6. WATER RESOURCES

A balanced approach to supply for both potable water and irrigation quality water is presented in this master plan to ensure that adequate supplies are evaluated and planned to meet demands over the next twenty years.

6.1 Existing City Water Resource Infrastructure

The City of Cape Coral has been a role model in water resource management for over 30 years, with a comprehensive and integrated program that utilizes brackish groundwater resources for potable supply and a combination of reclaimed water and stormwater harvesting for irrigation supply. Brackish water wells primarily completed in the Lower Hawthorn aquifer provide the raw water supply to the City's Reverse Osmosis Water Treatment Plants (WTPs) for the production of potable water. Irrigation is supplied, as of January 2020, by five freshwater canal pumping stations (CPSs) and augmented by treated wastewater from the City's two Water Reclamation Facilities (WRFs) and from FGUA as a condition of an interlocal agreement. The City has plans to begin receiving additional reclaimed water from the City of Fort Myers in 2025. The City's irrigation system is also being supplied by surface water that flows to the system over a 3-month period during dry season from Southwest Aggregates Mine reservoir.

As a part of the master planning effort, an evaluation of available water supply options was completed in order to identify a balanced way to provide supplies for both potable water and irrigation quality water over the twenty-year planning horizon. Surface water, groundwater and reclaimed water were reviewed along with various management techniques such as aquifers storage and recovery (ASR).

6.2 Groundwater Resources

The aquifer systems in the City are grouped into three principal systems: The Surficial, Intermediate, and the Floridan aquifers. These systems consist of several individual aquifers and production zones. The aquifers and confining units identified within the City are illustrated on **Figure 6-1.** The characteristics of the aquifers and their potential for development are described below.

6.2.1 Surficial Aquifer System

The Surficial aquifer in Cape Coral consists of two distinct units: a sand section and an underlying limestone unit. The underlying limestone unit, named the Tamiami limestone, transitions from a limestone unit in southern Cape Coral to sandy shell beds in northern Cape Coral. The overall thickness of the aquifer typically ranges between 20 and 40 feet. The Surficial aquifer is unconfined, generally fresh, and open to the direct influence of atmospheric conditions. Recharge to the aquifer originates principally from rainfall. Outflow of water from the Surficial aquifer occurs through evapotranspiration, drainage to surface water bodies and canals, downward leakance to deeper aquifers, and pumping of wells.

Transmissivity is the key parameter that determines the ease at which water flows through an aquifer. The transmissivity of the City's Surficial aquifer ranges between about 1,000 to less than 50,000 gallons per day per foot (gpd/ft) depending on the thickness of the limestone unit. The sand portion of the aquifer, which has relatively low transmissivity, provides base flow to the City's freshwater canal system during the dry season. Because a large portion of the canal system has been excavated only in the sand section of the aquifer, that base flow volume may be limited in many areas of the City. The limestone portion of the Surficial aquifer, which is more transmissive, represents a potentially under used fresh groundwater resource that could be utilized in the future to supplement dry season canal levels and the City's IQ water system. Groundwater within this aquifer, although fresh, can contain relatively high levels of undesirable constituents such as iron, color, tannins, etc. Because of these constituents, the aquifer is not considered a viable drinking water source.

The freshwater canal system is the most efficient way of utilizing the Surficial aquifer, but in areas where the canal system is absent, widely spaced, or only excavated into the sand portion of the aquifer, the deeper limestone portion of the Surficial aquifer may be considered for use as a supplement to the irrigation water system. Because of the high iron content, water from this aquifer should be first used to recharge the canal system where the iron would be oxidized and precipitated as iron hydroxide and then pumped into the irrigation distribution system. **Figure 6-2** shows areas where the aquifer could potentially be developed for additional future use. The criteria used for delineation of potentially developable Surficial aquifer include areas where: (1) limestone unit is present, (2) canal density is low, (3) there is at least 1 mile distance from the weirs separating freshwater/saltwater canals, and (4) an aquifer transmissivity greater than 25,000 gpd/ft.

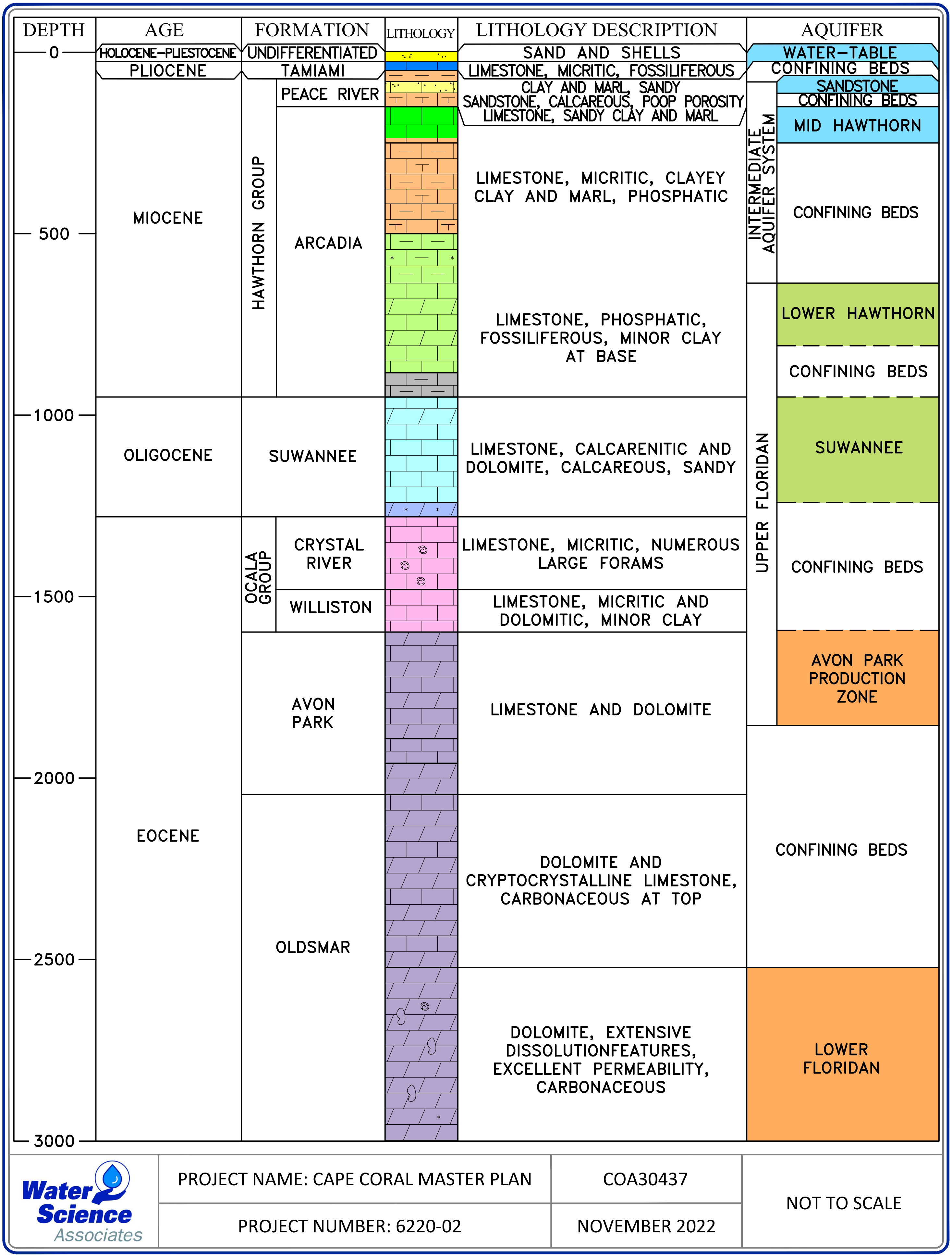


Figure 6-1: Generalized Stratigraphic Column.

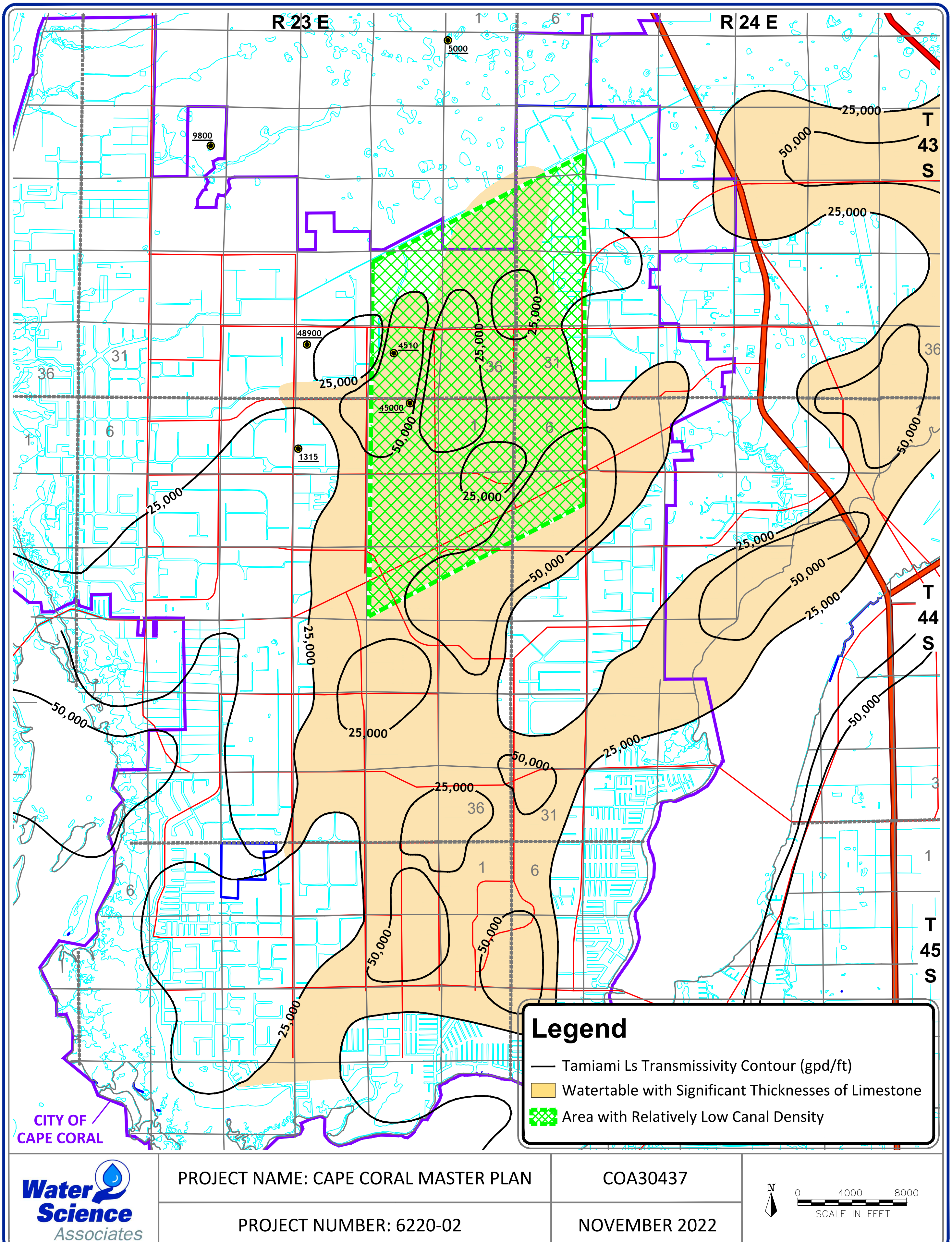


Figure 6-2: Map Showing Potential Developable Areas of the Surficial Aquifer.

6.2.2 Intermediate Aquifer System

Aquifers in southwestern Florida that lie beneath the Surficial aquifer system and above the Floridan aquifer system are grouped into the Intermediate aquifer system. The Intermediate aquifer system in Cape Coral consists of the Sandstone aquifer and the Mid Hawthorn aquifer.

6.2.2.1 Sandstone Aquifer

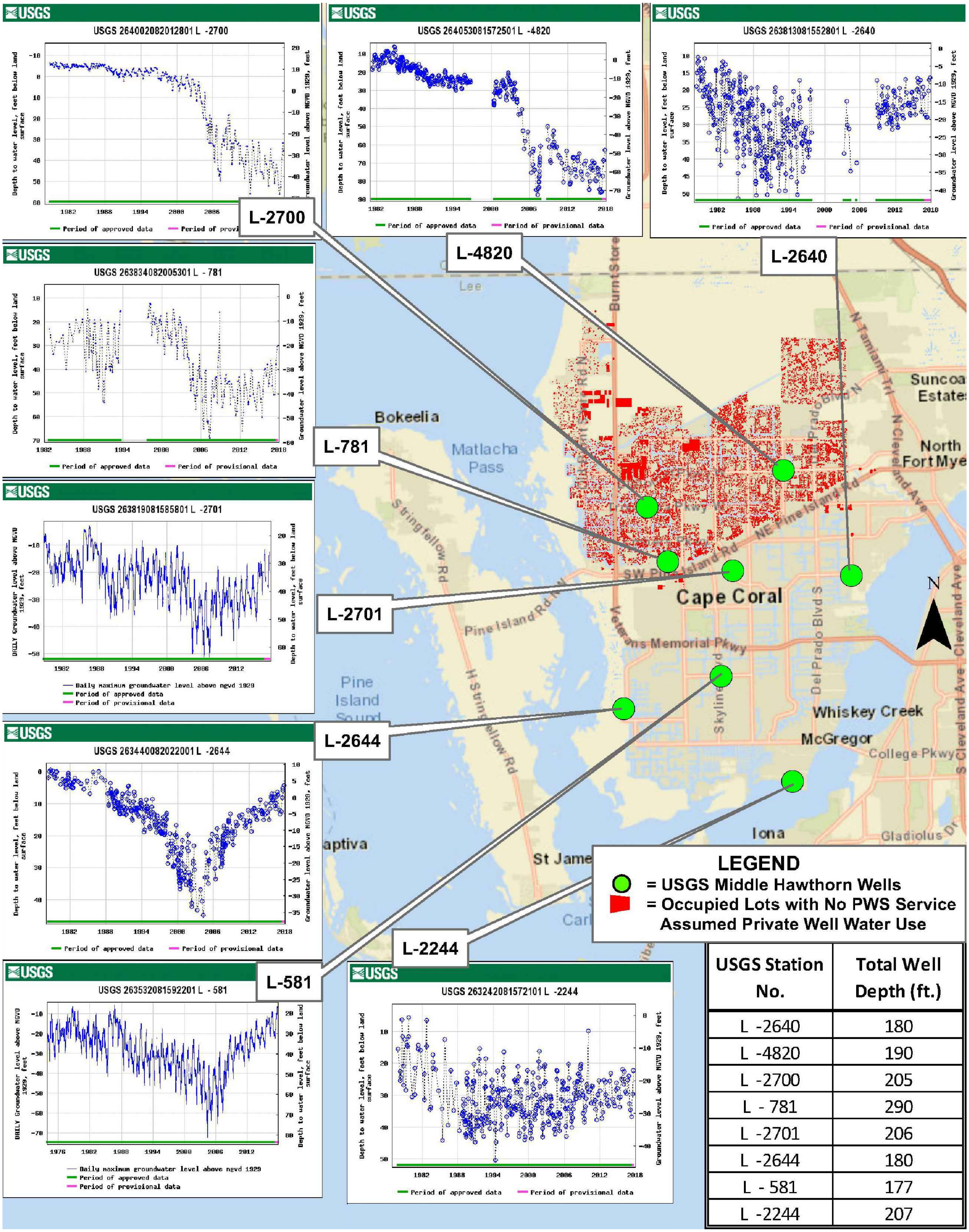
The Sandstone aquifer is considered a fresh water source with limited potential in Cape Coral for municipal supply due to its relatively low transmissivity and high usage for domestic self-supply. The aquifer consists of sandstone and sandy limestone units of variable thickness and areal extent and is separated from the Surficial aquifer above and the Mid-Hawthorn aquifer below by 30 to 50 feet of low permeability confining units (clay and marl). Several regional studies (e.g., South Florida Water Management District (SFWMD) Technical Publications 82-1 and WS-35) suggest that Sandstone aquifer is either absent or insignificant (less than 20 feet thick) in Cape Coral. The transmissivity of the aquifer depends on lithology and thickness, but is generally low and ranges between 5,000 and 15,000 gpd/ft. At a minimum, the aquifer is highly discontinuous and of very low permeability beneath Cape Coral. The aquifer is confined wherever it is present with a static water level in undeveloped areas that can approach land surface in the wet season. However, because the general low yield of the aquifer and its use, where present, for domestic self-supply, dry season water levels can decline to below the developable limits established by the SFWMD and below pump intake depths in existing wells. Because of this aquifer's inconsistent occurrence in Cape Coral, general low productivity, and existing use for domestic self-supply, there is no potential for utilization of this aquifer for municipal supply by the City.

6.2.2.2 Mid-Hawthorn Aquifer

The Mid Hawthorn aquifer consists of permeable limestones that extend from approximately 150 feet to 250 feet below land surface (bls) in Cape Coral. The aquifer is generally fresh, with chloride concentrations ranging from the high 100's to mid-200's mg/L. The transmissivity of the aquifer ranges between 6,000 to 12,000 gpd/ft. This aquifer has been a primary source of domestic and irrigation supply for the City's residents for many years and was the original source of raw water for the City's first water treatment plant. The aquifer was over utilized for many years causing a significant decline in water levels which in some cases exceeded 100 feet. These water level declines led the SFWMD to place limitations on use of the aquifer, resulting in the City developing a combination of deeper brackish groundwater, wastewater reuse, and stormwater harvesting to meet its growing water demands. Over time, the area of lowered water levels in the Mid Hawthorn aquifer spread along with the growth of residences from the southeast part of the City to the west and then north. However, with the advent of the City's utility extension program bringing water, sewer, and irrigation services to all areas of the City south of Pine Island Road and starting to extend services to the north of Pine Island Road, water levels in the Mid Hawthorn aquifer are showing substantial recoveries. **Figure 6-3** provides water level for eight of Mid Hawthorn aquifer wells located throughout the City graphs (as of 2019). Review of the hydrographs shows the significant declines in water levels starting at different times commensurate with residential growth patterns. In the southern portions of the City however, where implementation of the Utility Extension Program (UEP) has occurred, water levels have shown substantial recovery leaving only the areas north of Pine Island Road with the low water level condition (refer to hydrographs of Well L-2644 and Well L-581). For the past couple of decades, the Mid Hawthorn aquifer has been essentially off limits to any new use of significance. However, with the recovery of water levels south of Pine Island Road, the aquifer may have renewed viability as a supplemental resource for irrigation use or as a blending source for reverse osmosis (RO) treated brackish water. As the City further expands the UEP north of Pine Island Road, the Mid Hawthorn aquifer could be considered for additional use in that area as well.

The Mid Hawthorn aquifer could also be used to supplement the IQ water. However, because individual well yields from the Mid Hawthorn aquifer are typically in the 100 to 200 gpm range, the effect of Mid Hawthorn aquifer recharge to the canal system may be negligible. A more effective use of the Mid Hawthorn aquifer might be installing Mid Hawthorn aquifer wells at strategic locations, within the irrigation distribution system, that historically have experienced limitations maintaining adequate line pressures. The addition of a supplemental supply from the Mid Hawthorn aquifer directly to the irrigation distribution system could mitigate the pressure problems; with multiple wells installed as needed in those critical areas.

Alternatively, because the Mid Hawthorn aquifer is a fresh water source, it could have strategic value as a raw water by-pass blend to RO permeate produced at the City's two RO Water Treatment Plants (WTP). Typically, raw water by-pass blends with RO permeate are used to add needed mineral content and chemical stability to the finished drinking water product. The potential for raw water by-pass blending with brackish water is typically limited because of the high dissolved solids content of the source aquifer. A Mid Hawthorn aquifer blend could be used at a higher blend ratio than the existing raw brackish water from the Lower Hawthorn aquifer providing both an expanded potable supply and a convenient blending source for finished water production. Mid Hawthorn aquifer by-pass blend wells could be constructed at the Southwest RO WTP at this time because water levels in the Mid Hawthorn aquifer have improved south of Pine Island Road where the City utility systems have been installed. Mid Hawthorn aquifer wells could be constructed at the North RO WTP once the UEP is extended and Mid Hawthorn aquifer water levels have recovered in that area. **Figure 6-4** identifies the area where the Mid Hawthorn aquifer has the potential to be developed as an IQ supplemental source or RO permeate blend source.



USGS Station No.	Total Well Depth (ft.)
L -2640	180
L -4820	190
L -2700	205
L - 781	290
L -2701	206
L -2644	180
L - 581	177
L -2244	207

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N 0 2 4 APPROXIMATE SCALE IN MILES

Figure 6-3: Map Showing Locations of USGS Middle Hawthorn Aquifer Wells and Water Levels (as of 2019).

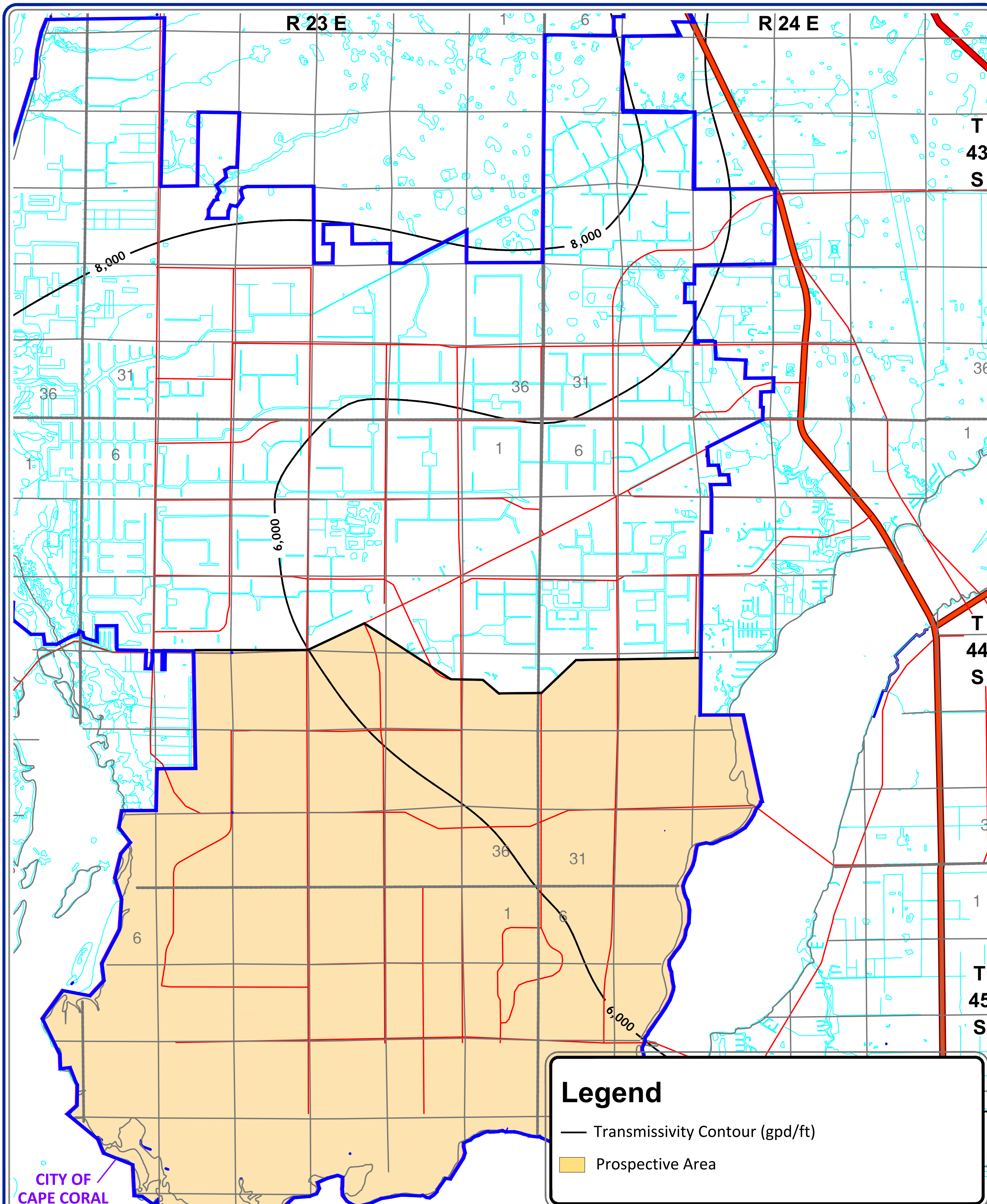

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Figure 6-4: Map Showing Potential Developable Areas of the Mid Hawthorn Aquifer.

6.2.3 Floridian Aquifer System

The Floridan aquifer system in Cape Coral consists predominately of limestone with interbeds of dolomitic limestone and dolomite. The Floridan aquifer System is further subdivided into the Upper Floridan aquifer, middle confining unit, and Lower Floridan aquifer. The Upper Floridan aquifer is currently used as the primary source of feed water for the City's two RO WTPs. Deeper portions of the Lower Floridan aquifer are currently used as disposal zones for RO concentrate and excess treated effluent from the City's two WRFs using deep injection wells. The characteristics of the Upper Floridan aquifer and Lower Floridan aquifer are described below.

6.2.3.1 Upper Floridian Aquifer

The Upper Floridan aquifer consists of the Lower Hawthorn aquifer and Upper Suwannee aquifer. All of the City's RO supply wells are completed into the Lower Hawthorn aquifer with some completion extending into the top of the Upper Suwannee aquifer. In Cape Coral, the base of the Underground Source of Drinking Water (USDW), defined by regulation as 10,000 milligrams per liter (mg/L) total dissolved solids (TDS), generally lies at the base of the Suwannee Limestone or upper portion of Ocala Group.

Lower Hawthorn Aquifer

The Lower Hawthorn aquifer generally extends from approximately 500 feet bls to 800 feet bls beneath Cape Coral and consists of permeable fossiliferous limestone units. Transmissivity data for the Lower Hawthorn aquifer are mainly from the aquifer performance tests (APTs) conducted by the City on their two existing wellfields. The aquifer is reported to have moderate to high transmissivity with values typically ranging between 50,000 and 150,000 gpd/ft. The chloride concentrations in the aquifer typically ranges between 800 and 1,200 mg/L over most of the City, but up to 2,500 mg/L or higher in the periphery of the City. **Figure 6-5** is a map showing chloride values of the Lower Hawthorn aquifer. **Figure 6-6** is a map showing transmissivity iso-contours of the Lower Hawthorn aquifer and potentially developable areas where chloride concentration is less than 1,000 mg/L.

The SFWMD encourages use of the Lower Hawthorn aquifer for public water supply because competing users are fewer than shallower aquifers and there is limited potential to affect sensitive environmental areas, freshwater aquifer systems, or existing water users. With increased reliance on brackish groundwater sources, however, the phenomenon of rapidly increasing salinity has occurred in some City production wells. This phenomenon is caused by the preferential movement of higher salinity water from deeper aquifers and is well documented in many public utility's wellfields in South Florida. In most cases, the effect is only observed in certain wells in service indicating the presence of preferential vertical flow paths from deeper aquifers underlying the primary production aquifer.

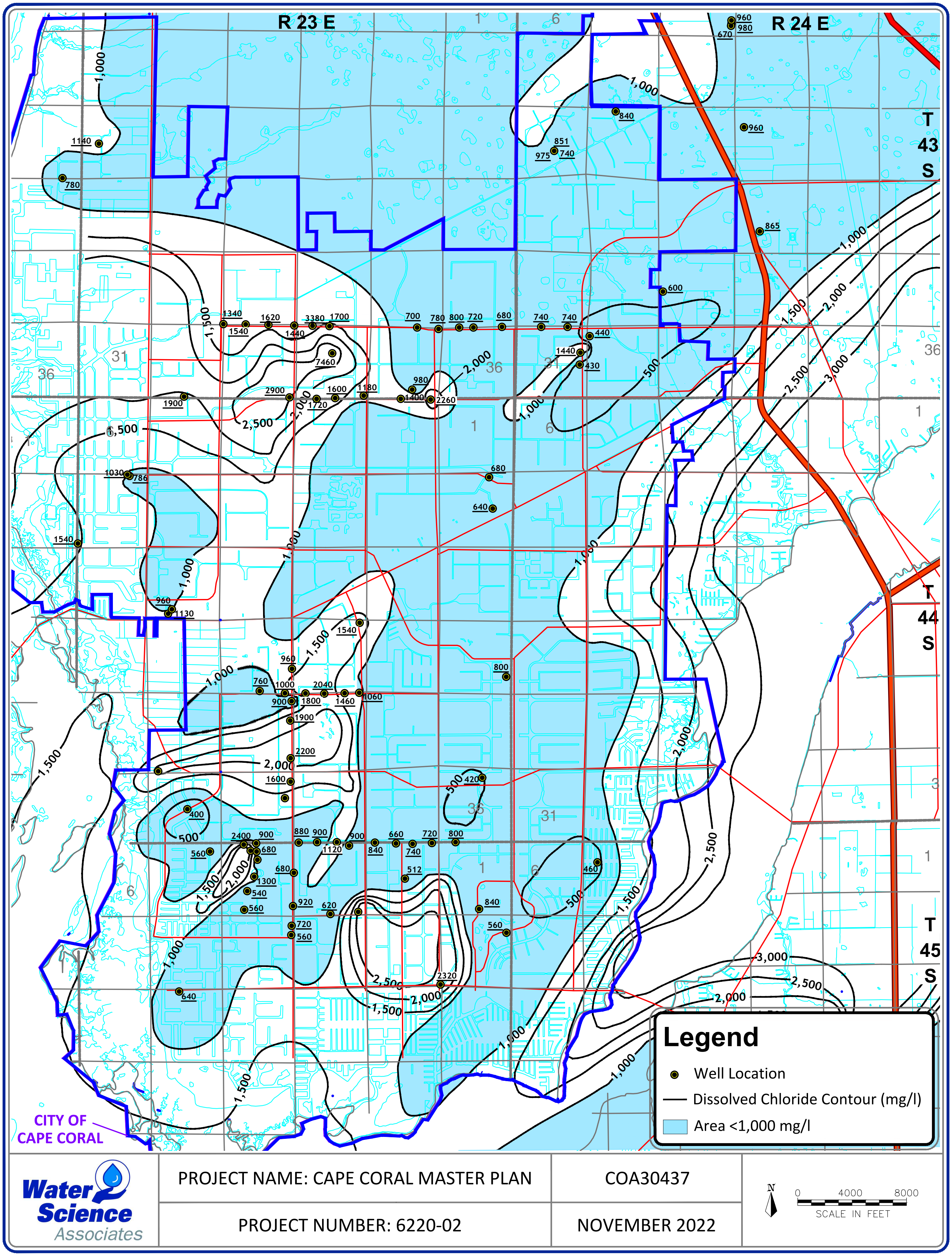

Figure 6-5: Map Showing Reported Chloride Concentration in the Lower Hawthorn Aquifer (2007-2019).

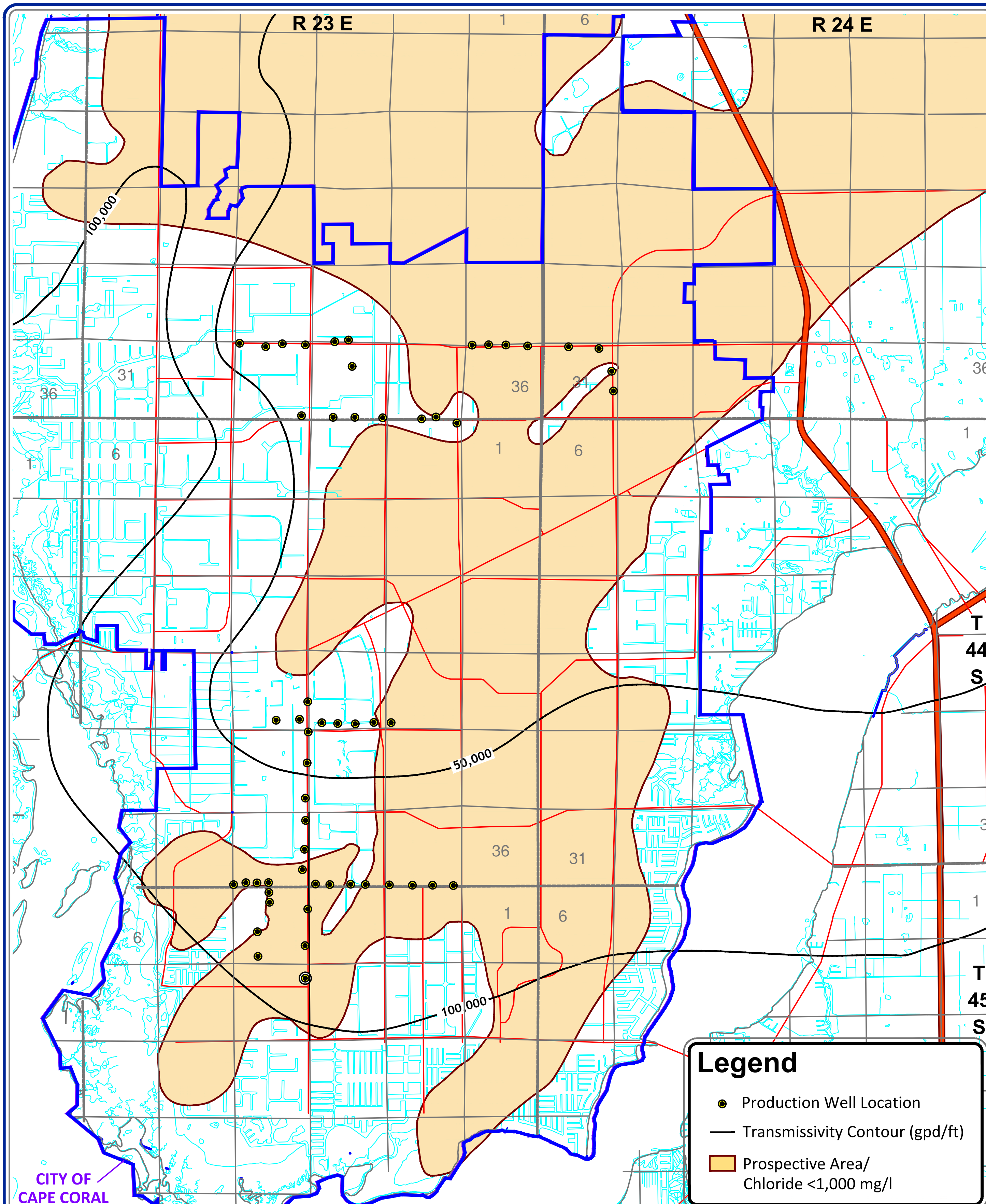

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Figure 6-6: Map Showing Potential Developable Areas of the Lower Hawthorn Aquifer.

Although the decline in water quality has been slow and predictable in most of the City's production wells, there have been several cases of rapid water quality decline, especially in the western end of the City's North RO wellfield. The City's utility operators have been addressing this issue through strategic use of the available wells with blending of well water sources and rotation of wells to meet the feed water quality requirements of the two RO WTP's. The City's Southwest RO wellfield operated for many years without any significant water quality issues but in the past decade a few of the wells are showing trends of salinity increase. This degradation phenomenon is becoming more prevalent throughout south Florida as more municipalities expand use of RO technology and brackish groundwater supplies. Localized enhanced vertical permeability underlying the wellfield production zone is the apparent cause of the degradation as some wells are affected and other immediately adjacent wells are not. The best solutions being applied include expanding the number of production wells to allow for more rotational capacity and supply of water from a larger geographic area; all of which reduce impacts on any one well location and allow for greater flexibility in wellfield operations. Currently, the City is undertaking a comprehensive evaluation of available water resources and approaches to water resource development as a study separate from this Master Plan. In addition to new test wells and aquifer investigations, the City is using seismic reflection analyses as a means of identifying potential enhanced vertical connectivity underlying potential production intervals to avoid future well sites that might suffer from rapid degradation of water quality.

The Lower Hawthorn aquifer continues to be a reliable feedwater source for meeting potable demands through the City's two RO water treatment facilities and further development of this resource is recommended in areas identified to be most favorable for water quality and water yield. Generally, the eastern and northern portion of the City and areas outside the City towards the northeast are suitable for expansion as shown in **Figure 6-6**. The criteria utilized to identify prospective areas for the Lower Hawthorn aquifer development included: (1) a dissolved chloride concentration of less than 1,000 mg/L and (2) an aquifer transmissivity greater than 50,000 gpd/ft. Although not shown on **Figure 6-6**, it is generally recommended to install new wells at least 1,000 feet from currently developed Lower Hawthorn aquifer wells.

The City's current wells are generally "open hole" to an interval between 450 and 850 feet bls. Some of the early wells installed to supply the Southwest RO WTP (Wells 101 to 110, except 106) are cased to relatively shallower depths between 350 and 450 feet. These wells are noted to have an approximate 15% lower dissolved chloride concentration than the later wells that were developed with deeper casings. The reason for deeper casing depths in supply wells constructed more recently is due to the possible high clay content in the interval between 350 and 450 feet bls which could result in high entrained fines resulting in pre-filter fouling. In future wellfield expansions, the City may want to consider casing to shallower depths where this relatively fresher upper zone exists if supported by the current hydrogeological studies. It is relevant to note that some of the well casings of existing production wells that were set at shallower depths, subsequently required liner installation due to excessive production of fine materials.

Suwannee Aquifer

The Suwannee aquifer extends from approximately 900 to 1,200 feet bls and is composed of interbedded limestones, marls and dolostones (MWH, June 2009). Potential water bearing units occur in the upper portion (900 to 1,000 feet bls) and lower portion (1,100 to 1,200) of the Suwannee aquifer. The semi-confining bed that separates the Upper Suwannee aquifer and the overlying Lower Hawthorn aquifer is approximately 20 to 30 feet thick and consists of crystalline limestone (MWH, June 2009). This semi-confining unit provides some level of protection to the Lower Hawthorn aquifer from underlying more saline aquifers. The transmissivity of the aquifer ranges between 10,000 and 50,000 gpd/ft and averages about 30,000 gpd/ft. Dissolved chloride concentrations in the Upper Suwannee aquifer are expected to be higher than Lower Hawthorn aquifer. The Lower Suwannee aquifer is differentiated from the Upper Suwannee aquifer by the observed increase in lime muds and fine-grained material. The underlying Ocala Limestone and Avon Park Formation are separated from the Lower Suwannee aquifer by low permeability, semi-confining dolostones (MWH, June 2009). This unit also provides protection to the Lower Hawthorn aquifer wells from upconing of saline water except in areas where fracture conduits exist. Strategic use of the Upper Suwannee aquifer in concert with use of the Lower Hawthorn aquifer is a viable use of the resource as a raw feedwater for RO treatment and as a possible storage zone for an ASR system.

Avon Park Aquifer

The Avon Park aquifer is a productive saline groundwater source consisting of highly permeable dolomites and dolomitic limestone that extends from approximately 1,400 to 1,700 feet bls. Chloride concentration in the aquifer is typically in the range of 12,000 to 20,000 mg/L, the upper range being similar to sea water salinities. Based on limited available data, the aquifer is considered to have very high yield potential with transmissivities ranging between 0.5 million gpd/ft to 2 million gpd/ft. The Avon Park aquifer typically has secondary porosity and conduits that allow relatively easy movement (flow) of water within the formation, sufficient available drawdown, and well yield potential of at least 2 MGD per well. The aquifer has the potential to be developed as a source of seawater quality water to feed a desalination plant if the more cost-effective brackish water supplies reach their developable limits. Using a groundwater source for seawater quality water offers a substantial cost savings over direct use of saline surface water due to the water being of a much more consistent and predictable quality and having essentially no turbidity or marine biota to address. However, the RO treatment process would require seawater pressure membranes with recovery efficiencies of only about 50% and overall cost for infrastructure and operations would be significantly higher than the current treatment of brackish water.

In addition to a possible future saline water supply, strategic use of the aquifer could serve to supplement use of the Lower Hawthorn aquifer and possibly help manage and mitigate the degradation of water quality currently occurring in wells withdrawing from the Lower Hawthorn aquifer. Location of Avon Park production wells adjacent to Lower Hawthorn wells currently experiencing rapidly increasing salinities would provide a reduction in hydraulic head in the deeper sources of higher salinity water thereby reducing the potential for upconing of saline water into the Lower Hawthorn aquifer. Carefully coordinated management of both aquifers could provide a significant increase in total raw water supply and a higher degree of control on the quality of the fresher Lower Hawthorn supply.

6.2.3.2 Lower Floridian Aquifer

The Lower Floridan aquifer consists of the Oldsmar Formation and the upper part of the Cedar Keys Formation. Groundwater in the Lower Floridan aquifer closely matches the chemistry of seawater, and the aquifer is located well below the base of the USDW. The aquifer is primarily used as an injection zone for disposal of RO concentrate from the City's RO WTP's and for backup disposal of excess reclaimed water. The transmissivity of the lower dolostone (locally called the Boulder Zone) is typically very high providing for high-capacity injection wells throughout south Florida. The high permeability in the Boulder Zone is due to the cavernous porosity and extensive fracturing present in the aquifer. These features of the Boulder Zone are generally present south of Sarasota and Highlands Counties on the west coast and south of Volusia County on the east coast of Florida. Injection wells constructed at the City's SW RO WTP showed high capacity and confinement for receiving and containing injected fluids. The injection well-constructed at the Everest WRF showed smaller and more moderate cavities and fractures by comparison, but still provided for good disposal capacity and containment. The injection well-constructed at the North RO WTP showed good disposal capacity but less overlying confinement than the other locations.

6.3 Surface Water Resources

Major surface water features in and around the City include the Canal system, Caloosahatchee River, Matlacha Pass, Charlotte Harbor, and former mining pits (reservoirs). The freshwater portion of the Canal system, which is currently the primary surface water source for the City, has been the most viable option considering it is fresh and has an extensive network within the City limits. The City also recently permitted use of an offsite mine reservoir in Charlotte County for fresh water supply during dry season months. However, it should be noted that all fresh surface water sources are limited by seasonal lack of water, saline water intrusion, or environmental impacts. During the wet season months of June through November, available surface water supplies typically far exceed irrigation demands. However, nearing the end of the dry season (April and May) available surface water resources may become inadequate. Use of freshwater resources beyond their dry season limitations will require a major seasonal storage system such as Aquifer Storage and Recovery (ASR). Saline and tidal surface water resources such as Caloosahatchee River and Charlotte Harbor are essentially a perennial supply with little or no competing use or limitations. However, treatment of saline surface water from these sources is extremely expensive and operationally far less desirable than operation of seasonal storage of available freshwater or development of a saline groundwater source such as the Avon Park aquifer which has more consistency in water quality, lack of biologic activity, and turbidity.

The Caloosahatchee River, the Cape Coral Canal System, and Southwest Aggregates Reservoir were evaluated as three potential surface water sources that contain fresh water on a perennial or seasonal basis. The Caloosahatchee River has the greatest flow; however, the river is tidal downstream of S-79, the Franklin Lock, which is 16 miles upstream from the City of Cape Coral. Lee County Utilities Department has a freshwater intake upstream of Franklin Lock, however that intake cannot be used when dry season salinity levels increase above freshwater drinking standards or during the occurrence of algae blooms. Accordingly, the Caloosahatchee River is not considered as a reliable water supply source for the City of Cape Coral. The City canal system has been utilized as an irrigation source since the late 1980's, and yields are far greater than irrigation needs during the wet season; however available yield is limited during the dry season. The City has utilized water from inactive mining pits in Charlotte County and the mining pits can be developed into a reservoir that stores water during the wet season for subsequent use by the City in the dry season. A more detailed discussion of these potential surface water sources is presented in the following paragraphs.

6.3.1 Caloosahatchee River

The Caloosahatchee River, which borders to the east of the City, runs from Lake Okeechobee to Caloosahatchee River Estuary. Many agricultural farms and residential communities rely on the River as a source of water. Three control structures, S-77, S-78, and S-79, control stage and flow in the River and serve as means to prevent saltwater intrusion. The South Florida Water Management District, Florida Department of Environmental Protection (FDEP), Florida Department of Agriculture and Consumer Services in coordination with the Lee County, City of Cape Coral and other stakeholders have developed the Caloosahatchee River Watershed Protection Plan which recommends that the Minimum Flow and Level at the S-79 structure be set at 450 cfs. The Plan also established a set of goals for all stakeholders to follow including reducing the Total Maximum Daily Load of nutrients (Total Phosphorous and Total Nitrogen) by 38%. The use of water from the planned Caloosahatchee River (C-43) reservoir or regulatory releases from Lake Okeechobee to the Caloosahatchee River are not considered reliable sources for the City due to the seasonal nature and inherent uncertainty of how the stages and flows will be managed under the Comprehensive Everglades Restoration Program project. Use of the Caloosahatchee River is a not a feasible option for the City during the dry season when the City needs water the most. Flow is not adequate and water quality is not desirable during the dry season as shown in **Figure 6-7**.

6.3.2 Cape Coral Canal System

The Cape Coral canal network, which consists of approximately 300 miles of freshwater canals and 100 miles of saltwater canals, is a unique feature of the City. The canal system was identified as the primary source of water to supplement reclaimed water from the WRFs in the City in the late 1980's water supply plans. Subsequently, Cape Coral implemented their current integrated water management approach to use desalinated brackish groundwater for residential dwelling and business potable water demands and the canal system to supplement reclaimed water to meet irrigation demands. The City has relied on reclaimed wastewater supply from the two WRFs to supplement the freshwater canal supply and the canal system has proven to be a reliable resource to meet the City's irrigation demands for the past 30 years.

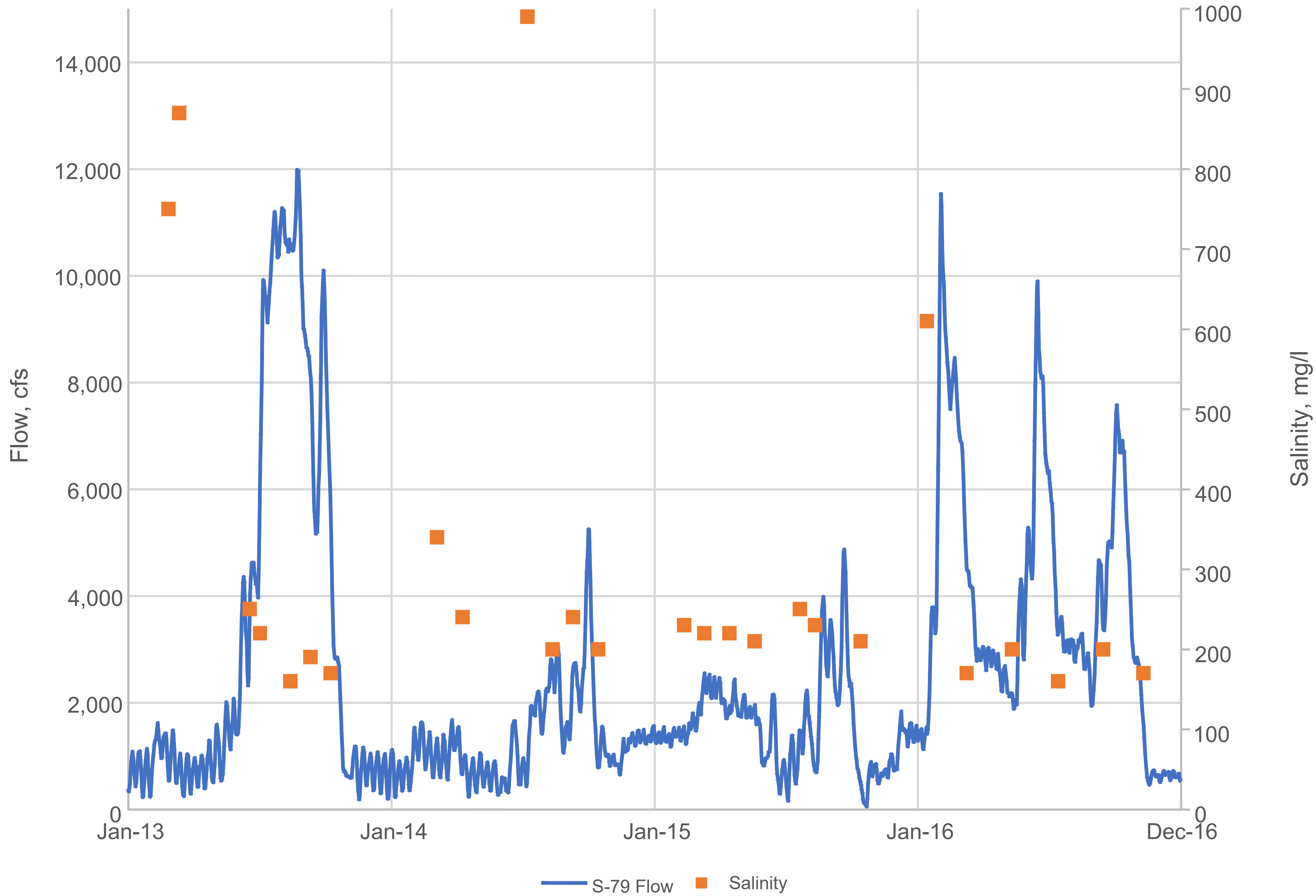

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Figure 6-7: Plot Showing Caloosahatchee River Flow at S- 79 and Salinity One Mile West of S-79.

Use of the canal system for water supply provides for a large water storage mechanism and a highly efficient way to manage and beneficially utilize stormwater generated within the City and utilize the Surficial aquifer underlying the City. Irrigation water supplied from the canal system provides for multiple reuse cycles for both stormwater and reclaimed water, with irrigation water being applied to residential lawns percolating into the shallow groundwater system, seeping back into the canal network, and being reapplied to lawns multiple times before ultimately being discharged to the estuary system surrounding the City. These multiple reuse cycles of seepage, filtration, and the commensurate uptake of nutrients by vegetation and soil provide a robust water treatment process that results in a better water quality than is typical for most stormwater management systems.

The canal system is dependent upon rainfall and resulting stormwater runoff and attendant groundwater inflow for the amount of water available at any given time. **Figure 6-8** illustrates calculated flows for Horseshoe Canal at Weir 14, a point of discharge of the canal system to tidal water and shows that flows are typically restricted to the wet season. Flow patterns at other Cape Coral canals follow a similar pattern. To take full advantage of the large amount of water potentially available seasonally from the City's canal system, the supply would require a large-scale seasonal storage component like an ASR System.

The canal water delivery system consists of, as of 2020, five pump stations, which pump water directly into the reuse/irrigation distribution system after screening and liquid chlorine injection. Water distribution pumps are located in the southern canal system as only areas south of Pine Island Road are part of the City's IQ system in 2020 as shown in **Figure 6-9**. While the dry season canal system water supply is limited to some degree by total water volume available, it is more critically limited by specific conditions of the canal system water use permit (e.g., Minimum Operating Levels [MOLs] in canals) and infrastructure elements of the water management and pumping system such as canal system interconnects and depth of pump intakes. Water levels in several canal basins are managed with adjustable weirs that have wet and dry season control elevations. These weirs allow the City to maximize storage in the dry season while maintaining adequate levels of flood control in the wet season. As water levels decline in the southern canals, a transfer pump station is utilized to pump water from canals north of Pine Island Road into the southern canal system. Over its time in service the City has made several improvements in the canal system control infrastructure and operations to maximize the capacity of the canal system for water supply, including new and modified weir structures that have added as much as a billion gallons of storage to the system. A new canal pump station, CPS 10, was constructed in 2021 to support the extension of the IQ system north of Pine Island Road to the North 2 UEP and allow canal water to be pumped directly into the irrigation distribution system.

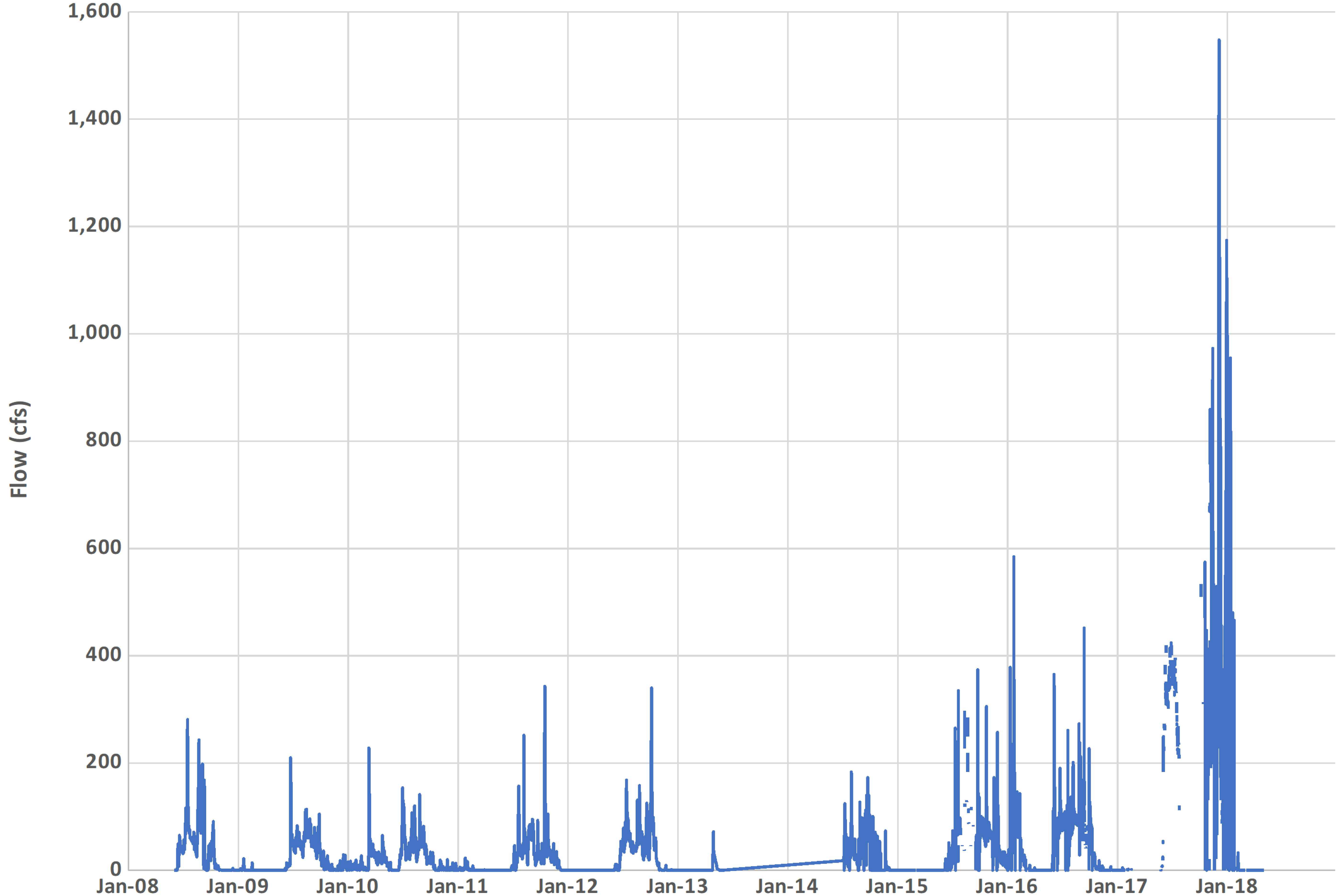

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Figure 6-8: Recorded Flows in Horseshoe Canal, Weir 14.

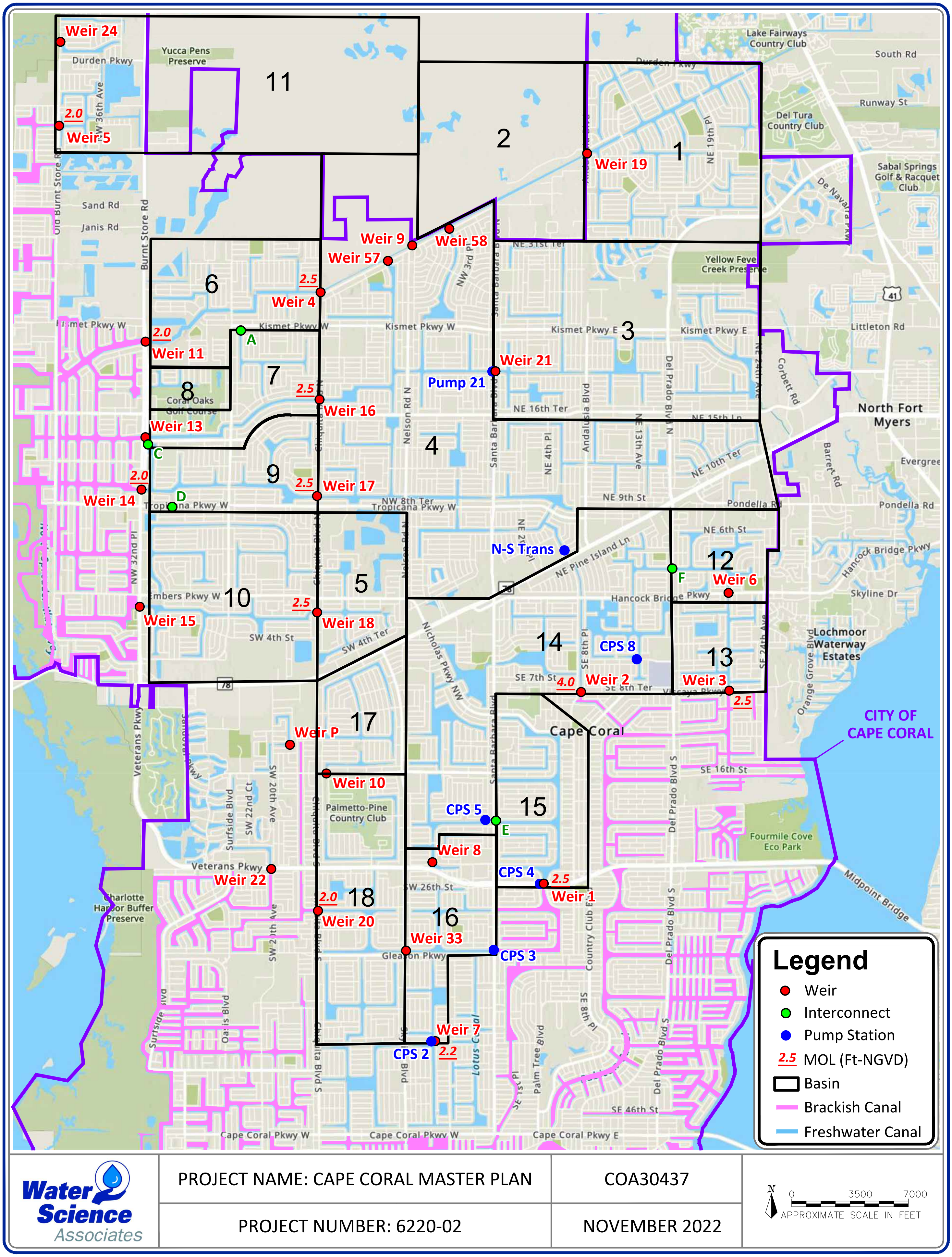

Figure 6-9: Map Showing Locations of 2020 Canal Pump Stations, Weirs, Basins, and Interconnects.

Since completion of the UEP south of Pine Island Road expanded the IQ water user base, the canal system has experienced some capacity limitations in the dry season months of April and May including exposing pump station intakes during extreme drought conditions. **Figure 6-10** shows the various water supply components used to meet irrigation demands from late 2014 until 2020. As noted on **Figure 6-10**, the principal supply sources are the City's reclaimed water from the two WRFs (Everest WRF denoted on the figure as EV and Southwest WRF denoted on the Figure as SW) and the City canal system (denoted on the Figure as CPS). During the 5 years leading up to 2020, the CPS supply ranged between 200 MG/month and 600 MG/month, while the reuse supply from the WRFs was approximately 400 MG/month. To meet drought condition demands however, it has been necessary for the City to supplement the IQ system with potable water from the RO WTP and surface water from the Southwest Aggregates Reservoir. The potable supplement occurred between January and April of 2017 and 2018 and generally ranged between 50 MG/month and 150 MG/month. During extreme drought conditions (between April and June of 2017 and 2020), the City utilized water from the Southwest Aggregates Mine (denoted as Mine on Figure 6-10). In 2017 and 2020, approximately 325 MG and 425 MG of supplemental water were supplied from the Southwest Aggregates Mine, respectively.

Currently, the canal system is permitted to withdraw 36.9 MGD on an average annual basis and 50.2 MGD on a peak monthly basis. The canal system has the necessary capacity to yield the permitted allocations; however, recent historic pumping records indicate that, during extreme drought conditions, the canal system's current configuration of weirs, pumps, interconnects, and maintenance of canal levels above MOLs specified in the SFWMD irrigation permit (Limiting Condition number 30, Water Use Permit number 36-00998-W) may limit withdrawal capacity to a range of 6 to12 MGD in the driest months when the system is most needed. While the system can meet current average irrigation demands, the primary challenge for the City is meeting peak irrigation demands that typically occur at the end of the dry season (April and May) when the canal system yields are lowest.

The City produces an average of approximately 14 MGD of reclaimed water throughout the year from the two WRFs with the canal system meeting the remainder of the City's current irrigation demands for most months of the year in most years. Total demand for IQ water averaged at 27 MGD for the past 10 years.

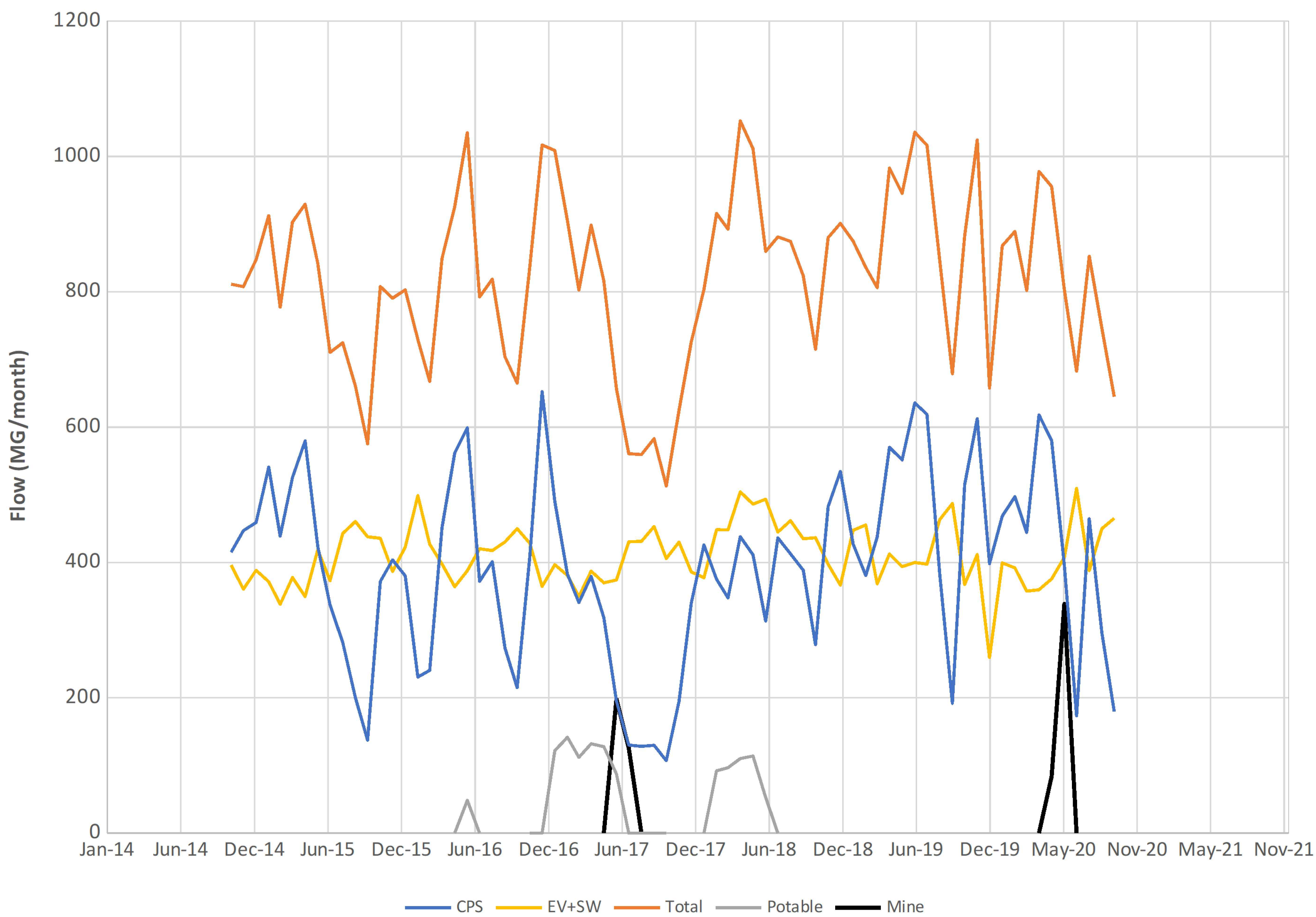

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Figure 6-10: Plot Showing Various Water Supply Components Used to Meet Irrigation Demands.

Several projects to increase the availability of canal water to supply the current irrigation demand are underway or have been recently completed, including:

- Construction of a new CPS and pipeline to support the North 2 UEP was recently completed in 2021.
- Design and permitting of modifications to Weir 29 to increase the capacity of the canal system by up to 1 MGD.
- Construction of 4 additional storage tanks, each with a storage capacity of 5 MG.

Tetra Tech and A.D.A. Engineering, Inc. conducted a modeling study to determine the benefits of additional improvements to Cape Coral water control structures to increase canal water availability to the irrigation system (Tetra Tech, 2017). The recommendations from that study were:

- Replacement of Weirs 16 and 17 with gated weirs (similar to existing weir 19) that would allow for higher dry season water levels while maintaining existing levels of flood protection.
- Replacement of Gator Slough weirs 4 and 9 with gated weirs to allow for higher dry season water levels while maintaining existing levels of flood protection; and
- Replacement of Structure 57 with two underflow gates that would be opened in conjunction with operation of Weirs 4, 9, 16, and 17.
- Implementing a new Irrigation Ordinance that will require more water efficient sprinkler heads and the addition of a day to the irrigation schedule.

Implementing the planned canal system improvements outlined above is expected to increase water availability from canal system by 1 to 3 MGD. Further, recharging the irrigation distribution system with Mid Hawthorn aquifer wells has the potential to increase the water availability by 2 to 4 MGD.

6.3.3 Southwest Aggregates Mine Reservoir

The City was recently issued a water use permit from the Southwest Florida Water Management District (SWFWMD) for up to 16 MGD of irrigation water from the Southwest Aggregates Mine Reservoir. The Southwest Aggregates Mine, located in southern Charlotte County just east of US 41, is a 90% mined out facility that has been identified as a potential offline reservoir for the City. The mined area forms a reservoir that is approximately one square mile in area. The mine reservoir has been studied in progressive levels of detail between 2014 and 2018. An initial feasibility study was conducted in 2014 (AECOM, 2015), and a basis of design report was prepared in 2016 (Tetra Tech, 2017). A pilot water delivery test was conducted in 2017 during a major drought in which an average of 15.5 MGD was pumped over a 40-day period (Water Science Associates, 2017). Water levels were measured at multiple wells surrounding the mine during and after the emergency water delivery pilot test and the collected data were used to evaluate groundwater hydraulics in the surrounding aquifer and support an application for a water use permit from the SWFWMD.

The source of water to replenish the mine reservoir is rainfall and wet season flows that are currently stored on Cecil Webb Wildlife Management Area. Blockages to historic flow-ways west of Cecil Webb have caused the impoundment of water on the Wildlife Management Area (WMA) to the extent that the southwest portion of Cecil Webb has elevated water levels and extended hydroperiods that are damaging both wetland and upland habitats. Reconnecting a flow-way from Cecil Webb to the Southwest Aggregates property would have substantial habitat benefits for the flooded lands on the southwest portion of Cecil Webb WMA and potentially provide a viable source of irrigation water to the City of Cape Coral. A Basis of Design Report (Tetra Tech, 2017) provided results from a 9-year continuous simulation of reservoir operation that indicated that the reservoir could capture an average of 4,700 acre-feet per year in 8 of the 9 years. Refer to **Figure 6-11** for a map showing Southwest Aggregates mine with respect to the City's canal system.

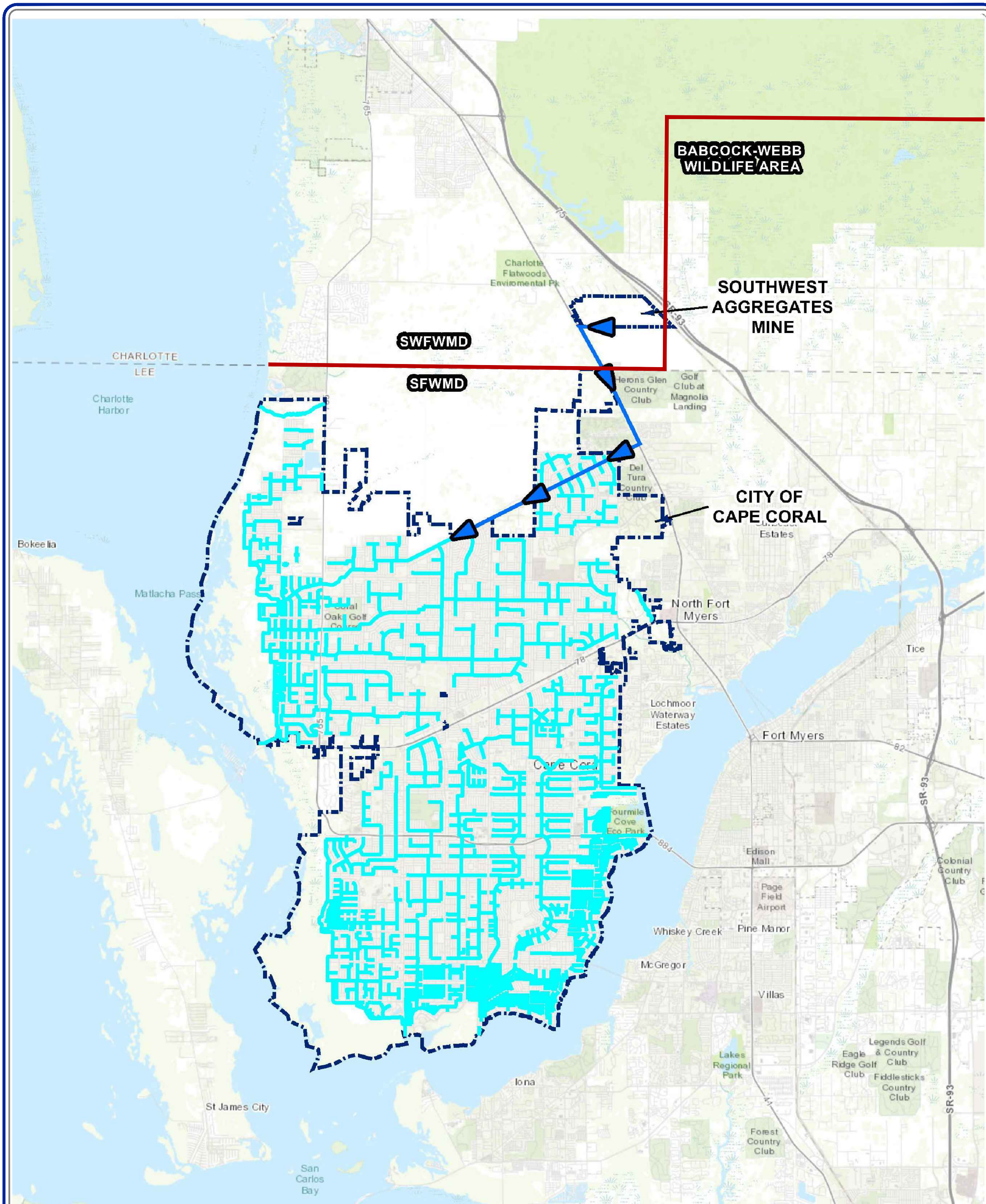
The Southwest Florida Water Management District Water Use Permit allows a peak month use of 16 MGD for up to 90 days per year in the dry season. Conditions of reservoir use include:

- Water may be diverted from the Babcock-Webb WMA when:
- Wet season water levels in the WMA are above 25.5 ft NAVD; and
- Water levels in the Reservoir are below 25.0 ft NAVD

Water may be delivered to the City of Cape Coral when at least one of the following conditions are met:

- Water levels at Weir 17 are below 6.5 ft NGVD;
- Water levels at Weir 7 are below 3.5 ft NGVD; and
- Water pressure in the IQ distribution system are below 35 psi for more than 3 hours in a 24-hour period.

Hydraulic barriers may be constructed around the reservoir, if necessary, to minimize seepage into or out of the reservoir during periods when reservoir water levels are higher than the surrounding area (November through February) and when reservoir water levels are lower than the surrounding area (April – June).



Water Science Associates

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N 0 1.5 3 APPROXIMATE SCALE IN MILES

Figure 6-11: Map Showing the Location of the Southwest Aggregates Mine Reservoir with Respect to the Cape Coral Canal System.

6.3.4 Reclaimed Water

Reclaimed water is a highly utilized year-round reliable source with the supply averaging 15 MGD (refer to **Figure 6-12**). The historic irrigation water use compiled from annual reports submitted to the FDEP and SFWMD and the number of irrigation accounts are presented on **Figure 6-13**. As noted on this figure, the City's growth with regards to irrigation customers and corresponding water usage have steadily increased over the past 30 years.

The City has the capacity to meet current irrigation demands with reclaimed water from its WRFs, stormwater from the City canal system, and the offsite reservoir once completed. However, as population grows and the IQ system is expanded, the demand for irrigation water will increase and additional irrigation sources may be needed. The City has a contract with Florida Governmental Utility Authority (FGUA) and recently entered into an agreement with the City of Fort Myers to receive the excess reclaimed water from those public utilities for beneficial reuse within the City of Cape Coral. A total dry season supply of about 7.5 MGD from these two external reclaimed water sources is expected to supplement the City's irrigation supply. **Table 6-1** presents the IQ water sources and their availability in 2025.

Table 6-1: Estimated Wet & Dry Season Capacities of Available Irrigation Water Resources for Year 2025

Source	Wet Season Supply (MGD)	Dry Season Supply (MGD)
CC Reclaimed Water[1]	18.0	19.0
CC Canals	36.9	12.0
FGUA	3.5	1.5
Ft. Myers	12.0	6.0
Southwest Aggregates Mine Reservoir	N/A	16.0[2]

1 Reclaimed water availability for wet and dry seasons is based on reclaimed water projections and historical seasonal multipliers.

2 Allowable withdrawal rate for 90 days as permitted.

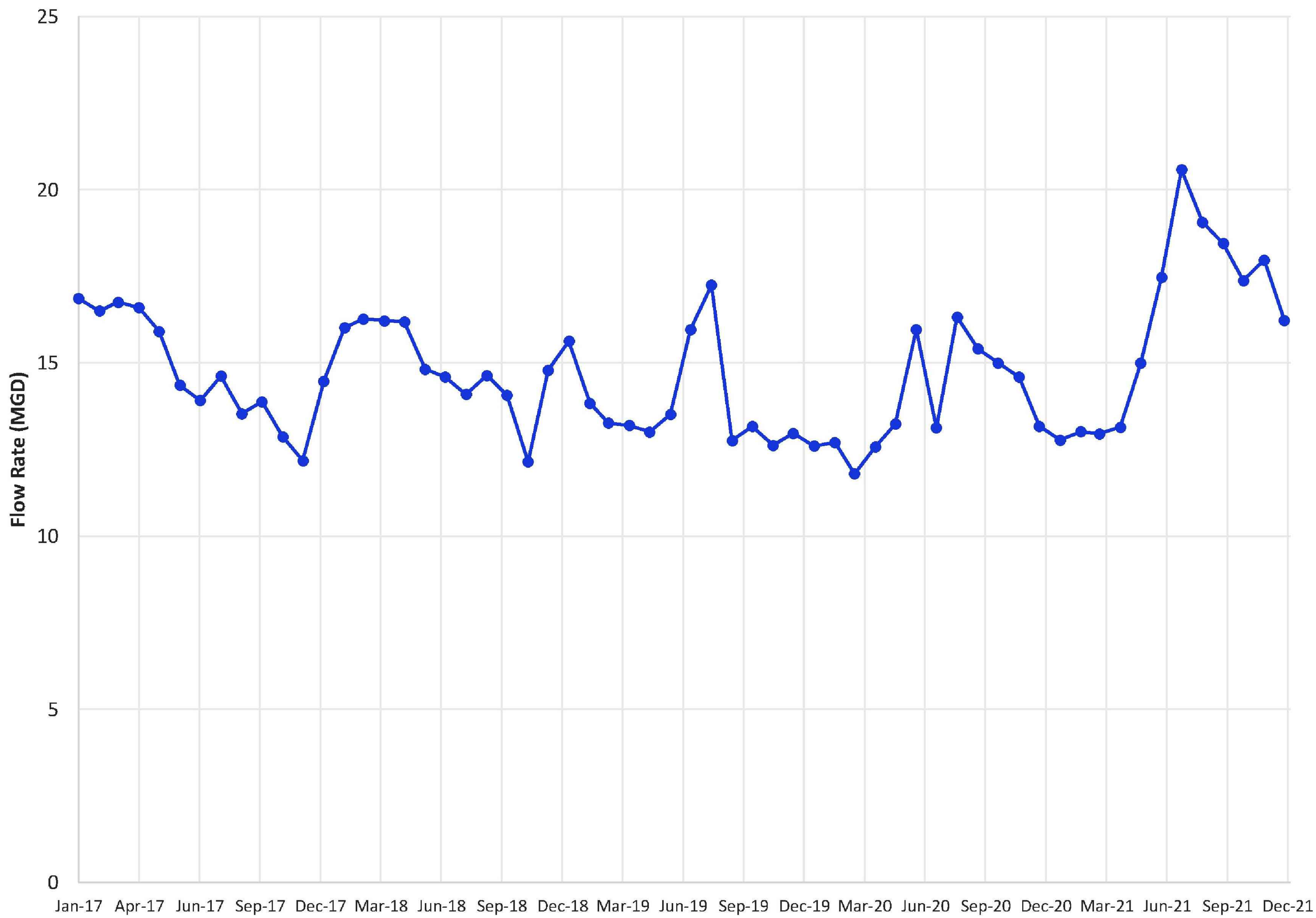

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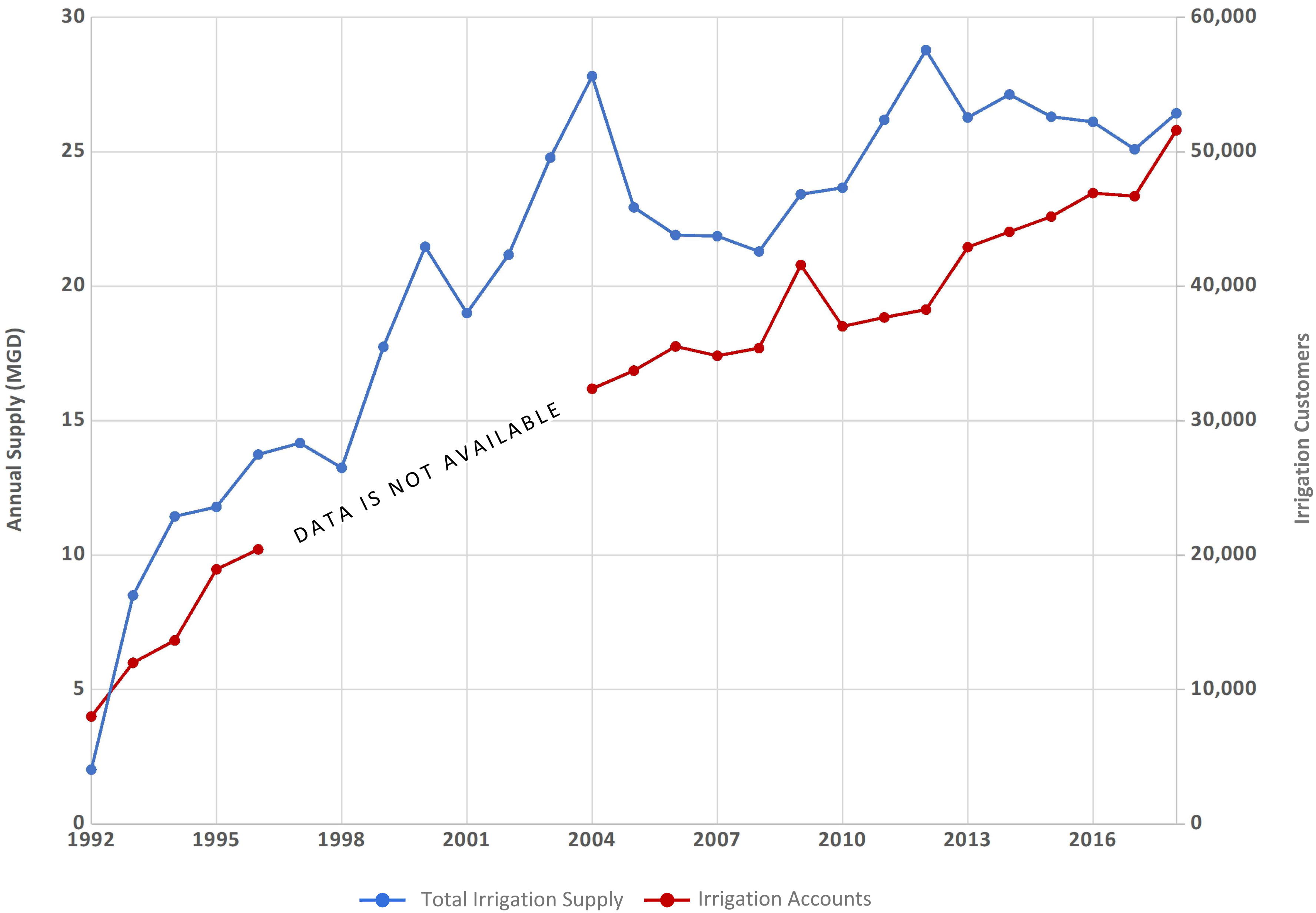
Figure 6-12: Historical Monthly Average Reclaimed Water Supply from the City's WRFs.



Water Science Associates	PROJECT NAME: CAPE CORAL MASTER PLAN	COA30437	
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Figure 6-13: Plot Showing Historical Irrigation Water Usage and Number of Irrigation Accounts.

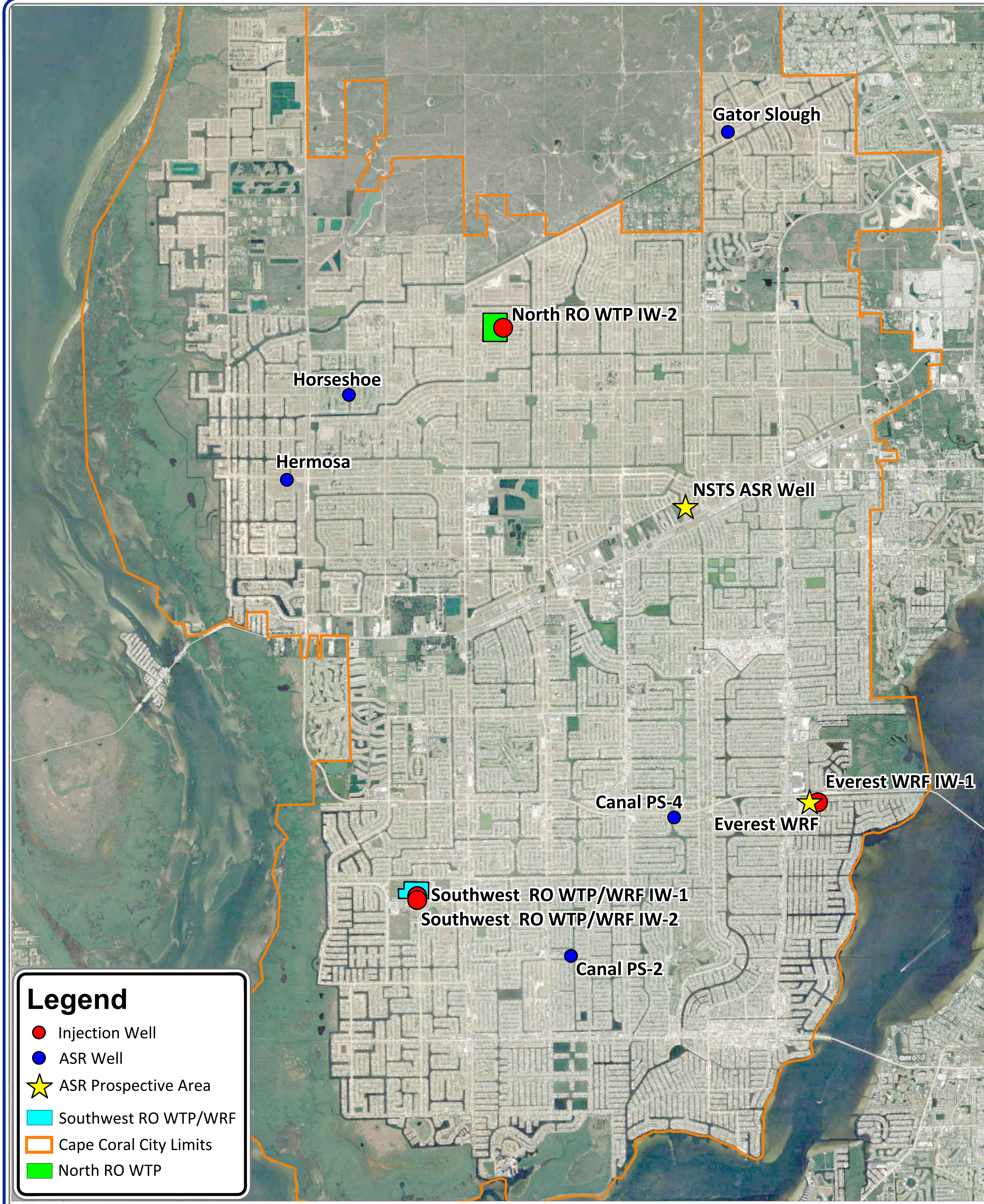
6.4 Aquifer Storage and Recovery

While the City has a sizable ASR test program, the use of ASR technology has not advanced beyond the construction phase into an operational phase. This is principally because the City has already made large investments in the development of raw water supplies from the Upper Floridan aquifer system typically used for ASR storage and regulatory uncertainty. Sharing the same subsurface interval for both ASR and Public Water Supply could potentially result in interference between the two. The Lower Hawthorn and Upper Suwannee aquifers are highly developed in the City for potable water supply from the City's two RO WTP's. ASR has potential for supplementing the City's potable and/or irrigation water supplies, but it must be developed without affecting the City's existing RO supply wells. Areas surrounding the Everest WRF and the North-South Transfer Station (NSTS) have the most potential for development of irrigation ASR as they are both relatively distant from existing potable water supply wellfields and near major irrigation water supplies. Location of ASR wells at the Everest WRF may be of particular importance in managing proposed supplies of reclaimed water that will be received from the City of Fort Myers. Strategic use of ASR or managed aquifer recharge (MAR) could also be considered to aid in the management of the City's brackish water aquifers where upward preferential flows of deep higher salinity groundwater are occurring.

The City currently has three, Class V, Upper Floridan ASR test wells located at the NSTS, CPS-2 and CPS-4. The monitoring wells for the ASR sites NSTS and CPS-4 include two (2) storage zone monitoring wells constructed within the same formation as the ASR zone and one (1) overlying aquifer monitor well within the Hawthorn Formation. At the CPS-2 ASR site, there is only one shallow zone monitoring well (SMW-1) constructed, to date. In addition, the City has three (3) Class V, Group 9, ASR Exploratory wells, at the following sites: Gator Slough, Horseshoe Canal, and Hermosa Canal. Refer to **Table 6-2** for well construction details of the ASR system wells and **Figure 6-14** for the locations of the ASR wells. No cycle testing has been conducted on any of the City's ASR wells since construction and none of the wells has an operational permit from the FDEP. The current FDEP issued Underground Injection Control (UIC) permits are Class 5 Group 7 Construction Permits with a monitoring and maintenance only condition. A request to FDEP to commence operation testing is required and can be issued under the existing UIC Construction Permits. The wells are not currently equipped with either pumps or discharge/return piping. All wells are currently capped and not equipped for operational testing.

Table 6-2: ASR Well Construction & Permit Details

<table>
<tr><th>System Name</th><th>FDEP Facility ID</th><th>FDEP Permit Number</th><th>Well Name</th><th>Casing Diameter and Type</th><th>Depth Cased (ft. bls)</th><th>Depth of Open Hole (ft. bls)</th><th>Current Permit Issued</th><th>Permit Expiration</th></tr>
<tr><td>Gator Slough Site ASR-1</td><td>98751</td><td>357902-001-UC/5SR</td><td>ASR-1 Gator Slough Site</td><td>6.626-Inch PVC</td><td>770</td><td>910</td><td rowspan="3">19-Jun-18</td><td rowspan="3">19-Jun-23</td></tr>
<tr><td>Horseshoe Canal Site ASR-1</td><td>98752</td><td>357904-001-UC/5SR</td><td>ASR-2 Horseshoe Canal Site</td><td>8.625-Inch</td><td>523</td><td>694</td></tr>
<tr><td>Hermosa Canal Site ASR-1</td><td>98753</td><td>357905-001-UC/5SR</td><td>ASR-3 Hermosa Canal Site</td><td>6.626-Inch PVC</td><td>880</td><td>950</td></tr>
<tr><td rowspan="4">North-South Transfer Station ASR-1</td><td rowspan="4">99494</td><td rowspan="4">357898-001-UC/5SR</td><td>ASR-1 NSTS Site</td><td>18-Inch FRP</td><td>800</td><td>920</td><td rowspan="10">19-Jun-18</td><td rowspan="10">19-Jun-23</td></tr>
<tr><td>SMW-1</td><td>6.625-Inch PVC</td><td>810</td><td>920</td></tr>
<tr><td>SZMW-2</td><td>6.625-Inch PVC</td><td>800</td><td>914</td></tr>
<tr><td>SMW-1R</td><td>6.625-Inch PVC</td><td>445</td><td>545</td></tr>
<tr><td rowspan="2">Canal Pump Station 2 ASR</td><td rowspan="2">99495</td><td rowspan="2">357899-001-UC/5SR</td><td>ASR-2 CPS-2 Site</td><td>18-Inch FRP</td><td>780</td><td>860</td></tr>
<tr><td>SMW-1</td><td>6.625-Inch PVC</td><td>515</td><td>615</td></tr>
<tr><td rowspan="4">Canal Pump Station 4 ASR</td><td rowspan="4">98662</td><td rowspan="4">357900-001-UC/5SR</td><td>ASR-3 CPS-4 Site</td><td>14.48-Inch FRP</td><td>783</td><td>871</td></tr>
<tr><td>SZMW-1</td><td>6.625-Inch PVC</td><td>780</td><td>871</td></tr>
<tr><td>SZWM-2</td><td>6.625-Inch PVC</td><td>800</td><td>900</td></tr>
<tr><td>SMW-1</td><td>6.625-Inch PVC</td><td>500</td><td>600</td></tr>
</table>



PROJECT NAME: CAPE CORAL MASTER PLAN	COA30437	N 0 4000 8000 APPROXIMATE SCALE IN FEET
PROJECT NUMBER: 6220-02	NOVEMBER 2022	

Figure 6-14: Map Showing ASR and Injection Well Locations.

6.4.1 ASR Target Zones Evaluation Criteria

There are many factors that can influence success of an ASR water storage program and a number of studies have been published documenting ASR success and suggesting means for evaluation of ASR feasibility based on these critical success elements. An evaluation of existing ASR programs developed by the USGS (Reese and Alvarez-Zarikian, 2006) identified three hydrogeologic and design factors that were common to successful ASR systems. These included (1) an aquifer thickness of less than 150 feet, (2) an aquifer transmissivity of less than 250,000 gpd/ft, and (3) an aquifer chloride concentration of less than 2,500 mg/L. Aquifer transmissivity and target aquifer salinity (as measured by chloride) showed the most influence in ASR success. Efforts toward developing a systematic method for evaluating ASR feasibility are seen in SJRWMD 1997; Brown et al 2004; and Zuurbier et al 2013. Each of those publications uses various hydrogeologic elements in their evaluation approach including aquifer thickness, aquifer transmissivity, aquifer confinement (or leakance), aquifer ambient water quality, aquifer hydraulic gradient, and various approaches to assess water mixing and dispersion within the aquifer. Our discussion here focuses on major evaluation criteria, namely: thickness, transmissivity, native water quality, and regulatory acceptance.

6.4.2 Potential ASR Storage Zones

A major factor in determining regulatory acceptance of an ASR system is the classification of the target zone aquifer as defined by the FDEP in FAC 62-520.410 based on use and total dissolved solids (TDS) concentrations. Potential target ASR aquifers are classified as follows:

Class G-I Potable water single source aquifer with a TDS of less than 3,000 mg/L

Class G-II Potable water aquifer with a TDS of less than 10,000 mg/L.

Class G-III Non-potable water unconfined aquifer with a TDS of greater than 10,000 mg/L.

Class G-IV Non-potable water confined aquifer with a TDS of greater than 10,000 mg/L.

The FDEP classifications dictate the type and quality of water that can be injected into the aquifer which in turn dictates the level of water treatment required and the level of difficulty in obtaining necessary permits for an ASR system. There are four potential ASR zones in Cape Coral; three of which would be classified as G-II aquifers and one that would be classified as a G-IV aquifer. The G-II aquifers would include the Lower Hawthorn and the Upper and Lower Suwannee aquifers. The G-IV aquifer would include the Avon Park aquifer. These potential target ASR aquifers are generally separated by lower permeability confining units that occur throughout the Intermediate and Floridan aquifer systems. Descriptions of each of these potential ASR zones and their applicability and feasibility for development of an ASR system are provided below.

6.4.2.1 Lower Hawthorn Aquifer

The Lower Hawthorn aquifer generally extends from approximately 500 feet bls to 800 feet bls and consists of moderately to highly permeable fossiliferous limestone units. This aquifer is currently the principal source for public water supply to the residents of Cape Coral. The Lower Hawthorn aquifer is separated from the overlying Intermediate aquifer System by the Lower Hawthorn Confining Zone which consists of approximately 100 feet of low permeability dolosilt. This degree of confinement ensures that there is a very low potential for upward vertical migration of injected and stored water from this aquifer. The transmissivity of the Lower Hawthorn aquifer ranges between 50,000 gpd/ft to 150,000 gpd/ft. Dissolved chloride concentrations in the Lower Hawthorn aquifer generally range between about 800 and 1,200 mg/L over most of the City, but up 2,500 mg/L or higher in the western portions of the City have been reported. Groundwater within the Lower Hawthorn aquifer within the City is classified as G-II. Permitting of a reclaimed water ASR system in a Class G-II groundwater will require full treatment and disinfection of reclaimed water and will be subject to the highest level of regulatory enforcement of any of the potential target aquifers. ASR injection and recovery rates for the Lower Hawthorn aquifer are estimated to be 1 MGD. Recovery efficiency for the Lower Hawthorn Aquifer is estimated at 75%, meaning for every 100 million gallons stored, approximately 75 million gallons would meet criteria for distribution into the irrigation system. Assuming a 120-day injection period during the wet season, 90 million gallons per well could be recovered each year from each Lower Hawthorn ASR well.

6.4.2.2 Upper Suwannee Aquifer

The Suwannee aquifer extends from approximately 900 to 1,200 feet bls and is composed of interbedded limestones, marls and dolostones. Although the Suwannee aquifer is generally considered a single aquifer, it may be subdivided into upper and lower portions separated by units with semi-confining characteristics. Potential water bearing units occur in the upper portion (900 to 1,000 feet bls) and lower portion (1,100 to 1,200) of the Suwannee aquifer. For this report, the upper water bearing formation is referred to as Upper Suwannee aquifer and the lower water bearing formation is referred to as Lower Suwannee aquifer. The semi-confining bed that separates the Upper Suwannee aquifer and the overlying Lower Hawthorn aquifer provides a moderate potential for upward migration of injected/stored water from the aquifer. The transmissivity of the aquifer ranges between 10,000 gpd/ft and 50,000 gpd/ft with an average of about 30,000 gpd/ft. Dissolved chloride concentrations in the Upper Suwannee aquifer are expected to be higher than Lower Hawthorn aquifer. Groundwater within the Upper Suwannee aquifer is classified as a G-II. The use of this aquifer is subject to the same protective regulations as those for the Lower Hawthorn aquifer. ASR injection and recovery rates for the Upper

Suwannee aquifer are estimated to be 1 MGD and recovery efficiency is estimated to be between 65% and 75% depending on native chloride concentration in selected ASR zone. Assuming a 120-day injection period during the wet season, between approximately 75 and 90 million gallons per well could be recovered each year from each Upper Suwannee ASR well.

6.4.2.3 Lower Suwannee Aquifer

The Lower Suwannee aquifer is differentiated from the Upper Suwannee by the observed increase in lime muds and fine-grained material. The major producing zone of the Lower Suwannee aquifer is encountered at depths from 1,100 feet to 1, 200 bls. This zone is included as an isolated bed with relatively high porosity and permeability that is overlain by approximately 100 feet of limestone and clays with relatively low permeability. There is a moderate potential for upward migration of stored water through the overlying confining layer. The underlying Ocala Limestone and Avon Park Formation are separated from the Lower Suwannee aquifer by low permeability, semi-confining dolostones (MWH, June 2009) meaning that there is a moderate potential for downward migration from this aquifer to the underlying limestone. Transmissivity values in the Lower Suwannee aquifer are similar to the Upper Suwannee aquifer. Dissolved chloride concentrations in the Lower Suwannee aquifer are expected to be higher than Lower Hawthorn aquifer and the Upper Suwannee aquifer. The groundwater within the Lower Suwannee aquifer is classified as G-II. Permitting an ASR system in this aquifer would require less effort than the effort required for the two overlying aquifers because the Lower Suwannee aquifer is not used for public water supply and native groundwater TDS concentrations likely exceed 3,000 mg/L. ASR injection and recovery rates for the Lower Suwannee aquifer are estimated to be one MGD. The recovery efficiency is estimated to be 50%. Assuming a 120-day injection period, 60 million gallons per well could be recovered each year from each Lower Suwannee ASR well.

6.4.2.4 Avon Park Aquifer

The Avon Park Formation of the Upper Floridan aquifer system occurs from approximately 1,400 to 2,200 feet below grade. The major water bearing unit within this aquifer occurs between about 1,400 and 1,700 feet below grade. There is generally good hydraulic confinement below the highly permeable section of the Avon Park due to the high density and low permeability dolomite layers which have very little fracture porosity. However, rapidly increasing salinity in some of the City's RO production wells indicates that vertical fracture and preferential flow paths for upward migration exist in the top confining layer of the Avon Park aquifer. The extent of these fractures is largely unknown. The City is planning on conducting a seismic reflection study to delineate the confining unit and suspected fracture network in deeper aquifer systems.

Where the Avon Park aquifer has been tested in Lee County, transmissivity values have been estimated as generally ranging from 0.5 to 2 MGD/ft although no long-term performance tests have been conducted (AECOM, December 2010). Dissolved chloride concentrations in the Avon Park Formation are expected to range between about 12,000 and 20,000 mg/L. Groundwater within the Avon Park Formation is classified as G-IV. Because the aquifer contains water with TDS in excess of 10,000 mg/L, it is considered to be below the USDW and therefore subject to the lowest level of regulatory restriction of the potential target storage zone aquifers. ASR injection and recovery rates for the Avon Park Formation are estimated to be 2 MGD. Estimated recovery efficiency is 25%. Assuming a 120-day injection period, 60 million gallons per well could be recovered each year from each Avon Park Formation ASR well.

6.4.3 ASR Options

For an ASR system to be successful, the following criteria should be favorable: aquifer transmissivity, upper confinement, lower confinement, aquifer thickness, native water quality, aquifer uses for other purposes, regulatory acceptance, anticipated recovery and capital costs. Based on available data, the Lower Hawthorn aquifer would likely have the highest chance of success followed closely by the Upper Suwannee aquifer.

The Lower Suwannee aquifer is not used as a source for public water supply; hence the permitting process may be relatively easier. However, note that the Lower Suwannee aquifer is still a USDW with restrictions on the quality of water that can be injected but also has high native water salinities and high hydraulic connection to adjacent aquifer water sources that will reduce recovery efficiencies. Additionally, the aquifer has relatively high construction costs as compared to the Lower Hawthorn and Upper Suwannee aquifers. Weighing in these factors, the disadvantages likely outweigh the advantages, and hence this aquifer is not considered a viable candidate for ASR. The Avon Park aquifer has high transmissivity and high salinity generally leading to a low recovery efficiency. Additionally, higher capital costs for the deeper well construction also make this aquifer a non-viable option.

The Lower Hawthorn and Upper Suwannee aquifers have been successfully used for ASR development in Florida. Note that these aquifers are designated sources of drinking water and contain Class G-II waters which places regulatory limitations on the quality of water that can be injected into it. Generally, the poorer the water quality in the target aquifer (higher salinity), the lower the level of treatment and disinfection of reclaimed or source water that will be required prior to injection. Also, if the target aquifer is currently used or may be used in the future for a public water supply, permitting will likely include protection measures such as restrictions on aquifer use. Having to meet full treatment and disinfection criteria will likely add significant costs in additional infrastructure and operations for any water injected into the Lower Hawthorn or Upper Suwannee aquifers.

Demonstrating that the aquifers with ASR potential are not used as a drinking water source could be a challenge in Cape Coral considering the raw water supply wells are completed in the Lower Hawthorn and Upper Suwannee aquifers, which are utilized to supply the City's two RO treatment facilities. The City may be required to provide hydrogeologic modeling and other supporting information to establish a defined zone of discharge that will require monitoring and institutional controls to prohibit any use of the potentially affected zone from being utilized for a drinking water supply. The City has already made large investments in the raw supply of water from the aquifers typically used for ASR storage. ASR has potential for supplementing the City's potable and/or irrigation water supplies, but it must be developed without compromising the City's existing RO supply wells. Well sites close to Everest WRF and North South Pump station have the most potential since these locations are distant from existing wellfields and strategically located at a major source of water supply.

Developing an ASR system from conceptual design to an operational testing phase can take several years. The process typically involves a pilot study phase that will include planning (6 months), design and permitting (12 months), procurement (6 months), construction (18 months), and cycle testing (36 months). After the pilot phase is completed, the system may be expanded by adding additional wells and infrastructure, which can take another five years from design to operational approval from the FDEP, depending on the number of wells and above-ground infrastructure added to the system.

6.5 Summary and Recommendations

A summary of several potential options to expand the RO raw water supply infrastructure were discussed in the previous sections. **Table 6-3** summarizes the existing resources and recommended expansion strategies.

Table 6-3: Summary of Current & Potential New Sources for Raw Water Supply

Current Sources	Current Max. Production Capacity (MGD)	Permitted Max. Capacity (MGD)	Potential New Sources	Potential Additional Water / Capacity	Limitations / Comments
Lower Hawthorn Aquifer	31 MGD	43.7	Develop Lower Hawthorn wellfield North and Northeast	0.7 MGD per well	Need to manage wellfield to minimize saline upconing
			Use Mid-Hawthorn wells for blending of treated RO water	0.5 MGD per well	Potential permitting hurdle. Conditions are expected to become favorable for permitting during the planning period of this Master Plan. Strategic placement needed.
			Avon Park aquifer wells for saline RO treatment after brackish sources are exhausted	2 MGD per well	More expensive wells and treatment infrastructure. Consideration of development of the Avon Park aquifer source will not need to occur until utilization of the Lower Hawthorn results in aquifer water quality that approaches the Avon Park aquifer water quality and/or Lower Hawthorn aquifer water levels reach minimum source safe yield levels as dictated by SFWMD.

A summary of existing City infrastructure for irrigation water supply and several options to increase supply were discussed in the previous sections. **Table 6-4** summarizes the existing resources and recommended expansion strategies.

Table 6-4: Summary of Current & Potential New Sources for Irrigation Supply

Current Sources	Current Max. Production Capacity (MGD)	Permitted Max. Capacity (MGD)	Potential New Sources	Potential Additional Capacity	Limitations / Comments
2 WRFs **Canal System** **SW Aggregates Mine Reservoir** **Reclaimed Water from FGUA**	14-15 MGD of reclaimed water from WRFs on average. Reclaimed water varies based upon expansion of wastewater service area 12 MGD from canals during dry season and 36.88 MGD permitted during wet season. 3 MGD from FGUA during wet season, 1.5 MGD during dry season	50.22 MGD permitted for canal system. No limit on WRFs supply. 16 MGD from the SW Aggregates reservoir for 90 days.	Recharge canals with Surficial aquifer wells where canal network has low density and the aquifer has productive limestone. This has limited potential as the groundwater recharge could be offset by evaporation from the canals.	0.25 MGD per Surficial aquifer well.	Iron and color issues. Potential permitting hurdle.
			Recharge IQ line with Mid-Hawthorn aquifer wells strategically placed where line pressure is low	0.25 MGD per Mid Hawthorn aquifer well.	Need impact assessment study, higher scrutiny from the District.
			Add offsite reclaimed water City of Fort Myers	12 MGD during wet season and 6 MGD during dry season	Dependence on external sources.
			Canal System Improvements	1 to 3 MGD	Reaching the storage limit of current system.