TECHNICAL MEMORANDUM

Partially Treated Surface Water ASR Desktop Study

PREPARED FOR:	Peace River Manasota Regional Water Supply Authority
PREPARED BY:	CH2M and ASRus
DATE:	March 24, 2016
WORK ORDER NUMBER:	15-02
REVISION:	FINAL

1 Executive Summary

The Peace River Manasota Regional Water Supply Authority's (Authority's) potable water Aquifer Storage and Recovery (ASR) system has been a critical water storage component, enabling the Authority to manage seasonal demands when flows from the Peace River are too low or water quality is not acceptable for treatment. The potable water ASR system, as currently permitted and operated, requires that the stored water be fully treated prior to recharge into the aquifer and then fully treated again when the stored water is recovered. This makes storing water in the ASR system economically less favorable for the Authority than storing raw surface water in the off-stream reservoirs, which only requires treating the surface water supply once prior to delivery to its customers. Even with the higher operational cost, the potable ASR system remains an important water resource element providing the Authority with additional storage and redundancy to the off-stream reservoirs.

There is, however, the potential to operate the ASR system in a manner far more economically similar to the reservoirs. Converting the ASR system to a partially treated surface water (PTSW) ASR system (recharge with water directly from the above ground reservoir rather than potable water) would significantly reduce the treatment cost of operating the ASR system, since it would only require full treatment to drinking water standards one time, when recovered from ASR storage.

There would also be a marked benefit in water quality since the surface water treatment process adds about 75 milligrams per liter (mg/L) of inorganic salts to the water (mostly sulfate, chloride and sodium). So by skipping this rigorous treatment up front, the water being recharged would have about 25 percent lower total dissolved solids (TDS) concentrations, and the final drinking water produced would be commensurately better in quality as well.

Uncoupling ASR injection from the initial high treatment cost eliminates surplus treatment capacity as a constraint. This creates the potential for excess fresh river water which would normally flow to tide to be recharged. This could offset the impacts of groundwater withdrawals elsewhere in the region and contribute to the Southwest Florida Water Management District's recovery plan goals for the Southern Water Use Caution Area by boosting aquifer levels. This existing site represents a significant public investment in ASR-related infrastructure; this is one of the largest and longest operating ASR systems in the United States. That investment reflects 21 ASR wells, miles of pipe, a network of monitoring wells, a legacy of water quality data, the human capital/expertise and all of the related ancillary infrastructure needed to support this complex and sophisticated system in a reliable, highly controlled manner. Locations with such a constellation of success factors are rare; there is not a similar facility in the state of Florida which offers such promise and possibility for success on such a significant scale.

Increasing ASR recharge capability and improving TDS of recharged water will improve system response to drought events and increase system reliability ratings. The Authority has developed sophisticated modeling tools to make operational decisions. These tools can also be used to evaluate a portfolio of future conditions to insure that infrastructure element capacities are properly sized to maximize system reliability. Also, over the past decade, emerging recognition of the risk of climate variability and sea level rise has compelled the Authority to infuse features into its suite of modeling tools so they can be used to quantify risk associated with various optimization and adaptation management strategies. Efforts are underway to incorporate PTSW ASR water capability into the current reliability modeling platform to quantify the expected benefits to water quality and quantity reliability into the future.

The current aquifer used as the storage zone for the ASR system is designated an underground source of drinking water (USDW) as defined by Florida Department of Environmental Protection (FDEP). A USDW is defined as groundwater with TDS concentration less than 10,000 milligram per liter (mg/L), and certain water quality standards must be met to allow injection to occur in this groundwater source. The main parameter of concern when considering PTSW ASR is total coliform which is ubiquitous in all surface water bodies. Other PTSW aquifer recharge and ASR systems have shown that coliform bacteria do not persist in the aquifer beyond a few days after injection and within a short distance from the recharge well. These data have allowed the FDEP to consider injection of PTSW into a USDW under certain circumstances.

Perhaps the most important criterion for obtaining FDEP approval to inject PTSW into a USDW is the ability to meet primary and secondary drinking water standards prior to the stored water leaving the area under control of the owner. Since the Authority has significant institutional control of land surrounding the existing ASR wellfields, the prospect of allowing a zone of discharge to the property boundary as a possible regulatory mechanism to allow injection of PTSW is a viable concept. This is the fundamental basis for the water quality criteria exemption for arsenic previously issued to the Authority for the potable ASR system.

1.1 Summary of Benefits

Advantages to the conversion of the source water for the ASR system from potable water to PTSW include:

- Significant reduction in treatment cost (currently the water must be treated twice to drinking water standards prior to use)
- Frees up treatment capacity of the Peace River Facility (PRF) during the wet season (treatment capacity used for potable water ASR during recharge events is reduced or eliminated). This would generate additional redundancy in treatment facilities, bolstering regional reliability in that sense
- Reduced operational complexity – ASR can be used as an extension of the reservoir system
- Environmentally responsible – effectively manages our surface water resources, and does so using a smaller energy footprint than the current potable water ASR system
- The ASR system would be used more often and would store larger volumes of water over time resulting in a gradual freshening of the storage zone which would further offset drought risk.
- Can be used to advance the District’s Recovery Plan for the SWUCA by recharging excess fresh water to bolster regional aquifer levels
- Recharge water will be 25% lower in TDS concentration than current potable water, thus recovered water will have commensurately lower TDS levels as well provide for improved public drinking water quality upon final treatment and delivery
- Provides the regulatory framework to also cost-effectively recharge PTSW into the permeable unit underlying the ASR storage zone in the future to further improve ASR water quality and reliability by improving the quality of upconed water that has been observed in WF2
- Improved system sustainability and reliability

1.2 Summary of Proposed Implementation Plan

The proposed implementation of the PTSW ASR concept includes the following steps:

- Phase 1
    - Complete preliminary FDEP permit authorizing short-term demonstration cycle tests at ASR Wellfield No. 2 (WF2) using PTSW water for ASR recharge.
    - Install temporary piping and equipment to conduct demonstration cycle testing at two select wells at WF2. A cycle test would include a recharge event (injection), a storage period, and recovery event (withdrawal).
    - Conduct PTSW demonstration cycle tests ideally coinciding with potable water storage periods in the normal ASR operation of WF2 to prevent lateral movement of injected water caused by adjacent well operation.
    - Evaluate data and, if appropriate, apply for a permit or modification of the existing ASR permit to allow storage of PTSW as the source water for WF2. The permit should allow either PTSW or fully treated surface water into the ASR system to provide the Authority the most flexibility in future use of this system.

- Phase 2 (as applicable to Phase 1 outcome)
- Design and construct a permanent 20 mgd pump station to supply up to 20 mgd PTSW to the existing WF2 wells or allow for future expansion of the wellfield.

1.3 Examples of Other PTSW Aquifer Recharge Systems in Florida

Examples of successful PTSW aquifer recharge systems include the following:

- Marco Lakes ASR system – 6 ASR wells; 9 mgd capacity; Chloramine disinfection; Class V Operation Permit issued
- Kissimmee River ASR system – 1 ASR well; 5 mgd capacity; UV disinfection
- Hillsboro Canal ASR system – 1 ASR well; 5 mgd capacity; UV disinfection
- Taylor Creek ASR system – 1 ASR well; 5 to 10 mgd capacity; Cycle testing proposed with disinfection to resume after well sitting idle for several years; Pursuing exemption for coliform bacteria
- City of West Palm Beach ASR system – 1 ASR well; 8 mgd capacity; Cycle testing ongoing to support a Class V Operation Permit; Exemption for total coliform granted
- Suwannee River Spring Restoration Aquifer Recharge – 1 Recharge Well, surface water recharge into less than 500 mg/L TDS aquifer, no exemption required
- City of North Port ASR system – 1 ASR well; 1 mgd capacity; permitting underway to convert to a PTSW ASR system

1.4 Cost Estimate Summary

The estimated cost to implement a demonstration cycle testing program with two existing wells to confirm viability of PTSW conversion is estimated to cost up to approximately $186,500. The cost to perform this demonstration test includes the cost of recharging an equivalent amount of potable water.

Full conversion of WF2 to a PTSW ASR system is estimated at approximately $6.6M - $7.5M assuming construction of a 20 mgd raw water injection pump station.

Considering the capital cost of a new pump station, debt service on a loan for this construction, new pump station maintenance costs, and reduced ASR operational costs, estimated direct savings of PTSW ASR is approximately $334,000 - $394,000 per year. Section 5 provides details on assumptions used in the budgetary cost estimates provided.

The Authority has a significant investment in the current ASR system, not just in the capital cost of the infrastructure and the cost of the water currently in storage, but also the considerable resources spent collecting years of data that have led to a regulatory solution enabling the ASR system to receive an operation permit. Conversion of the potable system to a PTSW system would maximize the use of this valuable resource, allowing the Authority to see a greater return on their investment.

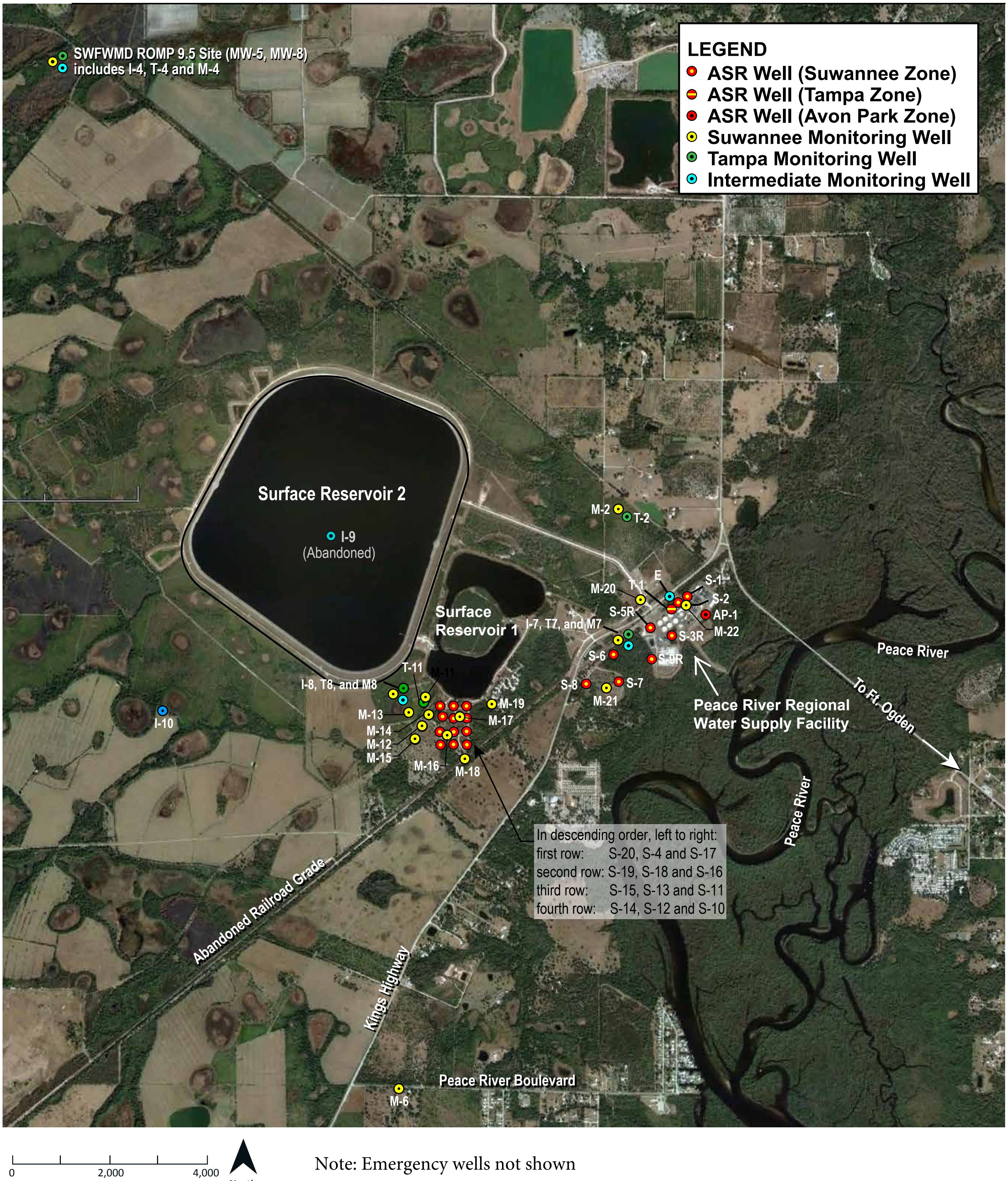
The following sections provide further background and detail on the proposed permitting, testing, and implementation of PTSW ASR at the PRF.

2 Introduction and Background

The Authority currently operates a potable water ASR system referred to as ASR Wellfield No. 1 (WF1) and ASR Wellfield No. 2 (WF2). These two wellfields are operated under permit 0136596-014-UO5Q. **Figure 1** shows the location of the PRF in southwest DeSoto County, Florida. WF1 consists of nine ASR wells located on the Peace River Regional Water Supply Facility (PRF) treatment facility property and has been in operation since the mid-1980s. Each well has the capacity to recharge or recover approximately 1 million gallons per day (mgd). WF2 consists of 12 ASR wells each with a capacity of approximately 1 mgd. WF2 is located directly south of the PRF Surface Reservoir No. 1. The 12 ASR wells in WF2 were completed in 2002 into the Suwannee Zone of the UFA. The final casing depths of the WF2 ASR wells range from 568 feet to 621 feet below land surface (bls) and the total well depths range from 883 feet to 905 feet bls. The WF2 wells were installed in a grid pattern with approximately 300 feet between each ASR well. **Figure 2** presents a site plan of WF2 showing the locations of the ASR wells and associated monitoring wells.

The Authority continuously explores various options to increase the treatment system reliability by increasing water supply or storage for drought tolerance. Repurposing WF2 as a PTSW ASR system would provide for additional storage with a significant decrease in overall potable water delivery cost from the ASR system. Rather than the current ASR operating practice of treating stored river water to potable standards twice before distributing treated water to the public (once on injection/recharge to ASR and again after recovery from ASR), the Authority would only need to treat the water once.

Replacement of potable water with PTSW for the Authority's ASR recharge program at WF2 would provide cost, efficiency, reliability, environmental, permitting and resource recovery benefits. The following sections provide an overview of the permitting, potential benefits, proposed implementation plan, and budgetary level costs related to the conversion of WF2 to a PTSW ASR system.



Note: Emergency wells not shown

FIGURE 1
Peace River Facility ASR Site Map

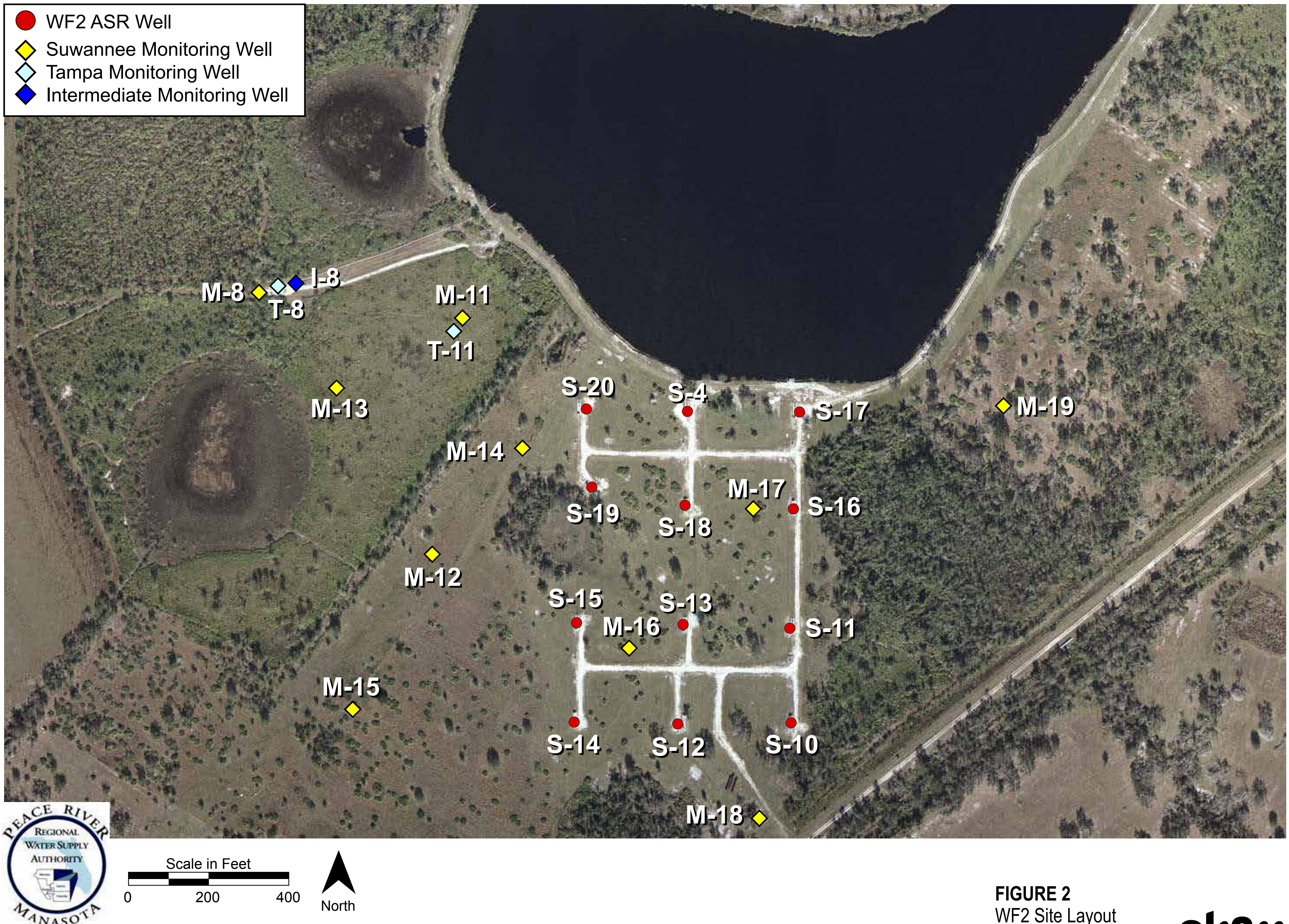


FIGURE 2
WF2 Site Layout

WT0714151011GNV

3 Partially Treated Surface Water ASR Conversion Evaluation

3.1 Underground Injection Control Permitting Review

3.1.1 Overview

Permitting of ASR wells is under the oversight of the Florida Department of Environmental Protection's (FDEP) Underground Injection Control (UIC) Program. Because the recovery function of the ASR system utilizes the water stored underground as an alternative water supply to the Authority, water withdrawal rates from the wellfield are permitted by the Southwest Florida Water Management District (SWFWMD) through a Water Use Permit (WUP). The concept of storing or recharging the aquifer with PTSW is not a new or unproven technology. Though regulatory constraints in the past have made implementation of PTSW ASR or aquifer recharge wells difficult, some systems are in place such as Marco Lakes, West Palm Beach, Suwannee River, as well as hundreds of drainage wells throughout Florida. In addition, the City of North Port, one of the Authority's own customers, is undergoing permitting activities to convert its ASR system to a PTSW ASR system. Currently there is more emphasis on finding sustainable and economical methods to utilize our water resources and more data are now available supporting PTSW ASR systems as a safe alternative water supply technology to help the state meet growing water supply challenges.

Regulatory precedent has shown that the use of a PTSW ASR system is acceptable to increase PTSW storage to continuously meet potable water demand during all seasonal conditions. The City of West Palm Beach instituted a surface water ASR program into a 5,000 mg/L TDS aquifer with the FDEP's approval of a Water Quality Criteria Exemption (WQCE) for total coliform. The Suwannee River Spring Restoration project has also implemented a surface water recharge program into a less than 500 mg/L TDS aquifer with approval from FDEP.

To permit WF2 for this alternative ASR operating method, the Authority would need to seek a regulatory relief mechanism for any primary or secondary drinking water quality exceedances in the PTSW. The water quality parameters that will likely require exemptions are color, turbidity and total coliform. Alternatively, FDEP may elect to issue a Zone of Discharge (ZOD) for the site that would move compliance from the individual ASR wellheads to select monitoring wells located on Authority controlled land. If a ZOD is the preferred mechanism, which it appears to be with the current FDEP position with similar projects, it would likely cover all primary and secondary drinking water standards.

While these are two possible regulatory approaches to implementing non-potable ASR operations at this location, the ultimate regulatory path would be selected after discussion with the FDEP at a pre-application meeting in Tallahassee. As a condition of full conversion to PTSW ASR at WF2, it is envisioned that FDEP will require a small scale cycle test program to demonstrate compliance of drinking water standards at select compliance monitor wells. It is presumed that out of the dozens of existing compliance monitoring wells situated onsite, there would be adequate coverage to monitor the PTSW test and the drilling of new compliance monitoring wells would not be needed.

Looking forward, while modifying the ASR system from utilizing potable water to PTSW may not require a modification to the current WUP, adding more wells to the wellfield and expanding its recovery capacity in the future will likely require the Authority's current WUP to be modified.

3.1.2 Water Quality

One of the main obstacles of advancing PTSW ASR technology in the past was the water quality of the source water, in particular total coliform which is found in all Florida surface water bodies. The groundwater standard for recharge into an aquifer classified as a USDW is 4 colony forming units per 100 milliliters (CFU/100 mL). A USDW is an aquifer that has a TDS concentration that is less than 10,000 mg/L. Even though the secondary drinking water standard for TDS is 500 mg/L, the FDEP has broadened the salinity range for a USDW with the assumption that water with a TDS concentration less than 10,000 mg/L is economically viable for treatment through desalination technology.

A primary concern with any ASR system is the ability to recover a significant percentage of the water stored. A significant portion of stored water is intermixed with native water, therefore most ASR systems used to supplement drinking water are in aquifers that are much fresher than 10,000 mg/L TDS to assure a reasonable recovery efficiency. The PRF ASR system is constructed into an aquifer that has a native TDS concentration of approximately 1,100 mg/L. Therefore a regulatory relief mechanism must be in place to allow recharge of surface water that has a total coliform count greater than 4 CFU/100 mL. The regulatory relief mechanism should also allow elevated color levels and aluminum concentration above the secondary drinking water standard of 15 color units and 200 mg/L, respectively, since PTSW from the Peace River or from the Authority's surface reservoirs is expected to exceed these standards. Other occasional excursions in the raw source water should also be addressed in the regulatory relief implemented. Finally, the raw water has variable turbidity ranging from under 2 to as much as 10 nephelometric turbidity units (NTU). The drinking water standard for turbidity is 1 NTU, and although there is no groundwater discharge standard for turbidity, the PTSW may undergo initial screening to remove gross macro particulates, micron level filtration is generally required to remove the size range of particulates contributing to turbidity in natural waters. For the purposes of this report, a sand strainer is included in temporary and permanent piping alternatives to perform the micron level filtration.

3.1.3 Potential Regulatory Relief Mechanisms

Several regulatory mechanisms are available including an aquifer exemption, a water quality criteria exemption, or zone of discharge (ZOD). Aquifer exemptions can be difficult to receive and can take years of negotiation. The US Environmental Protection Agency (EPA) must also be involved with the determination of whether or not an aquifer exemption should be granted for an ASR system.

3.1.3.1 Water Quality Criteria Exemption

To receive a WQCE the petitioner must demonstrate that they meet the following criteria:

1) Granting the exemption is clearly in the public interest;
2) Compliance with such criteria is unnecessary for the protection of present and future potable water supplies;
3) Granting the exemption will not interfere with existing users or the designated use of the water or contiguous water;
4) The economic, environmental and social costs with the criteria outweigh the economic, environmental and social benefits of compliance;
5) An adequate monitoring program approved by the Department is established to ascertain the location and approximate dimensions of the discharge plume, to detect any leakage of contaminants to other aquifers or surface waters, and to detect any adverse effect on underground geologic formations or waters; and
6) The exemption will not present a danger to the public health, safety or welfare.

The Authority was in the past able to make this demonstration to receive a WQCE for arsenic mobilization during ASR operations. It is anticipated that the same demonstration would be possible to exempt coliform bacteria (or any other primary drinking water exceedance) introduced to the groundwater. Institutional control is a significant criteria that would weigh heavily on the FDEP's decision to grant such a system. This was a major factor in the Authority's ability to secure the WQCE for arsenic for the current potable ASR system.

3.1.3.2 Zone of Discharge

Water quality criteria exemptions such as that received by the Authority for arsenic are not currently the FDEP's preferred regulatory mechanism for dealing with permitting of aquifer recharge and ASR wells where certain drinking water standards will not be reliably met. The FDEP currently appears to prefer implementing a ZOD, when applicable, to deal with exceedances of a primary or secondary drinking water standard that will attenuate in the aquifer and not leave the area under institutional control by the ASR owner. A ZOD exists in the groundwater rule (62-520 and 62-522), however contrary to past interpretations of the rule, the FDEP is now willing to consider it for primary drinking water standards under some ASR situations.

FDEP may require that a demonstration test be completed similar to the WQCE criteria before awarding a ZOD for the PTSW ASR system. A primary criterion for this permitting strategy to be considered is the ability to demonstrate institutional control of the injected water. If the ASR system owner has significant property to demonstrate that water quality standards are not exceeded before the water leaves the land under control of the owner, the FDEP will view the site more favorably for a ZOD for a primary drinking water quality standard. Since the PRF ASR system has a large area of land under control of the Authority, PTSW ASR is a viable option worth exploring.

3.1.4 Regulatory Precedent

FDEP has recently permitted PTSW ASR and aquifer recharge into USDW aquifers, most recently West Palm Beach (approximately a 5,000 mg/L TDS aquifer) and the Suwannee River in Mallory Swamp (approximately a 300 mg/L TDS aquifer). Many other drainage wells and recharge wells constructed prior to FDEP's regulation of underground injection have been "grandfathered" into the UIC program and are still operational. Some examples of these wells are the Orlando area drainage wells, the Gainesville Lake Alice drainage well, and various drainage wells in the Ocala area. The City of West Palm Beach obtained a WQCE for coliform for their surface water ASR system that was recently issued. Also, it is our understanding that the City of North Port will be utilizing a ZOD to address water quality excursions at the ASR wellhead.

Approximately 18 years earlier, the City of West Palm Beach submitted an application for a limited aquifer exemption and, although this was signed by the FDEP Secretary, the application was denied at EPA Region IV in Atlanta. This required the City and FDEP to pursue a WQCE to allow non-disinfected water to be used during cycle testing, which is a state regulatory process that does not require federal approval. This WQCE waives the total coliform standard to a certain distance from the ASR well.

The Mallory Swamp Aquifer recharge project however was permitted as a PTSW aquifer recharge system into a fresh aquifer, with no exemptions issued. The precedent set by these two recent PTSW aquifer recharge permits suggests that the FDEP has accepted the abundance of data that suggests that microorganisms of concern do not persist underground, and that aquifer recharge and ASR projects using PTSW do not pose a threat to public health if the proper precautions are taken and there is an adequate monitoring framework in place and the system is well maintained and operated within design parameters.

3.1.5 Anticipated Permitting Path

It is likely that the FDEP will want to see data from a limited demonstration test prior to authorizing WF2 to convert from fully treated surface water to PTSW. The Authority would also want this data as a prudent step in performing due diligence on what would be a major capital project. To initiate a demonstration cycle testing program at WF2 to evaluate PTSW ASR, FDEP approval will be required. A meeting with the FDEP is recommended to determine in what form this request will need to be submitted, but it is anticipated that this will require a major existing Class V Operation Permit, permit modification and a public notice period.

Full conversion of the WF2 to a PTSW ASR system would likely require a major modification to the existing Class V Operation Permit, which expires on April 23, 2018. This would be requested once the demonstration cycle testing is completed and only if evaluation of the data supports conversion to PTSW ASR. Ideally, the renewal of the permit and major modification to the permit would occur during the same permit application process in Fall 2017.

As this project leads to a more sustainable alternative water supply on a regional level, the process of obtaining cooperative funding by SWFWMD should be explored. An application for cooperative funding to be granted by October 2017 would need to occur by October 2016. Cooperatively funded projects meet one or more of SWFWMD's areas of responsibility: water supply, flood protection, water quality, and natural systems. The conversion of WF2 to PTSW ASR is anticipated to meet the water supply area of responsibility as this conversion could vastly grow the Authority's stored water supply and could improve the Authority's current recovery efficiency. As a product of cooperative funding, a third party review of the 30 percent design, schedule, and cost estimate is required. The cost of the third party review would be shared between SWFWMD and the Authority.

If future expansion of WF2 is sought by the Authority, a major modification to the current WUP will also be required. This major modification would also require public noticing.

3.2 Qualitative Review of the PTSW ASR Concept

PTSW ASR has the potential to provide many benefits to the Authority including financial, efficiency, operational, and environmental benefits, however other considerations must also be evaluated including the ability to obtain a permit, and the cost to implement the system. The following sections provide discussion on these various considerations.

3.2.1 Potential Cost Savings

The primary benefit of an ASR system is the large volume of water that can be stored in the aquifer within a smaller footprint than a surface water reservoir, thereby saving on land and construction cost. One disadvantage of the PRF potable ASR system is that the water stored must be treated to full potable water standards before entering the ground, and then treated again after it is recovered from the aquifer directly to the surface reservoir system. This makes it operationally more costly than raw surface water stored in the above ground reservoir. By conversion to PTSW as the source water for storage in the ASR system, the water would only be treated once when it is recovered from the ASR well. This would reduce the cost of water in the ASR system and make it much more comparable to the operating cost of water stored in the surface reservoirs. Estimated cost benefits of conversion to PTSW ASR including an evaluation of capital, O&M, and debt service costs are further described in Section 5.

3.2.2 Operational Benefits

PTSW ASR would have benefits beyond treatment cost savings discussed above. Excess treatment capacity (treatment capacity above that needed to meet Customer demand) is currently required at the PRF to enable recharge of the ASR system. As Customer demand increases, the excess capacity available to recharge ASR is reduced. This severely limited ASR recharge in the past prior to the most recent plant expansion, causing the Authority to over-recover from the ASR wells resulting in less desirable water quality from the ASR system. Without expending significant funds to increase treatment plant capacity, eventually the increased Customer demand could compromise the Authority's ability to effectively recharge ASR which reduces the viability of ASR to meet storage needs. Operation of ASR as a PTSW system does not require utilization of any excess treatment capacity from the PRF, and recharge can be accomplished at high rates. The ASR system could operationally be considered an extension to the surface reservoir system, maximizing storage during periods of high river flows with favorable water quality.

The Authority has indicated that the PRF might conceptually be expanded in the future as part of a coordinated plan to meet growing regional water supply needs. The existing raw water pump station on Reservoir No. 1 was constructed in the late 1970's and cannot be significantly expanded as it sits over an engineered sheet pile wet well. It is also may not be prudent to replace the existing raw water pumps with larger units because of uncertainty of the ultimate floor slab design strength; this facility was constructed by a private developer and while some drawings remain, there is no information about the specificiations of the concrete mix design, quality control information on the concrete pours made and the steel reinforcement design cannot be verified. Additionally, the deteriorating conditions of the wet well sheet pile raises concerns and a significant rehabilitation effort is planned within the next 5 – 7 years to address these issues. Why does this matter? The PTSW ASR design will require significantly sized raw water pumps so there is an opportunity to coordinate the PTSW ASR pump station design in such a fashion that those pumps can work in tandem with the existing raw water pump station to deliver water to the treatment facilities and reduce dependence on the existing pump station.

The PTSW system will require significantly higher service pressure than delivery to the treatment plant does (75 psi vs 30 psi). However, the pumps could be equipped with variable frequency drives (VFDs) so that they can be operated across a wider range of service conditions. These new pumps, located separate and apart from the existing raw water pumps would provide the benefit of distributing raw water pumping capability – eliminating what is now a critical point of failure and providing valuable redundancy and resiliency to operations. Thoughtful sequencing of the construction of this secondary pumping station could facilitate the ability to take the older pump station offline to effect the needed comprehensive rehabilitation work.

The hydraulic connection between Reservoir No. 2 and Reservoir No. 1 was designed for a maximum flow of 60 mgd. During a scenario where an expanded PRF to 70 mgd is only able to use water stored in the reservoirs for supply, the existing hydraulic connection would cause Reservoir No. 1 to drain by a rate of 10 mgd. The Alternative No. 2 pump station described in section 4.4.2 below may allow water beyond 60 mgd to be pumped from Reservoir No. 2 to Reservoir No. 1 on an as needed basis all year, thus continually supplying the Reservoir No. 1 pump station with adequate water to convey to the expanded 70 mgd PRF for treatment as needed.

3.2.3 Environmental Benefits

PTSW ASR will reduce the chemical and energy footprint for the utility as compared to a potable system making the PTSW ASR system a "greener" and more sustainable program. Additionally any stored water left in the aquifer (not recovered) could be considered an environmental benefit as the excess stored water would supplement the aquifer and mitigate future regional withdrawals from the UFA. This may allow the Authority to negotiate with SWFWMD to receive groundwater withdrawal credits for a portion of the excess water left in the aquifer to help restore regional water levels in the UFA. This could support future development of brackish groundwater supplies at the PRF. Since the cost of storing the PTSW would be significantly reduced, leaving excess water in the aquifer will not be cost prohibitive if it results in other benefits such as groundwater credits for the Authority. Obtaining groundwater credits from the SWFWMD would need to be explored further with the agency but the concept is under consideration at other recharge facilities (e.g., the SHARP project in Hillsborough County).

The PTSW recharged into the ASR wells is also anticipated to have lower ultimate dissolved oxygen (DO) and TDS concentrations than potable water. DO concentrations in surface water vary as a result of photosynthetic activity from algae, for example, at Reservoir No. 1 values as high as 12 mg/L (50% above saturation levels) have been measured during peak solar insolation periods. However, this DO would quickly be consumed by microbiological activities using TOC as a growth substrate and through chemical interaction with native water in the highly reducing environment found deep underground in ASR wells of the UFA. The lower DO concentrations may help mitigate arsenic mobilization observed at the current ASR wells. ASR recovery efficiencies are expected to improve after conversion to PTSW due to the lower TDS in PTSW being used for recharge, and the increased volume of recharge water available.

The Authority could also explore the possibility of recharging PTSW in the Avon Park High Permeability Unit beneath WF2 to mitigate the upconing of brackish water into WF2 from below. Elevated chloride, sulfate, and TDS concentrations observed during ASR recovery events are much more influenced by upconing of brackish water from below rather than mixing with native water within the storage zone. This is expected to improve the overall quality of water recovered from WF2, thereby improving the quality of water delivered to the Authority's drinking water customers and increasing the volume and potentially the rate of water available for recovery in WF2.

3.2.4 Potential Adverse Impacts

The planned pilot cycle testing program will provide an opportunity to evaluate potential adverse impact of PTSW as the source water for storage. One concern is the potential for a reduction in specific capacity/injectivity of the wells as a result of the addition of total suspended solids (physical plugging), bio-fouling (biological plugging), or chemical precipitation (scaling or chemical plugging). These are believed to be relatively minor concerns but conducting testing initially on two wells will allow determination of the potential for adverse impacts without jeopardizing the entire wellfield. If plugging of the formation occurs, well capacity is expected to be re-established with acid washing and/or re-development of the wells. Re-development of the wells is straight-forward since each well is equipped with a vertical turbine pump. For example, if a reduced specific injectivity is related to elevated TSS, the rehabilitation may be as simple as turning on the recovery pump in the well and purging the well until any suspended solids introduced into the well have been pulled back out.

Control of TSS is an important consideration for pre-treatment of the surface water prior to recharge. The amount of suspended solids that the ASR well can accommodate is primarily a function of the amount of secondary porosity vs. primary porosity of the receiving zone. Wells with higher amounts of secondary porosity (e.g., fractures) can handle higher TSS concentrations compared to wells where primary porosity dominates.

Various filtration systems for TSS control have been evaluated and implemented at Florida's PTSW facilities. The Marco Lakes ASR program uses filter canisters to reduce TSS loading to the well. In-line filtration systems were evaluated and used for two of the CERP demonstration projects, the Hillsboro Canal ASR system, and the Taylor Creek ASR system. In West Palm Beach, an in-line filtration system was originally installed to keep large solids out of the well, but it was discovered that this system had corroded, and no effective filtration was in place at this well during the initial three ASR cycles. The City of West Palm Beach ASR system did not experience significant plugging during recharge; however, it should be noted that this site is known for a high degree of secondary porosity in the storage zone.

If TSS concentrations are relatively low in the source water from Reservoir No. 1 or Reservoir No. 2 (e.g., typically 20 mg/L or less), it is likely that plugging potential could be effectively managed with a backflushing program designed to restore capacity lost during extended aquifer recharge periods. Some ASR wells across the US have incorporated regular (up to daily) backflushes into its operating protocol and this has worked acceptably well at many sites.

Another concern is the potential for geochemical interaction, primarily the mobilization of arsenic. Mobilization of arsenic has been exhibited in the PRF potable ASR system but has shown significant improvement over years of cycle testing. A WQCE is in place to allow exceedances of arsenic, however it is still a concern that must be monitored since the arsenic standard must be met at the compliance monitor wells. The dissolved oxygen concentration of the recharge water is a major factor in the mobilization of arsenic in the aquifer, and while the PTSW is anticipated to have a similar to slightly higher initial DO concentration compared to potable water, biological activity will likely result in accelerated decay of DO resulting in a similar to improved response regarding arsenic mobilization.

However, it will be important to evaluate the effect other differences in the water chemistry has on arsenic mobilization.

Some reclaimed water ASR systems (e.g. City of St Petersburg) have shown a significant attenuation of arsenic concentrations after the initial early cycle tests and some geochemists have theorized that total organic carbon (TOC) concentrations and the native aquifer microbes may play a role in the complex interactions that are involved in arsenic mobilization and re-absorption. PTSW ASR will have a higher TOC concentration which may have a positive impact on arsenic concentrations, further reducing the attenuation rates observed at the PRF ASR system.

4 Proposed Implementation Plan

4.1 Permitting of Demonstration Test

Prior to initiating a PTSW demonstration test at WF2, approval will be needed from FDEP. This will likely be in the form of a permit modification to allow testing with PTSW for a short defined period of time with the key objective of demonstrating coliform die-off in the aquifer during storage. A pre-application meeting with FDEP is critical to determine how this request will be submitted, however a major modification and public notice requirement is anticipated to be approximately a 6-month process.

4.2 Temporary Testing Plan

4.2.1 Test Well Selection

ASR Well S-4 and S-20 at WF2 are proposed as the test wells to evaluate the feasibility of PTSW ASR at WF2. Temporarily PTSW stored in Reservoir No. 1 will be recharged in the wells and then later recovered back to the reservoir system using the existing recovery structure located at Reservoir No. 1. ASR Wells S-4 and S-20 are recommended as the pilot test wells for the following reasons:

- They are closest to Reservoir No. 1 requiring the least amount of temporary piping.
- They are some of the furthest wells from the property boundary, maximizing the buffer and the maximum possible distance to assess water quality prior to leaving entity-controlled property.
- The clustering of monitor wells near S-4 and S-20 provides a comprehensive monitoring network to evaluate water quality at different distances (travel times) from the ASR well.
- S-20 has a relatively high specific injectivity and S-4 has a relatively moderate specific injectivity that is representative of most of the other ASR wells in WF2. This will allow for the comparison of well performance regarding the effect of PTSW on a well whose capacity relies primarily on matrix primary porosity (S-4) and one with a more secondary porosity (fractured) flow profile (S-20).

4.2.2 Proposed Cycle Test Program

Table 1 is a proposed cycle testing program to evaluate PTSW ASR at WF2. Up to three cycles are proposed using S-4 and S-20. Due to the effort involved with obtaining permission to cycle test under this program, it is recommended that three cycles be included in the test plan recharging and recovering PTSW at each well simultaneously. This will give the Authority flexibility to conduct multiple tests if needed to demonstrate compliance with water quality standards at the monitoring wells without having to repeat a test authorization/permit modification process. However, the test plan will indicate that possibly less than 3 successful cycles may be conducted to demonstrate water quality compliance before submitting a request for full conversion of the ASR wellfield to PTSW.

Proposed storage volumes for each of the three cycles is 100 million gallons (MG), followed by a static storage period of 15 days subsequently followed by approximately 50 MG of recovery over a period of approximately 50 days. The intent of the cycle testing plan is to conduct the PTSW recharge and recovery event during a non-operational period of the normal potable water ASR operation. This is typically between the months of October through February.

Table 1. Proposed Cycle Testing Program
Peace River Facility WF2 PTSW ASR Demonstration Test

Cycle	Recharge Rate (MGD) (2)	Recharge Duration (days)	Recharge Volume (MG)	Storage Duration (days)	Recovery Rate (MGD) (2)	Recovery Duration (days)	Recovery Volume (MG)	Cumulative Storage (MG)
1	2-4	25-50	100	15	1.5-2.5	20-33	50	50
2(1)	2-4	25-50	100	15	1.5-2.5	20-33	50	100
3(1)	2-4	25-50	100	15	1.5-2.5	20-33	50	150

Notes:

(1)If required

(2) Rates and volumes are based on the combined rate and volumes from S-4 and S-20

(General) Testing duration, rates, and volumes are approximate and may vary due to logistical issues, mechanical breakdown, availability of water, etc.

4.2.3 Proposed Monitoring Plan

Monitoring of water quality during recharge events and during storage at multiple monitoring wells will be crucial in demonstrating the attenuation rate of total coliform viability in the groundwater as well as how other constituents may change or alter native conditions as injected water travels through and resides within the formation. Monitoring should also adequately document the arrival of the PTSW through use of natural tracers in the stored water. A proposed monitoring program for the cycle testing period is presented in **Table 2**. However some water quality parameters may be added or removed from the testing program with input from the FDEP. Multiple monitor wells that currently exist at WF2 will be used to comprise the monitoring network. If possible, the PTSW demonstration test will be conducted while the remainder of WF2 is idle to avoid interference or dilution due to recharge from other sources. The focus of the monitoring program will be to evaluate water quality in the monitoring wells and ASR wells to examine the time required for attenuation of coliform (or any other exceeded primary or secondary drinking water standard) in the aquifer, and to evaluate geochemical responses in the aquifer resulting from using PTSW.

Table 2. Proposed Monitoring Plan
Peace River WF2 PTSW ASR Pilot Testing

Parameter	**Units**	**Recording Frequency**	**Frequency of Analysis**			
			Recharge (reservoir)	***Recovery (S-4, S-20)***	***M-14, M-13, M-11, T-11, M-8, M-17***	***T-8, M-18***
Flow Rate, max.	gpm	daily	D/M	D/M		
Flow Rate, min.	gpm	daily	D/M	D/M		
Flow Rate, avg.	gpm	daily	D/M	D/M		
Total Volume Recharged	mg	daily	D/M			
Total Volume Recovered	mg	daily		D/M		
Injection Pressure, max.	psi	continuous	D/M			
Injection Pressure, min.	psi	continuous	D/M			
Injection Pressure, avg.	psi	continuous	D/M			
Water Level, max.	feet (NGVD)	continuous		D/M	D/M	D/M
Water Level, avg.	feet (NGVD)	continuous		D/M	D/M	D/M
Water Level, min.	feet (NGVD)	continuous		D/M	D/M	D/M
pH +	std. Units		W[a]	T[b]	T	M
Specific Conductivity +	µmhos/cm		W[a]	T[b]	T	M
Temperature +	°C		W[a]	T[b]	T	M
Dissolved Oxygen +	mg/L		W[a]	T[b]	T	M
Turbidity +	NTU		W[a]	T[b]	T	M
Oxidation-Reduction Potential +	mV		W[a]	T[b]	T	M
Total Dissolved Solids	mg/L		W[a]	T[b]	T	M
Chloride	mg/L		W[a]	T[b]	T	M
Sulfate	mg/L		W[a]	T[b]	T	M
Arsenic	µg/L		W[a]	T[b]	T	M
Total Suspended Solids	mg/L		W[a]	T[b]	T	M
Nitrate (as N)	mg/L		W[a]	T[b]	T	M
TKN	mg/L		W[a]	T[b]	T	M
Ammonia	mg/L		W[a]	T[b]	T	M
TOC	mg/L		W[a]	T[b]	T	M
Color	Units		W[a]	T[b]	T	M
Total Dissolved Solids	mg/L		W[a]	T[b]	T	M
Aluminum	mg/L		W[a]	T[b]	T	M
Total Coliform	CFU/100 mL		T[a]	T[b]	T	M
Primary and Secondary stds.	mg/L		B		-	-

Notes:

No sampling of ASR wells during storage.

W - weekly; D/M - daily and monthly; T – twice weekly; O - other (beginning and end of recovery);

a - during recharge only

b - during recovery only

+ - field samples

B - Background sample prior to cycle 1 recharge

The project team is optimistic about the outcome of this test regimen because it is markedly similar to the testing for the City of West Palm Beach in cycle testing using PTSW from Clear Lake. In that program, coliform bacteria was not observed in the groundwater monitor wells over the initial several months of recharge activities, even though the PTSW took only a few days to arrive at the nearest monitor well, 172 feet from the ASR well. Data collected to date at West Palm Beach further supports the rapid die-off of microbiota in the subsurface.

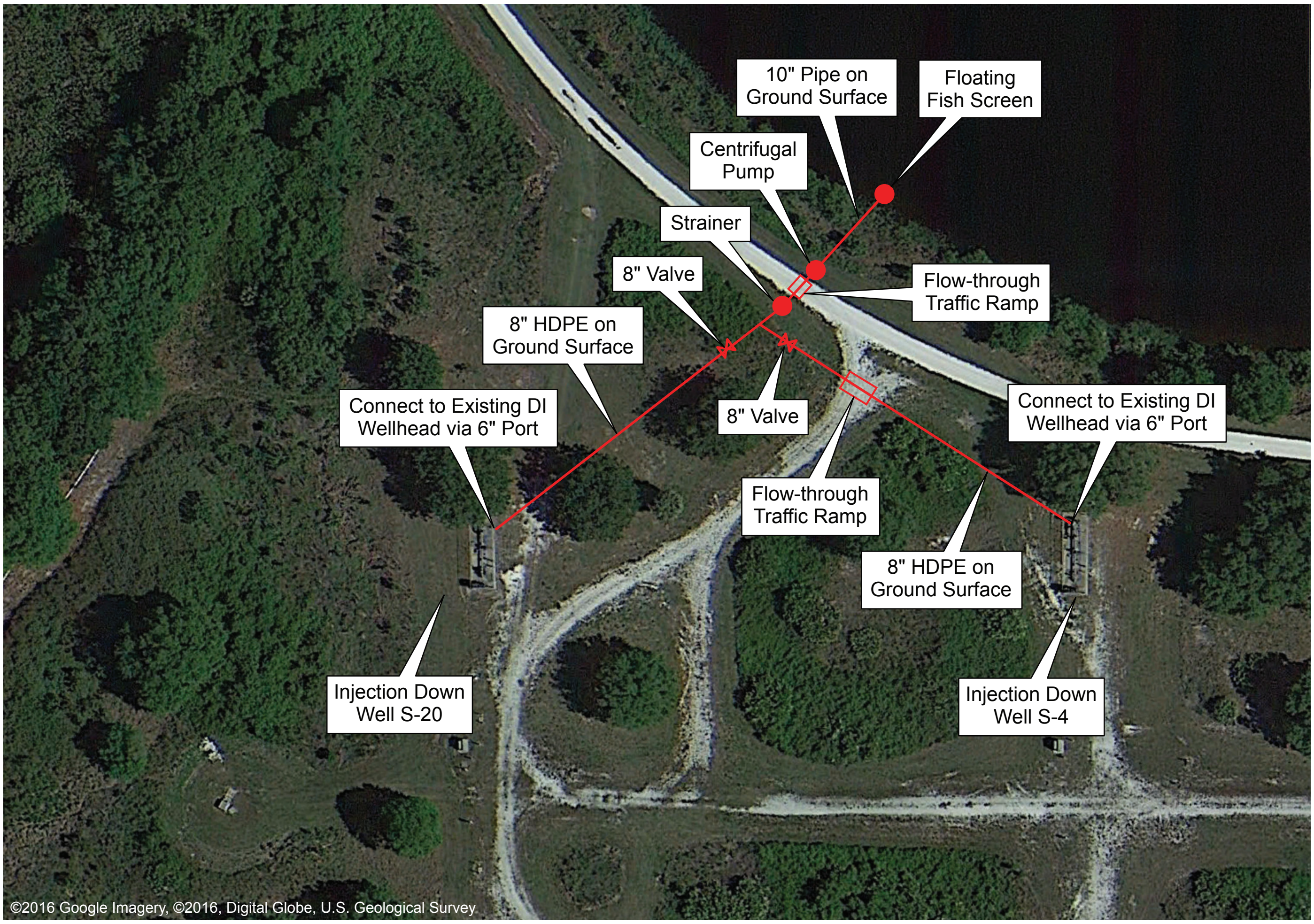
Operational data will also be collected during testing to monitor changes in ASR well capacity which may transpire as a result of water quality differences in the PTSW as compared to potable water, such as TSS. Daily flow rates will be recorded from an inline totalizing flow meter during recharge and recovery. It is anticipated that the existing wellhead flow instrumentation can be used to perform this testing if the temporary wellhead is set up accordingly. Existing data loggers/pressure transducers in the ASR wells will monitor water level responses in the ASR wells as currently occurs during normal ASR operation.

Baseline specific injectivity data will be recorded in the wells prior to implementing PTSW cycle testing to establish baseline conditions in the wells. The ASR wells would be recharged at a constant rate with potable water for a period of approximately 4 to 6 hours while the remaining ASR wells remain static. After a short static period, the wells would be pumped for approximately 4 to 6 hours to obtain baseline recovery specific capacity data. Water levels in the monitor wells will be recorded at the same frequency as required by the current ASR operation permit.

4.2.4 Conceptual Test Demonstration Setup

Temporary piping and pumping equipment will be installed at S-4 and S-20 so that the wells can be recharged directly from Reservoir No. 1 during this temporary test program. A single pumping and piping system will be provided to temporarily supply PTSW to S-4 and S-20 during the demonstration period. The pump intake will be located at Reservoir No. 1 near S-4 and S-20 to minimize the distance of temporary piping to the wells. Screening will be provided in the reservoir to avoid intake of aquatic organisms. A sand strainer will be installed downstream of the pump to remove particulates and TSS.

The temporary piping will be tied into existing tees located at the ASR wells which will allow use of the existing flow meters. The wells will be isolated from the rest of the wellfield by removing the hard piped riser elbow at the wellhead and installing a temporary blind flange on upward opening pipe to secure the rest of the wellfield. This will minimize the need to re-configure the ASR well piping associated with any other wells. This physical disconnection will protect the remainder of the wellfield and its associated piping from inadvertent contact with raw surface water should a valve leak or should a valve be accidentally opened through human error. The same piping used to deliver water to the wells will then be used in reverse when the wells are recovered to convey recovered water back to the reservoir through the floating intake structure. The piping will be installed with an adequate vertical rise component to insure fully developed flow in the reach that contains the flowmeter so that it remains fully flooded and functions accurately. Recovery will be conducted using the normal ASR operating protocol. **Figure 3** shows a conceptual diagram of equipment for this temporary demonstration testing.



0 50 100
Scale in Feet

North

PEACE RIVER REGIONAL WATER SUPPLY AUTHORITY MANASOTA

FIGURE 3
S-4 and S-20 Demonstration Testing

ch2m

4.3 Review of Testing Data and Full Scale Permitting

Following the demonstration testing period the data will be evaluated and a technical memorandum will be drafted for submittal to FDEP for review. If the results of the data are favorable and support full conversion to PTSW ASR, a major modification to the existing operation permit may be submitted to the FDEP requesting full conversion of WF2 to a PTSW ASR system. This step would be anticipated to take 6-monthso more, and may require additional meetings with FDEP to agree upon the conditions of the modified permit.

4.4 Full Scale Conversion Concept – Engineering and Construction

The conceptual full PTSW ASR system would recharge water directly from one of the Authority's two reservoirs. As needed, the stored water would be recovered back to the surface water reservoir system using existing infrastructure. To convert the existing WF2 to a full PTSW ASR wellfield, PTSW would need to be nominally sized for 20 million gallons per day (mgd). However, as discussed, the PTSW pumping component may be rolled into a new, larger raw water pump station complex that can serve as a backup to the existing 40 year old building and wet well system. This new pump station would either convey PTSW from Reservoir No. 1 or Reservoir No. 2. Design criteria for screening and straining of the water are still under development but conceptually the screening process would be installed at the intake of the pump station, and the straining process would be installed on the downstream end of the pump station on the leg of pipe which feeds WF2. The strainer system would utilize the pump's pressure to force water through the mechanism. Two alternatives for this pump station are considered:

Alternative 1 - To convey water from Reservoir No. 1, a new pump station would be constructed adjacent to the existing Reservoir Pump Station. Water would be conveyed to WF2 via the existing 36" dedicated pipeline which currently serves the wellfield. As an added benefit, situating the pump station here would allow it to readily serve as a redundant backup to that critical facility and help meet possible future facility capacity expansions.

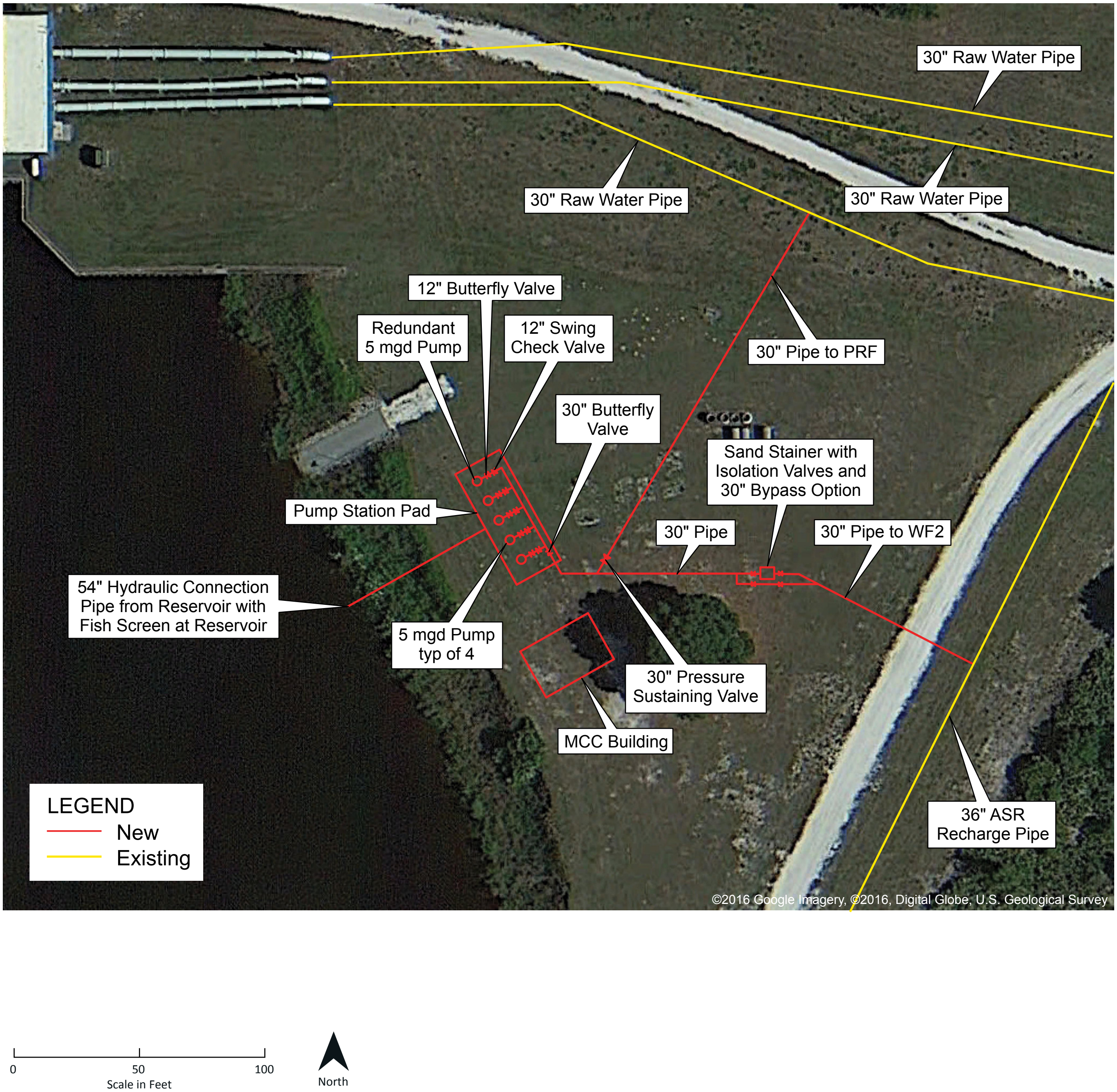
Alternative 2 –To convey water from Reservoir No. 2 before it enters Reservoir No. 1, the pump station would be constructed near the meter and plug valve facilities between Reservoirs No. 2 and No. 1. Water would be pulled from both the existing 54-inch gravity flow pipe between the two reservoirs and conveyed to ASR WF2 for recharge.

To convey PTSW to WF2, two alternatives were considered that would either convey water from Reservoir No. 1 or Reservoir No. 2. Per the Authority's direction, this pump station will be designed to deliver 20 mgd so as to provide at least 1 mgd to each of WF2's 12 existing wells and provide room for future expansion of the wellfield, provide additional capacity to convey water from Reservoir No. 2 to Reservoir No. 1, or provide additional capacity to convey water to the PRF for treatment.

4.4.1 Alternative 1: New Pump Station to supply water from Reservoir No. 1

This alternative would convey PTSW from Reservoir No. 1 to WF2. A new pump station would be constructed adjacent (within 100 yards) to the existing Reservoir Pump Station. As discussed above, the pump station could serve the dual role of providing backup to the existing raw water pump station serving the treatment facilities as well as delivering water to WF2. So, the final design capacity remains to be determined, but conceptually it would deliver at least 20 mgd to WF2. Water would be conveyed to WF2 via the existing 36-inch dedicated pipeline which currently serves the wellfield.

To prevent migration of aquatic organisms or debris into the pump intake a screening system with air-burst cleaning will be installed. A strainer with bypass option will be installed downstream of the pumps on the piping system to WF2 to remove large solids and TSS to minimize the potential for well plugging, if found to be necessary during the temporary testing program. An aerial schematic/rendering of this pump station is shown in **Figure 4.**



PEACE RIVER REGIONAL WATER SUPPLY AUTHORITY MANASOTA

FIGURE 4
Pump Station Concept to Supply Water
from Reservoir No. 1

ch2m

To supply additional pumping capacity to the PRF from Reservoir No. 1 or to provide redundancy to the existing Reservoir Pump Station, this new pump station could tie into the piping system from the existing Reservoir Pump Station to the PRF. A pressure sustaining valve may need to be installed on this line to prevent excess pressure at the PRF and curve runoff of the new pumps. However, use of VFD driven pumps may allow the pump station to run over a much wider operational band and efficiently serve both needs without wasting energy across a step-down valve.

This pump station would conceptually be remotely operated and controlled by integrating it with the existing supervisory control and data acquisition (SCADA) at the PRF along with the existing Reservoir Pump Station. Wet well level controls would be in place to ensure that the new pumps do not cavitate and that the reservoir is not drawn down below the minimum operating level. Conceptually, four (4) duty pumps would be operated in parallel with VFDs to achieve a wide range of flows between 0 mgd and 20 mgd, and one standby pump for redundancy. The ASR wells can essentially be operated as they are currently operated, recovering water back to the off-stream reservoir system. These concepts would certainly change with commitment for this new pumping station to serve both the treatment facilities and WF2. In that case, the pumps selected would likely be much larger in size and redundancy planning would need to factor in the existing raw water pumps as well.

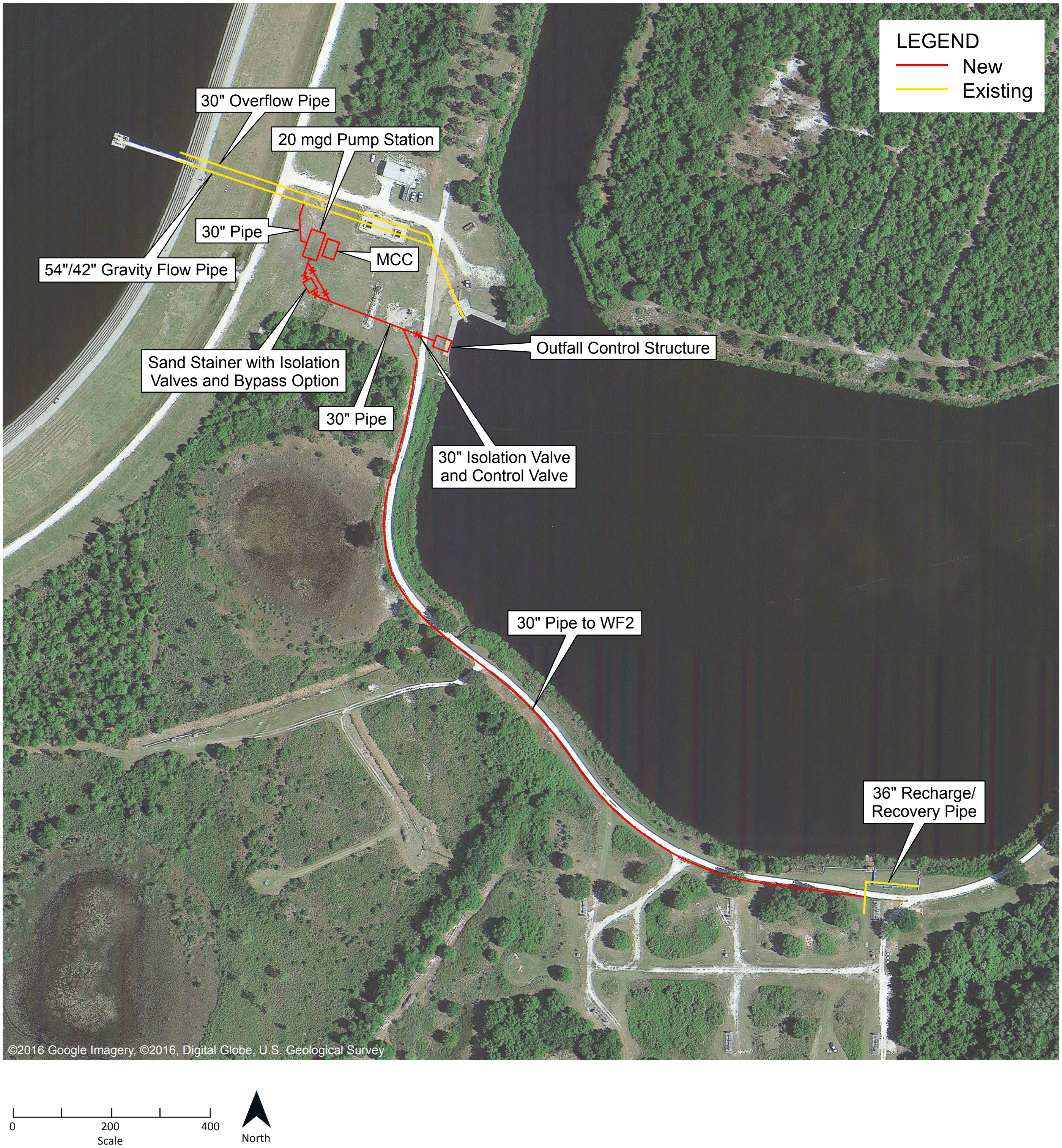
4.4.2 Alternative 2: New Pump Station to supply water from Reservoir No. 2

Currently, surface water is conveyed from Reservoir No. 2 to Reservoir No. 1 by gravity through a 54” pipe with a 42” bottleneck for a venturi-meter and control valve. Because the crown of the 42” pipe is lower than the invert of the 54” pipe on the upstream and downstream connections, this 42” segment of pipe is always flooded. This 54” pipe was designed for a maximum gravity flow of 60 mgd. Conceptually, in this alternative design, the pump station would tie into the 54”pipe and be located in the available greenspace between Reservoir No. 2 and Reservoir No. 1. An aerial schematic/rendering of this pump station and piping is shown in **Figure 5.**

This pump station would have the ability to convey up to 20 mgd to WF2, which, as discussed in the prior alternative, serves the existing wells and also leaves room for expansion. A sand strainer will be installed on the piping to WF2. Due to the likelihood of buried utilities in conflict with the current pipeline route from this pump station to WF2, this pipeline route may need to be altered. Because of the proximity of this pipeline route to onsite wetlands, additional permitting strategies may need to be implemented during design including wetland jurisdiction determination, wetland delineation, and environmental resource permitting. During construction, the original wetland grade may need to be restored.

Because the 54” pipe is only designed to gravity flow at a maximum of 60 mgd, there could be a concern with this pipe becoming a hydraulic restriction should the PRF be significantly expanded in the future. This pump station would primarily be used to recharge WF2, but it could also serve the purpose of boosting flows out of Reservoir No. 2 into Reservoir No. 1. This additional inter-reservoir transfer capability may facilitate future the treatment plant expansion.

This pump station could be operated remotely in the same manner as Alternative 1 with SCADA at the PRF similar to the existing Reservoir No. 1 Pump Station. Wet well level controls would be in place to ensure that the new pumps do not cavitate and that the reservoir is not drawn down below the minimum operating level. Conceptually, four (4) duty pumps would be operated in parallel with VFDs to achieve a wide range of flows between 0 mgd and 20 mgd, and one standby pump for redundancy. The ASR wells can essentially be operated as they are currently operated, recovering water back to the off-stream reservoir system. These concepts would certainly change with commitment for this new pumping station to serve both the treatment facilities and WF2. In that case, the pumps selected would likely be much larger in size and redundancy planning would need to factor in the existing raw water pumps as well.



PEACE RIVER MANASOTA REGIONAL WATER SUPPLY AUTHORITY

FIGURE 5
Pump Station Concept to Supply Water from Reservoir No. 2

ch2m

4.5 Compliance Monitoring of PTSW ASR System

A proposed monitoring program of the converted full scale system would be similar to the monitoring program in the current ASR permit with some additional water quality parameters added, such as total coliform. These parameters would require sampling at the individual ASR wellheads and select compliance monitor wells to confirm that any exceedances of drinking water standards remain under property controlled by the Authority. Some water quality parameters may be added or removed, or have modified frequency of collection based on the findings of the PTSW demonstration cycle test results. Ultimately, the adopted monitoring program would require FDEP input and concurrence and would be included in the permit modification request submitted to the FDEP following the demonstration testing program.

5 Partially Treated Surface Water ASR Conversion Cost Discussion

5.1 Demonstration Test

The following equipment has been considered for this demonstration test: a floating intake with screen, suction and discharge piping headers, centrifugal pump, check and isolation valve, duplex in-line sand strainer, and yard piping connection to well S-20 and S-4. **Appendix A** provides additional details for the components of the Demonstration Test which were provided to obtain an equipment rental quote. The rental quote for the proposed equipment pertaining to this conceptual test demonstration was obtained from Xylem. The approximate rental costs are as follows:

Mobilization/Demobilization - $1,000
Labor Setup/Teardown Charge - $9,000
Equipment Transition from Recharge to Recovery Charge - $3,000
Monthly Equipment Rental Charge for Recharge - $15,000
Monthly Equipment Rental Charge for Storage/Recovery - $5,500

Assuming each recharge period lasts two months as indicated in **Table 1** above, the recharge period per cycle would be approximately two months. After recharge, the pump, strainer, and check valves will be removed from the system, and the piping system will be reconnected in the missing equipment's place while the system is in storage mode for approximately two weeks. Thereafter, the existing ASR pumps will be turned on to recover through the temporary piping for approximately one month. The total cost per cycle for the equipment mobilization, recharge period, transition, storage period, recovery period, and equipment demobilization would be approximately $51,000.

After the cycle is complete, all of the temporary equipment may be removed from the site while the subsequent storage period and recovery event occurs. Then, the rental equipment would be reinstalled for each subsequent needed conceptual testing cycle. For three cycles, the rental equipment cost would be approximately $153,000. This total cost could be reduced by demobilizing all of the temporary equipment after recharge and utilizing the existing infrastructure for recovery.

Engineering, a conceptual testing completion report, and initial FDEP permitting fees are estimated to cost approximately $80,000. Additional construction costs such as pouring a concrete pad for the pump and strainer and routing conduit for electrical supply were not estimated. Assuming that three cycles are completed for conceptual testing, and including a 10 percent contingency, the total estimated cost is approximately $256,000. This estimate is considered a Class V cost estimate per AACEI standards and has an accuracy range of -30% to +50%.

The cost of purchasing the pump and strainer were also requested from Xylem; however, there would not be significant savings in purchasing the equipment even if multiple cycles were completed. The cost of the pump would be approximately $65,000. The corresponding Variable Frequency Drive for the pump would be approximately $40,000. The duplex strainer purchase cost would be approximately $40,000 as well. This option can be further evaluated if there are alternative uses of the equipment that justifies the purchase of the equipment rather than rental.

The chemicals and energy cost to treat water at the PRF amount to $0.74 per 1,000 gallons. The current potable water ASR system requires the water to be treated once at the PRF before being recharged in WF2, but the water recharged in the demonstration test will not require full treatment prior to recharge. Assuming that three cycles are used for this demonstration to recharge a total of 300 Mgal, the savings realized by not treating this water to drinking water standards could be considered equivalent to $220,000. This is roughly the cumulative associated demonstration test equipment rental, sampling, analytical and engineering costs for the program. So, this demonstration test program would essentially pay for itself in savings.

5.2 Full Conversion of WF2 to PTSW

5.2.1 Alternative 1

Alternative 1 conveys PTSW from Reservoir No. 1 to WF2 via a new pump station which is proposed to be constructed adjacent to the existing Reservoir Pump Station. The following major items were included in the budgetary cost estimate: pump station, piping to the WF2, and piping to the PRF.

The pump station improvements include an intake fish screen, pump station (vertical turbine pumps will be on a slab over the reservoir, not enclosed), suction and discharge piping, check and isolation valves, structural wet well and electrical building, and SCADA and I&C updates. The piping to the WF2 includes 30-inch DIP piping, fittings, and in-line strainer with bypass. The cost also includes piping for the option to convey reservoir water to the PRF which includes 30-inch DIP piping, fittings, hot tap into existing piping, and pressure sustaining valve. Alternative 1 pump station design alternatives and pump selection will be further developed during the preliminary design phase. **Appendix A** provides specific design details for Alternative No. 1 components proposed in the conceptual cost estimate.

The Class V conceptual cost estimate of Alternative 1 is $6.4M. Utilizing this cost estimate of the full scale conversion for the Alternative 1 pump station and assuming an additional 17 percent consultant fee for permitting, engineering, bid-phase assistance, services during construction, and part-time resident observation, the total capital cost for the conversion is estimated to be $7,500,000. Due to the level of detail considered in this concept, this estimate has an accuracy level of -30% to +50%.

Although utilization of self-priming centrifugal pumps instead of vertical turbine pumps may reduce the cost of this alternative’s pump station due to the lack of need for a wet well, the application of centrifugal pumps may drastically reduce the operating water level range of the reservoir. The centrifugal pump efficiency is also expected to be lower than the vertical turbine pumps, thereby increasing the horsepower requirement for each pump. This option may be further evaluated during the preliminary design phase.

5.2.2 Alternative 2

Alternative 2 proposes to draw water from Reservoir No. 2 before it enters Reservoir No. 1. The pump station would be constructed near the meter and plug valve facilities between Reservoirs No. 2 and No. 1. Water would be pulled from the existing 54-inch gravity flow pipe between the two reservoirs and conveyed to ASR WF2 for recharge or to Reservoir No. 1 for additional flow capacity.

The following major components were included in the budgetary cost estimate for this pump station. Components include 30-inch pump suction and discharge manifold, vertical turbine pump station, piping to WF2 and Reservoir No. 1, isolation, check, and control valves, in-line strainer with bypass, structural wet well, tap for connection to an existing 36-inch pipe, reservoir No. 1 outfall structure, electrical building, and SCADA and I&C updates. **Appendix A** provides specific design details for Alternative No. 2 components proposed in the conceptual cost estimate.

The Class V conceptual cost estimate of Alternative 2 is $5.3M. Utilizing the cost estimate of the full scale conversion for the Alternative 2 pump station and assuming an additional 17 percent consultant fee for permitting, engineering, bid-phase assistance, services during construction, and part-time resident observation, the total capital cost for the conversion is estimated to be $6,600,000. Due to the level of detail considered in this concept, this estimate has an accuracy level of -30% to +50%.

Any additional pretreatment that may be required by FDEP (i.e., if a zone of discharge for total coliform is not granted) was not included in either of the alternatives since the objective of PTSW conversion is to provide the most cost effective and environmentally beneficial system for the Authority. If additional treatment is required by FDEP following an evaluation of the results from the demonstration testing phase, the objectives of the project will be re-evaluated to determine if the project is worth further development.

5.3 Anticipated Operational Cost Savings

Operational costs savings for ASR WF2 operation assume a potable water treatment cost of $0.74 per 1,000 gallons, 100 mg of recharge per well per year, and a recovery efficiency of 80%. Operational cost savings of a new pump station considered include energy costs, maintenance cost, and wellfield monitoring costs, and debt service of a new capital cost. Because the new pump station will alleviate the existing system pumping demand, the additional energy costs of a new pump station are anticipated to be the same as the existing energy costs. Although the demand on the existing pumping system will be decreased, there will be an increased need for maintenance by the Authority on the new pump station. This increased maintenance cost is assumed to be approximately $50,000 annually. The costs of monitoring WF2 are anticipated to be the same as the existing monitoring costs. Using these assumptions, the annual cost savings of converting WF2 to PTSW ASR is estimated to be $838,000. These costs are shown in **Table 3** below.

Table 3. ASR Conversion Wellfield Operation Costs
Peace River Facility WF2 PTSW ASR

	Current	PTSW ASR Conversion
Potable Water Treatment Cost	$ 0.74	$ 0.74
mg recharge per well per year	100	100
recovery efficiency	0.8	0.8
number wells	12	12
Pump Station Annual Additional Maintenance Cost	$ -	$ 50,000
ASR System Operation Cost Per Year	$ 1,598,000	$ 760,000

Depending on which alternative is selected, debt service on a loan will impact the annual payment. Assuming a loan period of 20 years, and an annual interest rate of 3%, the following debt services as shown in **Table 4** would be anticipated for each pump station alternative.

Table 4. Debt Service and Annual Total Cost Savings
Peace River Facility WF2 PTSW ASR

	Alternative 1	Alternative 2
Engineering and Construction Cost	$ 7,500,000	$ 6,600,000
Annual Interest Rate	3%	3%
Loan Period (years)	20	20
Total Interest	$ 2,582,000	$ 2,272,000
Total Payment	$ 10,082,000	$ 8,872,000
Annual Payment	$ 504,000	$ 444,000
Total Cost Savings per Year	$ 334,000	$ 394,000

Using the above assumptions, the full conversion of WF2 to PTSW ASR utilizing both pump stations yield a total cost savings to the Authority. The annual cost savings of Alternative 1 and Alternative 2 are approximately $334,000 and $394,000, respectively. If the annual cost savings of $838,000 are applied to the loan payments, the estimated payback period is approximately 11 years and 9 years for Alternative 1 and Alternative 2, respectively. This was based on current energy costs, but if energy prices rise significantly into the future, then the payback period would become shorter.

If the Southwest Florida Water Management District were to contribute cooperative funding at a 50% match basis, it would reduce the payback period to about 5 years. Additionally, the system put into place will continue to serve the Authority long after debt service payments have been satisfied. So once that happens, the net result is a pure savings of $838,000 per year in operational as compared with the current operational scheme.

6 Summary and Recommendations

The PRF currently operates a potable water ASR system requiring the full treatment of raw water twice before it's delivered to the Authority's customers, making ASR a more expensive option to store water than the off-stream reservoirs. By converting to PTSW ASR, full treatment of water stored in the ASR would be required one time, after recovery from the ASR wells, resulting in significant operational cost savings. Additional benefits of PTSW conversion include:

- Frees up treatment capacity of the PRF during the wet season
- Reduced operational complexity – ASR can be used as an extension of the reservoir system
- Environmentally responsible – effectively manages available surface water resources, and does so using a smaller energy footprint than the current potable water ASR system.
- Can be used to advance the District's Recovery Plan for the SWUCA by recharging excess fresh water to bolster regional aquifer levels
- Recharge water will be 25% lower in TDS concentration and will provide for better public drinking water quality upon final treatment
- Provides the regulatory framework to also cost-effectively recharge PTSW into the permeable unit underlying the ASR storage zone in the future to further improve ASR water quality and reliability by improving upconing water quality that has been observed in WF2
- Improved system sustainability and reliability

A major modification of the current ASR permit will be required to convert to PTSW ASR. The water quality parameters of concern for PTSW is total coliform, aluminum, and color each expected to be above the ground water discharge standard. A ZOD may be applicable at the PRF to allow permitting of the PTSW system due to the institutional control available, requiring that compliance is met at selected monitoring wells rather than at the ASR wellhead.

Two recent PTSW systems have been permitted (West Palm Beach and Mallory Swamp) providing a regulatory precedent for development of additional PTSW aquifer recharge / ASR systems in Florida without the need for disinfection prior to recharge. Several other PTSW aquifer recharge and ASR projects are in various stages of development within the SWFWMD.

A small scale demonstration test will likely be required by FDEP before allowing full scale conversion of WF2 to PTSW ASR. Depending on the results of a demonstration test the Authority may be able to obtain a permit modification to convert the entire wellfield to PTSW ASR.

The budgetary cost estimate to implement conversion to PTSW is as follows:

- Temporary Demonstration Testing – Including Permitting, Engineering, Equipment and Construction - $251,000.
- Full Scale Conversion - Including Permitting, Engineering, Equipment and Construction
  - Alternative 1 - $7,500,000
  - Alternative 2 - $6,600,000

Assuming a 20 year loan and annual interest rate of 20 years, the total cost savings per year for implementation of the PTSW ASR conversion are $334,000 and $394,000 for Alternative 1 and Alternative 2, respectively. If the annual cost savings from conversion of WF2 from potable water ASR to PTSW ASR are used to pay off the needed infrastructure, there would be an estimated payback period of 11 years and 9 years for Alternative 1 and Alternative 2, respectively. Once the debt service is satisfied, the cost savings as compared with operation under the currently permitted scheme would balloon to $838,000 per year. Also, energy pricing is currently very favorable, should energy prices rise, then the payback period would become shorter. Lastly, cooperative funding could lower the payback period to about 5 years.

A comparison of the two alternatives are shown in **Table 5** below.

Table 5. Pump Station Alternative Comparison
Peace River Facility WF2 PTSW ASR

Alternative 1	Alternative 2
Provides additional pumping capacity from Reservoir No. 1 to the PRF	Provides additional flow transfer from Reservoir No. 2 to Reservoir No. 1
Provides redundancy for Reservoir Pump Station	Utilizes higher initial head from Reservoir No. 2 to require slightly less horsepower pumps
Can utilize adjacent power station electrical feed for power supply	Does not require a fish screening system
Requires less suction and discharge piping	Shallower wet well needed
Requires less pipe routing conflict with in-ground utilities	
Pipe route less likely to change	
No wetland mitigation strategies necessary	
Could be less expensive with centrifugal pumps, but Reservoir No. 1 operating ranges will be decreased	

The following recommendations are offered to initiate implementation of PTSW ASR at the Authority's WF2 ASR System:

1) The Authority should coordinate and attend a pre-application meeting with FDEP in Tallahassee to discuss converting WF2 to a PTSW ASR facility. Discussions should include incorporating the existing WQCE for arsenic at the site into the ZOD, since this WQCE essentially functions in this capacity as it is currently implemented. Discussions should focus on FDEP's willingness and support for long-term operation of WF2 in this mode.
2) The Authority should pursue authorization from FDEP to allow short-term cycle testing with PTSW at ASR WF 2. It is assumed this will require a major permit modification that has to be public noticed, therefore it is anticipated that these permitting activities will take approximately 6 months to complete.
3) The Authority should conduct short-term cycle testing with PTSW as outlined in this memorandum and in accordance with the conditions of the FDEP permit modification, once issued.
4) Following the demonstration test, if data support PTSW ASR, submit a permit modification to the existing FDEP Class V Operation Permit to allow PTSW ASR at WF2.
5) If PTSW ASR is granted by FDEP via modification to the operation permit, implement full scale conversion of ASR WF2 to PTSW ASR.

Appendix A – Conceptual Cost Assumptions

Demonstration Test

The following items considered for this demonstration test:

- Mobilization/demobilization
- Floating fish screen
- 50 feet of 10 “ suction piping
- Centrifugal Pump (2,100 gpm @160 ft head) with electrical power hookup
- Check valve and isolation valve for pump
- 500 feet of 8” discharge piping
- Sand strainer
- Connection to S-20 and S-4

Full Scale Conversion

Alternative 1 – Pump Station to Pull Water from Reservoir No. 1

- Pump Station (pumps will be on a slab over the reservoir, not enclosed):
    - Five 150 hp vertical turbine pumps (5 MGD @ 175 ft head each) with Variable Frequency Drives (VFDs)
    - 150 ft of 12” DIP buried shallow
    - Eleven 12” Butterfly valves
    - Ten 12” swing check valves
    - Ten 30”x30”x12” tees
    - 50’ x 20’ x 30’ wet well using a wet installation method into the reservoir
    - One 54” pipe (20 ft long) submerged and protruding the wet well to convey water from the bottom of Reservoir No. 1
    - One fish screen on 54” pipe, and one compressor with tubing for screen blow-off
    - Submerged pad for fish screen to prevent reservoir bottom soil disturbance
    - 20’ x 30’ x 10’ Electrical building with HVAC to house VFDs and MCCs
- Piping to WF2:
    - 100 ft of 30” DIP buried shallow
    - Four 30” 45 degree elbows
    - Tap for 30” pipe onto existing 36” pipe
    - One in-line strainer with bypass option and isolation valves

- Piping to PRF:
  - 150 ft of 30” DIP buried shallow
  - Hot tap to existing 36” pipe
  - Pressure sustaining valve

Alternative 2 – Pump Station to Pull Water from Reservoir No. 2

The following major components were included in the budgetary cost estimate for this pump station:

- Suction Manifold:
  - 250 ft of 30” DIP buried deep
  - One 30” isolation valve
  - Tap for 30” pipe onto existing 54” pipe
- Pump Station (pumps will just be on a slab, not enclosed):
  - Five 150 hp vertical turbine pumps (5 MGD @ 160 ft head each) with VFDs
  - 100 ft of 12” DIP buried deep
  - 150 ft of 12” DIP buried shallow
  - Eleven 12” Butterfly valves
  - Ten 12” swing check valves
  - Ten 30”x30”x12” tees
  - 110 ft of 30” DIP
  - 50’ x 20’ x 20’ wet well
  - One in-line strainer with bypass option and isolation valves
  - 20’ x 30’ x 10’ Electrical building with HVAC to house VFDs and MCCs
- Piping to WF2:
  - 1800 ft of 30” DIP buried shallow
  - 30” isolation valve
  - Eight 30” 45 degree elbows
  - Tap for 30” pipe onto existing 36” pipe
- Piping to Reservoir 1:
  - 210 ft of 30” DIP
  - One 30” motorized isolation valve
  - One 30” pressure sustaining valve
  - Two 30” 45 degree elbows
  - 30 ft long outfall structure with velocity dispersion baffles and riprap