PEACE RIVER MANASOTA REGIONAL WATER SUPPLY AUTHORITY

Hon. Alan Maio, Sarasota County | Hon. Elton A. Langford, DeSoto County | Hon. Bill Truex, Charlotte County | Hon. George Kruse, Manatee County

Mike Coates, P.G., Executive Director

May 24, 2020

Cindy Fischler, P.G.
Environmental Administrator
Aquifer Protection Program
Florida Department of Environmental Protection
2600 Blair Stone Road, MS 3530
Tallahassee, FL 32399-2400

Subject: Peace River Manasota Regional Water Supply Authority - Class V, Group 7 ASR Well System Operation Permit 0136595-014-UO/5Q Application - Petition for Water Quality Criteria Exemption and Associated Processing Fee

Dear Ms. Fischler:

In follow-up to our previous discussions, the Peace River Manasota Regional Water Supply Authority (Authority) is submitting the attached Petition for Water Quality Criteria Exemption (Petition). The Petition regards four secondary drinking water standards. Also included is a $24,000 check for the associated processing fee.

The Authority appreciates the Department's assistance, and we look forward to receipt of the requested exemption. If you have any questions, or if we can be of assistance, please do not hesitate to contact James Guida, P.G., of the Authority staff at 941-316-1776 or Pete Larkin, P.G. of ASRus, LLC at 813-382-8516.

Sincerely,

Mike J. Coates, P.G.
Executive Director

enclosure

cc: James Dodson, P.G, FDEP
James Guida, P.G., PRMRWSA
Doug Manson, Esq., Manson Bolves
Craig Varn, Esq., Manson Bolves
Mark McNeal, P.G., ASRus
Peter Larkin, P.G., ASRus
Joseph Haberfeld, P.G., ASRus

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

In Re: Petition for Water Quality Exemption
Pursuant to Rule 62-520.500, F.A.C., by:

Peace River Manasota Regional
Water Supply Authority
DeSoto County
_____/

PETITION FOR WATER QUALITY EXEMPTION

Peace River Manasota Regional Water Supply Authority ("Authority"), pursuant to rule 62-520.500, Florida Administrative Code ("F.A.C."), hereby files its Petition for Water Quality Criteria Exemption in the Suwannee Limestone of the Upper Floridan aquifer for the Authority's Aquifer Storage and Recovery System ("ASR System"). In support of this Petition the Authority states:

1. The Authority is an independent special district and a regional water supply authority authorized by section 373.1962, Florida Statutes ("F.S"), and subsequently reenacted in section 373.713, F.S., and created by an interlocal agreement executed in 1982 pursuant to section 163.01, F.S., between Charlotte, DeSoto, Manatee and Sarasota Counties for the purpose of developing, recovering, storing, and supplying water for the four-county region.

2. The address of the Authority is 9415 Town Center Parkway, Lakewood Ranch, FL 34202. The Authority's telephone number is 941-316-1776. The Executive Director of the Authority is Mike Coates, P.G.

3. The names and address of the Authority's attorneys are Doug Manson and Craig Varn, Manson Bolves Donaldson & Varn, 109 North Brush Street, Suite 300, Tampa, FL 33602. The attorneys' phone number is 813-514-4700. For purposes of this Petition, all correspondence should be directed to the Authority's attorneys at the referenced address.

4. The Department of Environmental Protection ("Department") has the authority, pursuant to rule 62-520.500, F.A.C., to grant water quality criteria exemptions in particular instances. Pursuant to this rule, the Department will grant an exemption if a petitioner provides alternative compliance levels for requested exemptions and affirmatively demonstrates:

(a) granting the exemption is clearly in the public interest;

(b) compliance with such criteria is unnecessary for the protection of present and future potable water supplies;

(c) granting the exemption will not interfere with existing uses or the designated use of the waters or of contiguous water;

(d) the economic, environmental, and social costs of compliance with the criteria outweigh the economic, environmental and social benefits of compliance;

(e) 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,

(f) the exemption will not present a danger to the public health, safety or welfare.

Background

5. The Authority acquired the Peace River Facility ("Facility"), located at 8998 Southwest County Road 769, Arcadia, Florida, in DeSoto County, from General Development Utilities in 1991. The Authority owns and operates the Facility currently providing potable drinking water to over 300,000 people in Charlotte County, DeSoto County, Sarasota County, and the City of North Port. The Authority is contractually obligated to supply up to an average of 34.7 million gallons of water per day ("mgd") to its customers by skimming, storing, and treating water from the Peace River. The storage sites are located on land owned by the Authority and land owned by the Southwest Florida Water Management District ("SWFWMD"). SWFWMD granted the

Authority two perpetual easements over SWFWMD-owned land to allow for water resource development. A project location map is presented in **Figure 1-1**.

6. The Authority developed the ASR System for the purpose of treating and storing water during the "wet season" to meet "dry season" demand. Through two wellfields, the Authority injects fully treated surface water meeting federal and state drinking water standards into the ASR System when river flows are high. This allows withdrawal of stored supplies from the ASR System, as needed, to meet seasonal water demands when low river flow limits or precludes withdrawal.

7. The ASR System and the two surface reservoirs are key components of the Authority's drinking water treatment system. The Peace River's flow is highly seasonal, and the Authority's Water Use Permit 20010420.011 ("WUP") restrictions are in place to protect downstream ecology by preventing river withdrawals during low-flow months. Under the WUP, a small percentage of river flow is harvested during higher flow periods, stored in the raw water reservoir system and in the finished water ASR System, and utilized to meet drinking water needs during the dry season when little or no water is available for harvest from the river. Therefore, seasonal system storage is a critical component of the Facility. The Authority has successfully developed a dependable and drought tolerant water supply through the combined use of ASR and off-stream surface reservoirs.

8. The Authority's ASR System includes Wellfield 1 (nine ASR wells and nine monitor wells) and Wellfield 2 (twelve ASR wells and fifteen monitor wells). This Petition applies only to Wellfield 2. A site plan for Wellfields 1 and 2 is provided as **Figure 1-2** and a close-up site plan for Wellfield 2 is shown on **Figure 1-3**.

Pilot Testing

9. A pilot test using partially treated surface water ("PTSW") was conducted under Department Permit 136595-016-017-UO/M5, issued December 14, 2016. The purpose of the pilot test was to study the potential of underground storage of PTSW from the surface reservoirs followed by recovery and potable treatment at the Authority's water treatment plant prior to distribution. Two cycle tests using PTSW at ASR wells S-4 and S-20 were conducted in 2017. In February 2018, the renewal permit application for the ASR System was submitted to the Department. As part of the renewal application, based on the results of the testing, PTSW was proposed as an additional source water solely for Wellfield 2.

10. A feasibility study of the treatment options to meet primary drinking water standards in the injected water without potable water treatment was conducted in 2021. The results were submitted as part of an email from the Authority to the Department on September 28, 2021. The Authority will use one or more treatment options to meet primary drinking water standards.

11. As part of the 2016 permit modification, the Department authorized a zone of discharge for total coliform bacteria, aluminum, and color. However, the pilot testing showed that the reservoir water occasionally exceeded the maximum contaminant levels (MCLs) for the secondary drinking water standards of color, aluminum, and iron. This Petition seeks water quality exemptions for these three parameters and odor.

12. The ASR System operates under the current permit 136595-014-UO/5Q, WACS No. 40593 as modified by permit 136595-016-017-UO/M5. The renewal application was assigned number 136595-018-038-UO/5SR. Completion details on the ASR and monitor wells can be found in the application and the 2020 Annual Report dated August 2021. A summary of the results of ASR testing with PTSW in 2017 is included in the renewal application. The full results were

submitted to the Department in the report "Peace River Facility Partially Treated Surface Water ASR Pilot Study" dated August 2018. The data collected during testing provides the information to support this Petition.

13. Cycle test 1 recharged 59 million gallons (MG) of PTSW and cycle test 2 recharged 178 MG into the ASR wells. Recovery of the PTSW achieved 100% recovery by volume either from ASR wells S-4 and S-20 or in combination with other ASR wells.

14. PTSW cycle test data for aluminum are presented in **Figure 1-4**. The maximum aluminum concentration in the PTSW was approximately 0.8 mg/L. Monitor wells exhibiting higher aluminum concentrations did so during recharge events. Four monitor wells were greater than 0.8 mg/L during storage, and two samples were approximately 20 mg/L in cycle 2. With one exception, once storage commenced, all monitor wells had aluminum concentrations less than the MCL. During cycle test 1, monitor well M-14 exceeded the aluminum MCL. Well M-14 concentrations followed the other monitor well trends after the conclusion of recharge in cycle test 2. The volume of water recharged for cycle test 2 was three times the volume recharged in cycle test 1 and is more representative of future operational conditions.

15. PTSW cycle test data for color are presented in **Figure 1-5**. The maximum color concentration in the PTSW was approximately 300 color units. Monitor wells which exhibited higher color concentrations did so during recharge and storage events. Once recovery commenced, all affected monitor wells had lower color concentrations with a strong downward trend in cycle test 2.

16. Odor concentration data in the surface reservoirs has not been collected. Reservoir odor is likely low in the cooler months and higher in the warmer months. Odor exceeds the MCL threshold odor number ("TON") of three (3) in many lakes and reservoirs, and it may exceed it in

the Authority's reservoirs, at least during the warmer months. Background water quality data for the ASR wells of Wellfield 2 is presented in **Table 1-1** and appears as Table 2.3 in the ASR Well Completion Report of 2000. Five of the twelve samples exceeded the odor MCL. Monitor well M-6, located approximately 7,500 feet south of Wellfield 2 and completed in the Suwannee ASR zone, was recently sampled for odor with a result of 67 TON. This well has shown no effects from the Authority's ASR system. Nonetheless, an exemption request for odor is included in this Petition.

17. Iron sampling of the surface reservoir water was not required during PTSW cycle testing, but iron sampling was performed for the geochemical study and showed the mean iron concentration in recharge water is 0.353 mg/L. (Appendix A). Testing results from the three monitor wells selected for iron analysis during the geochemical study, M-12, M-14, and M-15, show that the highest iron concentration prior to and during recharge was 0.48 mg/L. Background iron data were collected from the ASR wells of Wellfield 2 during construction of the wells, shown in **Table 1-1**, with only one well (S-17) exhibiting a concentration greater than the MCL, at 0.446 mg/L.

18. Rule 62-550.320, F.A.C., sets MCLs for aluminum, color, odor, and iron at 0.2 mg/L, 15 color units (CU), 3 threshold odor numbers (TON), and 0.3 mg/L, respectively. Other constituents with secondary drinking water standards are present at concentrations below their respective MCL. The PTSW cycle testing results show temporary increases in concentrations of aluminum, color, and iron in monitor wells sampled during recharge and storage. A safety factor has been applied to the proposed alternative standards for aluminum, color, odor, and iron, with concentrations requested based on what the Authority believes it can meet over the duration of the exemptions.

Requested Action

19. The Authority is requesting a Water Quality Criteria Exemption pursuant to rule 62-520.500, F.A.C., to allow the injection of partially treated water, at Wellfield No. 2, into the Suwannee Limestone of the Floridan aquifer with the following alternative compliance limits applicable to the PTSW injectate and the Authority's monitor wells: aluminum concentrations up to 40.0 mg/L, color values up to 600 CU, odor values of up to 75 TON, and iron concentrations up to 1.0 mg/L. The Authority has existing groundwater monitor wells in place to demonstrate compliance with this request. **Table 1-2** summarizes the data and requested alternative compliance levels for this Petition.

20. As discussed in detail below, this Petition satisfies each of the requirements of rule 62-520.500, F.A.C.

A. Public Interest

21. The Authority is obligated to supply up to 34.7 mgd of drinking water to Charlotte County, DeSoto County, Sarasota County, and the City of North Port. This is the sole source of drinking water for a significant number of residents and businesses in these communities. The Authority supplies approximately seventy-five percent of the drinking water used in the utility service areas of Charlotte, Sarasota and DeSoto Counties, and the City of North Port.

22. In October 2005, the Authority's member counties, plus the City of North Port, signed a contract with the Authority obligating the Authority to construct and operate expanded water facilities to meet their water needs. More than $300 million of public funds have been invested in new infrastructure including key storage components, such as an off-stream reservoir and the ASR System, to capture and maximize surface water for public supply in accordance with

the "Southern Water Use Caution Area Recovery Strategy" (Southwest Florida Water Management District, 2006).

23. The Authority's WUP contains restrictions on the amount of water that can be withdrawn from the Peace River, authorizing most withdrawals during wet-season high-flow periods, and minimal or no withdrawals during lower flow periods, reserving freshwater flow to support the estuary downstream. The viability of this environmentally sustainable drinking water supply operation depends on the availability of high volume off-stream storage to meet water supply needs during low river flow periods. The ASR System provides storage allowing for the seasonal withdrawal of water from the Peace River in compliance with the WUP while preserving flow needed to sustain the estuary downstream.

24. The Authority's ASR System is in the public interest as it is a key component of the Authority's, and the region's, overall water supply system to assure the reliability of the water supply and environmental sustainability of the Peace River and downstream estuary including Charlotte Harbor.

25. The Authority's water facilities, including the ASR System, have been paid for through local ratepayers of the Authority's customers and federal, state and SWFWMD grant funds.

B. Compliance with such criteria is unnecessary for the protection of present and future potable water supplies

26. The PTSW water will meet all primary drinking water standards and most secondary drinking water standards. These secondary standards, aluminum, color, odor, and iron, to some extent, are naturally occurring in Florida's aquifers. Odor and iron were documented in some Peace River background ASR zone samples in concentrations greater than their regulated drinking water standards. Secondary drinking water standards, which are not regulated by the

Environmental Protection Agency, are chemicals or physical characteristics which are organoleptic, potentially affecting the taste or odor of water. These secondary standards are established to assist public water systems in managing their drinking water for aesthetic considerations but are not considered to present a risk to human health at the secondary maximum contaminant level. Quite simply, these standards are not for the protection of present and future potable water supplies as they are not related to health hazards.

27. In addition, all water that is recovered from the ASR wells is returned to on-site reservoirs. These reservoirs have a combined capacity of over six billion gallons. Any elevated secondary standard concentration in the recovered water is reduced through blending with existing water contained in the reservoirs. It is the reservoir water that is sent to the Facility for treatment. After treatment the potable water meets all drinking water standards and is distributed to the Authority's customers. The concentrations of aluminum, color, odor, and iron from the ASR system and are not expected to require increased treatment requirements (e.g., RO treatment) at the Facility in order to meet potable standards.

28. Wellfield 1 has been in operation for over 30 years, and Wellfield 2 has been in operation for over 20 years. The Authority owns the Wellfield 1 property and has perpetual exclusive and non-exclusive easements over Wellfield 2 and the surrounding property. While the non-exclusive easement authorizes the use of some of the property for recreational and other uses by the public, these uses are not allowed to interfere with the Authority’s water supply operations or water resource development. As the installation of water wells would impair the Authority’s ability to store water, the placement of water wells by parties other than the Authority anywhere on the easement property is prohibited.

29. In June 2012, a well inventory survey utilizing information in the public record was compiled within a one-mile radius from each well in Wellfields 1 and 2. A second well inventory was completed in 2018 and confirmed the information provided in the 2012 survey. Based upon these surveys, no domestic or public supply wells greater than 500 feet in depth are located within a one-mile radius of either Wellfield. Of the 191 well construction permits and five water use permits issued within the one-mile radius, only ten wells (not owned by the Authority or SWFWMD) have well depths greater than 500 feet. This is mostly likely due to the Suwannee Limestone having a natural total dissolved solids (TDS) concentration of approximately 800 mg/L.

30. Despite being in operation since at least 2002, there have been no negative impacts from ASR System operations due to the aluminum, color, odor, or iron concentrations in the Suwannee Limestone storage zone of the Upper Floridan aquifer. While it appears unlikely that additional potable water wells will be constructed near either Wellfield, or that future potable supply wells will be constructed to withdraw from the Suwannee Limestone, continued monitoring, testing and wellfield management will ensure adequate protections for present and future potable water supplies.

C. Granting the exemption will not interfere with existing uses or the designated use of the waters or of contiguous water

31. Since the Wellfields have been in operation there has been no interference to existing uses or the designated use of the water or contiguous water. An extensive monitoring well network is in place to assure that stored water meets the required regulatory standards at distances representative of the Authority's owned or controlled property.

32. Further, there are a limited number of competing groundwater users in the Upper Floridan aquifer (UFA) within the two-mile Area of Review (AOR) radius used during the permit renewal process. Evaluation of the well inventory within the AOR indicated that there are no active

domestic or public supply wells that penetrate deeper than the Tampa Member of the Hawthorn aquifer system and therefore ASR operations with PTSW in the Suwannee Limestone of Wellfield 2 do not pose a potential threat to public health. The remaining wells that are 500 feet or greater in depth in the AOR are mostly irrigation wells. This is most likely due to the availability of higher quality potable water at much shallower depths.

33. As noted above, there are ten wells listed as agricultural wells. This is consistent with the predominant zoning designation of Agriculture (AG-10 and AG-5) in the area. The other zoning designation within the one-mile radius is Residential Multi-family (RMF-12 and RMF-6), all of which is located upgradient of the ASR wells.

34. Other than the Authority and the District, there are only five landowners within 1,000 feet of either Wellfield. Based upon the current ownership and zoning of the surrounding land and the placement of the existing wells, the likelihood of additional development that could be impacted by the ASR wells, particularly at or below a depth of 500 feet, is extremely low. Neither injection of PTSW at the Peace River site nor these exemptions are expected to interfere with any groundwater use in the area.

D. <u>The economic, environmental, and social costs of compliance with the criteria outweigh the economic, environmental, and social benefits of compliance</u>

35. The ASR System has been in operation since 1985, when Wellfield 1 was placed in service. Over $300 million of public funds have been invested in new infrastructure including key storage components of the off-stream reservoir and ASR System. As part of its testing, the Authority has performed numerous cycle tests, with more than 6.8 billion gallons of water being recharged in Wellfield 2. During this time there have been no negative impacts to the environment or existing uses.

36. From an environmental perspective, the stored surface water is an environmentally beneficial and sustainable alternative that utilizes excess water from the Peace River during periods of high flows normally lost to tide and not beneficial to the estuary. By using excess surface water as a water source, public supply does not compete with other groundwater users, such as agriculture, for the limited groundwater sources within the SWUCA. The recovered water is either treated or blended to assure compliance with all federal and state drinking water standards prior to distribution. This procedure will not change if the exemptions are granted. With these safeguards in place, granting the Water Quality Criteria Exemptions for the four requested secondary standards outweighs any potential environmental benefit of compliance.

37. Finally, treating all injectate to full drinking water standards would cost an estimated $82 million, including the construction of a new 24 mgd conventional treatment train with dual media filtration. This estimate does not include operation and maintenance costs and is, at best, a rough estimate given the uncertainty associated with the process to treat the injectate, and the accompanying costs to do so. This option would place an increased financial burden on the local ratepayers with no economic, environmental, or social benefit. Other alternatives are similarly cost prohibitive and/or unproven at this time. Therefore, use of additional treatment would result in significant costs with little, if any, derived benefit.

E. <u>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</u>

38. Between Wellfield 1 and Wellfield 2, the Authority has an extensive system of twenty-five (25) monitor wells for the ASR System. Sixteen wells are within the Suwannee Limestone of the Floridan aquifer, eight are within the overlying Hawthorn aquifer system, and

one is in the underlying Avon Park Formation. Ten monitoring wells are in Wellfield 1 and fifteen wells are in Wellfield 2. Thus, the ASR zone and the overlying Hawthorn aquifer system are rigorously monitored to detect any adverse effects related to ASR activities. The quality of the injected water, the water recovered from ASR wells, and the water quality of the monitor wells are monitored regularly to ensure compliance with the groundwater standards and other monitoring requirements contained in the ASR permit. The monitoring program will be continued under the new UIC permit for operation of both Wellfields.

39. All water quality samples are collected in accordance with the quality assurance requirements in Chapter 62-160, F.A.C. Samples and measurements taken for the purpose of monitoring are representative of the monitored activity and provide a sound representation of the water quality changes associated with the ASR System.

40. Operational and water quality data is submitted to the Department monthly. The monthly submittal includes tabulated data, signatory pages, laboratory pages and supporting documents. The monitoring program has been effective at monitoring water quality and water level responses resulting from injection activities at this site since injection activities began. Monthly operation reports will continue to be submitted to the Department summarizing injection rates and volumes, wellhead pressures and water level, and water quality data collected during the month of operation.

41. An annual report will be prepared for each year of operation summarizing the data collected during that calendar year. Historical data will be reviewed and compared to data collected over the past year to confirm that the injection system has had no adverse impacts at this site.

F. <u>The Exemptions Will Not Present a Danger to the Public Health, Safety or Welfare</u>

42. As noted above, these secondary standards were established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, not human health. The proposed Water Quality Criteria Exemptions will allow the Authority to operate its complete ASR System for the purpose of storing and recovering fully treated drinking water at Wellfield 1, and either fully treated drinking water or partially treated surface water at Wellfield 2. The distribution of the recovered water will meet all federal and state drinking water standards while the storage will provide the Authority with the ability to beneficially utilize surface water withdrawal during high river flow periods for use during drier periods when the river withdrawal is restricted or prohibited. The requested exemptions will not present a danger to the public health, safety, or welfare as the MCLs are not health-based standards, the Authority maintains its robust monitoring system and the use of the water is extremely limited by other users.

43. The proposed ASR operation will improve public health, safety, and welfare by providing a reliable source of suitable quality water at relatively low cost to help meet growing water demands in the service area.

Summary

44. To maintain the overall reliability in its drinking water supply facilities to meet its contractual obligation to its member counties, the Authority has developed its ASR System to store excess treated drinking water during the wet season to satisfy need in the dry season. The ASR System has been in some form of operation for over 25 years and while the referenced secondary drinking water standards have shown exceedances, the aluminum exceedances occur only during recharge and the iron exceedances are consistent with or below background data. As such, there has been no historic interference with the existing uses of the water. Further, the Authority is proposing continuation of a monitoring program to ensure adequate protections for present and

future potable water supplies. Finally, the distribution of the recovered water to the public will meet all federal and state drinking water standards through retreatment or blending at the Facility.

45. In summary, public health will not be endangered should the exemptions be approved as:

- the exceedances are of secondary drinking water standards and, therefore, are not a threat to human health;
- finished water from the Facility meets all state and federal drinking water standards;
- the Authority has an extensive monitoring well network with a very robust dataset that has shown the aerial extent of exceedances to be limited;
- there are no competing users of the same aquifer located near either wellfield; and,
- the Authority owns or controls a large area of land surrounding the ASR wellfields providing an institutional control of the stored water.

WHEREFORE, the Peace River Manasota Regional Water Supply Authority requests the Department of Environmental Protection issue Water Quality Criteria Exemptions for secondary drinking water standards pursuant to rule 62-520.500, F.A.C., specifically for aluminum concentrations up to 40.0 mg/L, color values up to 600 CU, odor values of up to 75 TON, and iron concentrations up to 1.0 mg/L for groundwater in the Suwannee Limestone of the Upper Floridan aquifer on property legally owned or under the control of the Authority at the Peace River Facility in DeSoto County, Florida.

RESPECTFULLY SUBMITTED this 26th day of May, 2022.

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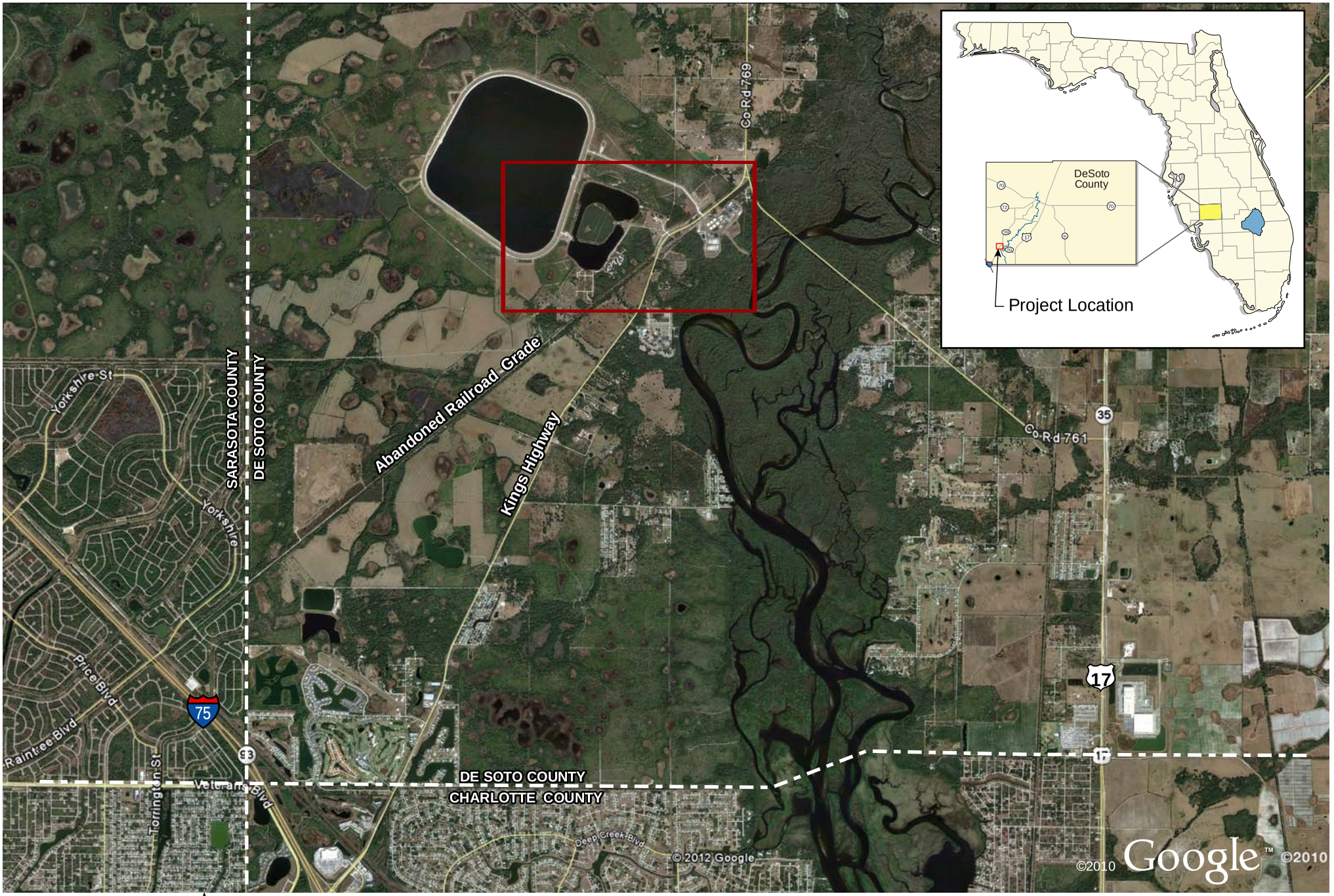


Peace River Manasota Regional Water Supply Authority

North

Scale in Miles

0 1/2 1

FIGURE 1-1 Project Location Map

ASRUS LLC

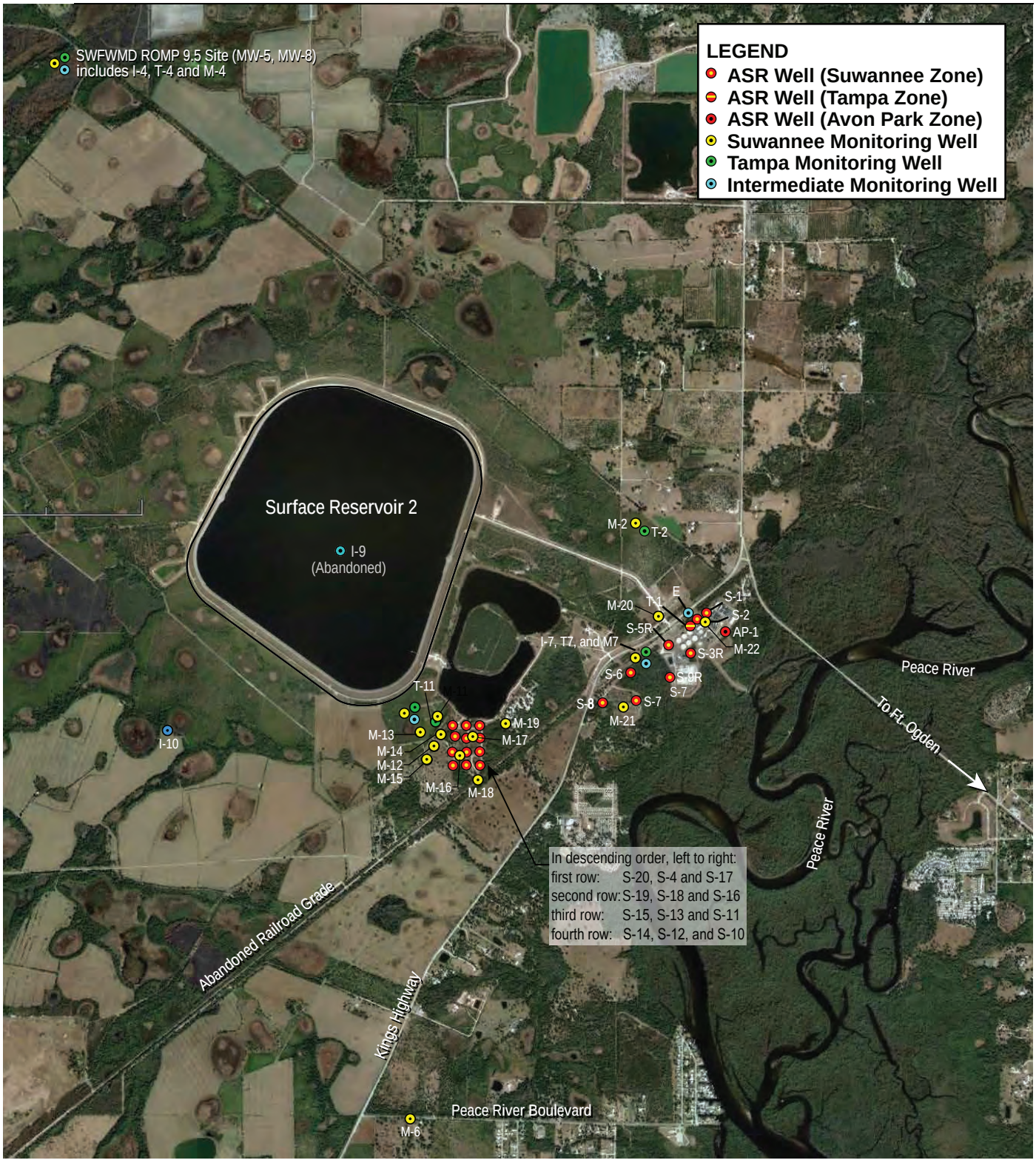
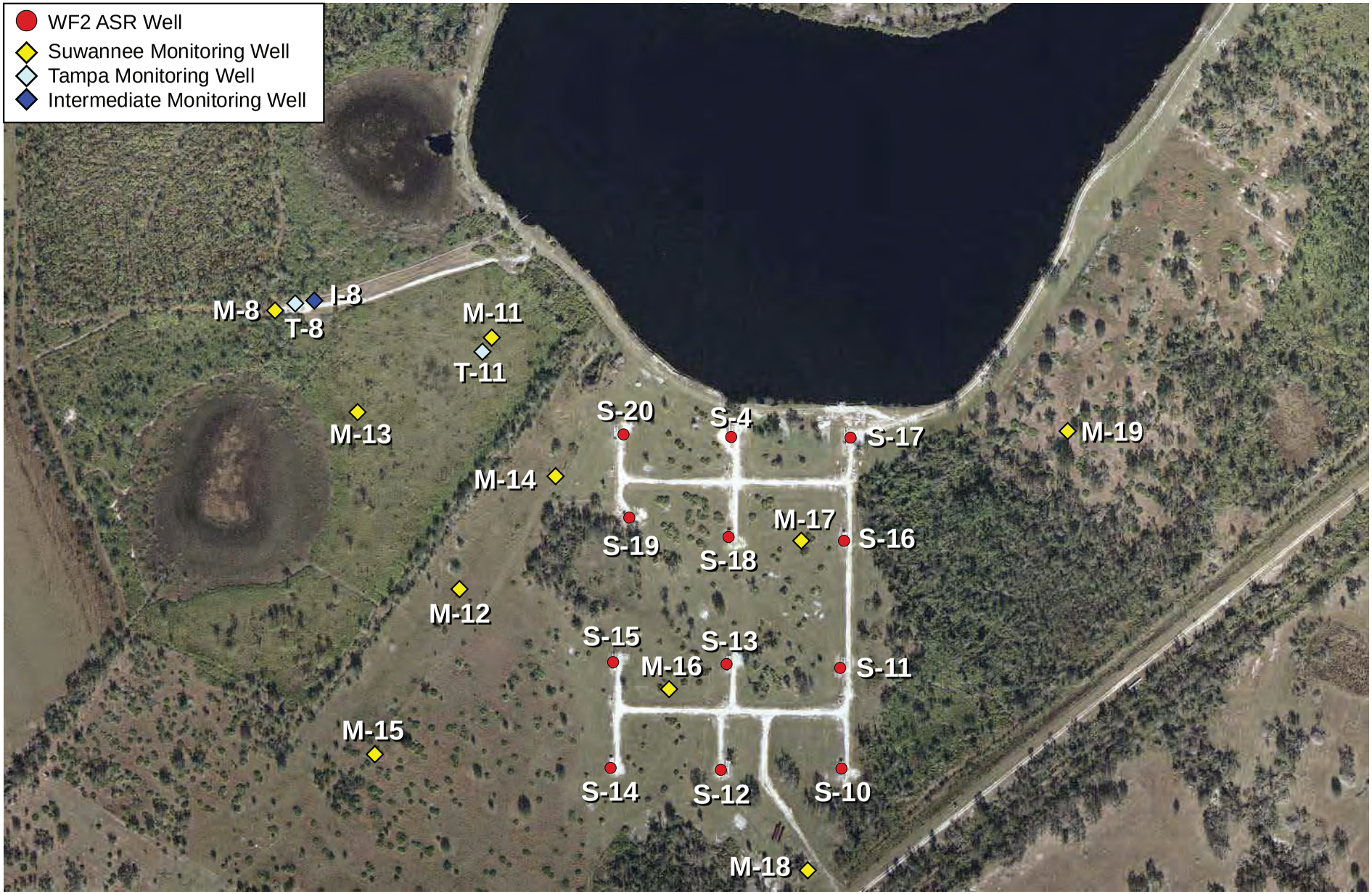


FIGURE 1-2
Peace River Facility ASR Site Plan



Peace River Manasota Regional Water Supply Authority

FIGURE 1-3
WF2 Site Plan

ASR US, LLC

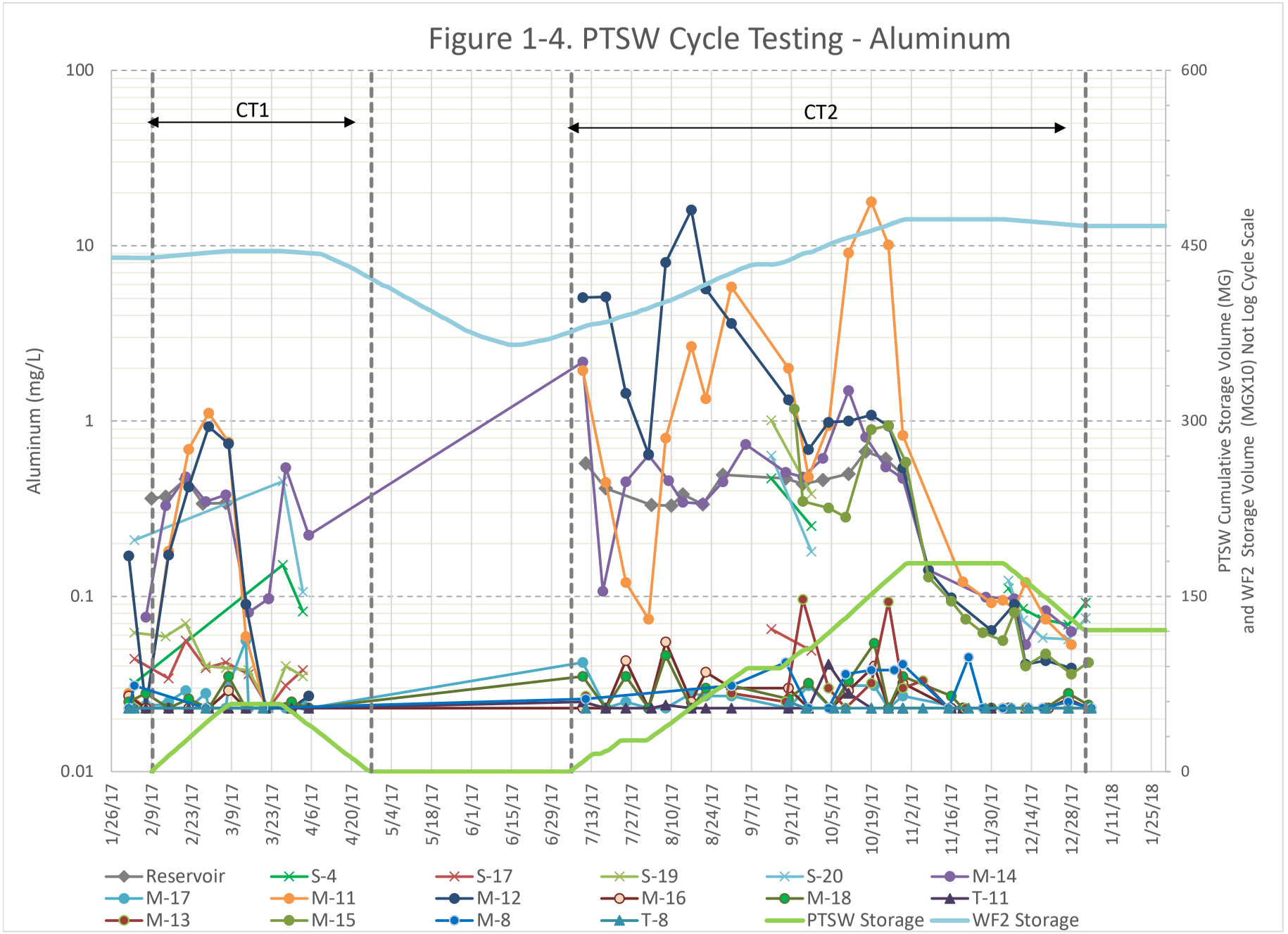


Figure 1-4. PTSW Cycle Testing - Aluminum
CT1
CT2
Aluminum (mg/L)
PTSW Cumulative Storage Volume (MG)
and WF2 Storage Volume (MGX10) Not Log Cycle Scale
100
10
1
0.1
0.01
600
450
300
150
0
1/26/17
2/9/17
2/23/17
3/9/17
3/23/17
4/6/17
4/20/17
5/4/17
5/18/17
6/1/17
6/15/17
6/29/17
7/13/17
7/27/17
8/10/17
8/24/17
9/7/17
9/21/17
10/5/17
10/19/17
11/2/17
11/16/17
11/30/17
12/14/17
12/28/17
1/11/18
1/25/18
Reservoir
S-4
S-17
S-19
S-20
M-14
M-17
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M-13
M-15
M-8
T-8
PTSW Storage
WF2 Storage

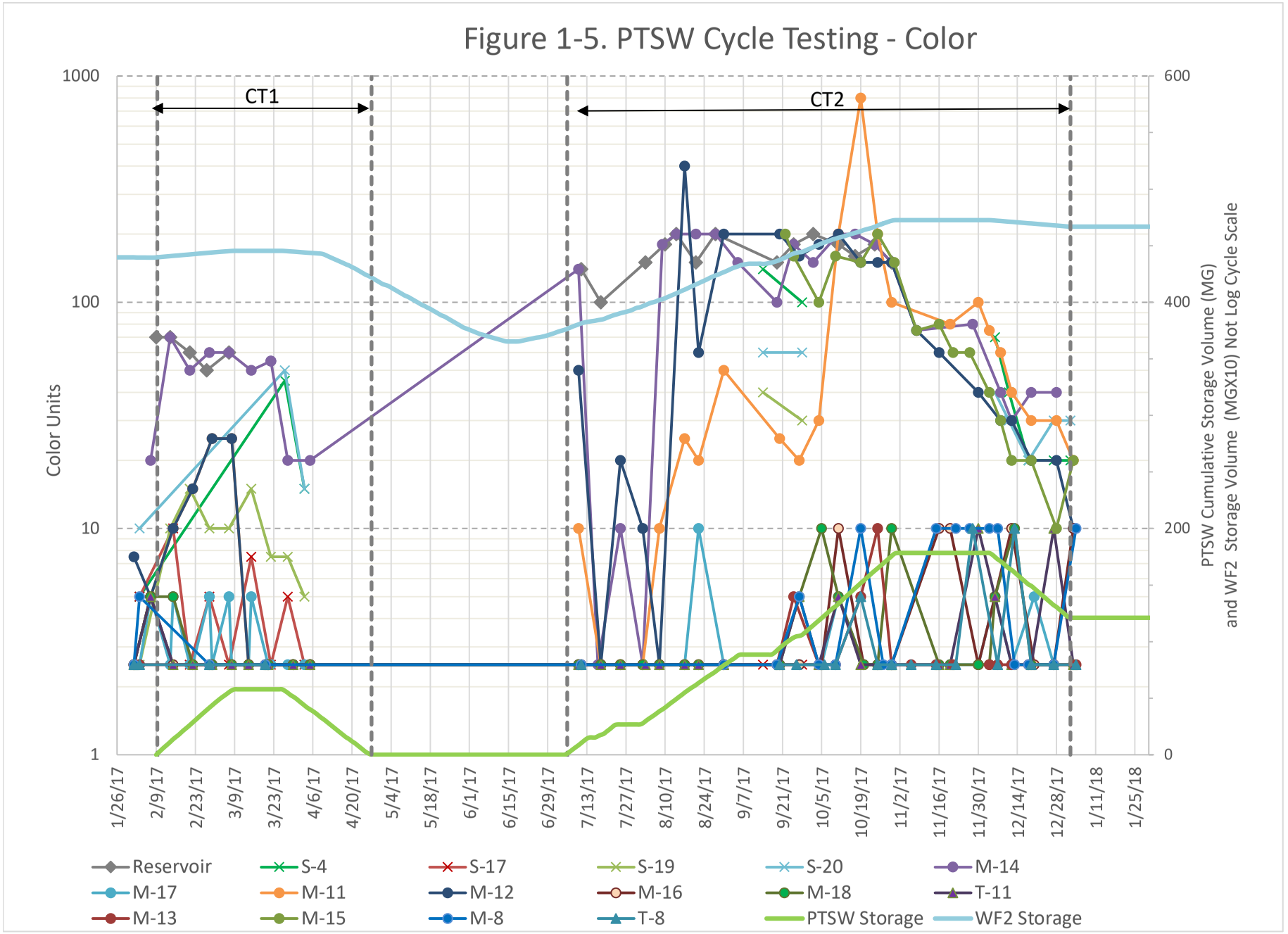
Figure 1-5. PTSW Cycle Testing - Color
CT1
CT2
Color Units
1000
100
10
1
600
400
200
0
PTSW Cumulative Storage Volume (MG)
and WF2 Storage Volume (MGX10) Not Log Cycle Scale
1/26/17
2/9/17
2/23/17
3/9/17
3/23/17
4/6/17
4/20/17
5/4/17
5/18/17
6/1/17
6/15/17
6/29/17
7/13/17
7/27/17
8/10/17
8/24/17
9/7/17
9/21/17
10/5/17
10/19/17
11/2/17
11/16/17
11/30/17
12/14/17
12/28/17
1/11/18
1/25/18
Reservoir
S-4
S-17
S-19
S-20
M-14
M-17
M-11
M-12
M-16
M-18
T-11
M-13
M-15
M-8
T-8
PTSW Storage
WF2 Storage

ASR WELL WATER QUALITY SUMMARIES

ASR WELL	S4	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
Coliform, Total (CFU/100ml)	BDL	30	1	5	BDL	250	10	BDL	10	BDL	BDL	BDL
Odor (TON)	25	5	50	2	2	BDL	2	BDL	BDL	25	2	5
pH (SU)	8.1	7.77	7.92	8.09	7.49	7.65	7.53	7.58	7.64	7.33	7.53	7.6
Residue, Total Filterable (TDS) (mg/l)	952	948	936	1070	950	876	894	922	968	844	1054	916
Turbidity (NTU)	BDL	11.6	8.01	44.6	BDL	17.9	BDL	3.7	6.18	BDL	BDL	0.8
Chloride (mg/l)	182	200	328	181	167	162	161	167	279	169	222	206
Fluoride (mg/l)	1.89	1.28	1.96	1.2	1.7	1.63	1.85	1.66	1.34	1.92	1.45	1.74
Nitrate (as N) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nitrate/Nitrite (as N) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nitrite (as N) (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Sulfate (mg/l)	251	300	412	226	255	231	241	264	351	264	263	252
Cyanide, Total (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
MBAS Surfactants (mg/l)	BDL	BDL	0.04	BDL	0.14	BDL	BDL	0.018	BDL	0.042	BDL	BDL
Aluminum (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Antimony (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Arsenic (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Barium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	3.3	BDL	BDL
Beryllium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Cadmium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Chromium (mg/l)	BDL	BDL	BDL	BDL	0.03	BDL	BDL	BDL	BDL	0.018	BDL	BDL
Copper (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Iron (mg/l)	BDL	0.3	0.114	0.193	BDL	1.17	BDL	BDL	0.446	BDL	BDL	BDL
Lead (mg/l)	0.021	BDL	0.001	BDL	BDL	0.001	BDL	BDL	BDL	BDL	BDL	BDL
Manganese (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Mercury mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Nickel (mg/l)	BDL	BDL	BDL	BDL	0.007	BDL	BDL	BDL	BDL	0.022	BDL	BDL
Selenium (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Silver (mg/l)	BDL	0.008	0.002	BDL	BDL	BDL	BDL	0.002	BDL	BDL	0.002	BDL
Sodium (mg/l)	93	110	76	91	88	85.5	88.3	57.2	108	176	121	86
Thallium (mg/l)	BDL	BDL	BDL	BDL	0.004	BDL	BDL	BDL	0.026	BDL	BDL	0.014
Zinc (mg/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Gross Alpha (pCi/l)	20	26	21	19	34	22	39	17.7	14.2	15.5	25	11.7
Total THM (ug/l)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Table 1-1. ASR Well Background Water Quality Sampling in Wellfield 2.
Source: *Well Completion Report for the Wellfield 2 ASR Wells, November 2000, Table 2-3.*

Table 1-2.
Requested Alternative Water Quality Criteria Exemption Concentrations

Parameter	Units	DWS Maximum Contaminant Level	Maximum Observed PTSW	Background Concentration ASR Zone	Proposed WQCE Concentration PTSW
Aluminum	mg/L	0.2	0.8	< 0.2	40
Color	CU	15	300	<15	600
Odor	TON	3	uncertain	≤ 50	75
Iron	mg/L	0.3	0.413	<0.3	1.0

Appendix A
Iron, Arsenic, and Phosphorus Geochemistry During Cycle Test 2

Source: Appendix E of “Peace River Facility Partially Treated Surface Water ASR Pilot Study” dated August 2018

IRON, ARSENIC, AND PHOSPHORUS GEOCHEMISTRY DURING CYCLE TEST 2, WELLFIELD 2, PEACE RIVER FACILITY

1. Groundwater Geochemistry of Arsenic Mobilization and Attenuation.

Arsenic mobilization due to pyrite oxidation is common in potable water ASR systems in the Upper Floridan Aquifer of Florida, including at the Peace River Facility. Arsenic mobilization and subsequent attenuation is less commonly observed during ASR cycle tests. Arsenic mobilization during recharge, and attenuation during storage and recovery was quantified during four cycle tests at the Kissimmee River ASR system (KRASR; Mirecki et al., 2013). Lightly treated surface water (filtration and UV disinfection) was recharged into the Upper Floridan Aquifer during four successive cycle tests at the KRASR facility.

Two mechanisms of arsenic attenuation have been identified and observed at ASR systems: 1) arsenic sorption on iron oxides; and 2) arsenic coprecipitation in iron sulfides. Arsenic sorption onto iron oxide surfaces in the aquifer occurs under primarily oxidizing redox conditions. Iron oxide is stable as grain coatings and fracture coatings in the aquifer, even if dissolved oxygen is absent. Arsenic coprecipitation in iron sulfides occurs under primarily reducing redox conditions. Iron oxide solids are not stable in the presence of dissolved hydrogen sulfide, and will dissolve, releasing sorbed arsenic back into groundwater. However, if sufficient dissolved iron and hydrogen sulfide are present in the aquifer, sulfate-reducing bacteria will facilitate precipitation of iron sulfide. Arsenic is co-precipitated with the iron sulfide solid, effectively removing arsenic from groundwater.

Both attenuation reactions can be characterized by iron and arsenic concentrations in monitor well samples, primarily during the static conditions of storage. In both arsenic attenuation reactions, iron concentrations should decline (dissolved iron precipitates as either solid iron oxide or solid iron sulfide). Arsenic concentrations should also decline, due to sorption onto iron oxides, or by co-precipitation of iron sulfide. Phosphorus behaves similarly to arsenic, so these trends should apply to phosphorus as well.

2. Iron, Arsenic, and Phosphorus Concentration Trends during Cycle Test 2.

Trends in iron and arsenic concentrations during cycle test 2 are shown in a series of plots of water quality data from monitor wells **(Figure 1)**. All monitor wells show similar trends during cycle test 2.

- Iron concentrations are highly variable during recharge (0.14 mg/L to 0.48 mg/L in all monitor wells).
- Iron concentrations peak, and then decline during storage.
- Iron concentrations reach a minimum during recovery.
- Arsenic concentrations generally increase during storage and recovery.
- Phosphorus concentrations generally decrease during storage and recovery.

These trends do not confirm either mechanism (described above) of arsenic attenuation. However, there are some indications that suggest that arsenic and phosphorus attenuation can occur when surface water is recharged in the Upper Floridan Aquifer (Suwannee Limestone Permeable Zone).

a. Iron Concentration Trends

Variable iron concentrations in monitor well samples during recharge probably result from interruptions in the water supply during Hurricane Irma and from operational issues, and also due to variable iron concentrations in recharge water (as measured at S-4 and S-20). The mean iron concentration in recharge water is 0.353 +/- 0.256 mg/L (S-4 and S-20, coefficient of variation 72%, n=4).

Iron concentrations peak during the static conditions of storage, at concentrations that equal or exceed that of recharge water (see M-14, **Figure 1**). This suggests that iron is mobilized during recharge and early storage. The only geochemical mechanism that can increase groundwater iron concentrations above that of recharge water is dissolution of pre-existing iron oxide solids in the aquifer as can happen in the presence of hydrogen sulfide in reducing redox conditions, as discussed earlier.

Declining iron concentrations are observed in all proximal monitoring wells after approximately two weeks of storage. Iron concentrations decline from approximately 0.3 to 0.4 mg/L to less than 0.2 mg/L. The mean iron concentration in recovered water is 0.155 +/- 0.055 mg/L (S-4 and S-20, coefficient of variation 35%, n=8). Similar iron concentrations are shown in monitor wells during recovery. Declining iron concentrations during storage strongly suggest precipitation of an iron solid in the aquifer. Iron concentrations reach minimum values during recovery.

b. Estimating Aquifer Redox Environment

Oxidizing versus reducing conditions in the aquifer will control whether that solid is an iron oxide or iron sulfide, respectively. Iron oxide solids are stable in the presence of dissolved oxygen and the absence of dissolved hydrogen sulfide. Iron sulfide solids are stable only where there is sufficient dissolved iron and hydrogen sulfide.

Dissolved oxygen concentrations measured in monitor well samples show measurable dissolved oxygen during storage and recovery. This is surprising, as dissolved oxygen concentrations usually decline quickly (hours or days) after recharge ends. Dissolved oxygen concentrations measured in monitor well during cycle test 2 are shown in **Figure 2**.

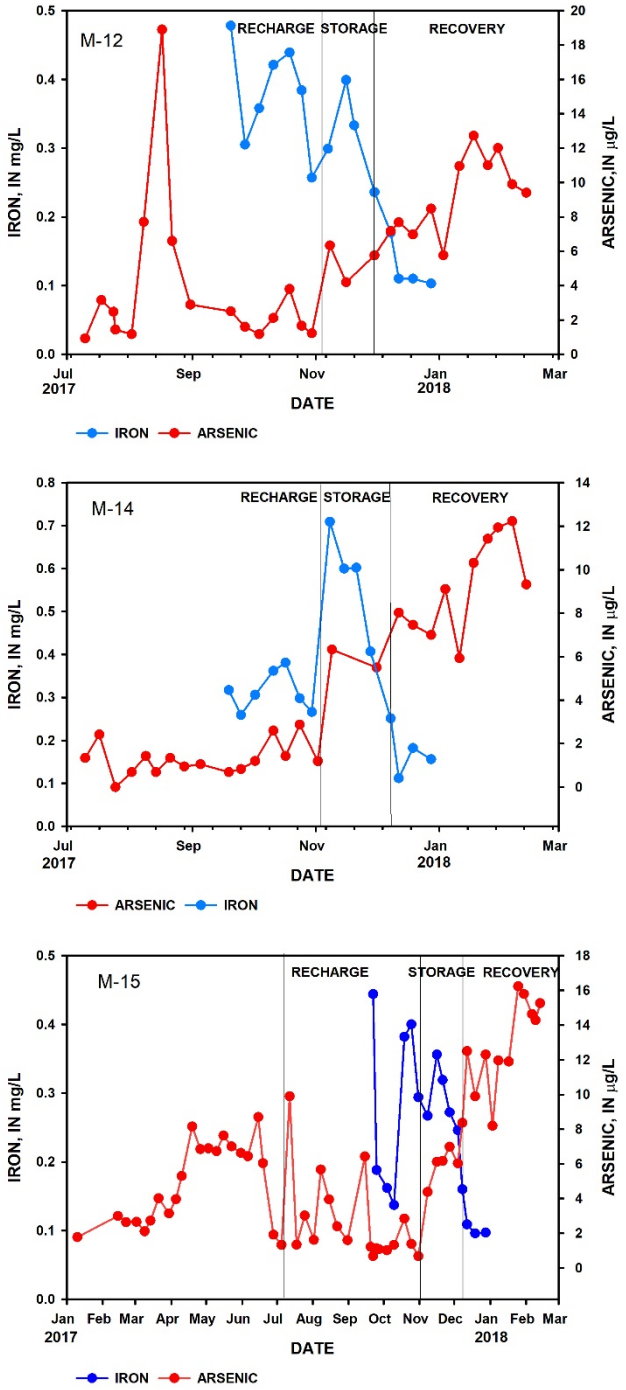

Figure 1. X-Y plots showing arsenic and iron concentrations in monitor well samples collected during cycle test 2.

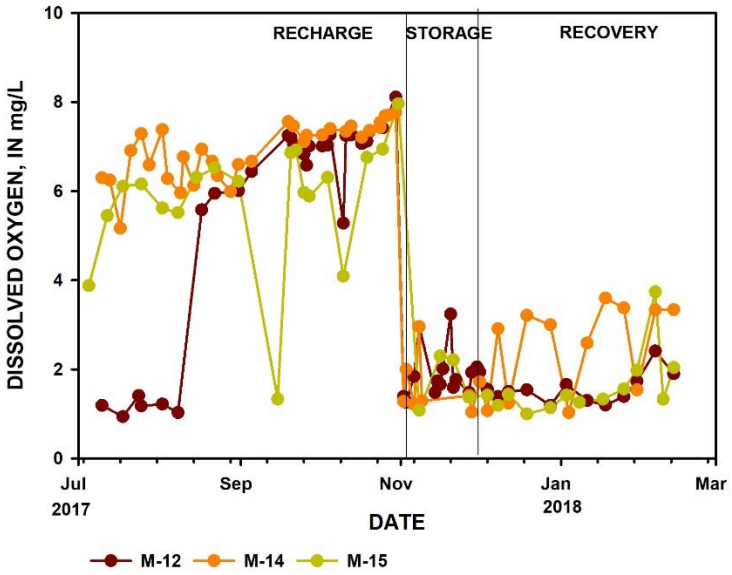

Figure 2. X-Y plot showing dissolved oxygen concentrations measured in monitor well samples during cycle test 2.

The presence of dissolved oxygen in monitor well samples during storage and recovery indicates that oxic to sub-oxic (dissolved oxygen concentrations less than 0.2 mg/L) redox conditions prevail in the aquifer during cycle test 2. Dissolved oxygen concentrations range between 1 mg/L and 4 mg/L in monitor wells during recovery. Measurable dissolved oxygen concentrations in monitor well samples during storage and recovery may have resulted from atmospheric exposure during sampling. However, even if dissolved oxygen is absent in storage and recovery samples, it is likely that iron oxide solids are stable under sub-oxic conditions. There are no data to suggest that dissolved hydrogen sulfide and precipitation of iron sulfide solids (that is, reducing conditions) exerts control on iron and arsenic in the aquifer.

c. Arsenic Concentration Trends

Arsenic concentrations generally increase in monitor well samples during recharge, which is the typical result of pyrite oxidation when oxic recharge water is introduced into an aquifer (**Figure 1**). The mean dissolved oxygen concentration of the reservoir water during recharge was 7.7 mg/L, which is sufficient to induce pyrite oxidation and arsenic mobilization at locations of proximal monitor wells.

Arsenic concentrations continue to increase in monitor well samples through storage and recovery phases of cycle test 2. The increase in arsenic concentrations is simultaneous with declining iron concentrations. So, even though declining iron suggests that iron oxide solids are precipitating during cycle test 2, attenuation resulting from sorption on the iron oxide surface is not indicated. Iron oxide is very insoluble under near-neutral pH and sub-oxic redox conditions, so precipitation would be expected to occur quickly, on the order of days. Arsenic sorption may occur more slowly. Also, arsenic and phosphorus compete for binding sites on iron oxide surfaces.

d. Total Phosphorus Concentration Trends

Dissolved arsenic and phosphorus often behave similarly when considering the types of reactions between water and minerals. Arsenic is just below phosphorus on the periodic table of elements, so aqueous speciation and reactions are similar. Trends in total phosphorus concentrations are shown in **Figure 3.**

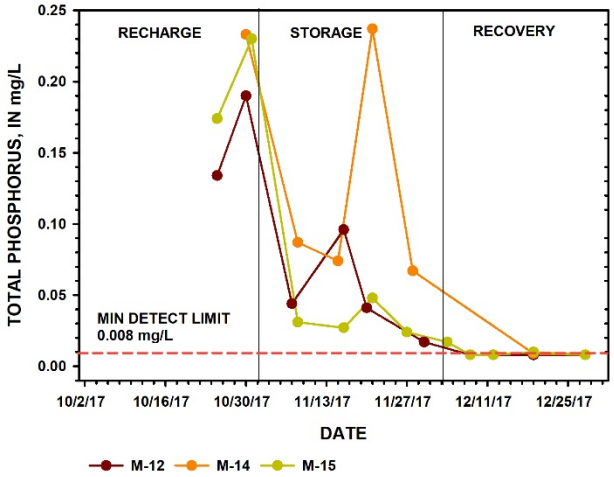

Figure 3. X-Y plot showing trends in total phosphorus concentrations measured in monitor wells.

Phosphorus would originate from two sources: 1) from partially treated surface water during recharge; and/or 2) release of sorbed phosphorus if iron oxide solids become unstable and dissolve under reducing conditions. It is likely that both sources contribute to phosphorus in the aquifer during cycle test 2. Total phosphorus concentrations measured in reservoir samples are 0.251 mg/L and 0.155 mg/L, identical to the range of concentrations measured in proximal monitor well samples during recharge. Total phosphorus concentrations vary during storage, possibly reflecting increases that result from iron oxide dissolution and release of sorbed phosphorus. However, unlike arsenic, total phosphorus concentrations decline during late storage and recovery. Because iron oxide solids are stable in the aquifer during these phases of cycle test 2, it is possible that arsenic and phosphorus compete for binding sites on iron oxide solids. Because phosphorus concentrations are far greater, phosphorus is likely sorbed preferentially compared to arsenic.

3. Conclusions and Recommendations

Cycle test 2 of the Partially Treated Surface Water Pilot Test was of relatively short duration. However, data are sufficient to identify major geochemical trends of iron, arsenic, and phosphorus in the ASR and proximal monitoring wells. Major conclusions are as follows:

- Dissolved iron and dissolved oxygen concentrations obtained during cycle test 2 indicate a mostly oxic to sub-oxic redox condition in the storage zone throughout the test. These conditions favor iron oxide as a stable solid existing as grain and fracture coatings.
- Arsenic is mobilized during the recharge phase of cycle test 2, and concentrations increase to a maximum value of 12.3 µg/L (M-12), 12.7 µg/L (M-14), and 16.2 µg/L (M-15) through the recovery phase. Despite the presence of stable iron oxide, arsenic sorption is not clearly shown.

- Phosphorus concentrations increase during recharge in monitor well samples, then subsequently decline during late storage and recovery. The geochemical behavior of arsenic and phosphorus are similar in that both species will sorb onto binding sites on iron oxide solids. Because phosphorus occurs at much higher concentrations than arsenic, it is possible that phosphorus sorption occurs preferentially on a finite number of binding sites on the solid. Phosphorus concentrations decline from approximately 0.2 mg/L to <0.008 mg/L (the detection limit) during late storage and recovery.

Two factors would clarify controlling geochemical reactions of iron, arsenic, and phosphorus during PTSW cycle testing, and these are recommended for future testing.

- Data for more conclusive characterization of aquifer redox environment. Dissolved oxygen measurements must not contact the atmosphere during sampling. The presence or absence of dissolved hydrogen sulfide requires confirmation. Iron, arsenic and phosphorus should be measured in every sample.
- The duration of storage should be increased, if possible. One month of storage may not be sufficient for the aquifer to equilibrate under static conditions