

**APPENDIX F**  
**PLAN FORMULATION**

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## **APPENDIX F PLAN FORMULATION**

This appendix is a compilation of plan formulation documents to describe the initial array of alternatives in more detail.

### **F.1 INITIAL ARRAY OF ALTERNATIVES**

To maximize efficiency in the plan formulation process, the project team utilized previous planning efforts from the C&SF Comprehensive Review Study (Restudy) and the Water Preserve Area Feasibility Study (WPAFS) to produce an initial array of alternative plans for an above-ground impoundment located at the selected project area. These alternatives were selected based on previous modeling, evaluations, screening, and planning performed in the Restudy and the WPAFS. Numerous iterations were performed by utilizing hydrologic computer simulations of the proposed Site 1 Impoundment and its surrounding areas during these previous studies. Six initial alternatives were identified as follows:

**1. No-Action (future-without)**

**2. CERP-SP Alternative**

- Restudy Starting Point for Site 1 Impoundment
- 1660 acres, 6-ft depth
- One compartment

**3. D13R Alternative**

- Restudy Selected Plan for Site 1 Impoundment
- 2,460 acres, 6-ft depth
- Two compartments

**4. WPAFS Alternative**

- WPAFS Alternative 3 for Site 1 Impoundment
- 2,246 acres, 6-ft depth
- Three compartments

**5. SP Alternative**

- WPAFS Tentatively Selected Plan for Site 1 Impoundment
- 1,660 acres, 8-ft depth
- Two compartments

**6. SI Alternative**

- Smaller Impoundment – developed by ratio and proportion method to bracket lower limit of impoundment size and depth.
- 830 acres, 6-ft depth
- One compartment

## 7. LI Alternative

- Larger Impoundment – developed by ratio and proportion method to bracket upper limit of impoundment size and depth.
- 2,460 acres, 8-ft depth
- One compartment

Tables F.1-1 through F.1-4 provide a detailed design summary of each initial alternative. Figures F.1-1 through F.1-4 provide a site plan layout for the CERP-SP, D13R, SP, and WPAFS Alternatives. The SI and LI alternatives were developed only for bracketing impoundment size and were not developed into complete alternatives. As such, there are no design summary tables and site plan layout figures for the SI and LI alternatives. Each of the alternatives was compared against the Future Without Project (FWOP) for evaluation of benefits.

**TABLE F.1-1: CERP-SP ALTERNATIVE DESIGN SUMMARY**

### **Purpose:**

Water supply storage impoundment to supplement water deliveries to the Hillsboro Canal during the dry season. The deliveries will be used to prevent saltwater intrusion, provide wellfield recharge and environmental deliveries to isolated wetlands. The storage area will reduce seepage from the adjacent natural areas, improve water quality and provide some measure of flood protection.

### **Operation:**

The reservoir will be filled during the wet-season from excess water in the Hillsboro Canal (back-pumped). Water will be released back to Hillsboro Canal to help maintain canal stages during the dry-season. If water is not available in the reservoir, existing rules for water delivery to this region will be applied. Aquifer Storage and Recovery (ASR) is being incorporated to improve efficiency. Fifteen (15) 5 MGD ASR wells will be added (total injection and recovery capacity 75 MGD). Water from the Site 1 Impoundment will be injected when stages in the impoundment are >14.0-feet NGVD (3 feet of depth in the impoundment). Water will be recovered from the ASR wells when stages in the Hillsboro Canal are < 7.0-feet NGVD.

### **Design:**

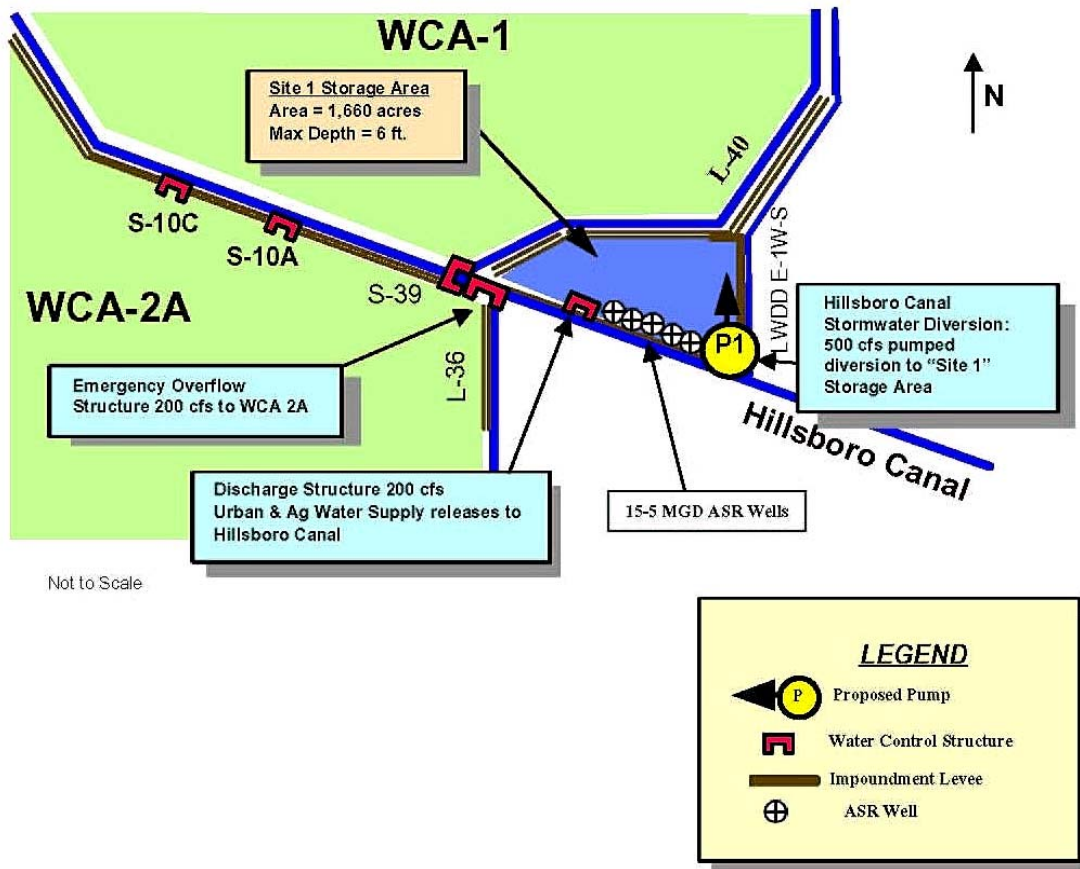
- 1,660 acres with a maximum depth of 6-feet.
- Inflow pump capacity = 500 cfs
- Outflow structure capacity = 200 cfs @ 4-feet of head
- Emergency outflow structure = 200 cfs
- Fifteen(15) – 5 MGD ASR wells (total capacity 75 MGD)

### **Location:**

The Water Preserve Area Land Suitability Analysis previously identified 2,460-acre site.

**Assumptions and related considerations:**

1. Excess storage could be discharged to Water Conservation Area 2A if a treatment facility could be added to meet Everglades' water quality standards.
2. Recovery rate of 70% efficiency for ASR wells is assumed.



**FIGURE F.1-1 CERP-SP ALTERNATIVE SITE PLAN**

**TABLE F.1-2: D13R ALTERNATIVE DESIGN SUMMARY****Purpose:**

Water supply storage impoundment to supplement water deliveries to the Hillsboro Canal during the dry season. The deliveries will be used to prevent saltwater intrusion, provide wellfield recharge and environmental deliveries to isolated wetlands. The storage area will reduce seepage from the adjacent natural areas, improve water quality and provide some measure of flood protection.

**Operation:**

The reservoir will be filled during the wet-season from excess water back-pumped from the Hillsboro Canal. Water will be released back to the Hillsboro Canal to help maintain canal stages during the dry-season. If water is not available in the reservoir, existing rules for water delivery to this region will be applied. Aquifer Storage and Recovery (ASR) is proposed in conjunction with the reservoir to improve water supply during dry seasons and droughts. A total of thirty (30) 5 MGD capacity ASR wells will be included in this alternative (total injection and recovery capacity is 150 MGD or about 230 cfs). Water from the Hillsboro Impoundment will be injected into the ASR wells when stages in the impoundment are greater than 12.0 feet NGVD (0.5 feet of depth). Water will be recovered from the ASR wells when stages in the Hillsboro Canal are less than 7.0 feet NGVD.

**Design:**

- 2,460 acres with a maximum depth of 6 feet located north and south of the Hillsboro Canal. The portion of the canal that is located within the proposed reservoir will be incorporated into the reservoir with any existing levees or roads removed so as to allow the reservoir to act as a level pool. Seepage will be collected and returned to the reservoir by two 64 cfs pumps. One will be located in the northeastern corner of the site and will be turned on when the stage in the seepage collection canal is at elevation 9.5 feet NGVD and turned off when the stage drops to elevation 8.0 feet NGVD. The other will be located in the southwest corner of the site and will be turned on when the stage in the seepage collection canal is at elevation 9.0 feet NGVD and turned off when the stage drops to elevation 8.5 feet NGVD.
- Inflow pump capacity = 700 cfs and is to be located at the eastern end of the Hillsboro Canal. Pump is turned on when the stage in the Hillsboro Canal is equal to 7.8 feet NGVD and turned off when the canal stage drops to elevation 7.6 feet NGVD.
- Outflow structure capacity into the Hillsboro Canal for water supply deliveries from Site 1 = 200 cfs @ 4 feet of head and consists of four, 4 ft diameter CMP gated culverts, each 70 feet long.

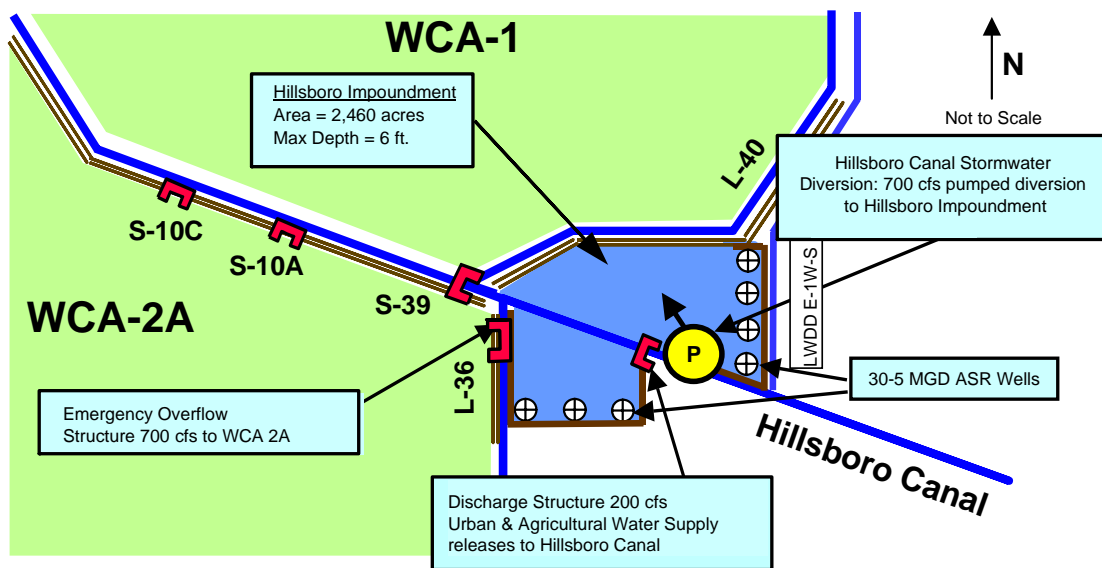
- Emergency outflow structure to Water Conservation Area 2A = 700 cfs and consists of a 225 ft long weir with a crest at elevation 16.0 feet NGVD.
- Thirty (30) – 5 MGD ASR wells (total capacity 150 MGD or about 230 cfs) to be located on the inside of the proposed eastern and southern perimeter dikes with 60 surficial wells (2 per ASR well) located on the outside of the perimeter dikes to supply the ASR wells.

**Location:**

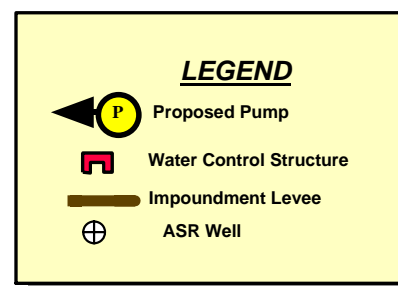
The Water Preserve Area Land Suitability Analysis previously identified 2,460-acre site.

**Assumptions and related considerations:**

1. Excess storage could be discharged to Water Conservation Area 2A if a treatment facility could be added to meet Everglades’ water quality standards.
2. Recovery rate of 70 percent for water stored by ASR.



This graphic is a conceptual tool utilized for project development only. This graphic is not self-executing or binding, and does not otherwise affect the interests of any person including any vested rights or existing uses of real property.



**FIGURE F.1-2: D13R ALTERNATIVE SITE PLAN**

**TABLE F.1-3: SP ALTERNATIVE DESIGN SUMMARY****Purpose:**

Water supply storage impoundment to supplement water deliveries to the Hillsboro Canal during the dry season. The deliveries will be used to prevent saltwater intrusion, provide wellfield recharge and environmental deliveries to isolated wetlands. The storage area will reduce seepage from the adjacent natural areas, improve water quality and provide some measure of flood protection.

**Operation:**

The impoundment fills during the wet season from excess water back-pumped from the Hillsboro Canal. Water releases back to the Hillsboro Canal to help maintain canal stages during the dry season. If water is not available in the impoundment, existing operating rules for water delivery to this region apply. Aquifer Storage and Recovery (ASR) is proposed in conjunction with the impoundment to improve water supply during dry seasons and droughts. Thirty (30), 5-MGD ASR injection wells are included for a total of 150-MGD (230 cfs) capacity. Water from the Hillsboro Impoundment is injected into the ASR wells when stages in the impoundment are greater than 12.5 feet NGVD (1-foot of depth). Water is released from the impoundment and is recovered from the ASR wells when stages in the Hillsboro Canal are less than 7.0 feet NGVD to help maintain canal stages during dry periods.

The impoundment is compartmentalized into two cells, located north of the Hillsboro Canal. The total acreage of the impoundment is 1660 acres. North Springs Improvement District (NSID) discharges are redirected north to the impoundment via the L-36 borrow canal and the proposed inflow pump station.

**Detailed design and operation:**

- 1660-acre impoundment is divided into two compartments, located north of the Hillsboro Canal. The western compartment is 836 acres in size. The eastern compartment is 824 acres in size. Each compartment has a maximum water depth of 8 feet. An internal levee separates the two compartments. Transfer of flow between the compartments is accomplished by a set of gated culverts.
- Inflow: The inflow pump station in the Hillsboro Canal provides the total inflow rate of 1500 cfs.
- Discharge: A 700 cfs outflow structure is located in the western compartment and discharges to the Hillsboro Canal. This structure consists of three gated culverts, each 4-foot in diameter and 70 feet long.

- There are two operational scenarios:
  1. On-peak operations: The impoundment fills during the wet season with excess water back-pumped from the Hillsboro Canal and NSID via the L-36 borrow canal. A 1500 cfs inflow pump station in the Hillsboro Canal turns on when the stage in the Hillsboro Canal reaches elevation 7.7 feet NGVD and turns off when the canal stage drops to elevation 7.0 feet NGVD. The pump also turns off when the stage in the impoundment north of the Hillsboro Canal reaches elevation 19.0 feet NGVD (8 feet deep).
  2. Off-peak operations: A 700 cfs outflow structure is located in the western compartment and discharges to the Hillsboro Canal. The structure discharges when the Hillsboro Canal stage drops below elevation 7.0 feet NGVD and stops discharging when the canal reaches elevation 7.5 feet NGVD. The water stored in the impoundment and ASR storage system is used to meet the following prioritized demands: LWDD, C-14, C-13 and North New River.
- Operational flexibility for the component is provided by interconnecting the compartments by culverts. Two structures, each containing two, 72” diameter CMP culverts, interconnect the northwestern and northeastern compartments. These interconnects allow water to be transferred between compartments.
- A 500 cfs emergency overflow spillway is designed as a lower section of the levee to maintain levee integrity. The spillway invert elevation is 1 foot above the maximum normal operating elevation of the impoundment and discharges into the Hillsboro Canal.
- Thirty (30), 5-MGD ASR injection wells (total capacity 150-MGD or about 230 cfs) are located around the perimeter of the impoundment. Ten (10) additional wells have been added to increase the withdrawal capacity to 200-MGD (310 cfs) which improves the effectiveness of the ASR storage system. Water is supplied for injection into the ASR wells via horizontal supply wells and toe drains located inside the impoundment. Water from the horizontal supply wells injects into the ASR wells when stages in the impoundment are greater than 12.5 feet NGVD (1.0 foot of depth).
- The conveyance of Hillsboro Canal is increased by deepening the cross section from the inflow structure at the impoundment eastward to LWDD E-2 canal. This will enable additional flows from the western Hillsboro Canal basin to be back-pumped into the impoundment.
- A canal running along the east side of the impoundment (north of the Hillsboro Canal) collects seepage where it is directed south to the Hillsboro Canal through a gated culvert (100-cfs capacity).

**Location:**

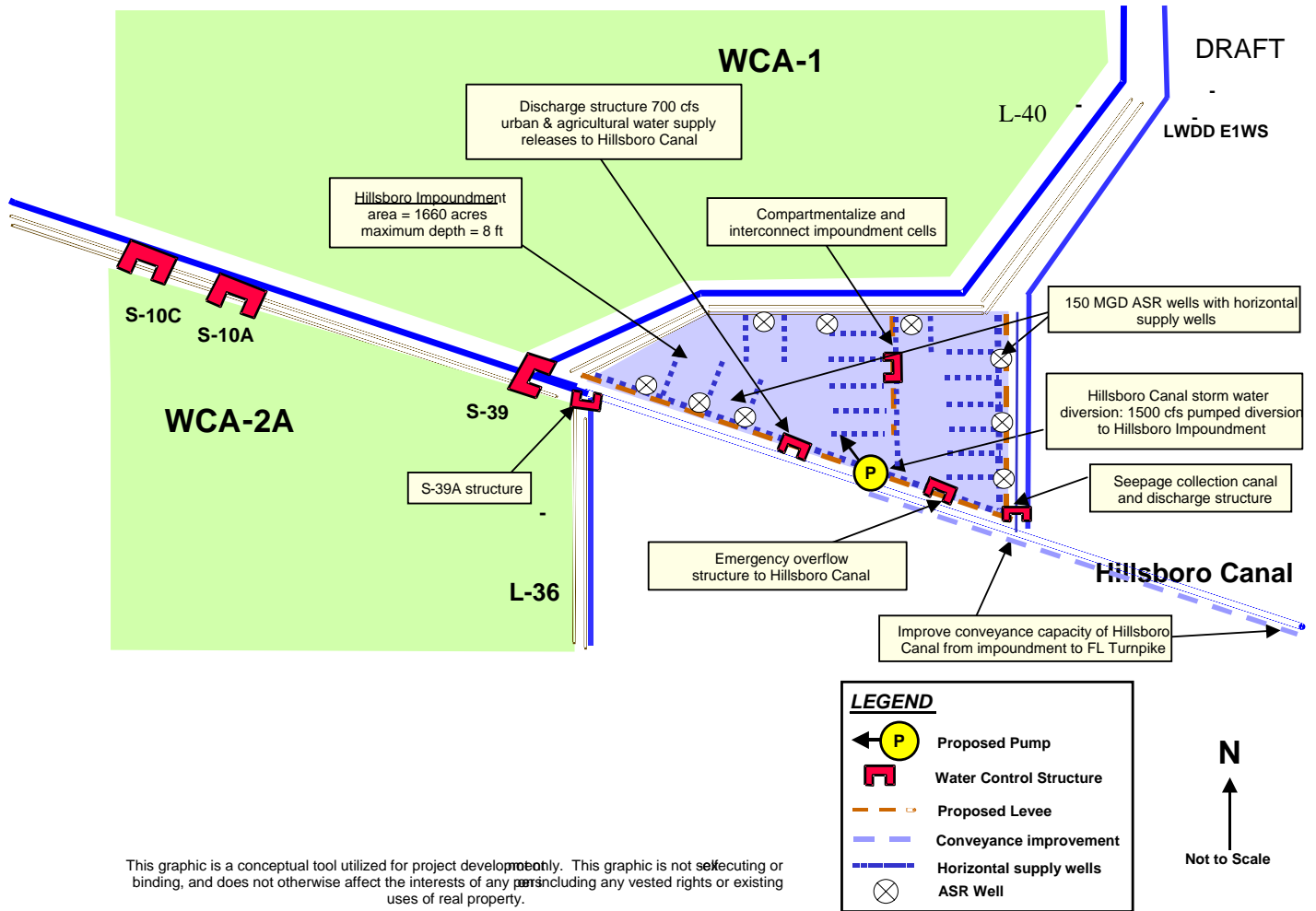
The Water Preserve Area Land Suitability Analysis previously identified 1660-acre site, north of the Hillsboro Canal and southeast of WCA-1.

**Summary of Modifications from D13R:**

The impoundment footprint is modified to 1660 acres and compartmentalized to optimize operations and reduce levee height requirements. The inflow pump is increased to 1500 cfs and Hillsboro Canal conveyance is also increased from the pump station eastward to LWDD E-1 Canal to capture additional flows. The seepage collection system is modified. The ASR supply wells are modified to horizontal wells and toe drains and ten (10), 5-MGD ASR wells are added to increase the withdrawal capacity to 200-MGD (310 cfs). NSID discharges are redirected north into the Hillsboro Canal via the L-36 borrow canal.

**Assumptions and related considerations:**

1. Recovery rate of 70 percent for water stored by ASR.
2. Telemetry systems are required for all operable structures and pump station.



**FIGURE F.1-3: SP ALTERNATIVE SITE PLAN**

**TABLE F.1-4: WPAFS ALTERNATIVE DESIGN SUMMARY****Purpose:**

Water supply storage impoundment to supplement water deliveries to the Hillsboro Canal during the dry season. The deliveries will be used to prevent saltwater intrusion, provide wellfield recharge and environmental deliveries to isolated wetlands. The storage area will reduce seepage from the adjacent natural areas, improve water quality and provide some measure of flood protection.

**Operations Summary:**

The impoundment stores excess water pumped from the Hillsboro Canal and North Springs Improvement District. Water releases are made back to the Hillsboro Canal to help maintain canal stages during the dry season. Water discharges to the Hillsboro Canal first from the Impoundment, then from ASR wells when stages in the Hillsboro Canal are less than 7.0 feet NGVD. If water is not available in the impoundment or ASR storage, existing rules for water delivery to this region apply. ASR is used in conjunction with the impoundment to improve water supply during dry seasons and droughts.

The impoundment remains compartmentalized into three cells; two are located north of the Hillsboro Canal and one south. The total acreage of the impoundment remains the same as Alternative 1 (2246 acres). North Springs Improvement District (NSID) discharges are redirected north to the southern compartment of the impoundment via the L-36 borrow canal and a proposed pump station.

**Detailed Design and Operation:**

- Impoundment: 2246 acres with a maximum depth of 6 feet located north and south of the Hillsboro Canal. A seepage canal running along the east side of the impoundment directs seepage south to the Hillsboro Canal through a gated culvert (100-cfs capacity). Seepage south of the Hillsboro Canal collects in the relocated L-36 borrow canal and discharges to the Hillsboro Canal through the relocated S-39A structure.
- Inflow: Total pump capacity = 2,000 cfs.
  - >1,500 cfs capacity pump station in the Hillsboro Canal operates when the stage Hillsboro Canal equals 7.7 feet NGVD and ceases when the canal stage equals 7.0 feet NGVD. The pump also ceases operation when the stage in the impoundment north of the Hillsboro Canal reaches 17.0 feet NGVD.
  - >500-cfs capacity pump station in the southwest corner of the impoundment directs NSID flow into the impoundment. The pump operates at elevation 7.3 feet NGVD and ceases at elevation 7.0 feet NGVD.

- Discharges: Outflow structure capacity = 700 cfs. This structure consists of three, 4-foot diameter, 70-foot long gated culverts.
- Structure operates when Hillsboro Canal stages <7.0 feet NGVD and ceases to discharge when the canal reaches 7.5 feet NGVD.
- An emergency overflow spillway is designed as a lower section of the levee to maintain impoundment levee integrity. The emergency overflow spillway invert elevation is 1 foot above the maximum normal operating elevation. The spillway discharges into the Hillsboro Canal.
- Thirty (30) 5 MGD ASR injection wells (total capacity 150 MGD or about 230 cfs) are located inside of the proposed eastern and southern perimeter levees. The horizontal supply wells are located inside the impoundment. A portion of the horizontal ASR wells have been relocated to the south bank of Hillsboro Canal – east of southern compartment – and on the east side of southern compartment to capture seepage.
  - >Water from the horizontal supply wells injects into the ASR wells when stages in the impoundment are greater than 12.0 feet NGVD (1.0 feet of depth).
  - >Increase conveyance of Hillsboro Canal by deepening cross section from inflow structure eastward to LWDD E-2 Canal to handle increased pump capacity.

**Location:**

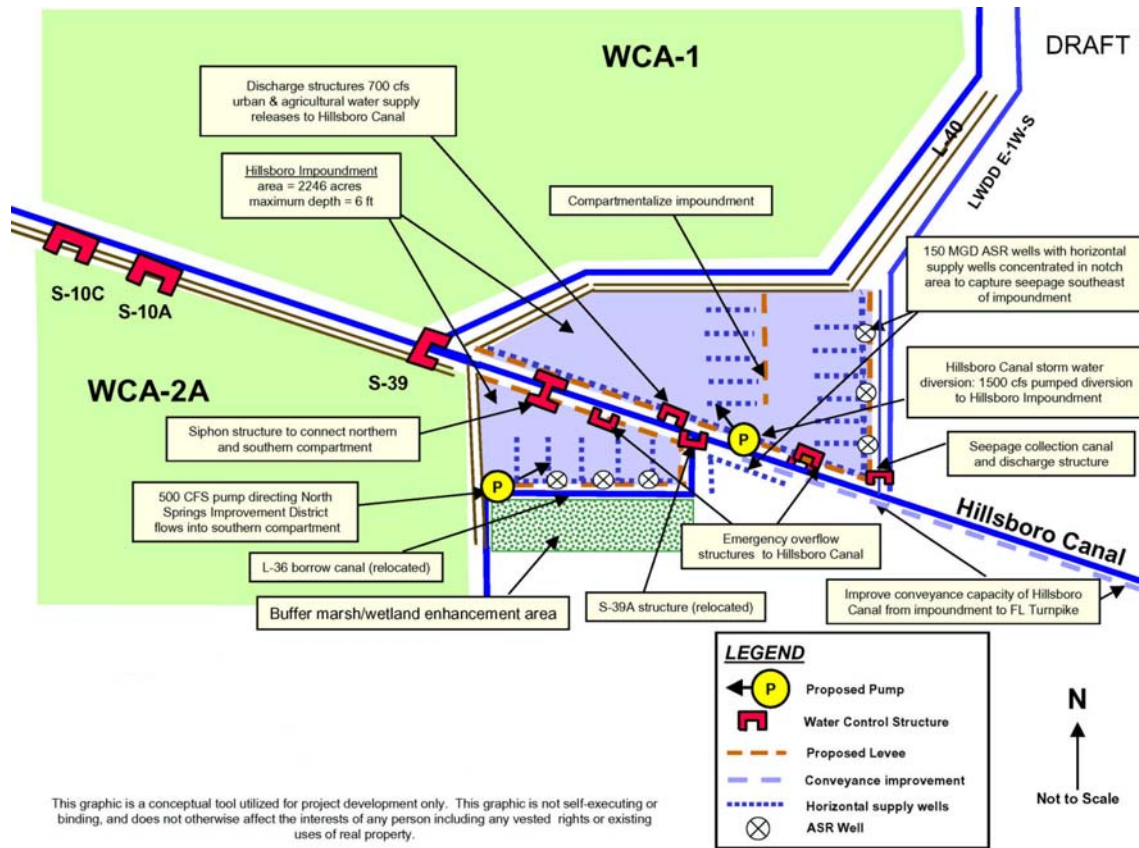
The Water Preserve Area Land Suitability Analysis previously identified 2246-acre site.

**Summary of modifications from D13R:**

Modify footprint to 2,246 acres. Compartmentalize impoundment to optimize operations and reduce levee height requirements. Increase inflow pump to 1500 cfs and modify seepage collection system. Revise the production wells to deep horizontal wells. The L-36 borrow canal and S-39A structures are relocated. NSID discharges are redirected north to the southern compartment of the impoundment via the L-36 borrow canal and a proposed pump station.

**Assumptions and related considerations:**

1. Recovery rate of 70 percent for water that is stored by ASR.
2. Conveyance of North Springs Improvement District flows to the Hillsboro Canal is maintained.
3. Conveyance improvement to Hillsboro Canal may enable secondary canal improvements.



**FIGURE F.1-4: WPAFS ALTERNATIVE SITE PLAN**