities defined within the project area. As the PSSF FNAI data (and subsequently the outparcel data) were delineated at a finer scale than the SFWMD FLUCCS data, the data were merged using the FNAI information. Along the boundaries of the PSSF, vegetation communities were again delineated using the FDOT imagery in order to tie the PSSF FNAI shapefile to the SFWMD shapefile. Once these communities were tied together, a seamless shapefile was created that maintained both the FNAI and FLUCCS information, as well as source information for each of the communities.

For analysis purposes, the FLUCCS-FNAI shapefile created for the project area was dissolved using the FLUCCS information in order to create a shapefile with slightly coarser detail and fewer very small shapefiles. These resulting shapefiles defined the vegetation community used in the analyses.

REFERENCES

FDOT 2018 – Florida Department of Transportation (FDOT), 2018. COL 2018. Flight 6438. Resolution 0.5 ft. Acquired 12/1/2017 - 12/11/2017. Prepared by GIS Office, FDOT, Tallahassee, FL. Obtained September 2018 from https://fdotewp1.dot.state.fl.us/AerialPhotoLookUpSystem/.

FLUCCS 2018 – Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Florida Land Cover Classification System*. Prepared by Robert Kawula & Jennylyn Redner, Center for Spatial Analysis, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

FNAI 2010 – Florida Natural Areas Inventory (FNAI), 2010. *Guide to the natural communities of Florida: 2010 edition*. Florida Natural Areas Inventory, Tallahassee, FL.

FWC 2018– Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Habitat Classification and Field Reconnaissance*. Prepared by Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Accessed September 2018 at: http://fwcg.myfwc.com/index_files/textonly/slide12.html

Florida Land Use/Cover Classification System - Florida Natural Areas Inventory Crosswalk

The Collier County Comprehensive Watershed Improvement Plan (CWIP) project area had vegetation community GIS information available in two different formats. As the vegetation communities within the existing shapefiles were attributed using two different classification systems, a crosswalk was used to attribute each of the shapefiles using both FLUCCS (Florida Land Use Cover Classification System) and FNAI (Florida Natural Areas Inventory) classification systems. The FLUCCS, developed by the Florida Fish and Wildlife Conservation Commission (FWC), incorporated classifications currently used by the Florida Fish and Wildlife Conservation Commission (FWC), Florida Natural Areas Inventory (FNAI), and Florida's water management districts (WMD) (FLUCCS 2018). It includes all categories of land use, including, but not limited to natural communities. The FNAI Classification System was developed by the Florida Natural Areas Inventory (FNAI) and categorizes the original, natural biological associations of Florida (FNAI 2010). A Natural Community is defined as a distinct and recurring assemblage of populations of plants, animals, fungi, and microorganisms naturally associated with each other and their physical environment (FNAI 2010). The crosswalk used for the majority of the communities in this project area (Table 1) was created using the Habitat Classification and Field Reconnaissance table provided by the Florida Fish and Wildlife Conservation Commission (FWC 2018), adjusted to include all of the communities defined within the project area. As the FNAI delineates vegetation communities in finer detail than FLUCCS, we found it necessary to create an additional crosswalk (Table 2) to use on case-by-case basis for certain community types in an effort to maintain more FNAI dataset detail for dominant FLUCCS codes in the project area.

REFERENCES

FNAI 2010 – Florida Natural Areas Inventory (FNAI), 2010. *Guide to the natural communities of Florida: 2010 edition*. Florida Natural Areas Inventory, Tallahassee, FL.

FLUCCS 2018 – Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Florida Land Cover Classification System*. Prepared by Robert Kawula & Jennylyn Redner, Center for Spatial Analysis, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

FWC 2018– Florida Fish and Wildlife Conservation Commission (FWC), 2018. *Habitat Classification and Field Reconnaissance*. Prepared by Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. Accessed September 2018 at: http://fwcg.myfwc.com/index_files/textonly/slide12.html

Table 1: Standard FLUCCS – FNAI Crosswalk

FLUCCS Code	FLUCCS Name	FNAI
1180	Rural Residential	Developed
1210	Fixed Single-Family Units	Developed
1290	Medium Density Under Construction	Developed
1320	Mobile Home Units	Developed
1330	Multiple Dwelling Units, Low Rise	Developed
1390	High Density Under Construction	Developed
1400	Commercial & Services	Developed
1700	Institutional	Developed
1900	Open Land	Clearing
2230	Other Groves	Agriculture
2230	Other Groves	Agriculture
2610	Fallow Cropland	Abandoned Field/Abandoned Pasture
2610	Fallow Cropland	Abandoned Field/Abandoned Pasture
3100	Herbaceous (Dry Prairie)	Dry Prairie
3200	Upland Shrub and Brushland	Dry Prairie
3210	Palmetto Prairies	Dry Prairie
4110	Pine Flatwoods	Mesic Flatwoods
4340	Upland Mixed Coniferous/Hardwood	Upland Mixed Coniferous Hardwood
5120	Channelized Waterways, Canals	Canal/Ditch
5300	Reservoirs	Artificial Pond
5300	Reservoirs	Inland Ponds and Sloughs
5300	Reservoirs	Swamp Lake
6120	Mangrove Swamp	Mangrove Swamp
6170	Mixed Wetland Hardwoods	Hydric Hammock
6191	Wet Melaleuca	Invasive Exotic Monoculture
6200	Wetland Coniferous Forests	Wet Flatwoods
6215	Cypress- Domes/Heads	Dome Swamp
6216	Cypress - Mixed Hardwoods	Strand Swamp
6250	Wet Pineland Hydric Pine	Wet Flatwoods
6300	Wetland Forested Mixed	Floodplain Swamp
6300	Wetland Forested Mixed	Mesic Hammock
6410	Freshwater Marshes / Graminoid Prairie - Marsh	Marl Prairie
6410	Freshwater/Graminoid Prairie – Marsh	Wet Prairie
6420	Saltwater Marshes / Halophytic Herbaceous Prairie	Salt Marsh
7400	Disturbed Land (Except Artificial Ponds and Roads)	Clearing
7400	Disturbed Land	Spoil Area
7400	Disturbed Land	Clearing
8140	Roads and Highways	Road

Table 2: Alternate FLUCCS – FNAI Crosswalk

FNAI	FNAI Subtype	FLUCCS Code	FLUCCS Name
Wet Flatwoods	Mixed Cypress/Pine/Palm	6240	Cypress-Pine-Cabbage Palm
	NOT Mixed Cypress/Pine/Palm	6172	Wet Pinelands Hydric Pine
Hydric Hammock	Wet Flatwoods	6250	Wet Pinelands Hydric Pine
	NOT Wet Flatwoods	6172	Mixed Shrubs
Dome Swamp	Palm	6240	Cypress - Pine - Cabbage Palm
	NOT Palm	6210	Cypress
Wet Prairie	Mixed Cypress/Pine/Palm	6240	Cypress-Pine-Cabbage Palm
	NOT Mixed Cypress/Pine/Palm	6430	Wet Prairie
Developed	CASE BY CASE	8140 /1400 / 1180	Roads and Highways / Commercial and Services / Rural Residential

Vegetation Community Shapefile Creation and Data Summary

Vegetation Community Shapefile Creation

Source Data

Table 1: Source Data

Source Data	Reference	Description
Picayune Strand State Forest (PSSF) Florida Natural Areas Inventory (FNAI)	FFS 2018	Florida Forest Service (FFS) Historic Natural Community Mapping Project: This is a polygon file that delineates natural communities on FFS managed lands as identified by FNAI staff during field surveys. Most polygons have associated natural community point data that describes the ecological condition within the polygons.
South Florida Water Management District (SFWMD) Land Cover Land Use 2014 – 2016	SFWMD 2018	This data set serves as documentation of land cover and land use (LCLU) within the South Florida Water Management District as it existed in 2014-16. Land Cover Land Use data was updated from 2008-09 LCLU by photo-interpretation from 2014-16 aerial photography and classified using the SFWMD modified FLUCCS classification system. Features were interpreted from the county-based aerial photography (4 in - 2 ft pixel). The features were updated on screen from the 2008-09 vector data. Horizontal accuracy of the data corresponds to the positional accuracy of the county aerial photography. The minimum mapping unit for classification was 0.5 acres for wetlands and 5 acres for uplands.
Collier County 2018 Aerial Imagery	FDOT 2018	Provided through the Florida Department of Transportation (FDOT) Aerial Photo LookUp System. Flight: 6438. Resolution: 0.5 ft. Acquired: 12/1/2017 - 12/11/2017.

Tools

Table 2: Processing Tools Provided within ESRI's ArcMap (ESRI 2016)

Tool Name	Toolbox	Description
ERASE	Analysis	Creates a feature class by overlaying the Input Features with the polygons of the Erase Features. Only those portions of the input features falling outside the erase features outside boundaries are copied to the output feature class.
CLIP	Analysis	Extracts input features that overlay the clip features.
DISSOLVE	Data Management	Aggregates features based on specified attributes.

Process Steps

1. Using the outline of the PSSF FNAI shapefile, a new shapefile was made containing the areas within the outparcels of the State Forest using the ERASE tool.
2. Using the FDOT 2018 imagery as a reference, vegetation communities were delineated within the outparcels by cutting each outparcel polygon into different shapes depicting the outline of the different vegetation signatures using a CINTIQ® 22HD Interactive Pen Display Tablet (WACOM Technology Corporation). Map scale was set between 1:500 to 1,500.
3. Polygons within the outparcel shapefile were attributed using the FNAI classification system (FNAI 2010) by using the corresponding vegetation signatures within PSSF FNAI shapefiles.
4. The PSSF FNAI shapefile, Outparcel shapefile, and SFWMD shapefile were each clipped to the project boundary using the CLIP tool.
5. The PSSF FNAI shapefile and Outparcel shapefile were erased from the clipped SFWMD shapefile using the ERASE tool.
6. The crosswalk described in **Appendix X** was used to attribute each of the shapefiles with the corresponding FLUCCS or FNAI information.
7. Using the FNAI attribute information, the data were merged together. Along the boundaries of the PSSF, vegetation communities were again delineated according the vegetation signatures using the FDOT imagery in order to tie the PSSF FNAI shapefile to the SFWMD shapefile via a CINTIQ® 22HD Interactive Pen Display Tablet (WACOM Technology Corporation).
8. Any new shapes were attributed with both FNAI and FLUCCS information.
9. A seamless shapefile was then created that maintained both the FNAI and FLUCCS information, as well as source information for each of the communities by merging the PSSF FNAI shapefile, Outparcel shapefile, and SFWMD shapefile (including the edits described in step 7).
10. After a single shapefile was created for all the information, the data were aggregated based on FLUCCS Information, FNAI Information, and Source Information using the DISSOLVE tool.
11. Topology was run on the dissolved shapefile to identify any gaps or overlapping data. Any errors identified were fixed. This shapefile (Final_FLUCCS_FNAI) was then uploaded into the Collier Watershed Improvement Plan GIS database for submittal to the County following project completion.
12. For analyses purposes only, an additional shapefile (FLUCCS_Only_ForAnalyses) was created that aggregated the polygons based only on FLUCCS information using the DISSOLVE tool. This was done in order to create a slightly coarser dataset that would be more appropriate for use with the hydrologic data information.

Vegetation Community Data Summary

Project Area

Table 3: FLUCCS Acreages

FLUCCS	Acreage
113/Mixed Units, Fixed and Mobile Home Units	3.36
118/Rural Residential	81.51
121/Fixed Single Family Units	4.27
122/Mobile Home Units	1.30
123/Mixed Units, Fixed and Mobile Home Units	1.20
129/Medium Density Under Construction	3.06
132/Mobile Home Units	0.09
133/Multiple Dwelling Units, Low Rise	2.27
139/High Density Under Construction	36.16
1423/Junk Yards	14.72
162/Sand and Gravel Pits	2.60
182/Golf Course	0.60
190/Open Land	15.40
211/Improved Pastures	0.88
223/Other Groves	143.98
232/Poultry Feeding Operations	14.56
251/Horse Farms	10.44
261/Fallow Cropland	831.21
310/Herbaceous (Dry Prairie)	6.38
320/Upland Shrub and Brushland	16.35
321/Palmetto Prairies	46.44
411/Pine Flatwoods	2619.09
422/Brazilian Pepper	0.92
424/Melaleuca	50.29
434/Upland Mixed Coniferous / Hardwood	45.43
512/Channelized Waterways, Canals	38.49
520/Lakes	4.23
530/Reservoirs	103.31
542/Embayments Not Opening Directly to Gulf or Ocean	153.33
612/Mangrove Swamp	1451.30
617/Mixed Wetland Hardwoods	94.93
6172/Mixed Shrubs	545.94
6191/Wet Melaleuca	99.86
620/Wetland Coniferous Forests	387.07
621/Cypress	7155.85
624/Cypress - Pine - Cabbage Palm	7471.77

FLUCCS	Acreage
625/Wet Pinelands Hydric Pine	2253.52
630/Wetland Forested Mixed	233.52
641/Freshwater Marshes / Graminoid Prairie - Marsh	93.62
642/Saltwater Marshes / Halophytic Herbaceous Prairie	527.75
643/Wet Prairie	101.23
644/Emergent Aquatic Vegetation	4.69
740/Disturbed Land	224.24
811/Airports	0.41
814/Roads and Highways	154.20
834/Sewage Treatment	1.09
TOTAL	25052.88

Table 4: FNAI Acreages

FNAI	Acreage
Abandoned Field/Abandoned Pasture	823.24
Agriculture	159.42
Artificial Pond	103.31
Basin Marsh	79.29
Basin Swamp	68.64
Canal/Ditch	38.49
Clearing	239.64
Developed	163.08
Dome Swamp	674.05
Dry Prairie	54.19
Floodplain Swamp	187.44
Hydric Hammock	492.94
Inland Ponds and Sloughs	153.33
Mangrove Swamp	1451.30
Marl Prairie	98.32
Mesic Flatwoods	2676.79
Mesic Hammock	46.99
Road	162.18
Strand Swamp	6659.41
Swamp Lake	4.23
Tidal Marsh	527.75
Upland Hardwood Forest	45.43
Wet Flatwoods	10042.18
Wet Prairie	101.23
TOTAL	25052.88

Data described in this appendix were created and processed using ArcGIS® software by Esri (Version 10.5.1). ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright© Esri.

References

FDOT 2018 – Florida Department of Transportation (FDOT), 2018. COL 2018. Flight 6438. Resolution 0.5 ft. Acquired 12/1/2017 - 12/11/2017. Prepared by GIS Office, FDOT, Tallahassee, FL. Obtained September 2018 from https://fdotewp1.dot.state.fl.us/AerialPhotoLookUpSystem/.

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SFWMD 2018 – South Florida Water Management District (SFWMD), 2018. *SFWMD Land Cover Land Use 2014 – 2016.* South Florida Water Management District, West Palm Beach, FL. Obtained November 2018 at: https://geo-sfwmd.hub.arcgis.com/datasets/sfwmd-land-cover-land-use-2014-2016.

Appendix 2.

FLUCCS Land Use for Project Evaluation Area and Receiving Waters Zone

Percent Cover by FLUCCS Code for Each Project Zone

		Project Zone			
FLUCCS ID	FLUCCS Description	Core Rehydration Area	Flowway Extent	Outside Communities	Receiving Waters
113	mixed units residential*				3.4
118	rural residential		2.2	78.2	1.1
121	fixed single-family units			4.3	
122	Mobile Home Units				1.3
123	mixed units residential				1.2
129	medium Density residential under construction		1.0	2.1	
132	Mobile homes - ≥ 6/ ac			0.1	
133	multiple units, low rise		0.3	0.5	1.4
139	High Density, under construction		12.9	23.2	
142	wholesale sales				14.7
162	Sand and Gravel Pits			2.6	
182	Golf Courses				0.6
190	Open Land			15.4	
211	Improved Pasture				0.9
223	Other groves (not citrus or fruit)		0.6	143.4	
232	Poultry Feeding Operations			14.6	
251	Horse Farms			10.4	
261	Fallow Crop Land		29.2	802.0	
310	Herbaceous (dry prairie			6.2	0.1
320	Shrub and Brushland		7.6	2.6	6.1
321	Palmetto Prairies		35.7	10.7	
411	Pine Flatwood	28.2	532.8	2049.4	8.7
422	Brazilian Pepper			0.9	
424	Melaleuca			50.3	
434	Hardwood Conifer Mixed		25.6	13.3	6.5
512	Channelized river / stream	5.6	2.0	21.4	9.5
520	Lakes		3.4	0.8	
530	Reservoirs	44.1	18.6	35.1	5.5
542	Embayment not directly connected to the Gulf of Mexico				153.3
612	Mangrove Swamps				1451.3
617	Mixed Wetland Hardwoods		7.6	18.7	68.6
6172	Mixed Wetland hardwoods - Shrubs	22.9	123.1	140.4	259.5
6191	Wet Melaleuca	10.4	37.3	38.7	13.5
620	Wet Coniferous Forest		174.8	174.7	37.5

		Project Zone			
FLUCCS ID	FLUCCS Description	Core Rehydration Area	Flowway Extent	Outside Communities	Receiving Waters
621	Cypress	1765.2	2222.4	3147.2	20.9
624	CPCP	418.0	2597.5	4456.1	
625	hydric Pine	41.3	689.0	1446.0	77.1
630	Wetland Forest Mixed	4.0	16.9	50.6	162.0
641	Freshwater Marsh			8.4	85.2
642	Estuarine Marsh Cordgrass				527.8
643	Wet Prairie	16.6	5.2	79.5	
644	Emergent Aquatic Vegetation			4.7	
740	Disturbed Land	26.8	32.5	163.7	1.2
811	Airports				0.4
814	Roads and Highways	6.6	29.0	117.7	0.9
834	Sewage Treatment				1.1
	Total Acreage	2389.68	6607.4	13134	2921.39
	TOTAL	**2389.7**	**6607.4**	**13134.0**	**2921.4**

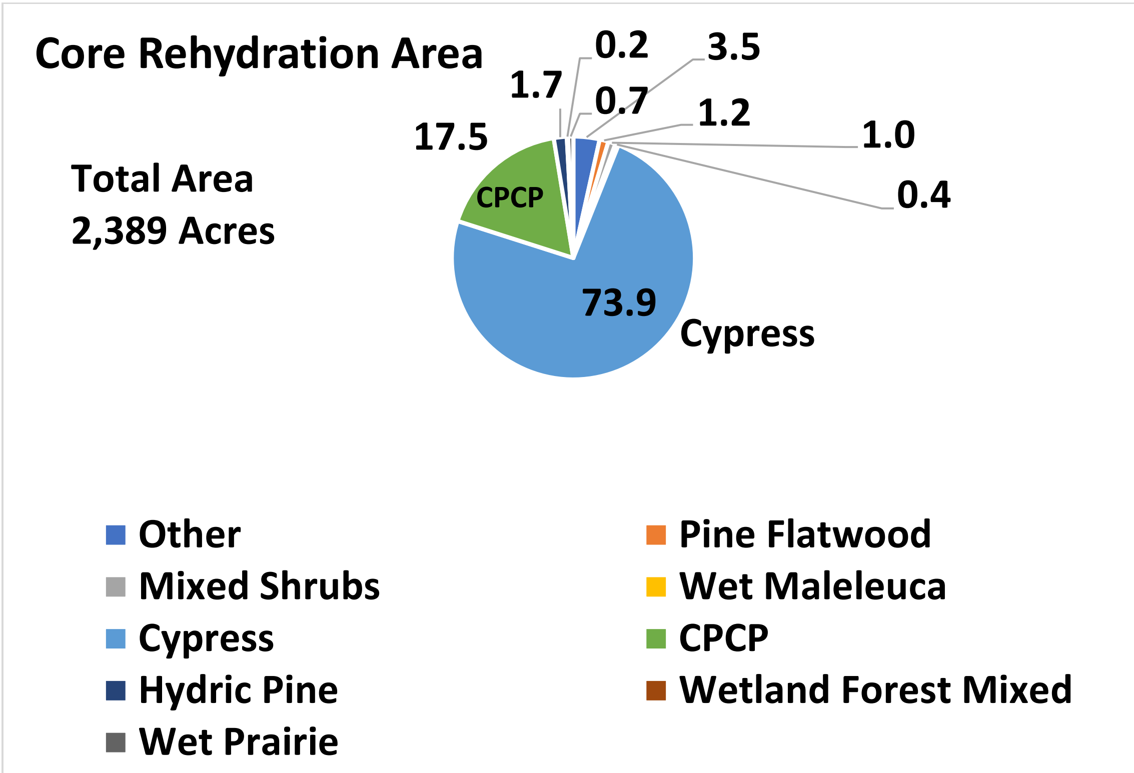
FLUCCS Percent Cover for Each Project Zone

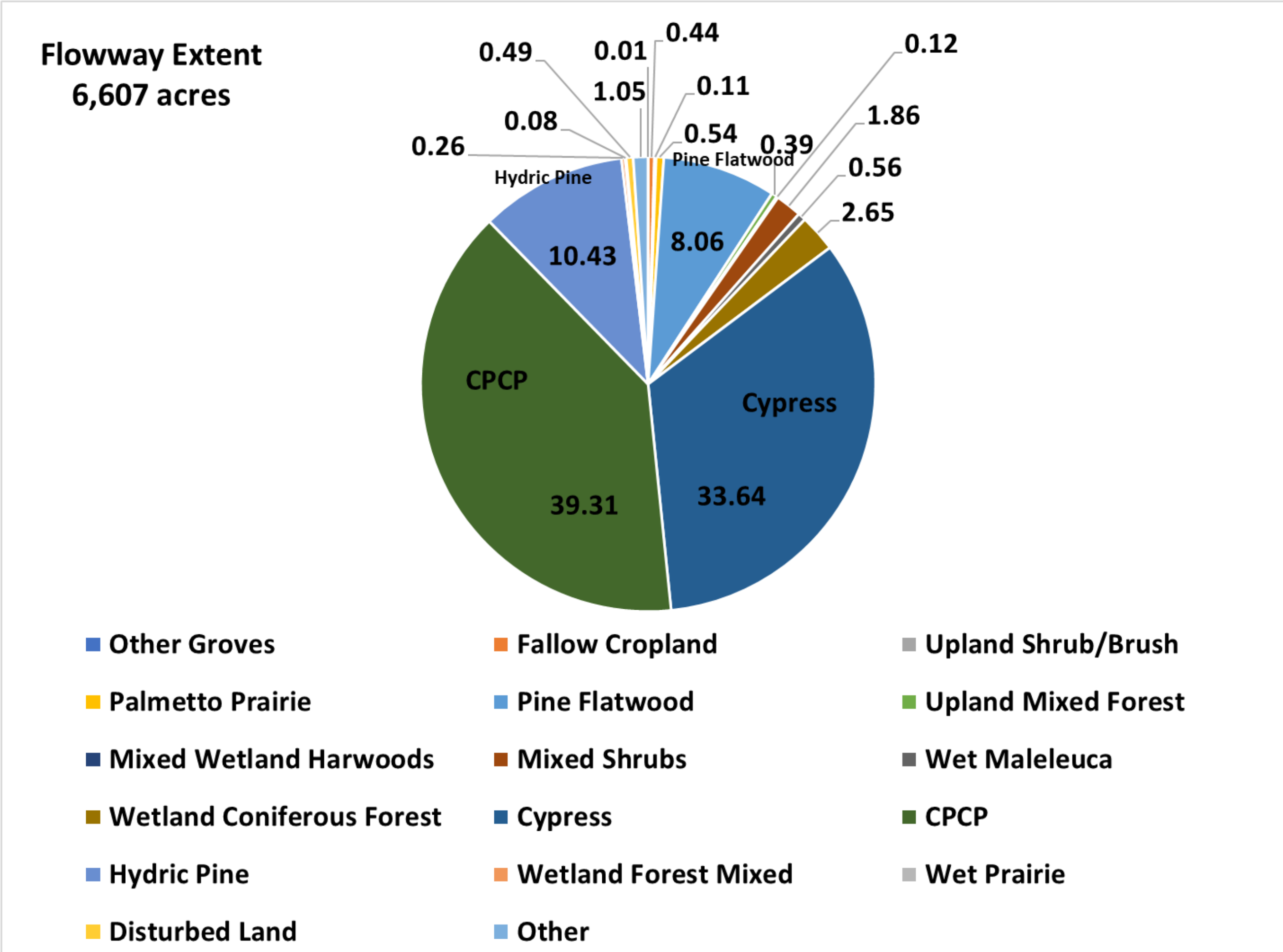
Core Rehydration Area

Flowway Extent

Other Communities

Receiving Waters


Core Rehydration Area
Total Area
2,389 Acres
0.2
3.5
1.7
0.7
1.2
17.5
1.0
CPCP
0.4
73.9
Cypress
Other
Pine Flatwood
Mixed Shrubs
Wet Maleleuca
Cypress
CPCP
Hydric Pine
Wetland Forest Mixed
Wet Prairie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0.01
0.44
0.12
1.05
0.11
0.08
1.86
0.26
0.54
0.39
Pine Flatwood
Hydric Pine
0.56
2.65
10.43
8.06
CPCP
Cypress
39.31
33.64
Other Groves
Fallow Cropland
Upland Shrub/Brush
Palmetto Prairie
Pine Flatwood
Upland Mixed Forest
Mixed Wetland Harwoods
Mixed Shrubs
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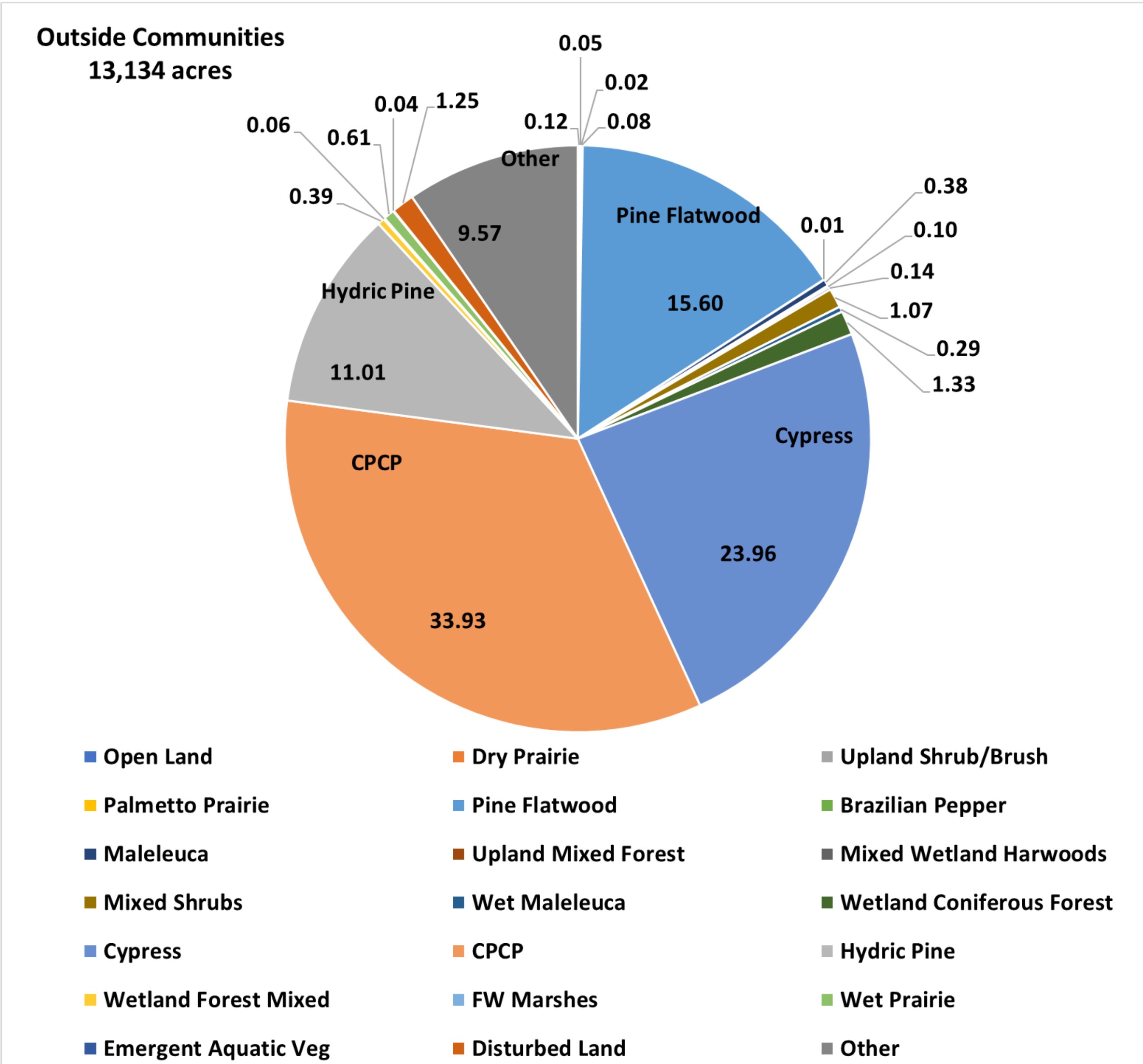
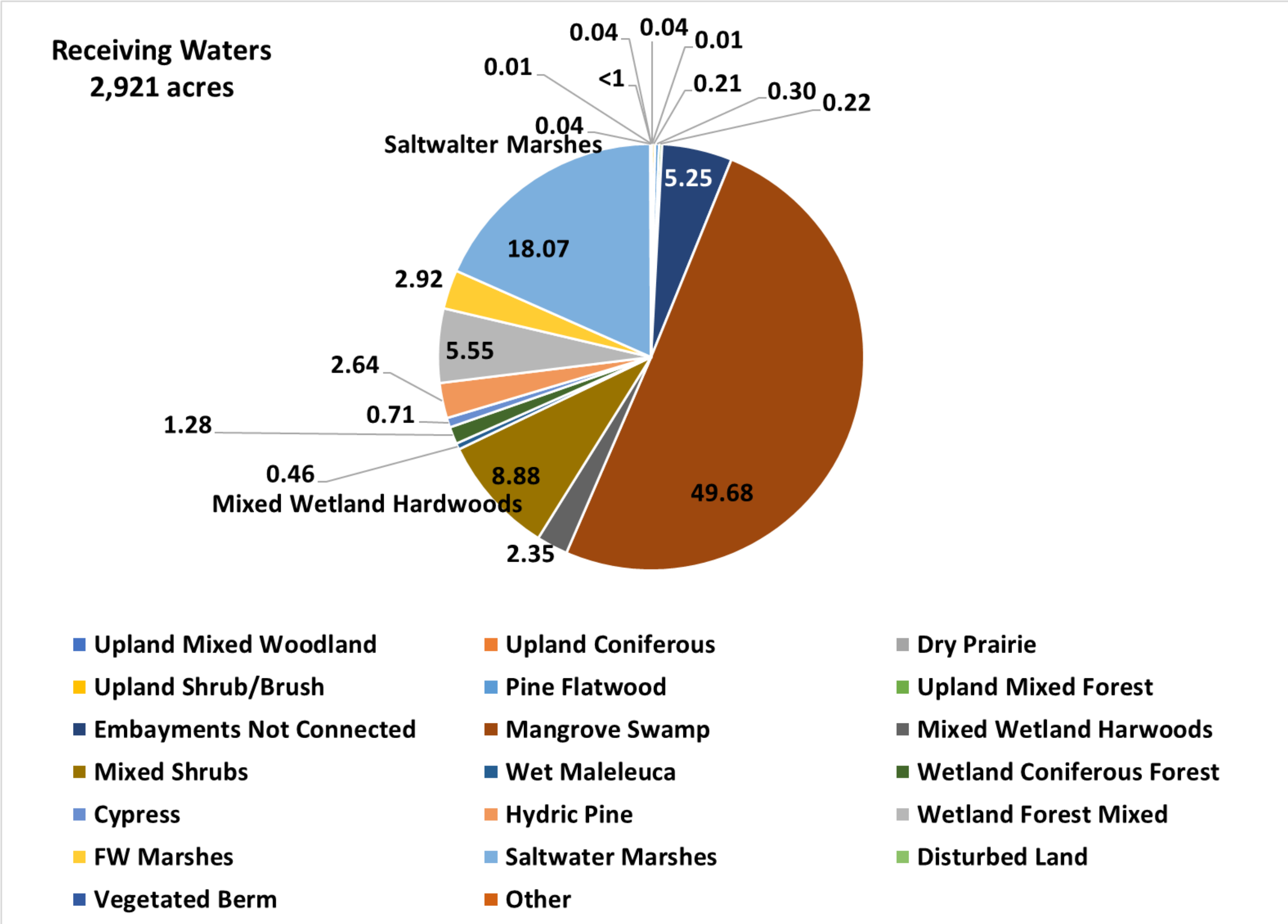
Wetland Coniferous Forest
Cypress
CPCP
Hydric Pine
Wetland Forest Mixed
Wet Prairie
Disturbed Land
Other


Outside Communities
13,134 acres
0.05
0.02
0.04
1.25
0.12
0.08
0.06
0.61
Other
0.39
9.57
Pine Flatwood
0.38
0.01
0.10
0.14
Hydric Pine
15.60
1.07
0.29
11.01
1.33
Cypress
CPCP
23.96
33.93
Open Land
Dry Prairie
Upland Shrub/Brush
Palmetto Prairie
Pine Flatwood
Brazilian Pepper
Maleleuca
Upland Mixed Forest
Mixed Wetland Harwoods
Mixed Shrubs
Wet Maleleuca
Wetland Coniferous Forest
Cypress
CPCP
Hydric Pine
Wetland Forest Mixed
FW Marshes
Wet Prairie
Emergent Aquatic Veg
Disturbed Land
Other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2,921 acres
0.04
0.04
0.01
0.01
<1
0.21
0.30
0.22
0.04
Saltwalter Marshes
5.25
18.07
2.92
5.55
2.64
0.71
1.28
0.46
8.88
Mixed Wetland Hardwoods
49.68
2.35
Upland Mixed Woodland
Upland Coniferous
Dry Prairie
Upland Shrub/Brush
Pine Flatwood
Upland Mixed Forest
Embayments Not Connected
Mangrove Swamp
Mixed Wetland Harwoods
Mixed Shrubs
Wet Maleleuca
Wetland Coniferous Forest
Cypress
Hydric Pine
Wetland Forest Mixed
FW Marshes
Saltwater Marshes
Disturbed Land
Vegetated Berm
Other

Appendix 3

Calculation of Weighted Average Hydrologic Statistics

Calculation of Weighted Average Hydrologic Statistics

Weighted hydrologic statistic for each shape within a FLUCCS codes:

$$H_{swn} = H_{cn} * (A_w / Ac)$$

$$\text{mean } H_{sw} = (\sum H_{swn})/n$$

Where

- s = a hydrologic statistic - hydroperiod, wet season annual average depth, dry season annual average depth, dry season 1/10-year annual average lowest depth
- H_{swn} = area-weighted cell hydrologic statistic value
- H_{cn}= raster cell hydrologic statistic value
- A_w = area of cell within intersecting veg polygon
- A_c = area of cell

Hydrologic statistic mean for each FLUCCS code:

$$H_{sfi} = (\sum(H_{wnix}) (A_{ix} / \sum A_{ix}))/n_i$$

Where:

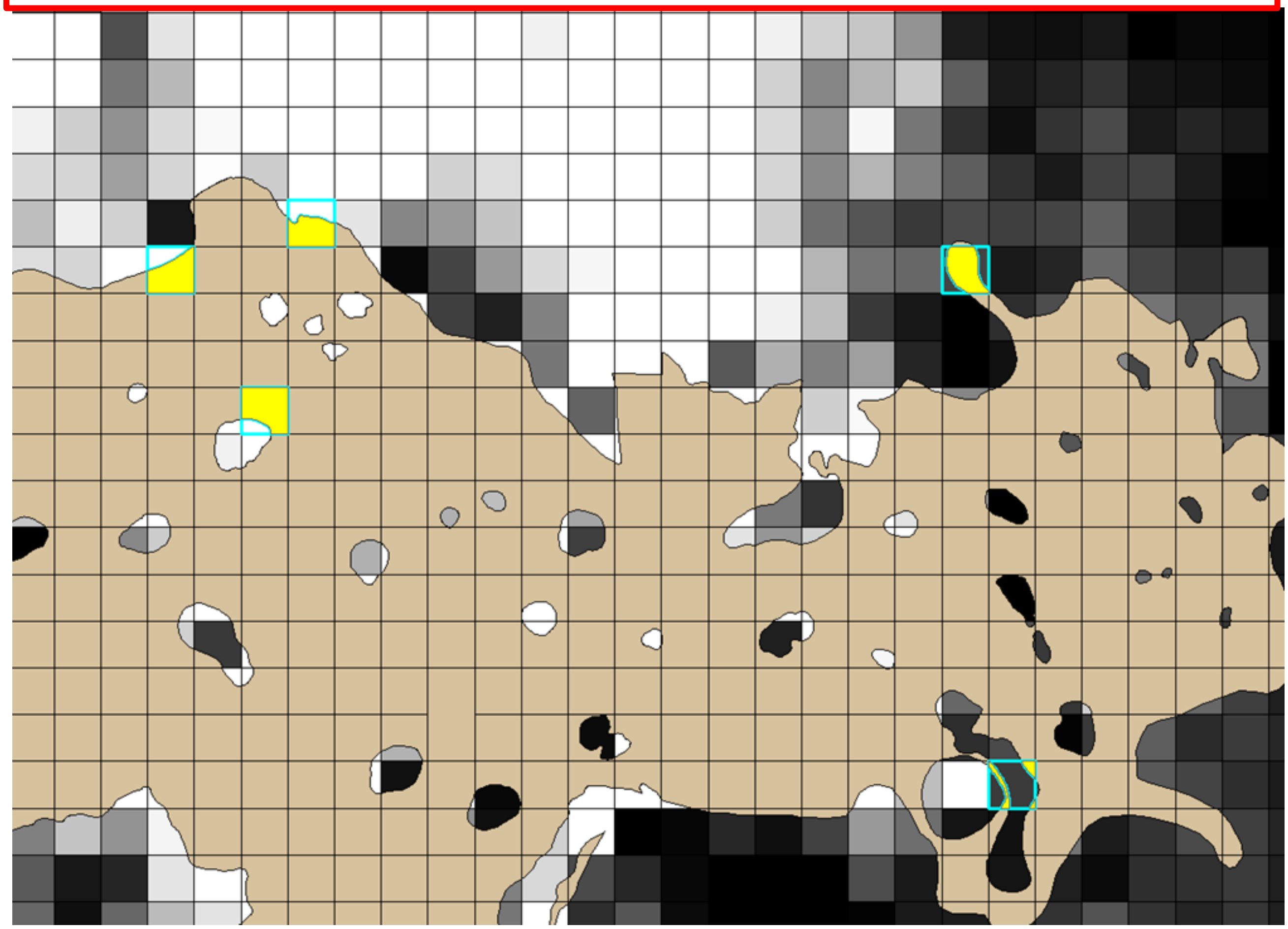
- H_{sfi} = The hydrologic statistic average value for FLUCCS code i
- s = a hydrologic statistic –
- H_{wnix} = A hydrologic statistic value wn for one shape x of FLUCCS code i
- A_{ix} = area of FLUCCS code i shape x
- n_i = number of shapes for FLUCCS code i

For different multiple polygon areas (e.g. for Red Cockaded Woodpecker core foraging areas - CFA) the same general equations would apply to a calculation of the weighted hydrologic statistics for each FLUCCS shape intersecting a CFA, each FLUCCS code, and CFA mean hydrologic statistics.

Polygon Example (and see Figure below)

- The cell with red borders (full cell) has the average overland depth of 9.0 inches.
- After intersection with cypress polygon, only about 71.9% of the cell falls in the cypress polygon (yellow colored segment). Hence, the area weighted average overland depth for the cypress cell comes out to be 6.5 inches (71.9% of 9.0 inches).
- I have shown some other bordering cells following the same methodology.
- Whereas, the cells that fall 100 % within the cypress polygons will retain the raster values.

The cell with red borders (full cell) has the average overland depth of 8.968 inches. After intersection with cypress polygon, only about 71.9% of the cell falls in the cypress polygon (yellow colored segment). Hence, the area weighted average overland depth for the cypress cell comes out to be 6.448 inches (71.9% of 8.968 inches). I have shown some other bordering cells following the same methodology. Whereas, the cells that fall 100 % within the cypress polygons will retain the raster values.



Appendix 4

Graphic Comparison of Simulated Hydrology and Duever (2004) Average Hydrology for Each Project Zone

Hydroperiod
Dry Season Water Table Elevation
Wet Season Water Elevation

Figure A5.1. Core Rehydration Area Hydroperiod

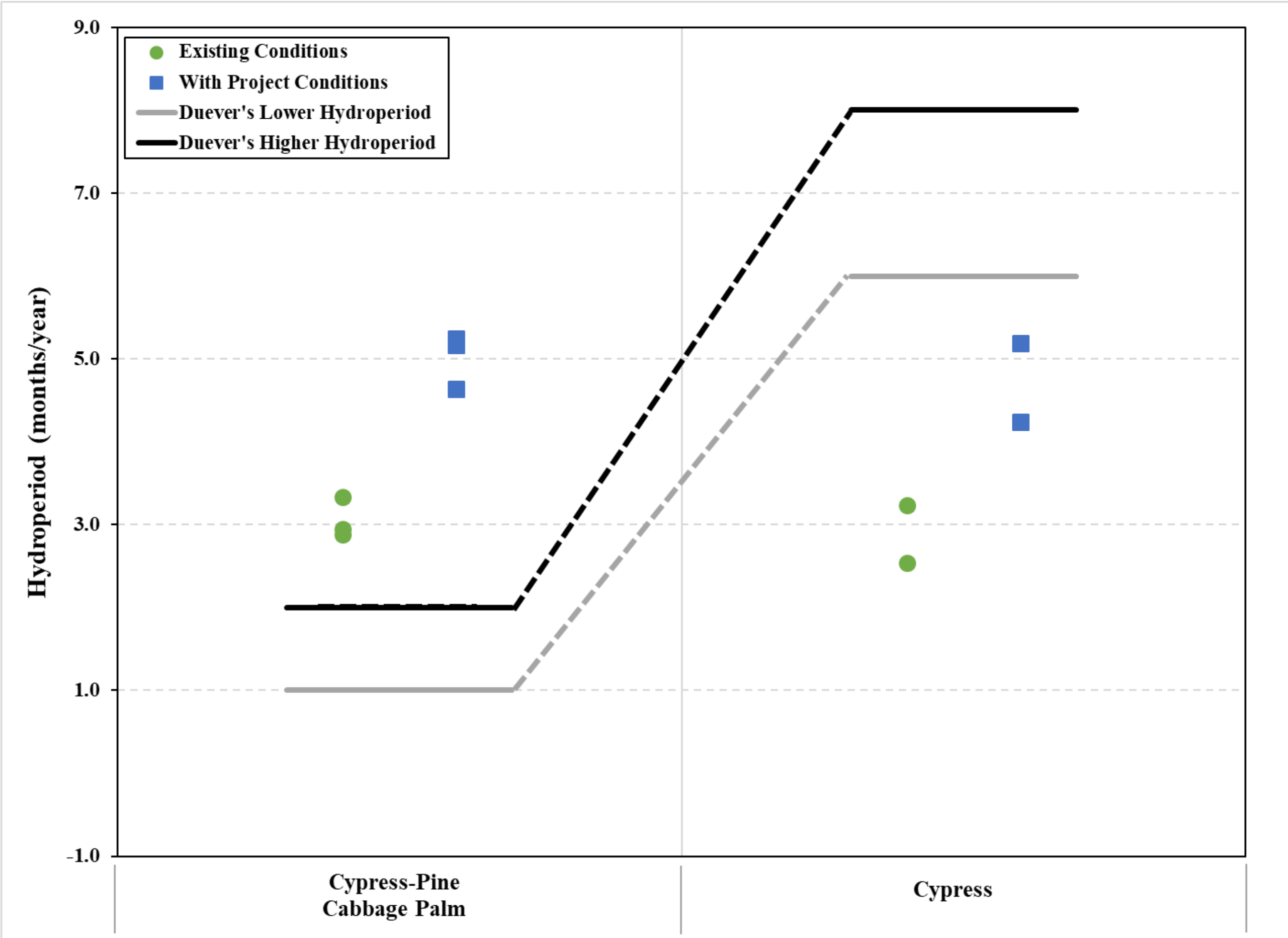


Figure A5.2 Core Rehydration Area Dry Season Water Table Depth

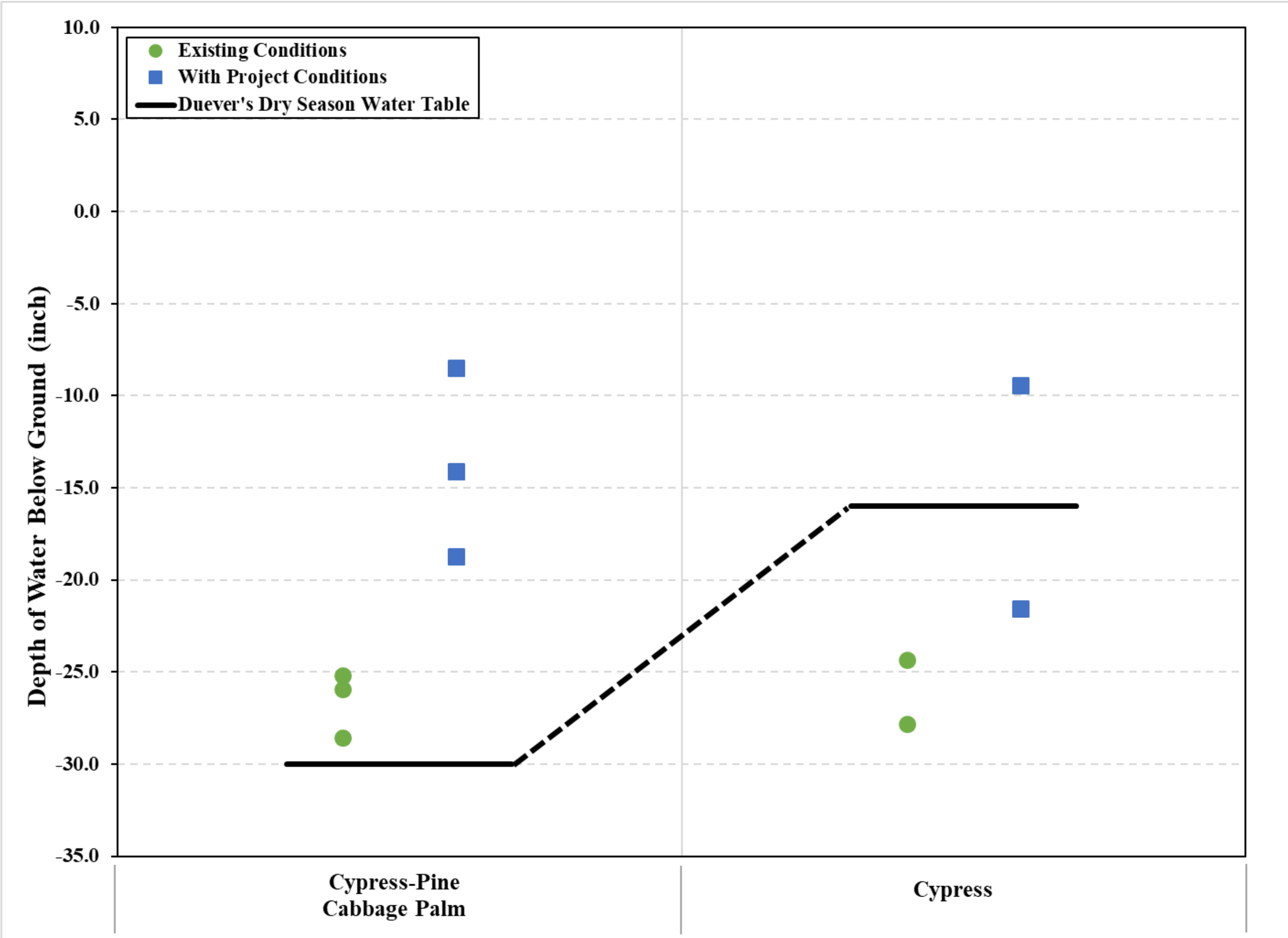


Figure A5.3 Core Rehydration Area Wet Season Water Depth

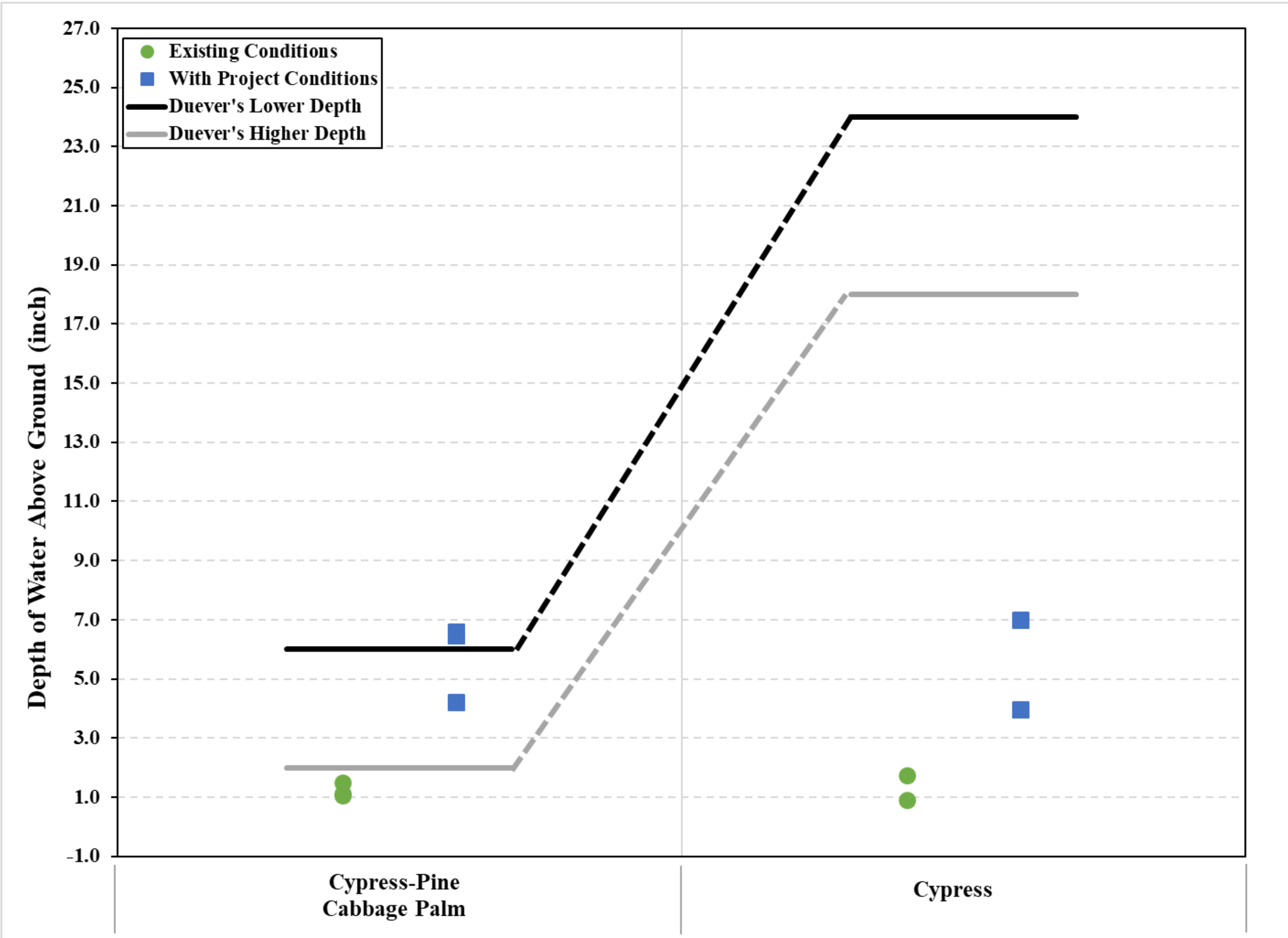


Figure A5.4 Flowway Extent Hydroperiod

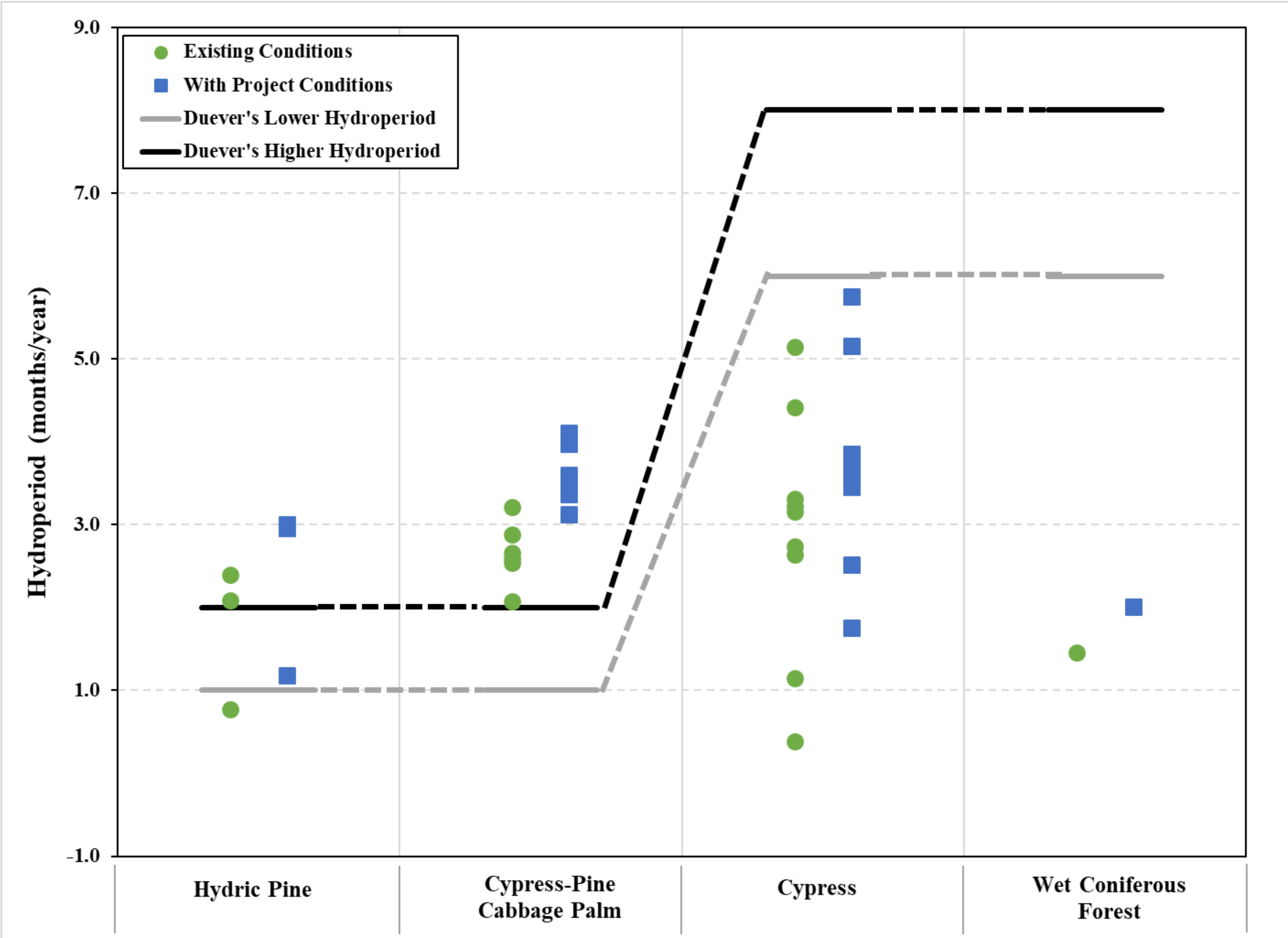


Figure A5.5 Flowway Extent Dry Season Water Table

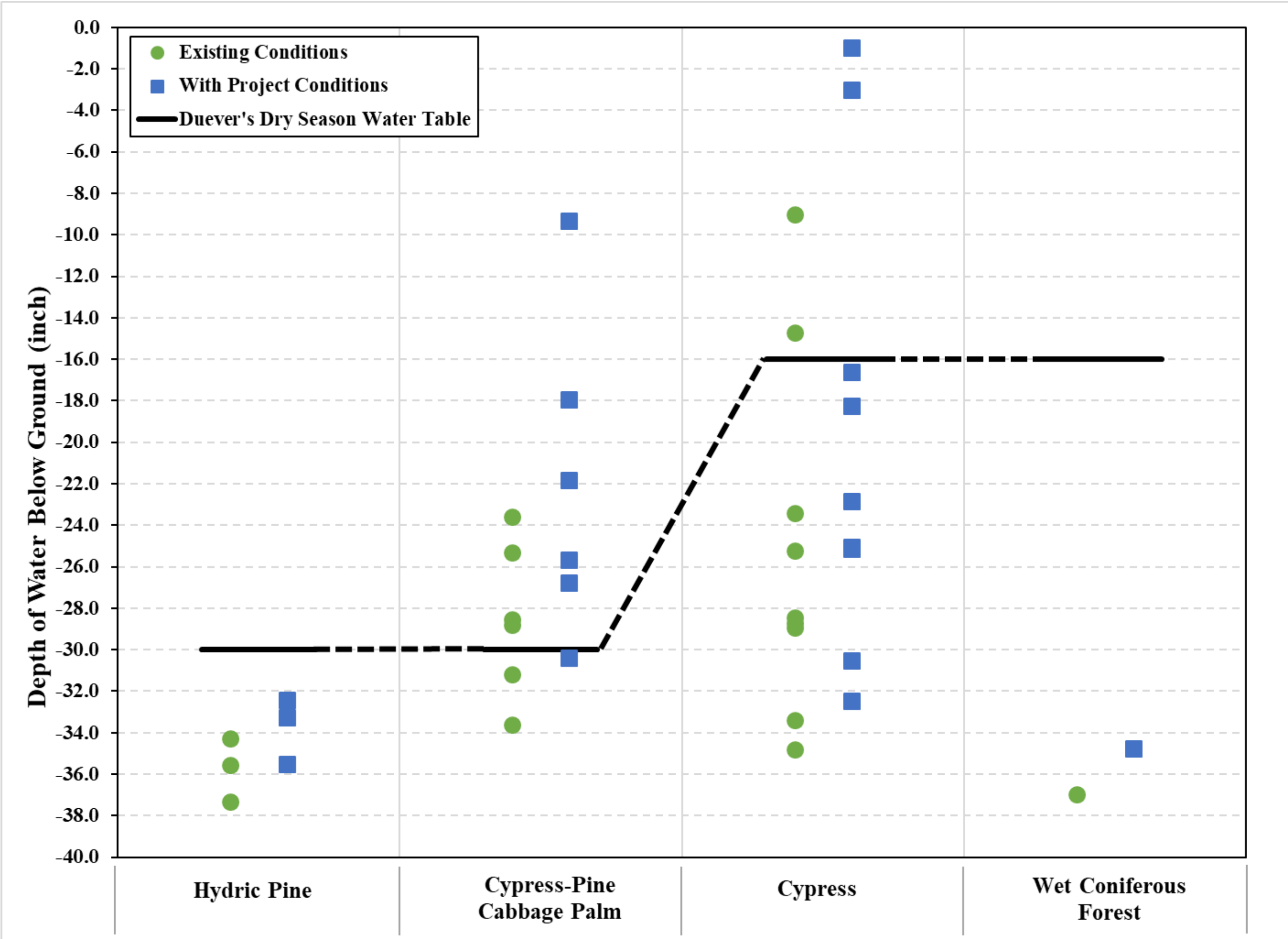


Figure A5.6 Flowway Extent Wet Season Water Elevation

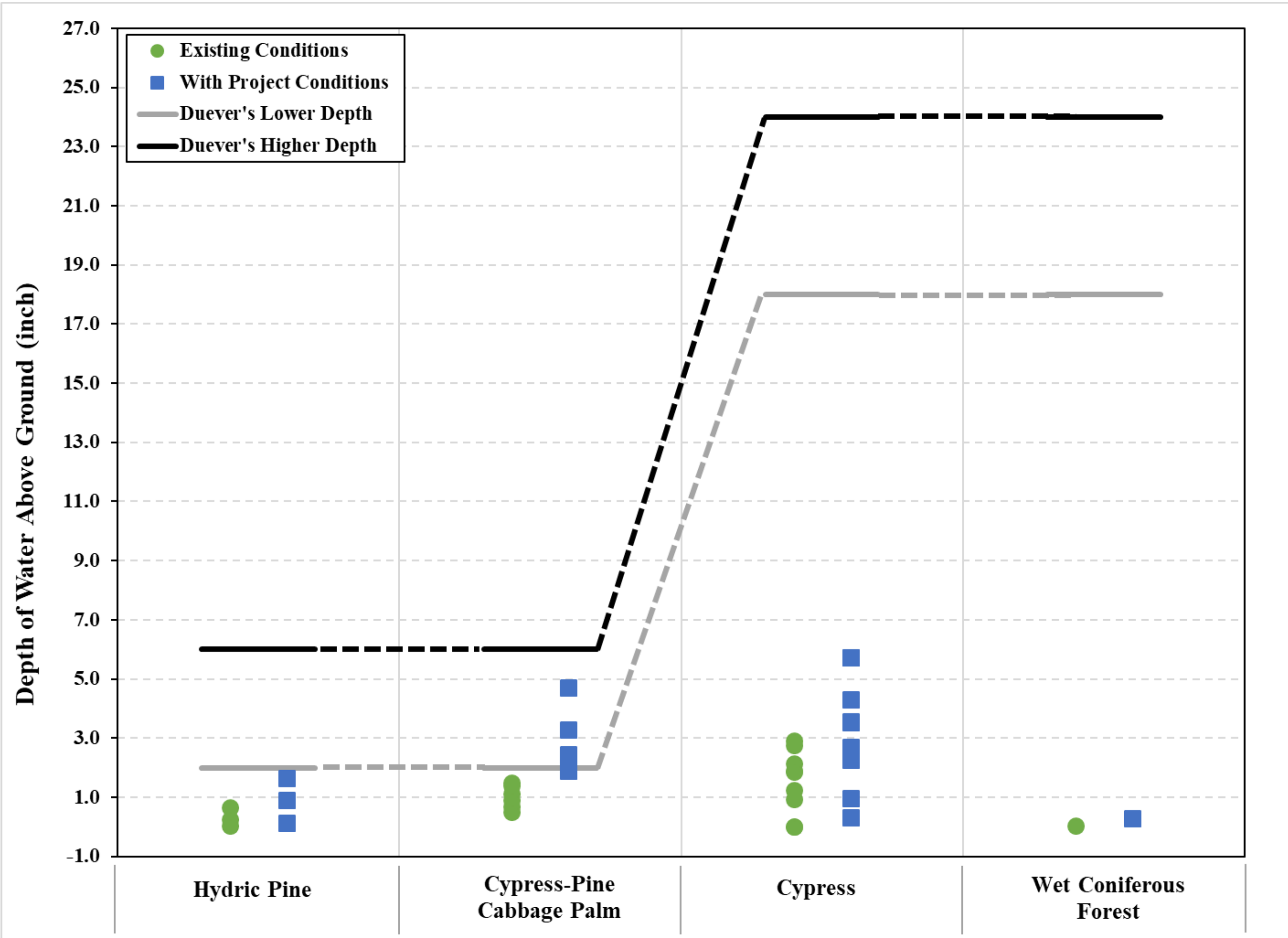


Figure A5.7 Outside Area Hydroperiod

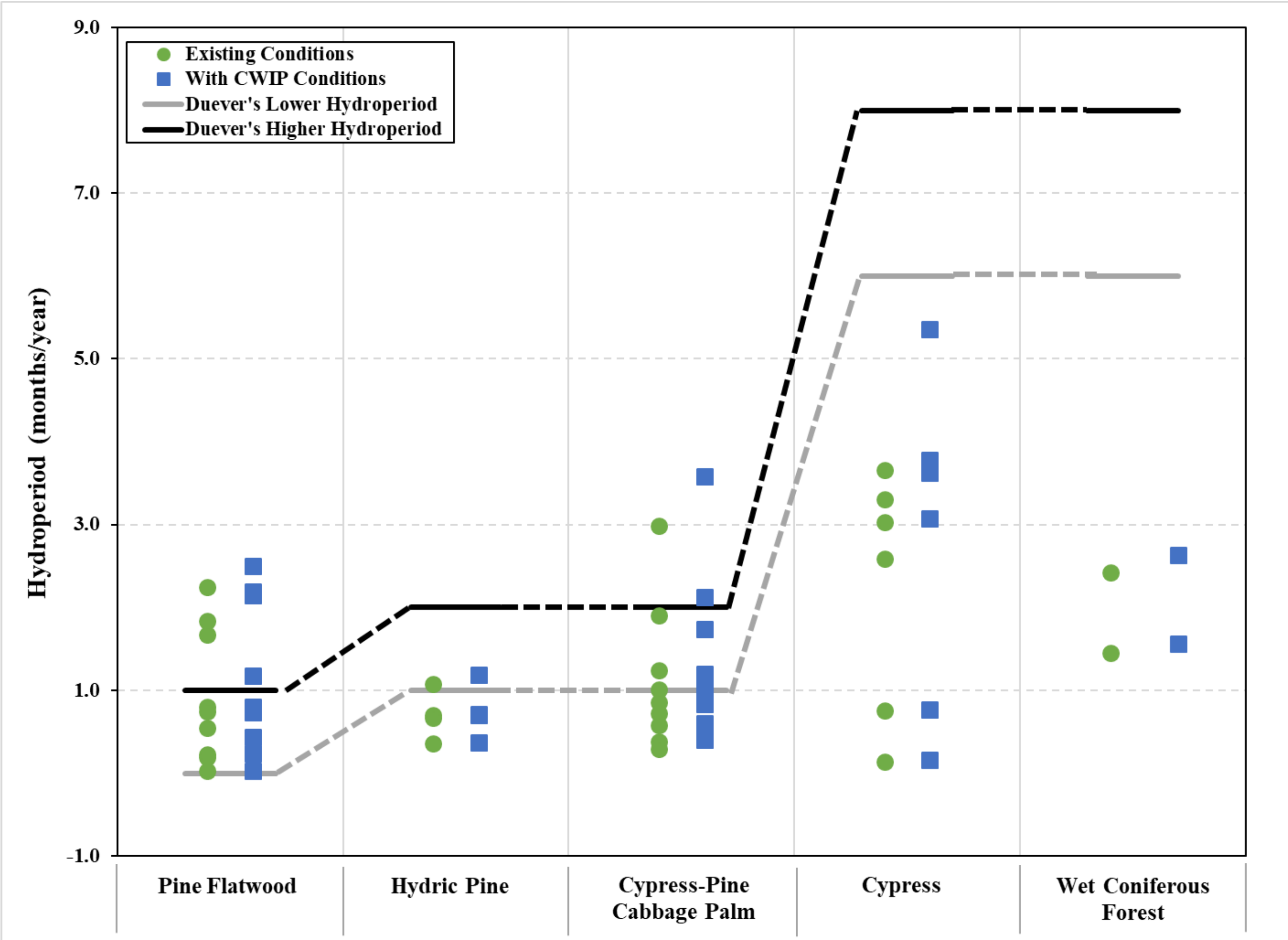


Figure A5.8 Outside Area Dry Season Water Table

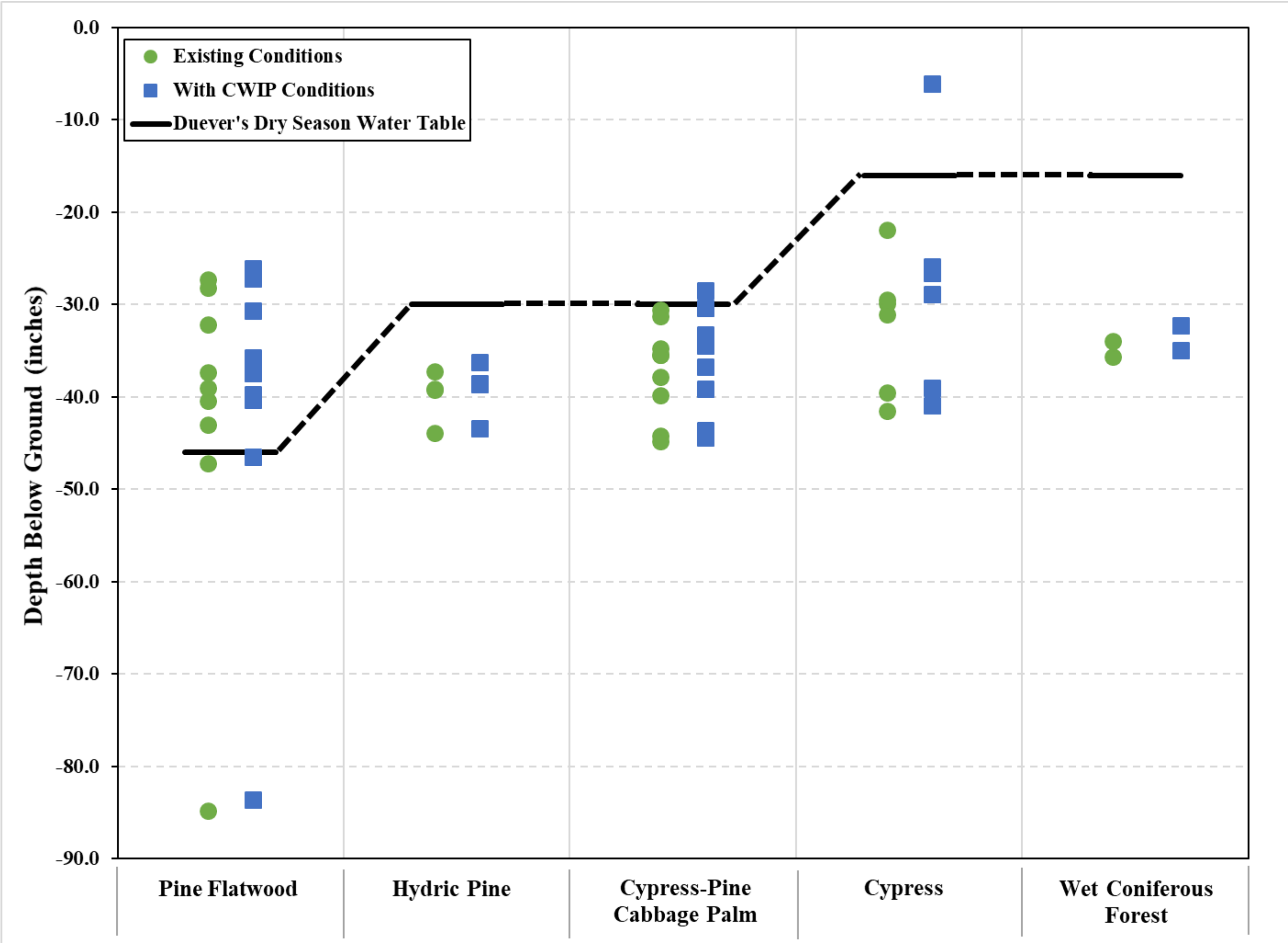


Figure A5.9 Outside Area Wet Season Water Elevation

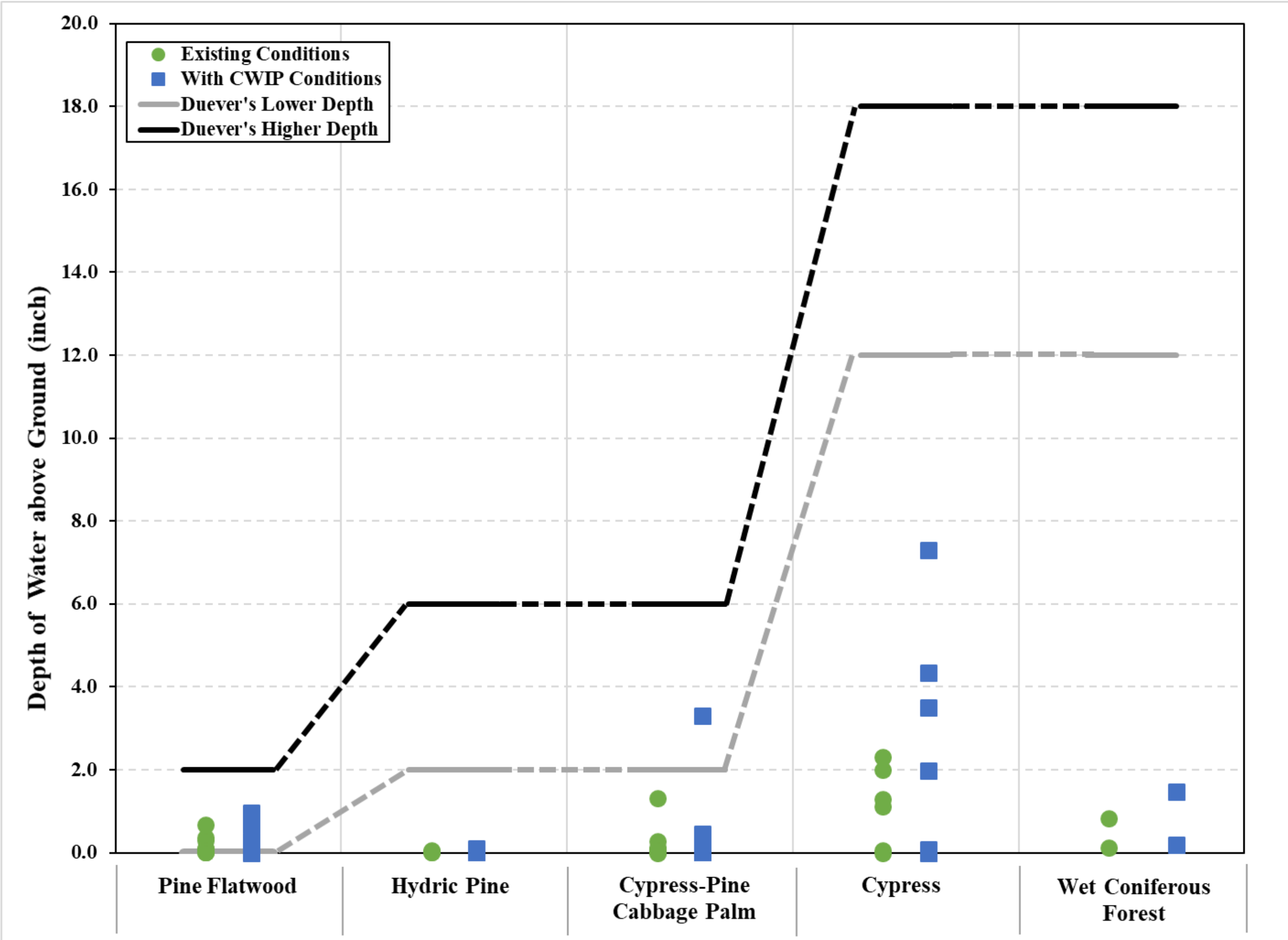


Figure A5.10 RCW Area Hydroperiod

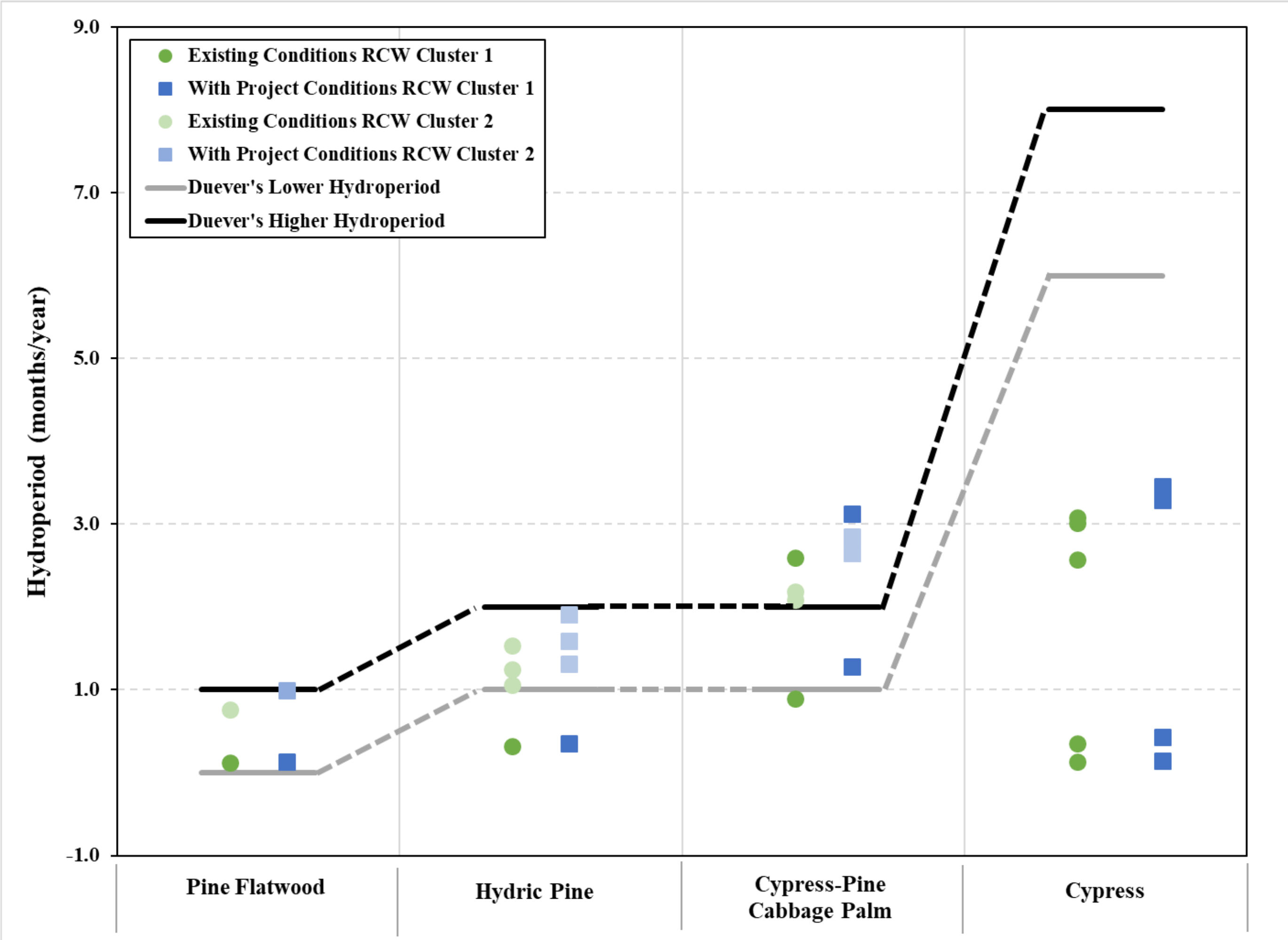


Figure A5.11 RCW Area Dry Season Water Table

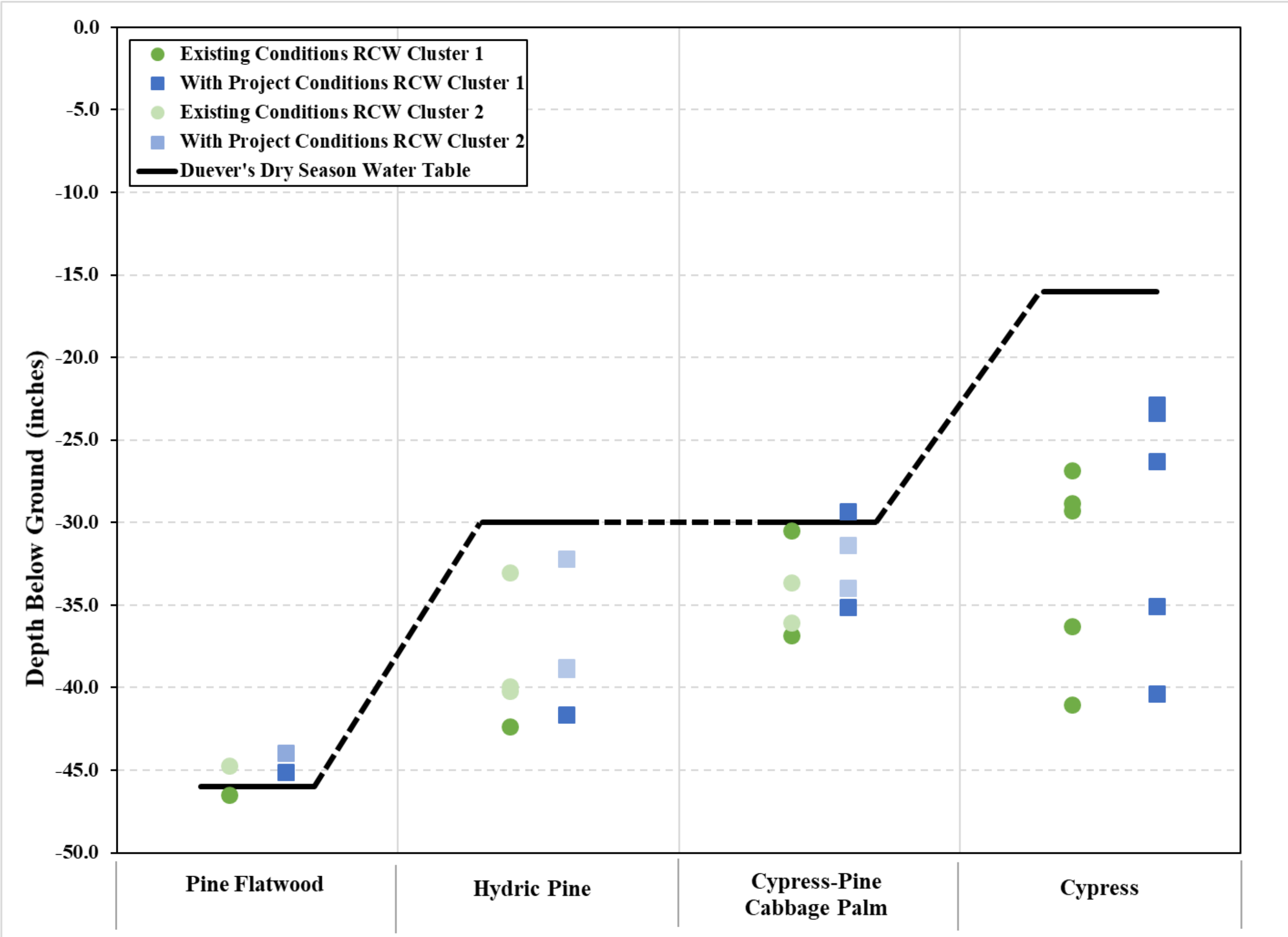
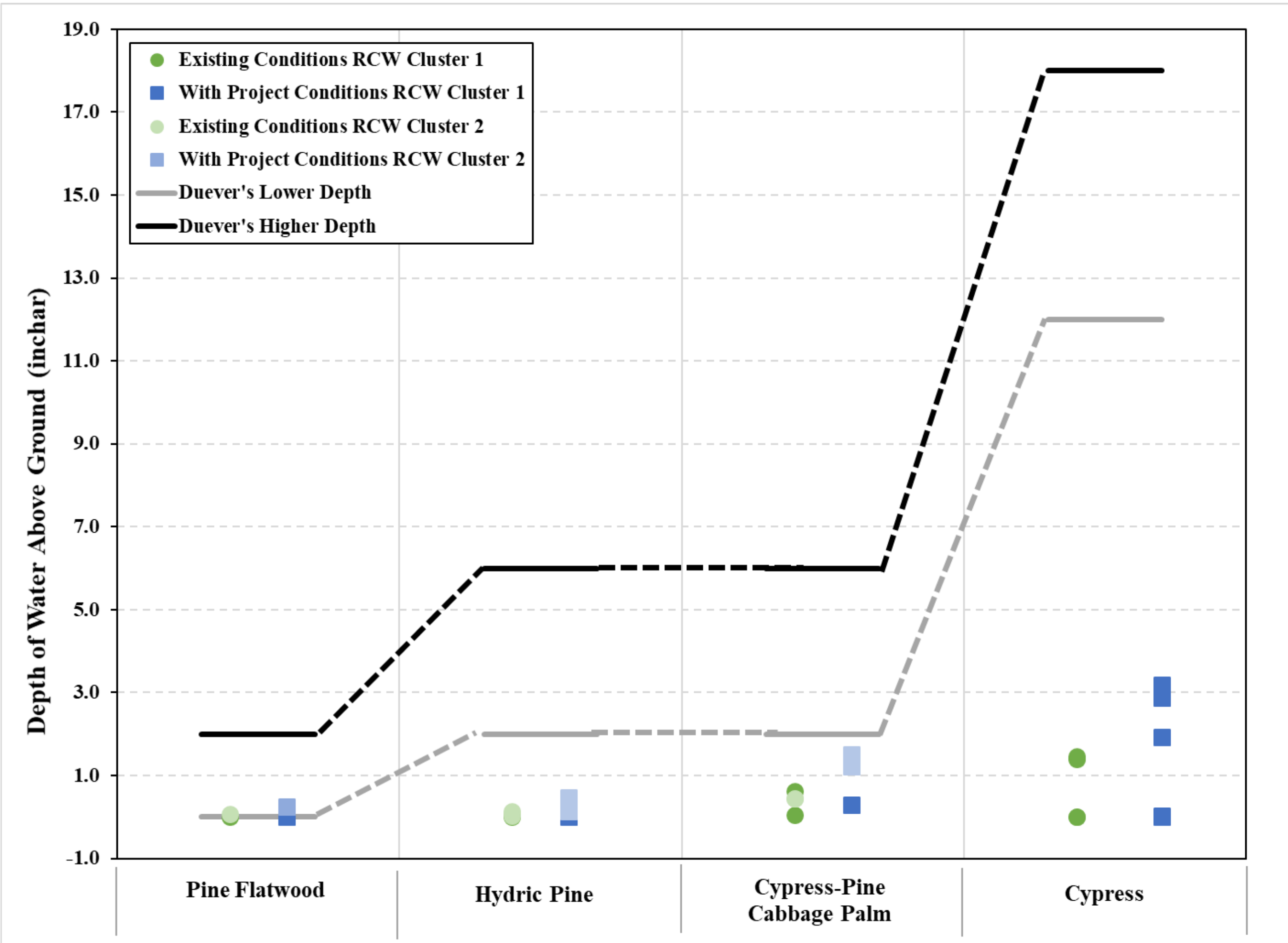


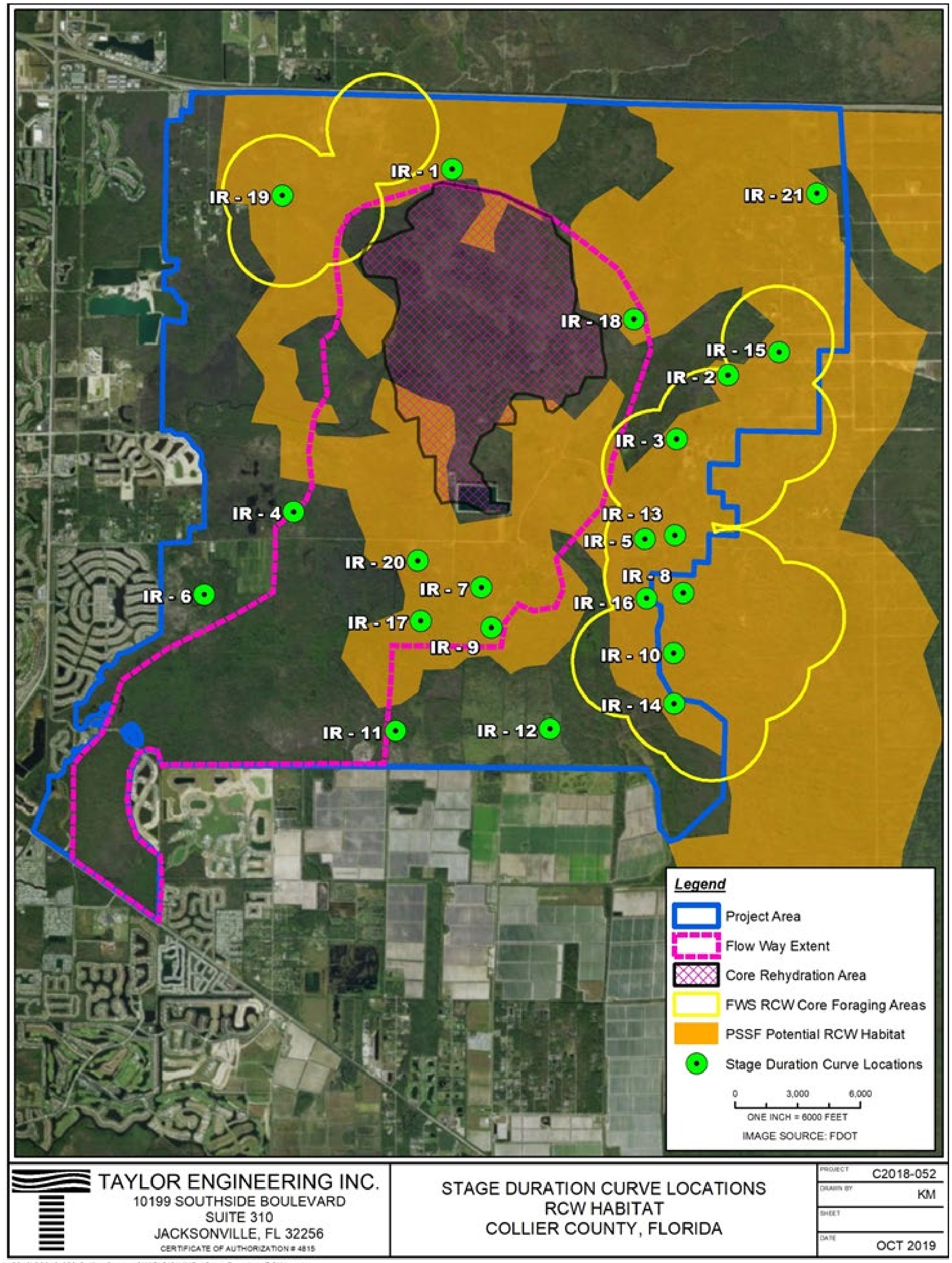
Figure A5.12 RCW Area Wet Season Water Depth



Appendix 5

Stage Duration Curves

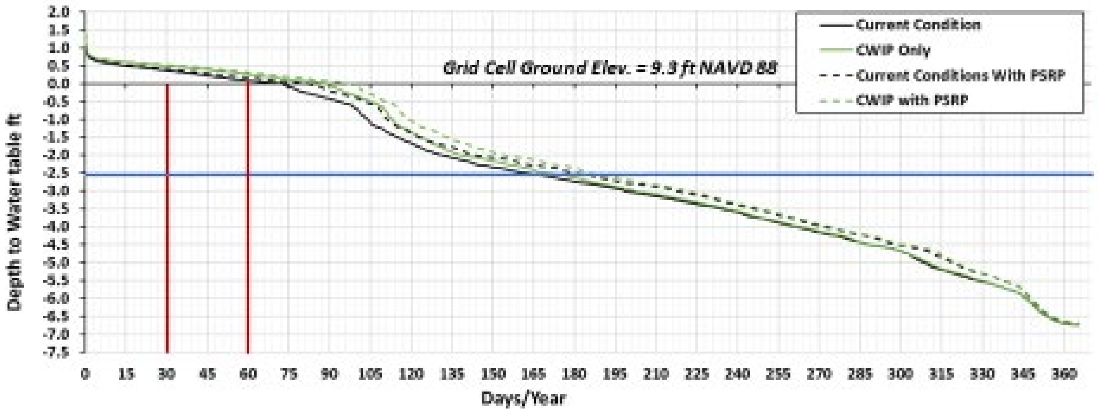
Figure A5-1. Stage Duration Curve Locations and RCW Habitat Areas



Stage-Duration Curves: Current Conditions and CWIP

IR-1: Pine Flatwoods (ID= 501)

IR-2: Cypress Pine Cabbage Palm



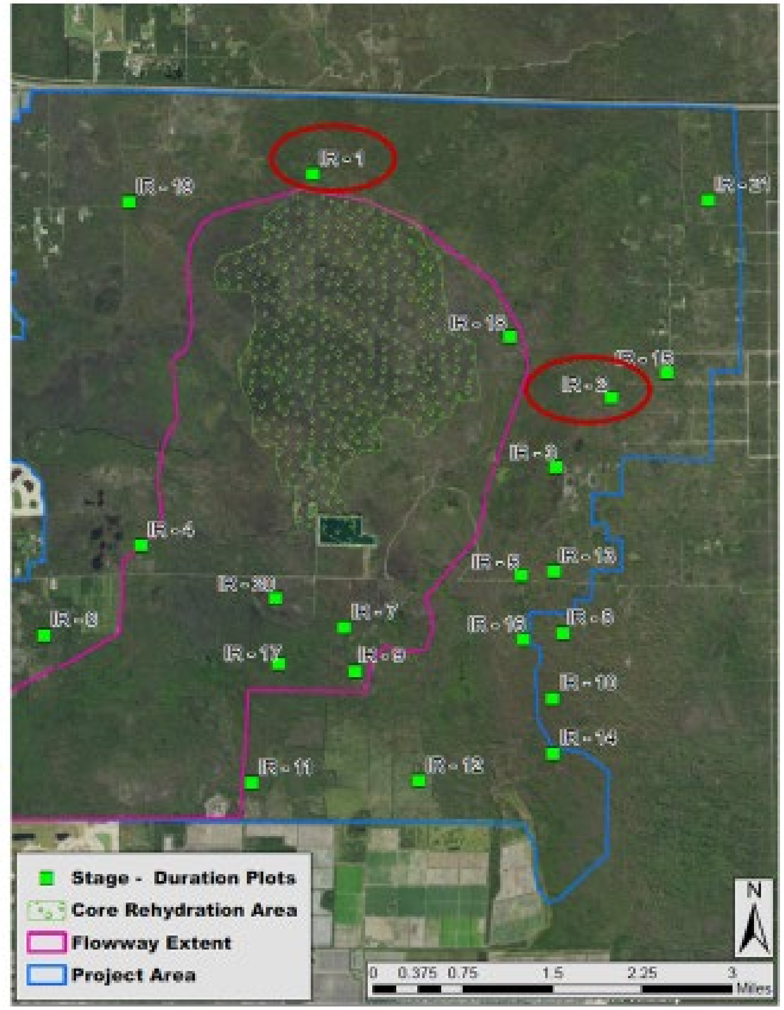
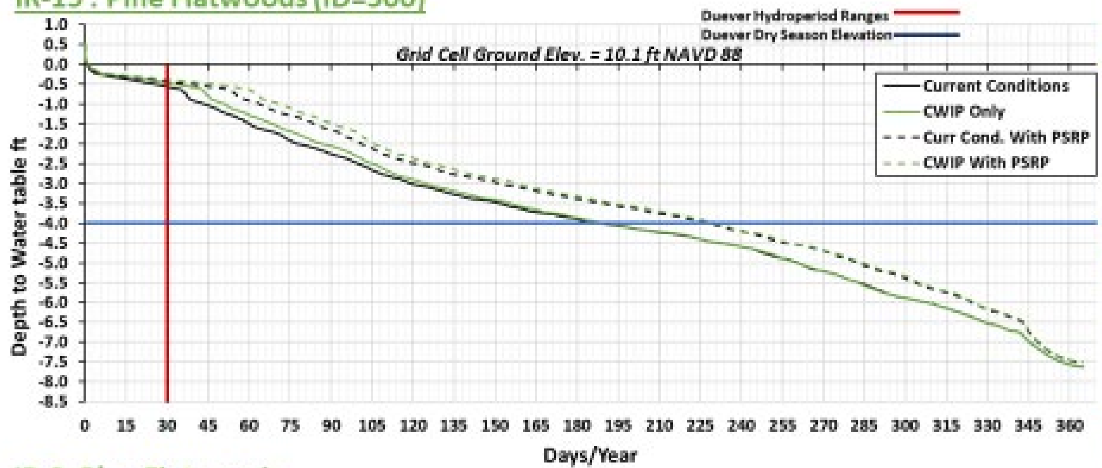


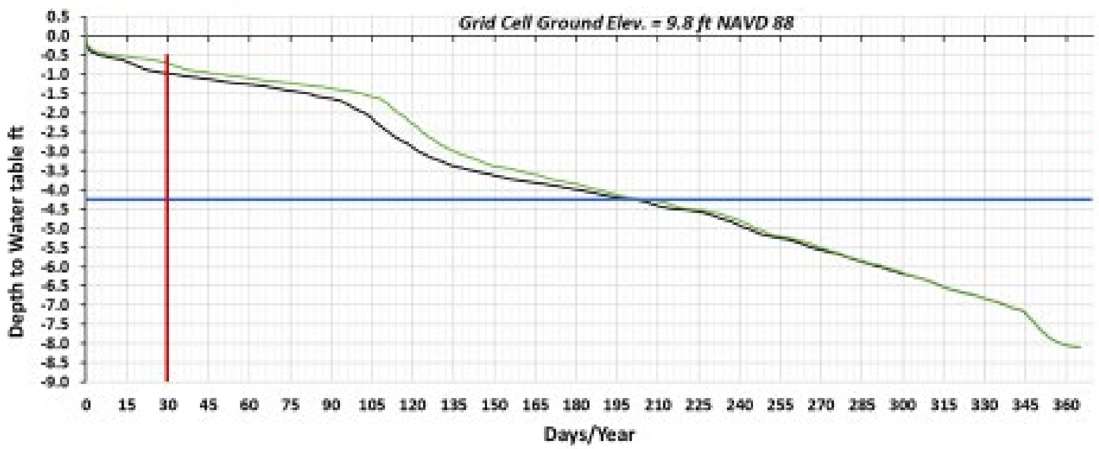
Figure A5-2

Stage-Duration Curves – Current and CWIP Conditions

IR-15 : Pine Flatwoods (ID=500)



IR-3 Pine Flatwoods



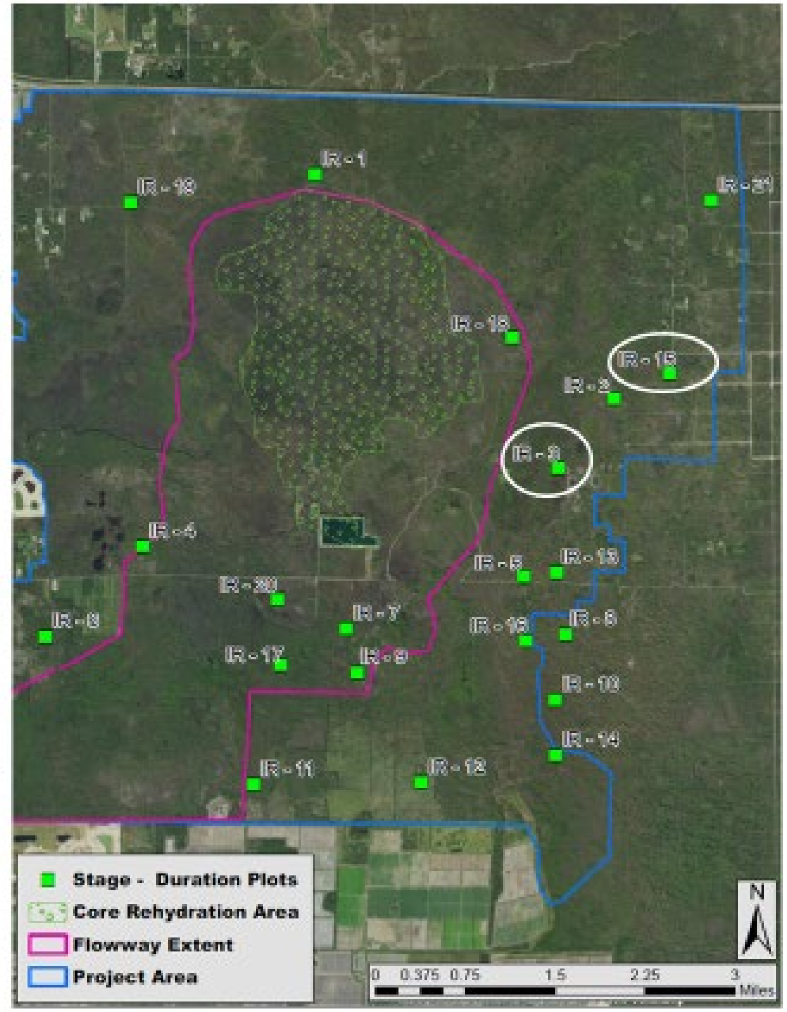


Figure A5-3

Stage-Duration Curves – Current and CWIP Conditions

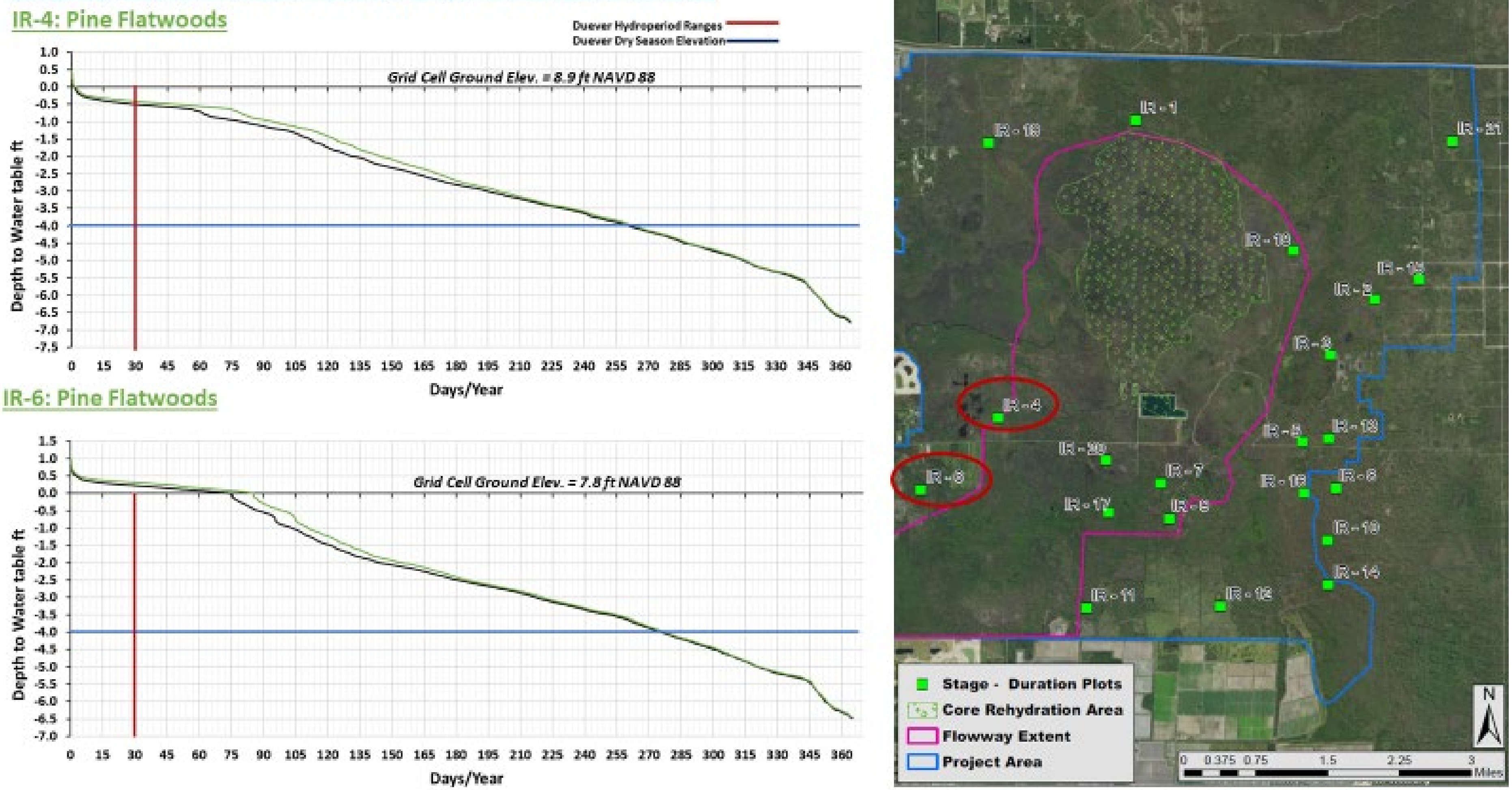
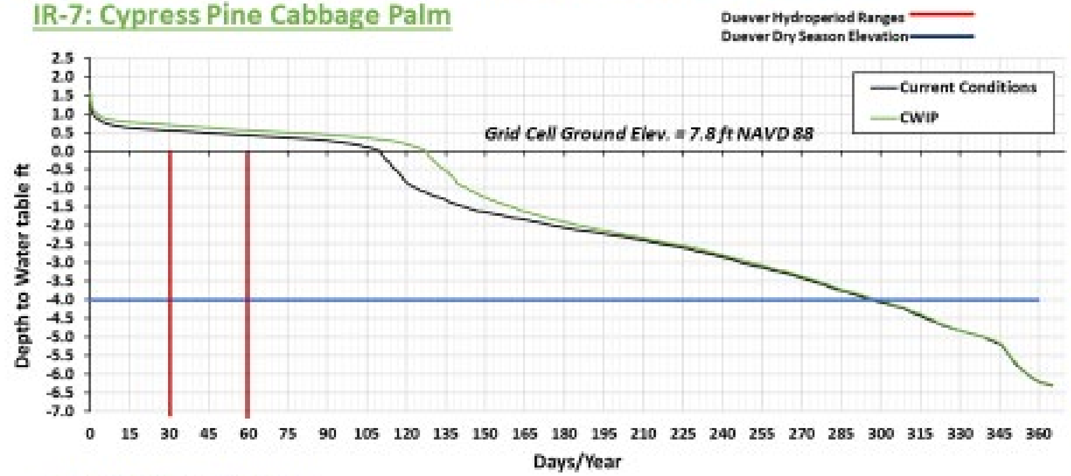


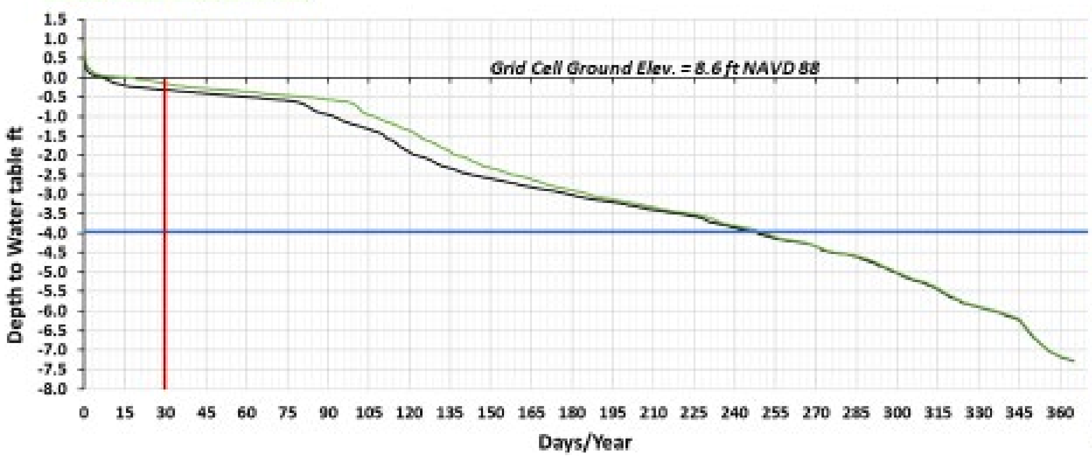
Figure A5-4

Stage Duration Curves – Current Conditions and CWIP

IR-7: Cypress Pine Cabbage Palm



IR-9: Pine Flatwoods



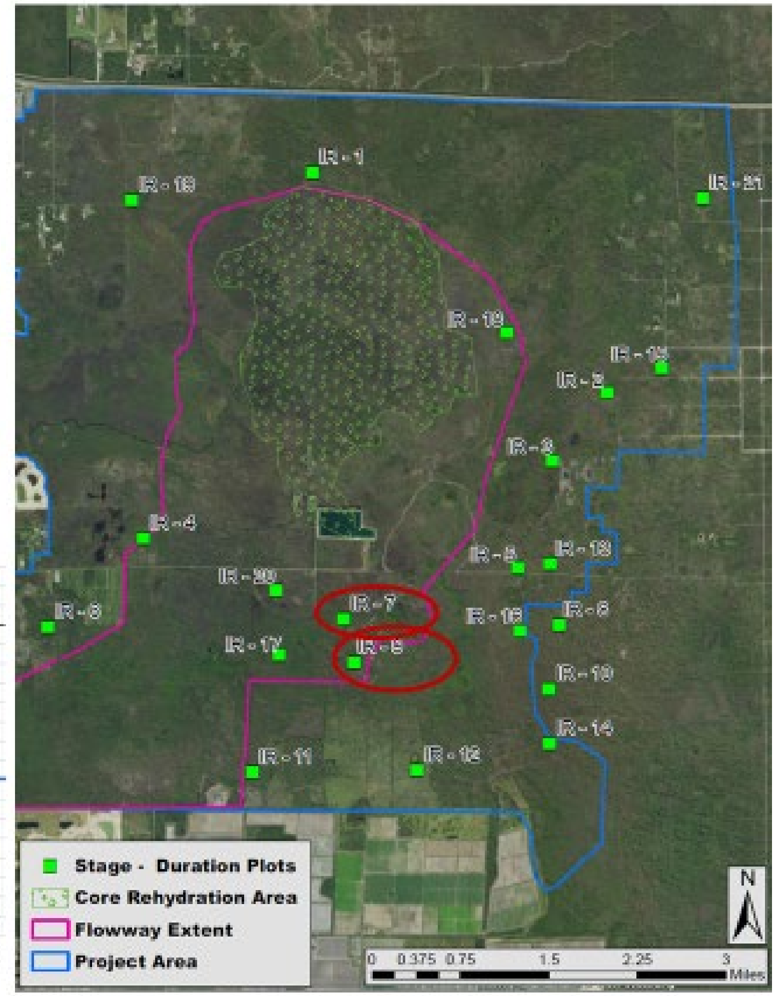
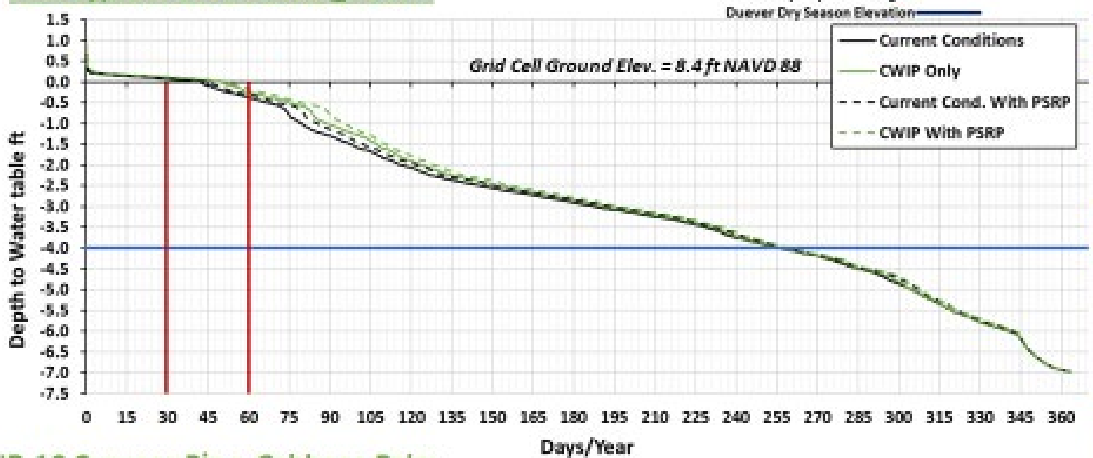


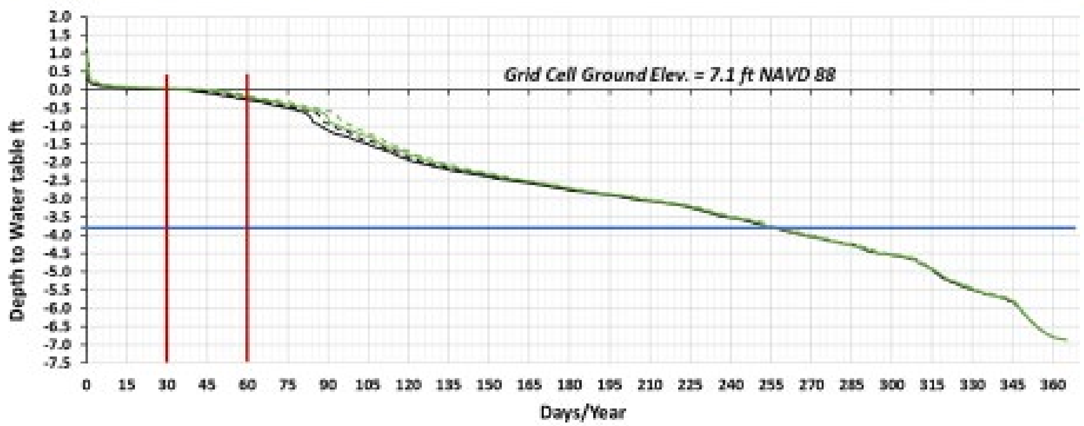
Figure A5-5

Stage-Duration Curves – Current and CWIP Conditions

IR-8 Cypress-Pine- Cabbage Palm



IR-10 Cypress-Pine- Cabbage Palm



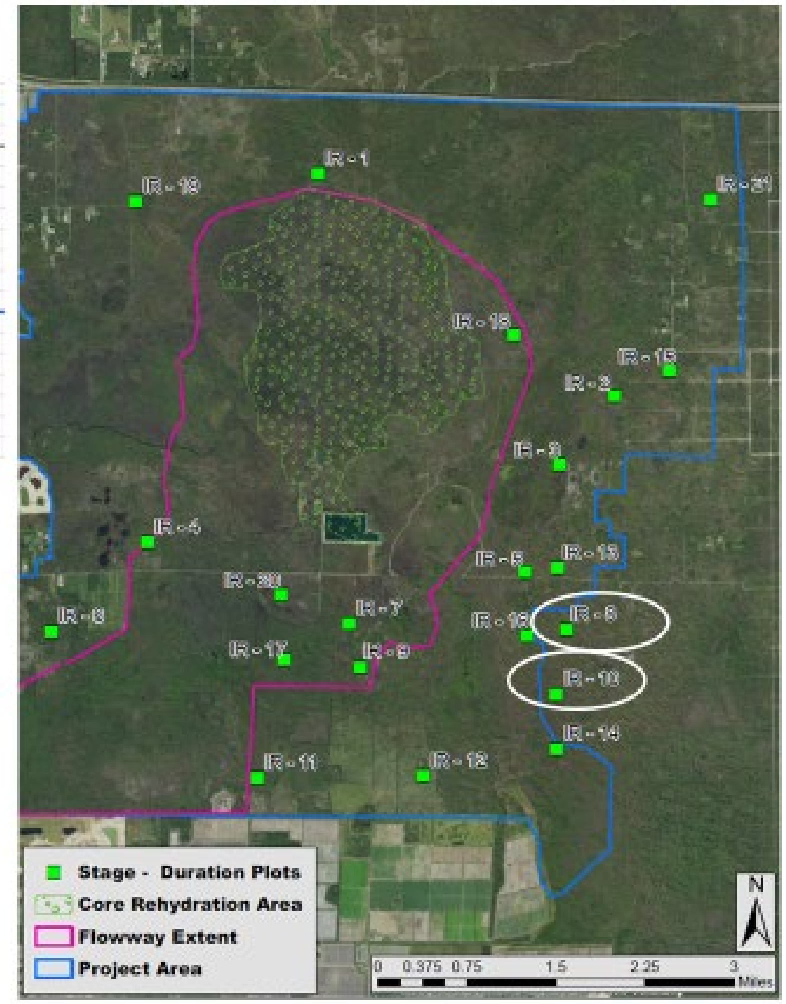
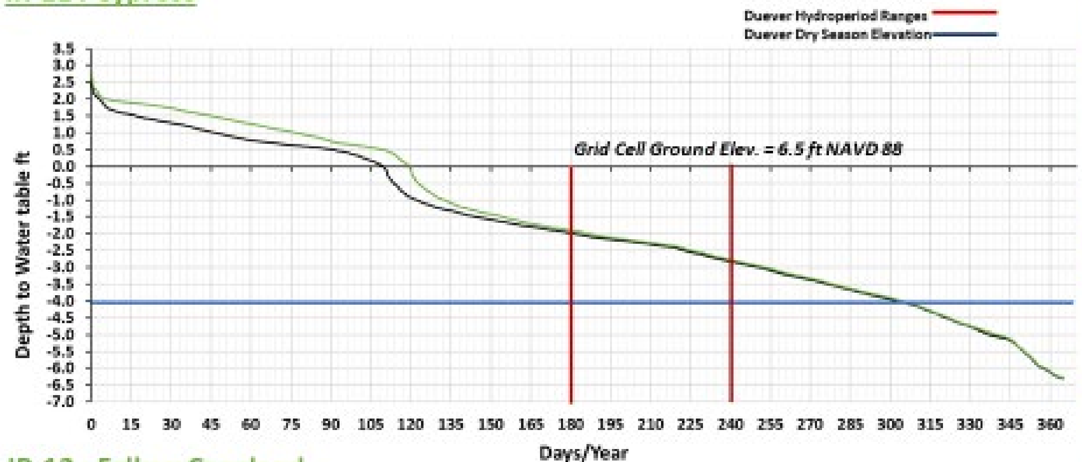


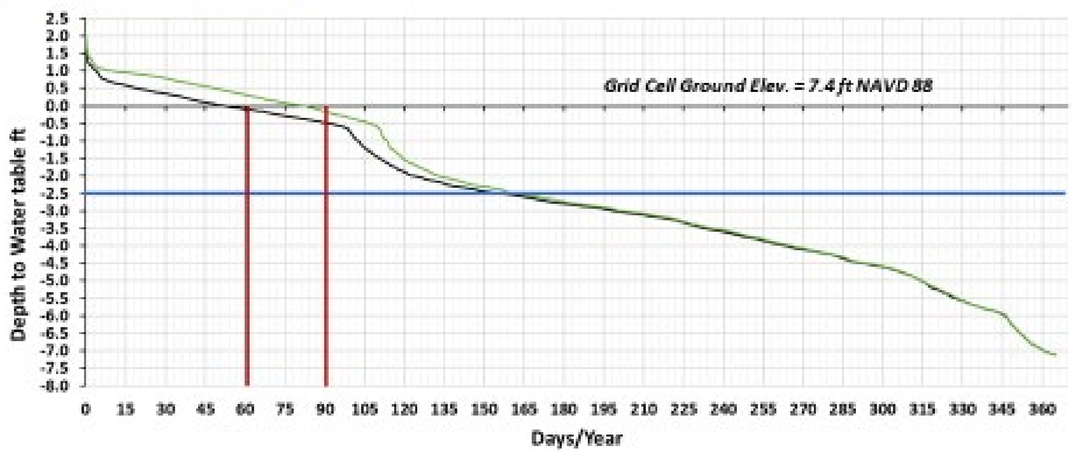
Figure A5-6

Water Table Depths (ft) – Current Conditions and CWIP

IR-11 : Cypress



IR-12 : Fallow Cropland



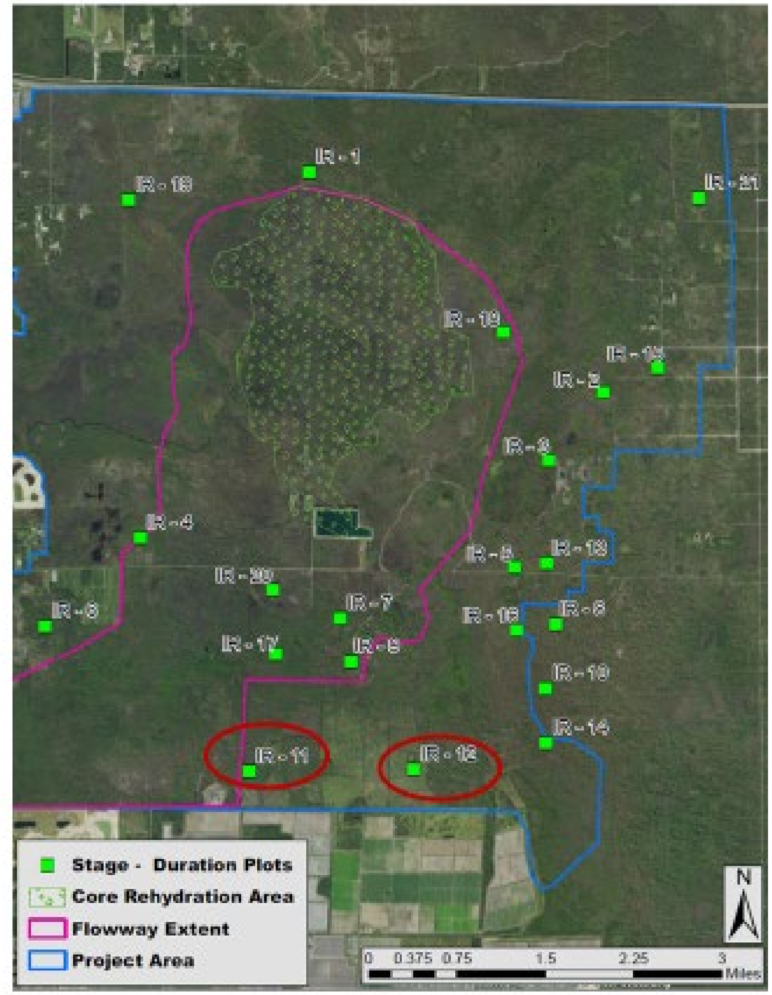
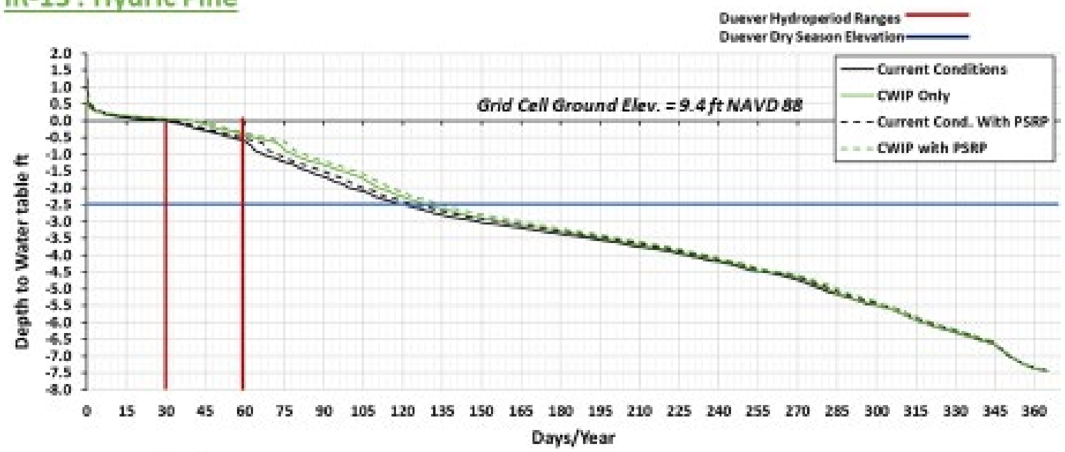


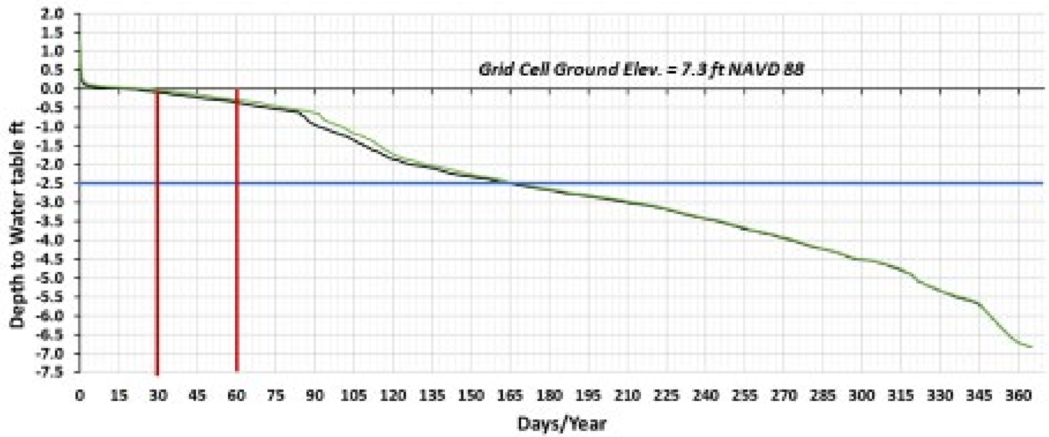
Figure A5-7

Stage – Duration Curves: Current Conditions and CWIP

IR-13 : Hydric Pine



IR-14 : Hydric Pine



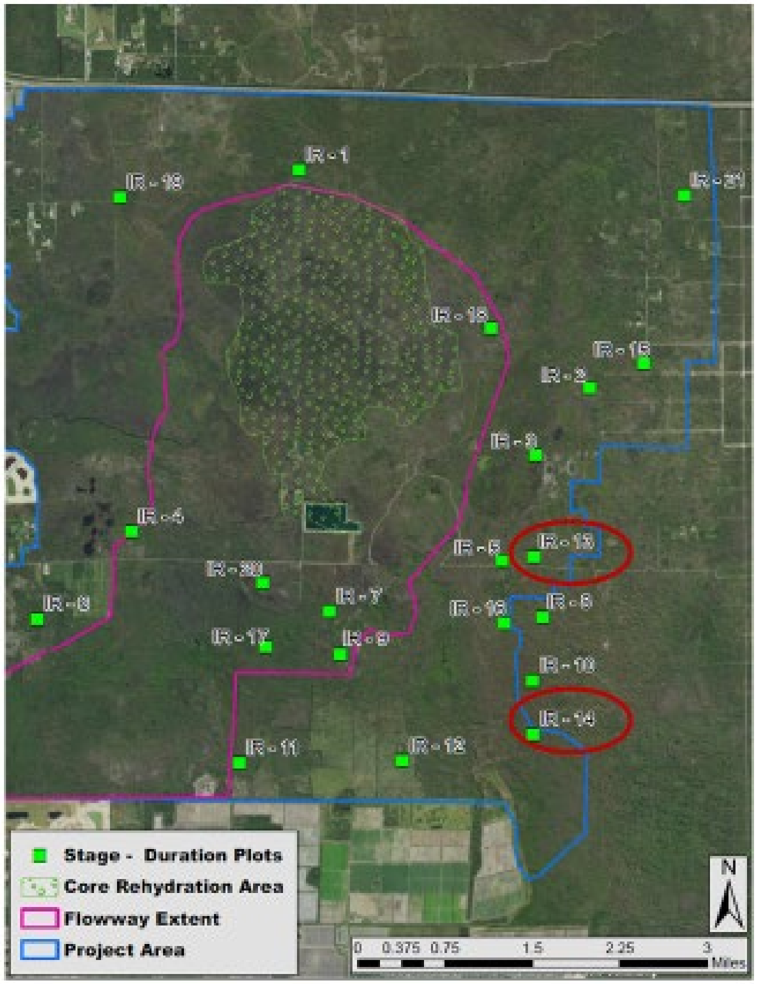
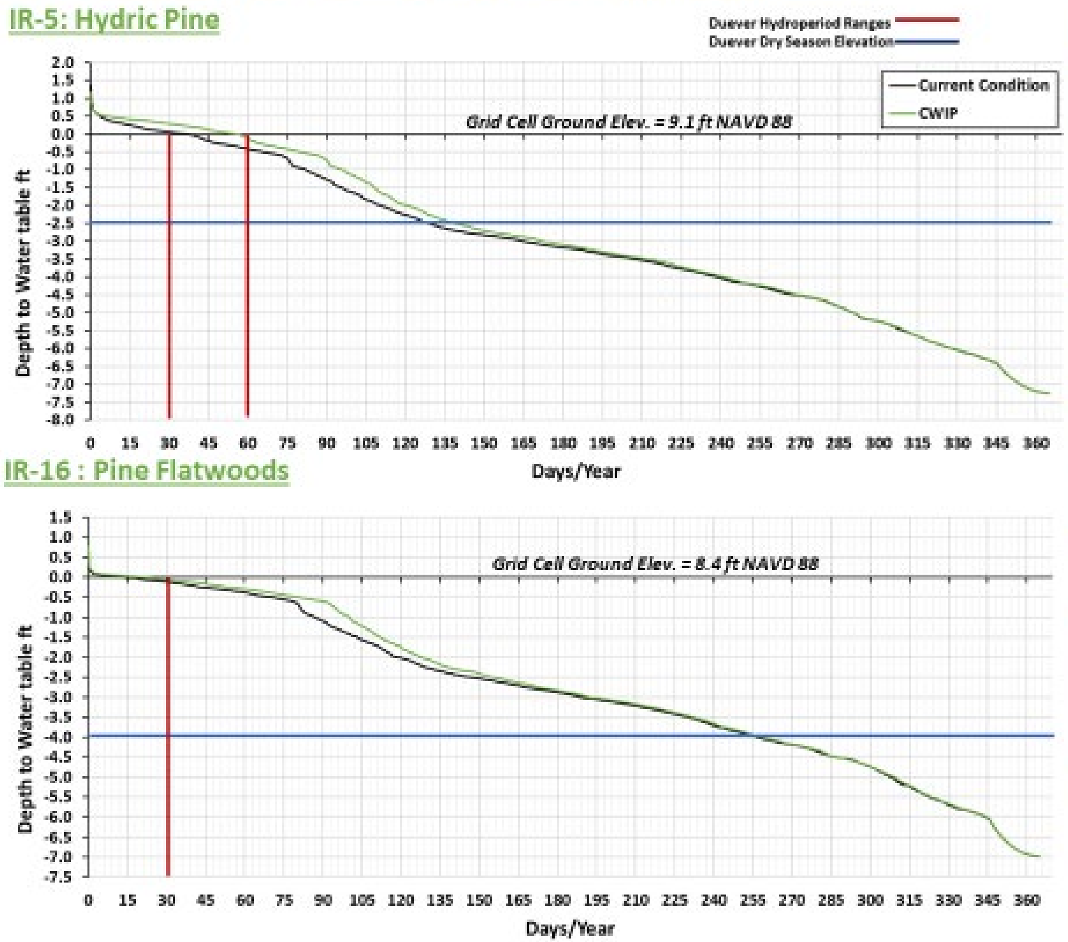


Figure A5-8

Stage Duration Curves – Current Conditions and CWIP



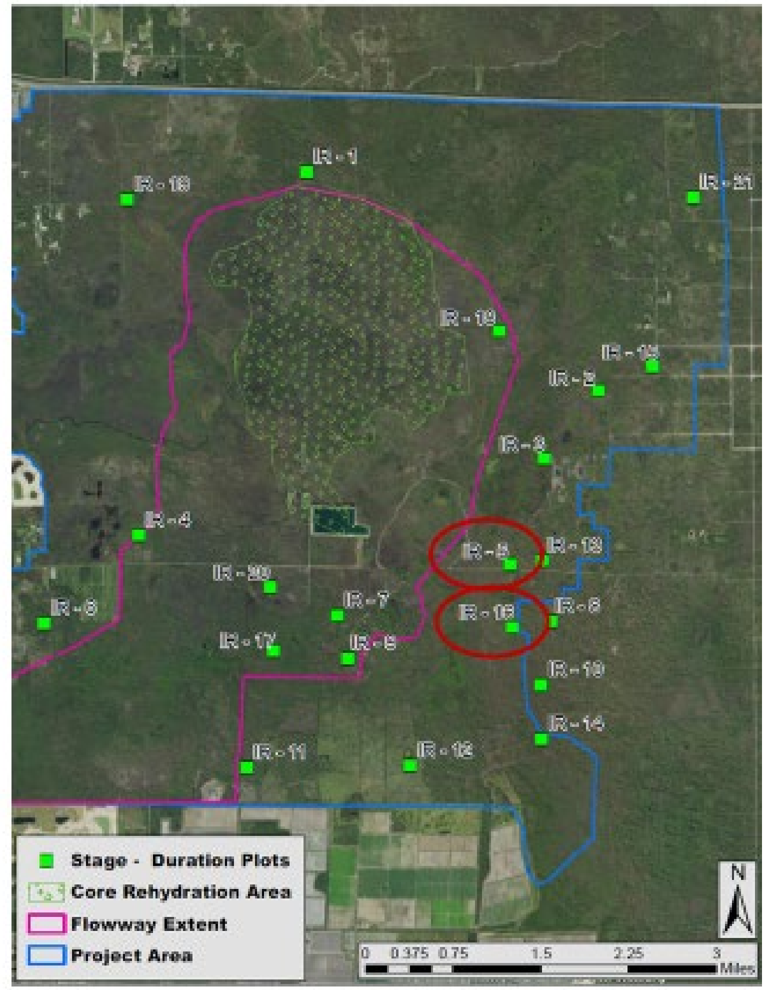
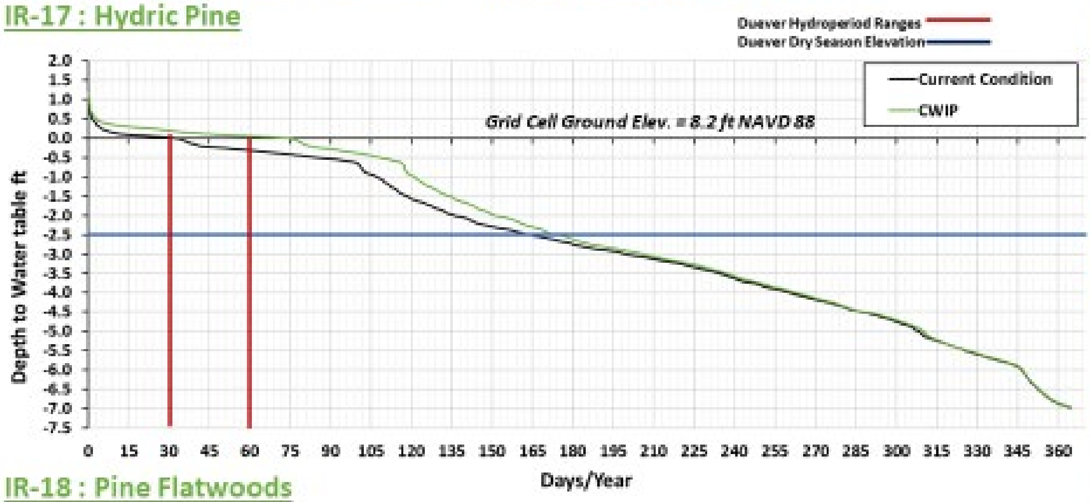


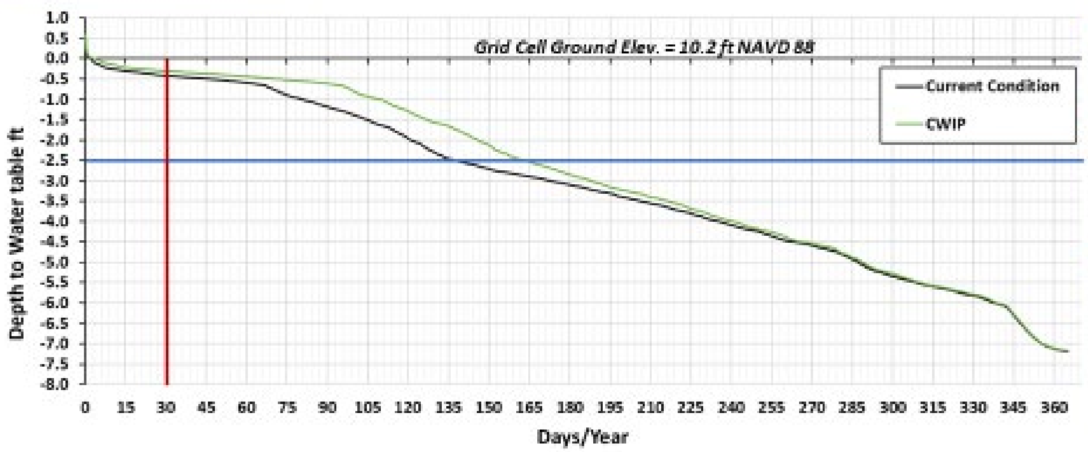
Figure A5-9

Stage Duration Curves – Current Conditions and CWIP

IR-17 : Hydric Pine



IR-18 : Pine Flatwoods



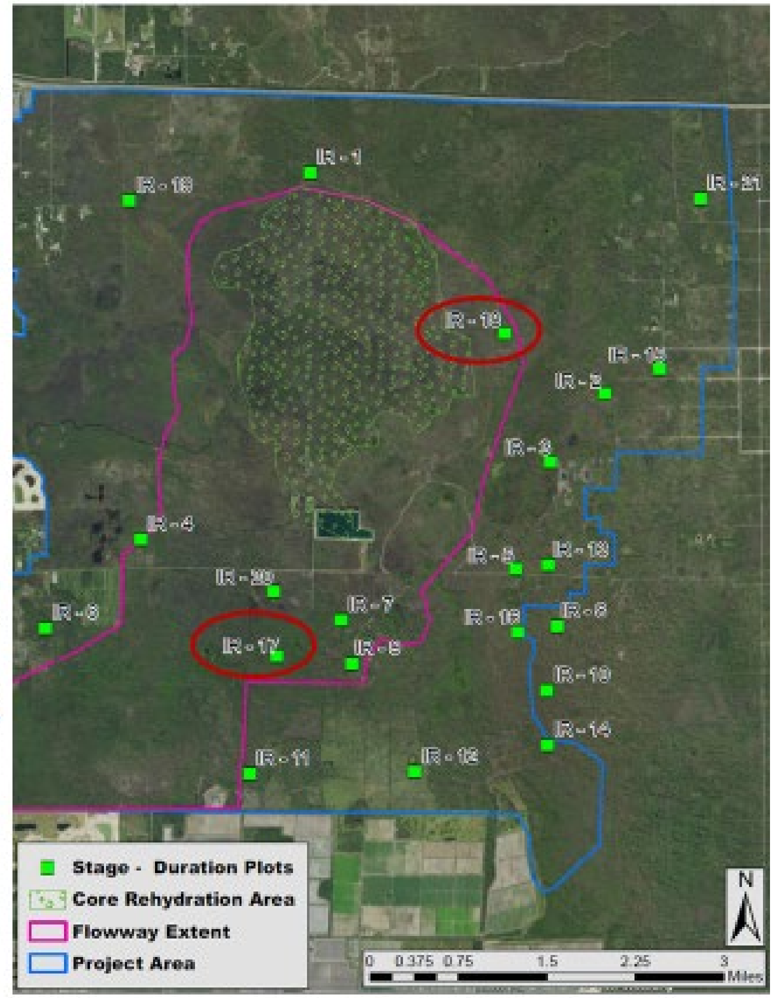
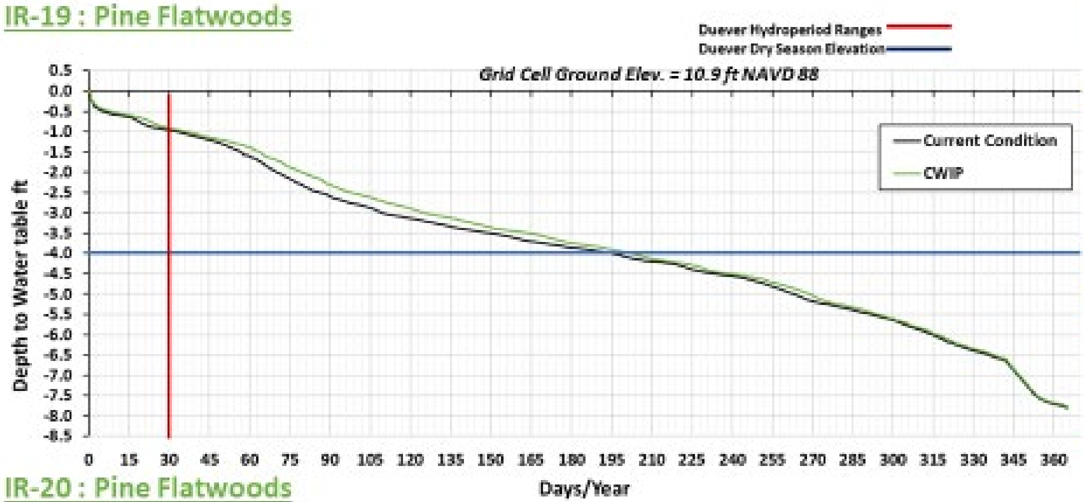


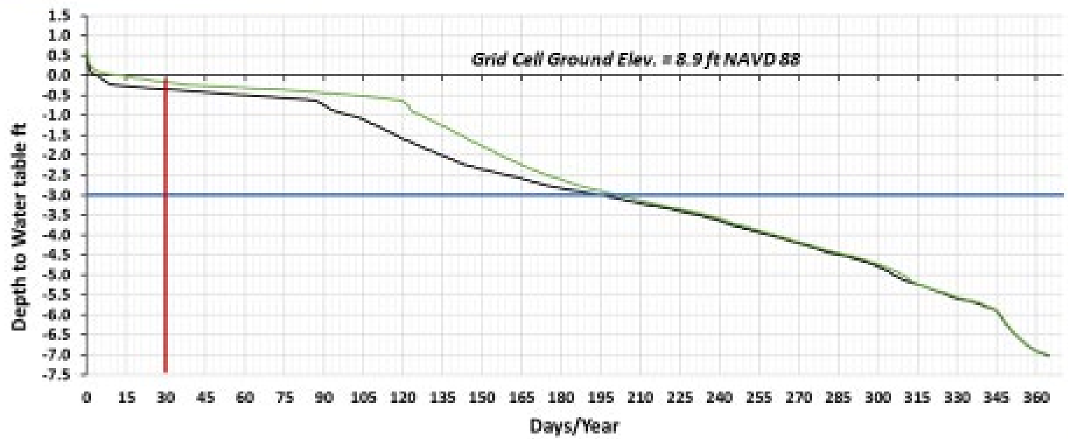
Figure A5-10

Stage Duration Curves – Current Conditions and CWIP

IR-19 : Pine Flatwoods



IR-20 : Pine Flatwoods



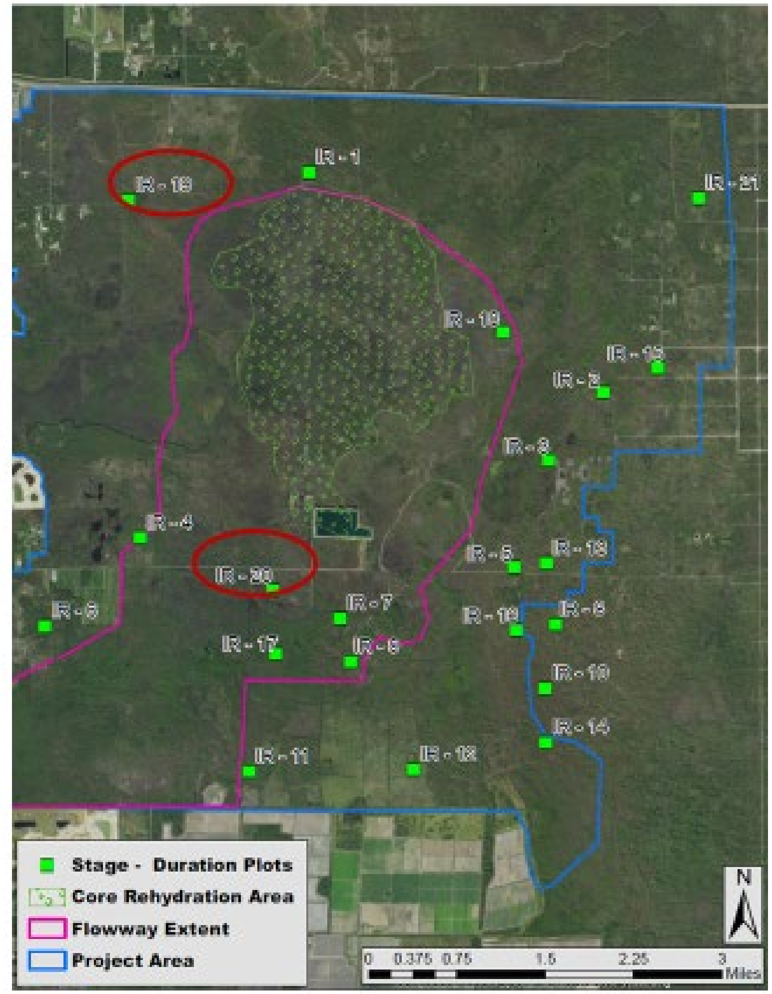
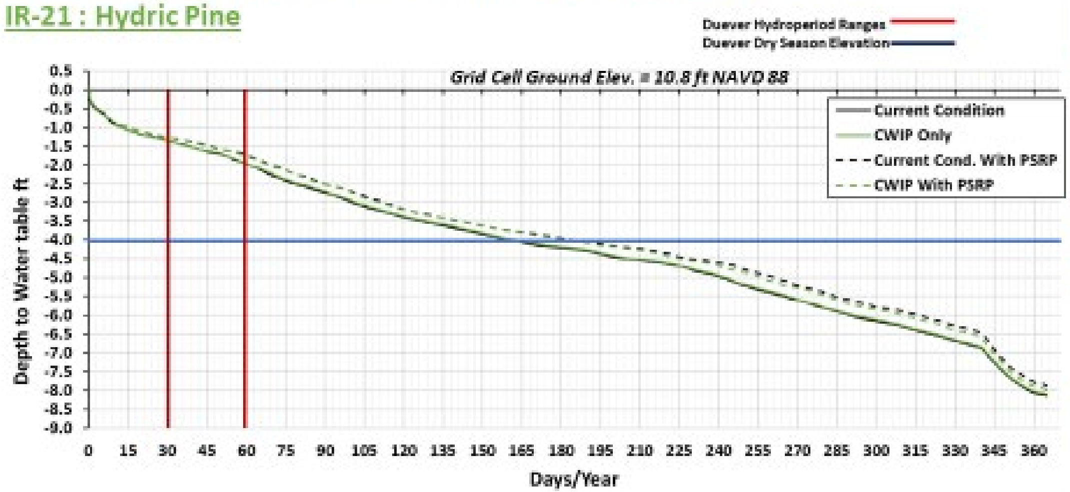


Figure A5-11

Stage Duration Curves – Current Conditions and CWIP

IR-21 : Hydric Pine



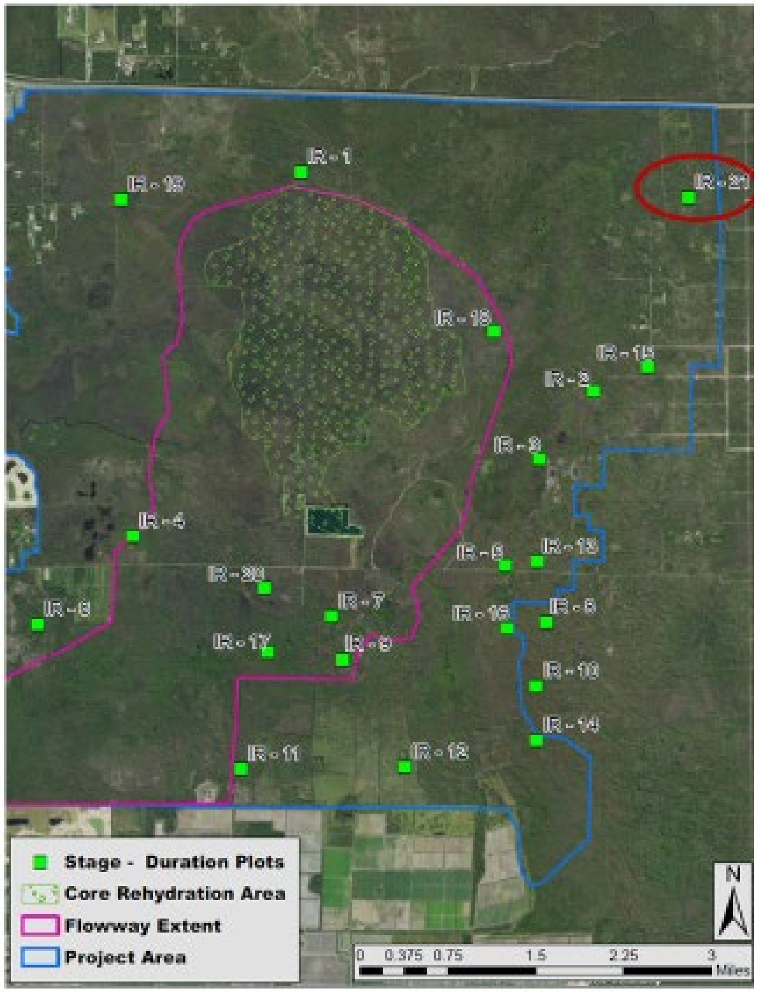


Figure A5-12