Hillsboro Aquifer Storage and Recovery Pilot Project
Cycle 1 Summary Technical Memorandum

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Purpose

The purpose of this technical memorandum is to provide a summary of the results of Cycle 1 at the Comprehensive Everglades Restoration Plan (CERP) Hillsboro Aquifer Storage and Recovery (ASR) pilot project. A project location map is presented on **Figure 1**. The results provide a basis for continued operation, testing and monitoring of the system.

Essential Findings

- Cycle #1 at the Hillsboro ASR pilot project was successfully conducted from January through March of 2010. The cycle consisted of 31 days of recharge, followed by 31 days of storage, followed by 31 days of recovery. Recharge and recovery rates averaged 3,400 gallons per minute.
- Equipment testing indicates that the facility is operating as designed. The system operated with occasional visits for monitoring and routine maintenance.
- Modification of the filtration units was required prior to the initiation of the cycle. Adjustment to the disinfection system intensity was also required during the cycle.
- During recharge, the ASR wellhead pressure remained below 60 pounds per square inch (psi)
- Water quality data from the storage-zone monitoring wells indicated that canal water mixed and diffused with groundwater at distances of 330 and 1,000 feet away from the ASR well. Wells completed above and below the storage zone indicated little if any impacts from water emplaced within the storage zone.
- The recovery efficiency for Cycle 1 was approximately 20 percent. Further improvement in the recovery efficiency is anticipated during subsequent cycles, as a target storage volume is developed.
- Water recovered from the system displayed no toxic effects and generated no elevated levels of mercury.
- Water recovered from the ASR well exhibited an arsenic concentration of 111 parts per billion (ppb) during the first flush, but declined to less than 10 ppb over the duration of the recovery period. The concentration of arsenic in all of the monitoring wells remained below 10 ppb during the entirety of Cycle 1.
- Continued testing of the system should proceed with Cycle #2, consisting of a longer (90 day) recharge duration.

Background

Construction of the Hillsboro aquifer storage and recovery (ASR) pilot project was completed in July 2009. The ASR system was built to recharge, store and recover partially treated water from the Hillsboro Canal, to demonstrate the effectiveness of this technology as part of the CERP. The system is located adjacent to the western terminus of Loxahatchee Road, along the Hillsboro Canal, in western Boca Raton, near

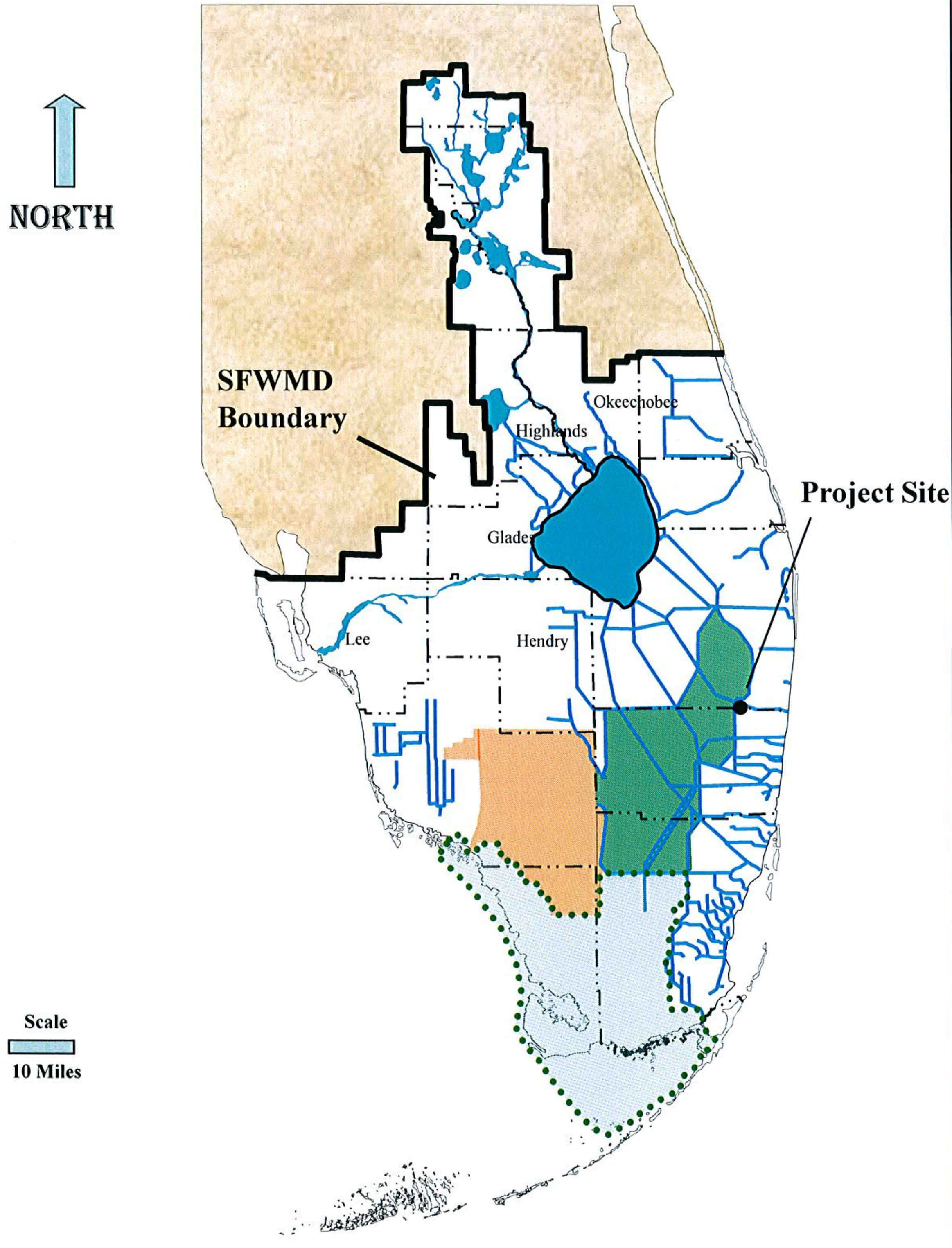

Figure 1. Project Location Map

the future location of the CERP Fran Reich Preserve, as shown in **Figure 2**. The project was built and is operating under the following permits and authorizations:

- UIC Permit 153872-002-UC
- CERPRA Permit: 01543872-003-GL
- NPDES Permit: FL0484890
- Water Quality Criteria Exemption: 06-0718
- Administrative Order: 153872-005-UC

The ASR system consists of an ASR well with connections to the Hillsboro Canal via an intake/discharge structure, injection pump, a mechanical screen filter, and ultraviolet (UV) disinfection system. The ASR well has 24-inch diameter casing cemented to a depth of 1,015 feet below land surface (fbls) and an open borehole completed below the casing, to a depth of 1,225 fbls. Recovery is accomplished via a vertical turbine pump mounted on the ASR wellhead, which routes water from the ASR well back through the surface piping to the intake/discharge structure.

The associated monitoring well network consists of the following wells, as shown aerially on **Figure 3**. The vertical relationships between the wells and the stratigraphy at the site are presented on **Figure 4**.

- PBF-10R: Storage-zone (Upper Floridan Aquifer) monitor well about 330 feet from the ASR well, consisting of a monitoring interval from 1015 and 1225 feet below land surface (fbls);
- PBF-11: Intermediate-depth monitor well about 330 feet from the ASR well with an intermediate monitoring interval from 1,515 to 1,670 fbls;
- PBF-12: Deep (Lower Floridan Aquifer) monitor well about 330 feet from the ASR well, with a monitoring interval from 2,135 to 2,260 fbls;
- PBF-14: Storage-zone monitor well 1,000 feet from the ASR well, single zone design with an open borehole from approximately 1,015 to 1,225 fbls, and;
- PBS-11: Surficial Aquifer System monitor well about 150 feet from the ASR well with a screened interval from approximately 180 to 200 fbls.

Cycle Overview

The Cycle 1-recharge phase began on January 4, 2010 and ended on February 5, 2010. During the recharge period, an average injection rate into the ASR well of approximately 3,400 gallons per minute (gpm) was maintained. A total of 31 days of recharge took place, resulting in 155,000,000 gallons (465 acre feet) of water stored in the upper Floridan aquifer. Cycle 1-storage phase began on February 5, 2010 and ended on March 8, 2010 (a total of 31 days). Cycle 1-Recovery began on March 8, 2010 and ended on April 7, 2010 and for a total of 31 days.

HILLSBORO ASR SITE

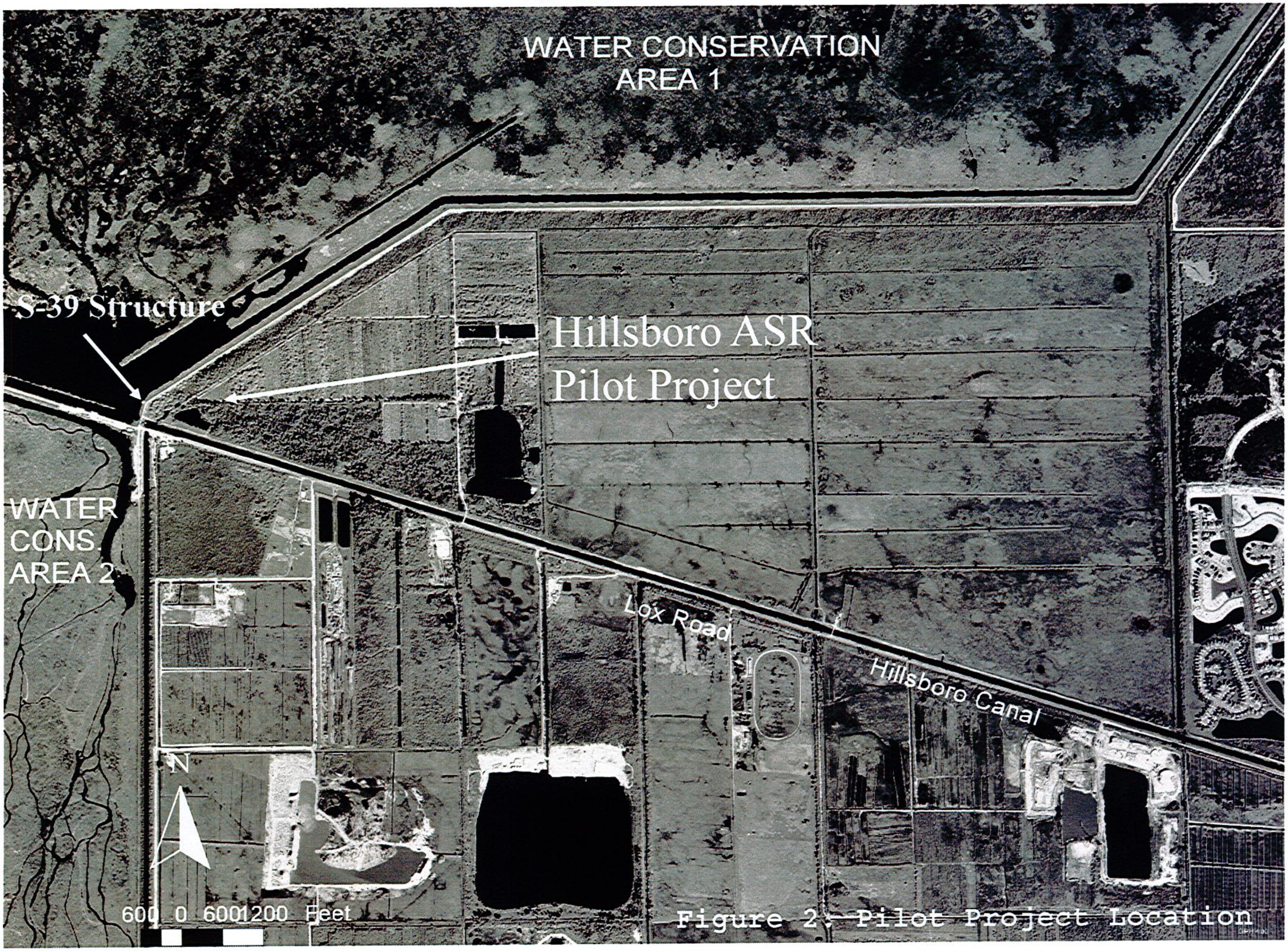

Figure 2. Vicinity Map

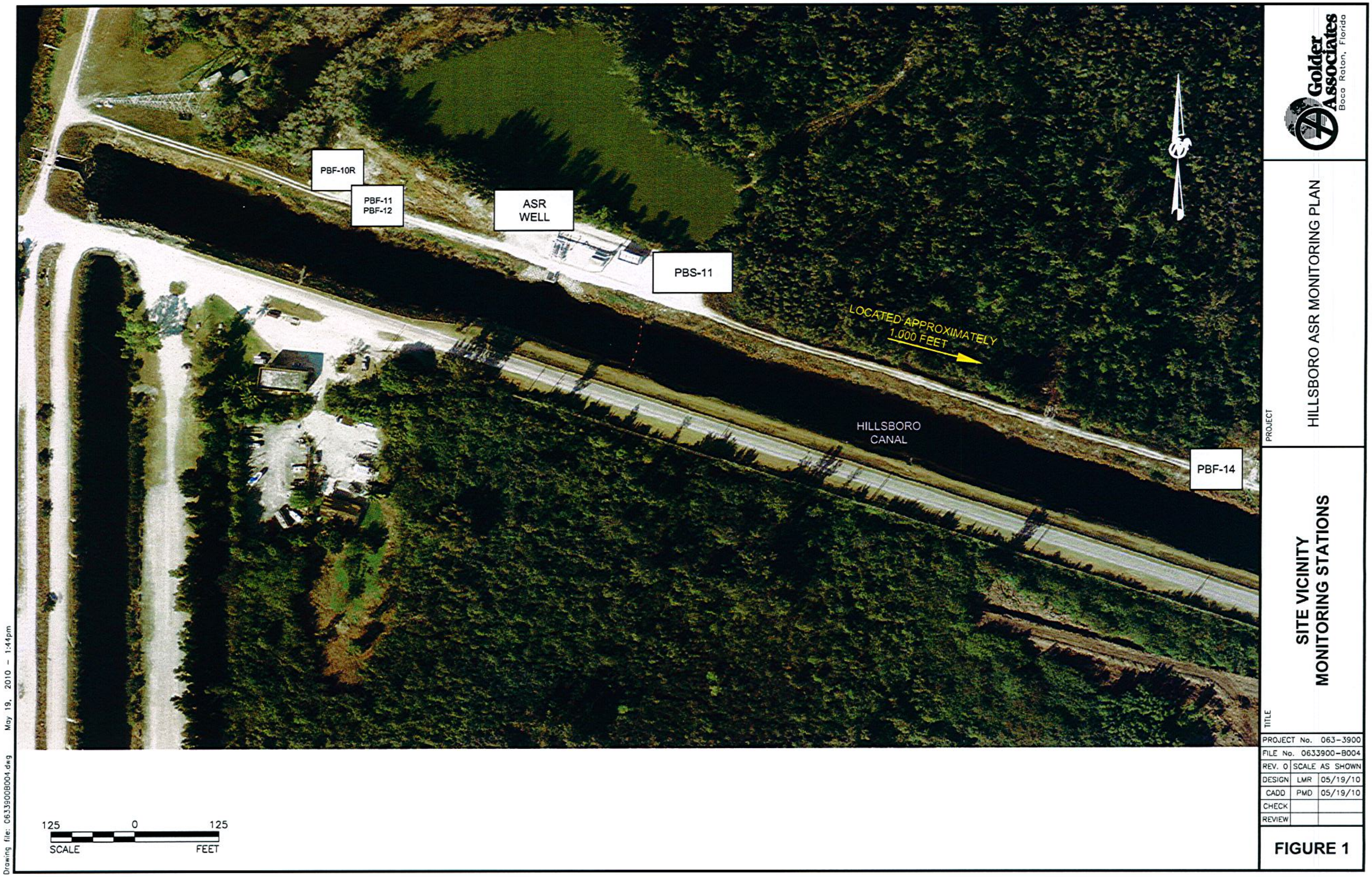

Figure 3. Monitoring Well Location Map

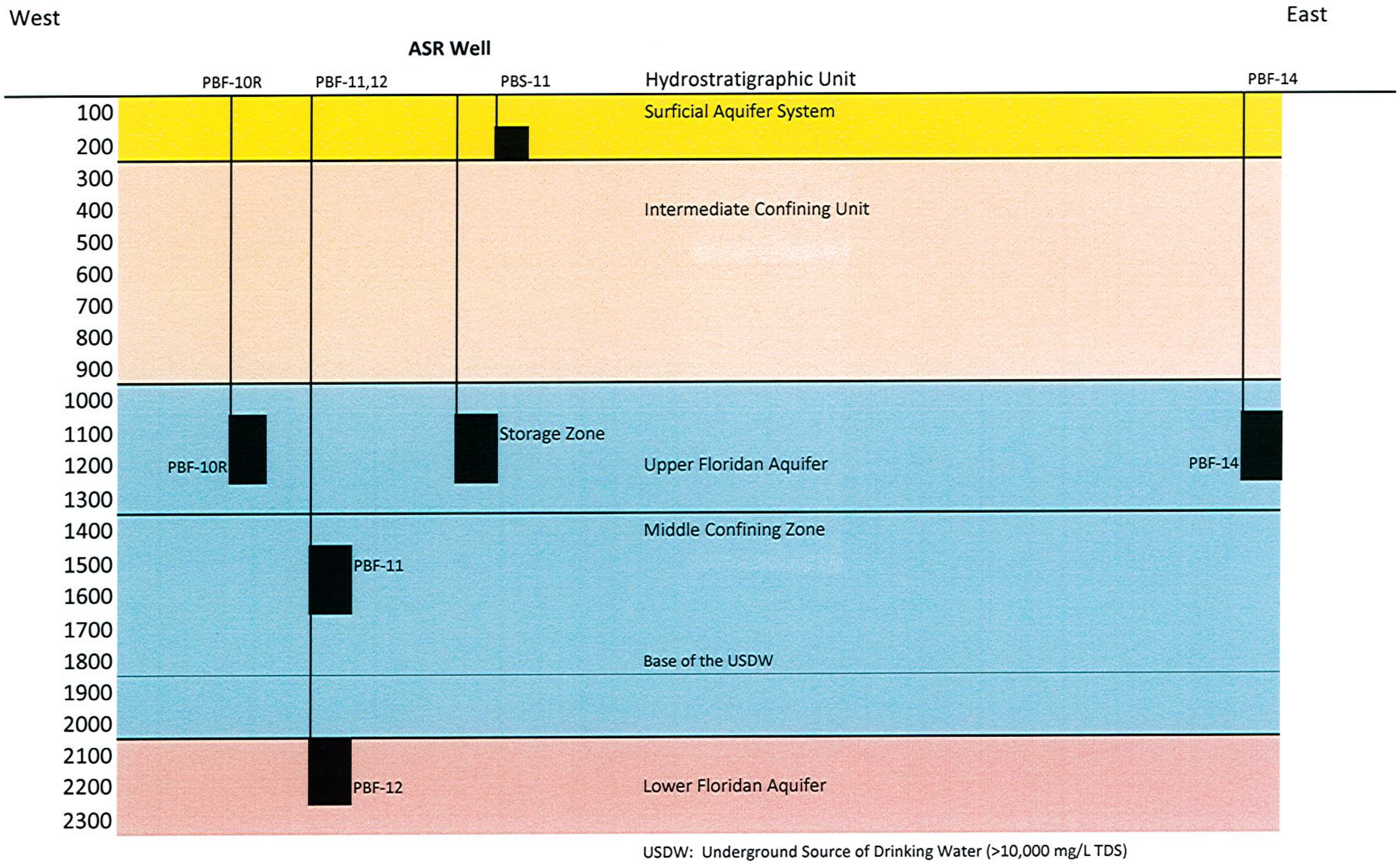

Figure 4.
Hillsboro ASR Pilot Project
Well Completion Cross Section

Water quality changes were anticipated during Cycle 1 due to mixing of fresh water from the Hillsboro Canal with the native brackish water of the Floridan Aquifer. **Table 1** provides a comparison of the source water from the canal to the native water from the Floridan Aquifer at the site. During the initial stages of recovery, the recovered water was nearly 100% source water; however, as recovery progressed, the percentage of native water increased at the expense of the source water.

Table 1. Water Quality Comparison

Parameter	Hillsboro Canal	Floridan Aquifer (ASR Well)
Total Dissolved Solids (mg/L)	370	4,064
Choride (mg/L)	70	1,800
Sodium (mg/L)	37	1,020
Sulfate (mg/L)	11	560
Specific Conductance (umhos/cm)	650	6,590
Color (units)	60	10

Operational Data

Intake/Discharge Structure and Recharge Pump

A concrete intake/discharge structure for the system is located along the bank of the Hillsboro Canal. A site schematic showing the location of the surface facilities of the system is presented on **Figure 5**. During the recharge mode, water from the canal is pumped via a recharge pump mounted on the structure, through filters and disinfection units, and into the ASR well. As the water flows from the canal and into the structure, it passes through a slotted intake screen mounted below the water surface in the canal. The canal intake screen contains an air burst system that is used to prevent clogging of the screen. During Cycle 1, the air burst system was activated periodically (at least once a week), as needed, to keep the screen slots open and free from accumulated debris.

During the recharge mode of Cycle 1, the recharge pump operated continuously, at discharge pressures ranging from 80 to 85 pounds per square inch (psi), with an average daily pressure of about 82 psi. Wellhead pressures at the same time were observed to remain within 40 to 54 psi.

During recovery, water pumped from the ASR well passes through the intake/discharge structure back into the canal, and is aerated via an eductor mounted within the structure. Dissolved oxygen readings during Cycle 1 ranged from 7.8 mg/l to 10.5 mg/l, indicating that the educator system successfully operated as designed to raise DO levels to a minimum of 5 mg/L, as required in the system NPDES permit.

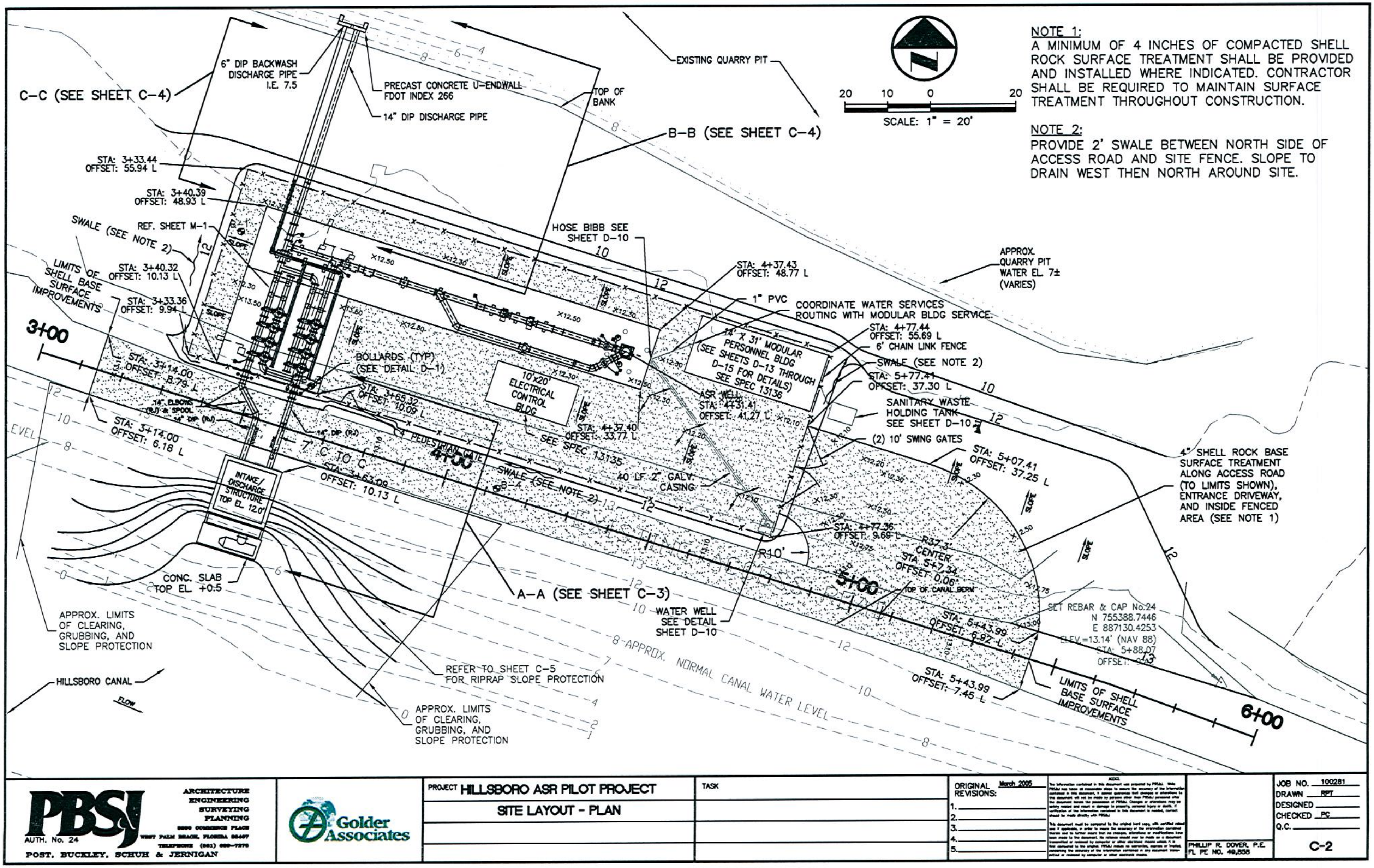

Figure 5. Site Schematic

Filtration System
The filtration system is designed to mechanically remove suspended solids before the water is disinfected and pumped into the ASR well during recharge. The system is comprised of eight self-cleaning individual filter units manufactured by Amiad Filtration Systems. The filter units work in parallel, meaning the total flow during recharge is split into eight streams as it passes through the system, before being re-combined as it exits the system.

Each filter unit uses mechanical filtration to separate the solids from the water. The filter unit media is comprised of a woven screen with a designed opening. For the Hillsboro ASR Pilot Project, a screen size of 10 microns was originally installed. However, start-up testing (before the initiation of Cycle 1) indicated that the 10-micron screen size was incompatible due to rapid and persistent clogging of the screens. As a result, the 10-micron screens were removed and replaced by 80-micron screens. The 80-micron screens were used throughout Cycle 1.

Each filter has the capability to self-clean (or backflush), which is triggered either by setting a specific time between cleanings or by a pressure differential across the filter screen. An increased pressure difference is produced when the screens begin to clog with the filtered material. When the pressure differential reaches a specified limit – the backflushing process is triggered. As designed, the filters are not backflushed simultaneously, but rather in quick succession. During Cycle 1, the filter backflush interval ranged from 26 to 65 minutes. Backwash water from the filters drains to the onsite quarry pit.

Disinfection System
The disinfection system for the Hillsboro ASR Pilot Project consists of two, in-line ultraviolet (UV) light units manufactured by Aquionics, Inc. Within each of the UV units are a series of high-intensity UV lamps. The UV units are placed in-series following the filtration units (described above) and before the water flows into the ASR well. Water is disinfected only during the recharge mode. In other words, water does not flow through the UV units during the recovery mode.

The intensity (i.e., dose) of the UV lamps can be altered, based on user settings. The intensity can be varied based on influent water quality conditions – specifically the transmissivity or clarity of the water. Using the automated mode, the lamp intensity increases when the influent water is less transmissive (cloudy) and decreases when the influent is more transmissive (clear). The other option is to manually choose either a low, medium, or high intensity setting. Cycle 1 started with the units set on the automated setting. The units were subsequently switched to the manual high intensity setting to assure that adequate disinfection occurred during the entirety of the recharge mode.

ASR Well
The Hillsboro ASR Pilot Project consists of one ASR well constructed into the upper Floridan Aquifer. The well is constructed with a 24-inch diameter carbon steel casing to 1,015 feet below land surface. Below the casing is a nominal 22-inch diameter open borehole from 1,015 to 1,225 feet below land surface.

Inside of the 24-inch diameter well casing resides the recovery pump and a pressure transducer. The recovery pump is used to withdraw water from the ASR well during the recovery mode. The recovery pump intake is located about 140 feet below land surface, within the ASR well. A pressure transducer is used to measure and record the water level, or pressure, during all phases of testing. It is set about 3 feet above the top of the recovery pump intake, to accommodate for the water-level drawdown inside the well during recovery.

During start-up testing, a banging noise emanated from inside the ASR well during recharge. The noise was the result of the recharge water flowing down the well, causing an oscillation in the recovery pump column hanging in the well. To remedy the situation, the recovery pump was pulled from the well, and a series of centralizers were installed on the pump column. This remedy solved the problem.

The ASR well is under artesian pressure. The natural (non-pumping) well pressure, measured at the surface before the start of testing is approximately 16 psi. During Cycle 1 recharge, the wellhead pressure started at 40 psi and slowly increased to 54 psi by the end of the recharge mode.

Electrical Consumption
The site's electrical consumption was monitored throughout Cycle 1. The electrical consumption is an important factor when considering the future operational costs associated with such facilities. Given the relatively large pumps and electric-intensive UV units, the electrical consumption could be significant.

During Cycle 1, the electrical consumption varied based on the operational phase. During the recharge phase, the consumption averaged about 2.1 kW per day. The consumption during the storage phase was predictably less, averaging about 0.06 kW per day. The consumption during the recovery phase averaged 1.83 kW per day.

Operational Oversight
It is important part of the pilot project to monitor the level of staffing required to keep the system operational and in compliance. The recorded manpower during Cycle 1 will be used to estimate costs for subsequent cycles and for ASR systems in the future. During Cycle 1, staffing was primarily spent on performing the required testing (recording data, sampling, system operation and maintenance).

Cycle 1 occurred over a total period of 94 days. The site was physically visited by consulting staff on 35 days of the testing. Site visits typically consisted of two people, although some visits were by one person. The transitions from one testing mode to another were generally attended by several people. The system is designed to not require daily attention. The data show that, on average, the site was visited two or three times per week. Site visits typically involve multiple tasks including data recording, sampling, and maintenance. It is expected that the required staffing will decrease slightly during subsequent cycles as the specified monitoring becomes less frequent and system operation becomes more reliable.

Hydraulic Data

ASR Well

Prior to the start of recharge, the wellhead gauge indicated 16 psi, which translates to 37 feet of "static" artesian head exhibited by the upper Floridan aquifer at this location. When recharge was initiated, the wellhead pressure increased to 40 psi, which translates to 92.4 feet of head. Subtracting the static head from the recharge (injection) head indicates that 24 psi (55 feet) of pressure built up inside the well during pumping at 3,400 gpm. This equates to a "specific injectivity" of 62 gallons per minute per foot (gpm/ft) of head buildup.

During the 31-day recharge period, the wellhead pressure increased from 40 psi to 54 psi, indicating a 16 psi (37 feet) increase – equating to decline in the specific injectivity from 62 gpm/ft to 37 gpm/ft. This increase in wellhead pressure was most likely attributed to slime buildup inside the well casing and particulate and biological plugging of the formation during recharge. During the storage mode, the ASR wellhead pressure declined to approximately 16 psi after the recharge pump was turned off and remained stable during the entire storage period.

Monitor Wells

PBF-10R –This well is completed in the same depth as the storage zone of the ASR well. Prior to the initiation of recharge, the static pressure at this wellhead was approximately 14.7 psi. During recharge, the wellhead pressure rose to approximately 22.5 psi, resulting in a difference of 7.8 psi - equivalent to 18 feet of head buildup in this well (located 330 feet from the ASR well). Upon the cessation of recharge, the wellhead pressure declined to 15 psi, as shown on **Figure 6**. During recovery, the wellhead pressure at this location declined to approximately 6.5 psi (equivalent to approximately 19 feet of drawdown at this location.

PBF-14- This well is completed at the same depth as the ASR well, but approximately 1,000 feet away from the ASR well. Prior to the initiation of recharge, the static pressure at this wellhead was approximately 13.6 psi. During recharge, the wellhead pressure rose to approximately 19.7 psi, resulting in a difference of 6.1 psi - equivalent to 14 feet of head buildup in this well. Upon the cessation of recharge, the wellhead pressure declined to 14 psi. During recovery, the wellhead pressure at this location declined to approximately 8 psi (equivalent to approximately 14 feet of drawdown at this location.

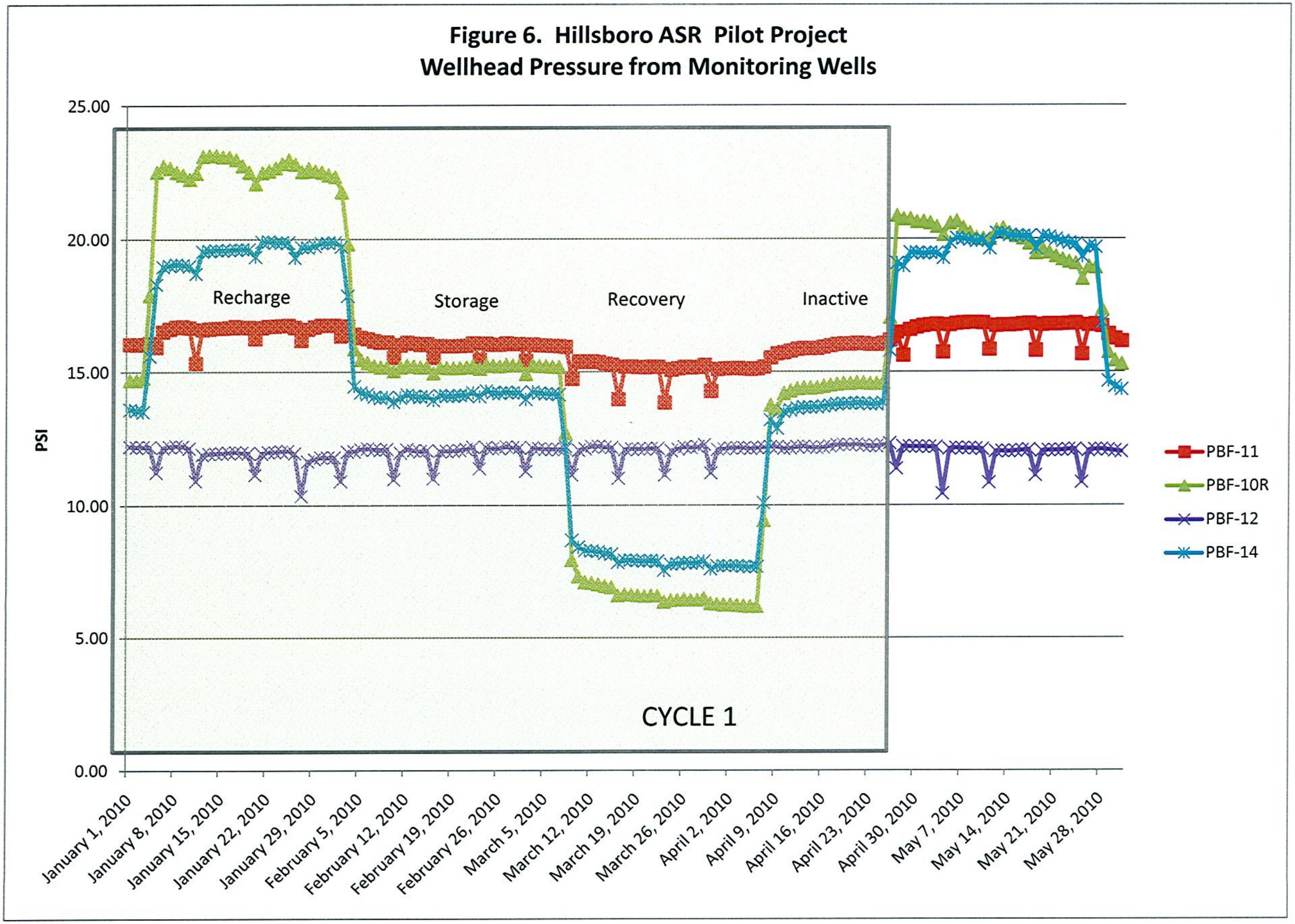
Figure 6. Hillsboro ASR Pilot Project
Wellhead Pressure from Monitoring Wells
25.00
20.00
15.00
10.00
5.00
0.00
PSI
Recharge
Storage
Recovery
Inactive
CYCLE 1
PBF-11
PBF-10R
PBF-12
PBF-14
January 1, 2010
January 8, 2010
January 15, 2010
January 22, 2010
January 29, 2010
February 5, 2010
February 12, 2010
February 19, 2010
February 26, 2010
March 5, 2010
March 12, 2010
March 19, 2010
March 26, 2010
April 2, 2010
April 9, 2010
April 16, 2010
April 23, 2010
April 30, 2010
May 7, 2010
May 14, 2010
May 21, 2010
May 28, 2010

Observations at PBF-14 are particularly important because they indicate that approximately 14 feet of head will be induced in the upper Floridan aquifer at a distance of 1,000 from ASR well, during times when the ASR wells are used for either recharge or recovery. This information should be useful when evaluating the cumulative interference effects that multiple ASR wells will have on each other at this location in the future.

PBF-11- This well is completed in an interval below the storage zone, at a distance of 330 feet from the ASR well. Prior to recharge, the wellhead pressure at this location was approximately 16 psi. During recharge, the wellhead pressure rose slightly, to approximately 17 psi, indicating a subtle head buildup in this well during recharge. After recharge was completed, the wellhead pressure declined to approximately 16 psi. Upon the initiation of recovery at the ASR well, the pressure in this well declined to approximately 15.2 psi, again indicating a subtle effect from withdrawal at the ASR. These observations are interesting in that there appears to be evidence of leakance between the storage zone (in the upper Floridan aquifer) with this zone, beneath it.

PBF-12 – This well is completed in a lower of the Floridan aquifer, below the USDW, at a location about 330 feet from the ASR well. Prior to Cycle 1, the wellhead pressure at this location was approximately 12 psi. During the entire cycle – from recharge, storage and recovery - the wellhead pressure at this location varied minimally, and did not show any direct responses to pumpage at the ASR well.

PBS-11 – This well is completed in the Surficial Aquifer System at a location about 150 feet from the ASR well. Prior to the cycle test, the water level elevation was approximately +10 feet NGVD, and during the Cycle 1 testing, it varied minimally, and did not show any direct responses to pumpage at the ASR well.

Water Quality Data

Background (Pre-Cycle) Data

Water from the ASR well, the monitor wells and the Hillsboro Canal (source water) was sampled during five (5) distinct events during 2008 as part of a background characterization of the site. Water from the Hillsboro Canal was sampled again, a few months prior to the initiation of cycle testing, during December 2009. The data are summarized in **Table 2**.

Some interesting observations of these background data include the difference in salinity between both monitoring wells completed within the ASR storage zone (PBF-10R and PBF-14). Water from PBF-14 (located about 1,000 feet from the ASR well) was considerably fresher than water collected from PBF-10R (located 330 feet from the ASR well). Water collected from PBF-14 exhibited a TDS concentration of 3,000 mg/L, whereas water from PBF-10R exhibited a TDS concentration of 4,400 mg/L. The water from PBF-10R is similar to water originally collected from the storage zone of an ASR well constructed by Palm Beach County Water Utilities Department (about 5 miles to the east) so, it appear that the salinity of this water is most regionally common in this area. One explanation for the fresher water at the location of PBF-14 is that it could be impacted by water from the Avon Park Permeable Zone, lying beneath it and containing fresher water. Perhaps leakance between the zones is higher at PBF-14 than at PBF-10R.

Water collected from well PBF-11, completed in the Avon Park Permeable Zone (APPZ) below the storage zone, exhibited lower salinity (i.e., was "fresher") than water collected from the upper Floridan aquifer storage zone. Water collected from this well exhibited a TDS concentration of 2,500 mg/L.

Water collected from well PBF-12 indicated that the monitor zone was completed below the base of the USDW, exhibiting water with a TDS concentration of 26,000 mg/L.

Table 2. Pre-cycle (2008) background water quality data.

Parameter	Monitoring Location					
	Canal	PBF-10R	PBF-11	PBF-12	PBF-14	PBS-11
Depth Interval (fbls)	Surface	1,015-1,225	1,515-1,670	2,135-2,260	1,015-1,225	180-200
Color	80					
pH		7.51	7.85	7.43	7.60	7.00
Specific Conductivity		8,700	4,400	44,000	5,400	4,746
Total dissolved solids	370	4,500	2,500	26,000	3,000	2,600
Chlorides	72	2,300	1,200	21,000	1,450	1,200
Sodium	37	1,200	na	na	800	na
Arsenic	bdl	bdl	na	na	bdl	na
Sulfate	11	840	340	1,800	400	210
Total Organic Carbon	19	8	2.4	na	2.1	na

Note: Median value reported analytical values are reported from the 5 events during 2008.
bdl signifies below method detection limits.
na signifies not analyzed.

Recharge Mode

Source Water (Hillsboro Canal)

During the Cycle #1 recharge period, water from the Hillsboro Canal was sampled weekly, as summarized on **Table 3**. The water exhibited a pH of approximately 7.8 and color of between 50 and 60 units. The water contained a chloride concentration of approximately 80 mg/L, a TDS concentration of 380 mg/L and a specific conductivity of approximately 620 umhos/cm. The arsenic concentration of the canal water averaged 1.1 ug/L. Dissolved oxygen concentrations averaged about 8.0 mg/L, and the oxidation-reduction potential (ORP) ranged widely, but averaged about +20. Measurement of dissolved oxygen and ORP of particular interest, since these constituents appear to be related to the release of arsenic at several ASR sites in south Florida.

Table 3. Chemical Characteristics at the ASR Well and Associated Monitoring Wells During Cycle 1.

Facility name: Hillsboro ASR
Permit Nº. 153872-002-UC

Operator's name: Bruce Weaver
Sampler: Bruce Weaver / Lianne Ramos

Location and total depth	Event: Phase		Date	Time	Chloride (mg/L)	TDS (mg/L)	Arsenic (µg/L)	Gross Alpha (pCi/L)	T Coliforms (CFU/100mL)	F Coliforms (CFU/100mL)	TSS (mg/L)	color (PCU)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)	ORP	Temperature
ASR Well	Recharge	B	1/4/2010	15:10	68.7	361	1.1	2.54U ± 1.12 (2.54)	U	U	5U	50	585	10.55	7.63	1.22	NC	NC
		1W	1/11/2010	11:23	102	387	1.1	1.41 ± 0.603 (0.735)	5	U	5U	60	679	8.94	8.08	1.31	NC	9.71
		2W	1/19/2010	10:27	82.4	383	1.3	2.35U ± 0.943 (2.35)	10	52***	5U	60	674	8.11	7.64	1.40	103.60	16.47
		A	1/19/2010	10:27	Under different spreadsheet								674	8.11	7.64	1.40	103.60	16.47
		3W	1/27/2010	11:52	70.3	352	1.0	1.82U ± 0.779 (1.82)	3	U	5U	50	631	6.83	7.98	1.30	-59.00	18.91
		4W/M/E	2/2/2010	14:32	82.8	379	1.8	1.62U ± 1.06 (1.62)	6	U	5U	60	678	7.83	7.64	1.62	24.70	21.83
	Storage	1W	2/10/2010															
		2W	2/16/2010															
		3W/M	2/23/2010															
		4W	3/2/2010															
	Recovery	1W	3/8/2010	14:30	81.2	343	102.0	3.05 ± 1.43 (2.00)	U	U	32.5	40	621	8.34	7.44	17.00	-77.70	21.21
		2W	3/16/2010	12:32	233.0	714	34.4	2.71± 1.74 (2.66)	U	U	5U	15	1388	8.12	7.06	0.31	-60.50	20.63
		A	3/22/2010	14:56	Under different spreadsheet								2075	7.23	7.55	0.26	-83.40	20.60
		3W	3/23/2010	13:00	456.0	1050	31.8	6.93 ±1.97 (1.64)	U	U	5U	20	2249	7.98	7.37	0.31	-119.10	20.67
		4W/M	3/30/2009	11:26	763.0	1750	15.3	8.01 ± 2.43 (2.53)	U	U	5U	10	3088	7.74	7.39	0.24	-146.30	21.03
		End	4/7/2010	9:56	NC	NC	6.7	8.41 ± 2.29 (1.82)	NC	NC	5U	NC	3988	6.76	7.50	0.22	-133.20	21.66
PBF-10R TD: 1225 ft	Recharge	B	1/5/2010	8:32	1920.0	5170	NC	NC	6	U	NC	5U	8611	1.36	7.12	7.13	NC	21.40
		1W	1/11/2010	9:12	2010.0	5470	NC	NC	1	U	NC	5U	8240	1.98	7.75	7.70	NC	21.04
		2W	1/20/2010	11:40	1880.0	4230	NC	NC	U	U	NC	5U	7661	0.68	7.80	6.39	-169.40	23.26
		3W	1/27/2010	9:25	1610.0	4260	NC	NC	U	U	NC	5U	7171	3.06	7.56	2.25	-132.30	22.73
		4W/M	2/2/2010	10:47	1850.0	4250	NC	NC	U	U	NC	5U	7269	0.17	7.65	5.41	-264.20	24.27
	Storage	1W	2/10/2010	9:34	1800.0	3320	0.53 I	9.94U ± 5.81 (9.94)	U	U	NC	5U	6525	0.55	7.50	1.25	-242.20	22.82
		2W	2/16/2010	9:28	1850.0	3270	0.90 I	7.74U ± 3.89 (7.74)	U	U	NC	5U	6178	1.13	7.64	0.26	-249.50	23.13
		3W/M	2/23/2010	9:36	1630.0	3350	0.86 I	2.24U ± 1.46 (2.24)	U	U	NC	5U	5878	0.95	7.50	0.15	-228.00	23.24
		4W	3/2/2010	9:23	1470.0	2910	0.85 I	8.32U ± 5.08 (8.32)	U	U	NC	5U	5908	0.95	7.51	0.45	-235.90	23.41
	Recovery	1W	3/9/2010	8:53	1600.0	2940	0.61 I	3.94 ± 1.55 (1.88)	U	U	NC	5U	6015	0.23	7.46	0.91	-265.10	23.21
		2W	3/16/2010	9:34	1950.0	3430	0.82 I	2.02 ± 0.925 (1.23)	U	U	NC	5U	7244	0.38	7.57	0.17	-260.10	23.25
		3W	3/23/2010	10:01	2050.0	4490	0.98 I	2.92 ± 1.68 (2.49)	U	U	NC	30	7777	0.16	7.64	0.16	-252.20	23.41
		4W/M	3/30/2010	9:08	2170.0	5400	0.52 I	6.47 ± 1.91 (1.79)	U	U	NC	5U	7948	0.38	7.66	0.11	-267.80	22.78
		End	4/7/2010	NC														
PBF-11 TD: 1677 ft	Recharge	B	1/5/2010	9:10	998.0	2350	0.97 I	2.96 ± 1.19 (1.41)	U	U	NC	5U	4293	0.83	8.47	0.30	NC	21.92
		1W	1/11/2010	11:44	1030.0	2480	0.5U	18.3 ± 4.14 (2.39)	U	U	NC	5U	4428	1.00	7.98	0.06	NC	21.62
		2W	1/20/2010	11:59	1160.0	2440	0.60 I	5.27 ± 1.85 (1.45)	U	U	NC	10U	4490	0.72	8.43	0.43	-158.60	23.21
		3W	1/27/2010	10:00	1020.0	2570	1.2	6.48 ± 4.04 (6.48)	U	U	NC	5U	4685	1.18	8.38	0.29	-159.30	22.84
		4W/M	2/2/2010	10:39	970.0	2540	1.1	6.16 ± 2.10 (2.53)	U	U	NC	10	4560	0.21	8.07	0.21	-248.60	23.87
	Storage	1W	2/10/2010	10:12	1150.0	2360	NC	NC	U	U	NC	5U	4527	0.40	8.14	0.28	-262.00	23.52
		2W	2/16/2010	11:18	1030.0	2510	NC	NC	U	U	NC	5U	4573	0.71	8.18	1.08	-267.60	23.02
		3W/M	2/23/2010	10:53	1160.0	2510	0.86 I	3.56 ± 1.57 (2.11)	U	U	NC	10	4535	0.45	7.85	0.30	-285.40	23.44
		4W	3/2/2010	10:21	973.0	2420	NC	NC	U	NA	NC	15	4510	0.27	7.92	0.39	-261.70	23.10
	Recovery	1W	3/9/2010	10:22	881.0	2290	0.55 I	6.97 ± 1.99 (1.77)	U	U	NC	35	4469	0.28	7.95	0.04	-293.30	22.97
		2W	3/16/2010	10:42	1190.0	2350	0.80 I	5.47 ± 1.48 (1.33)	U	U	NC	15	4465	0.36	7.90	0.16	-281.90	22.73
		3W	3/23/2010	11:11	1010.0	2180	1.0	7.79 ± 2.08 (1.61)	U	U	NC	5U	4410	0.27	7.86	0.39	-292.10	22.86
		4W/M	3/30/2010	9:44	1010.0	2420	0.53I	7.84 ± 2.11 (1.67)	U	U	NC	5U	4322	0.16	7.95	0.20	-282.60	22.48
		End	4/7/2010	NC														
	Recharge	B	1/5/2010	9:41	17800.0	28900	6.7 I	15.3 ± 3.46 (1.89)	U	U	NC	5U	45138	0.65	7.44	0.43	NC	20.96
		1W	1/11/2010	10:43	16600.0	25400	5.6 I	7.16 ± 2.11 (2.02)	U	U	NC	5U	44222	1.46	7.52	0.84	NC	19.95
		2W	1/20/2010	12:06	16500.0	29400	2.7	57.9 ± 12.4 (2.97)	U	U	NC	5U	45986	0.51	7.49	0.21	-129.70	22.79

Table 3.
Chemical Characteristics at the ASR Well and Monitoring Wells

PBF-12 TD: 2260 ft		3W	1/27/2010	10:26	16500.0	31400	4.61 I	134U ± 77.8 (134)	U	U	NC	5U	46583	0.70	7.53	0.11	-121.30	23.13
		4W/M	2/2/2010	11:19	16300.0	29100	4.3J	26.9 ± 5.58 (2.30)	U	U	NC	5U	45486	0.18	7.28	0.47	-237.00	23.33
	Storage	1W	2/10/2010	10:39	19500.0	27200	NC	NC	U	U	NC	5U	44860	0.27	7.35	0.27	-214.40	22.10
		2W	2/16/2010	9:54	16100.0	28900	NC	NC	U	U	NC	5U	45240	0.62	7.30	0.18	-207.20	22.17
		3W/M	2/23/2010	10:00	16400.0	26500	4.9 I	1.84 ± 0.400 (0.194)	U	U	NC	5U	44610	0.56	7.21	0.16	-192.10	22.89
		4W	3/2/2010	9:49	16800.0	24500	NC	NC	U	U	NC	5U	44505	0.55	7.22	0.16	-204.30	22.22
	Recovery	1W	3/9/2010	9:37	18500.0	25200	2.9 I	16.1 ± 3.61 (1.83)	U	U	NC	5U	44271	0.27	7.36	0.18	-212.30	22.86
		2W	3/16/2010	10:06	17600.0	24000	1.7	9.18 ± 3.00 (3.63)	U	U	NC	5U	45479	0.38	7.34	0.52	-206.30	22.24
		3W	3/23/2010	10:18	18500.0	23900	4.8 I	14.4 ± 3.41 (2.39)	U	U	NC	5U	45672	0.16	7.33	0.12	-205.80	22.21
		4W/M	3/30/2010	9:30	17700.0	29000	0.63 I	24.9 ± 5.27 (2.20)	U	U	NC	5	45031	0.25	7.30	0.21	-219.30	22.12
		End	4/7/2010	NC														
PBF-14 TD: 1225 ft	Recharge	B	1/5/2010	11:13	1490.0	3380	NC	NC	U	U	NC	5U	6024	1.03	7.63	11.90	NC	22.24
		1W	1/11/2010	15:34	1560.0	3150	NC	NC	U	U	NC	5U	6197	0.57	7.83	16.20	NC	21.29
		2W	1/20/2010	10:11	1330.0	2840	NC	NC	U	U	NC	5U	5000	1.00	7.83	19.90	-178.40	23.05
		3W	1/26/2010	10:17	1070.0	2860	NC	NC	U	U	NC	5U	5122	2.24	7.80	8.26	-145.70	22.35
		4W/M	2/2/2010	13:27	1040.0	2320	NC	NC	U	U	NC	5U	4317	0.30	7.60	14.30	-268.40	24.47
	Storage	1W	2/10/2010	12:41	966.0	2140	0.66 I	5.71U ± 3.12 (5.71)	U	U	NC	5U	3648	0.57	7.61	2.24	-208.60	23.15
		2W	2/16/2010	12:03	837.0	1860	1.1	4.70U ± 2.94 (4.70)	U	U	NC	5U	3243	0.33	7.65	1.32	-230.70	23.12
		3W/M	2/23/2010	12:51	691.0	1790	1.0	3.46 ± 1.40 (1.74)	U	U	NC	5U	3015	0.32	7.56	1.86	-185.10	24.71
		4W	3/2/2010	14:14	681.0	1590	1.0	5.06U ± 3.12 (5.06)	U	U	NC	5U	2981	0.40	7.52	1.38	-218.10	23.81
	Recovery	1W	3/9/2010	12:17	713.0	1630	0.75 I	4.07 ± 1.30 (1.38)	U	U	NC	5U	3045	0.21	7.64	0.81	-220.90	23.42
		2W	3/16/2010	14:03	865.0	2040	1.2	3.49 ± 1.19 (1.33)	U	U	NC	5U	4125	0.27	7.56	0.38	-229.30	23.52
		3W	3/23/2010	14:21	1040.0	2200	1.3	5.25 ± 1.88 (2.16)	U	U	NC	5U	4626	0.16	7.57	0.38	-240.00	23.88
		4W/M	3/30/2010	13:06	23.7*	2810	0.52 I	6.40 ± 1.85 (1.70)	U	U	NC	5U	4859	0.26	7.58	0.19	-233.60	24.04
		End	4/7/2010	NC														
PBS-11 TD: 206 ft	Recharge	B	1/5/2010	10:30	1170.0	2660	NC	NC	U	U	NC	10	4640	1.40	6.95	8.44	NC	22.44
		1W	1/11/2010	13:10	1000.0	2590	NC	NC	U	U	NC	5	4604	0.83	7.18	10.80	NC	22.22
		2W	1/20/2010	9:16	1060.0	2630	NC	NC	U	U	NC	15	4651	3.10	6.91	0.23	-126.00	22.70
		3W	1/26/2010	11:31	1070.0	2540	NC	NC	U	U	NC	15	4767	2.09	7.21	0.39	-143.30	23.40
		4W/M	2/2/2010	12:19	1020.0	2330	1.4	NC	U	U	NC	15	4681	0.66	7.09	0.43	-259.90	24.49
	Storage	1W	2/10/2010	11:40	1060.0	2560	NC	NC	U	U	NC	15	4602	3.44	7.07	0.18	-234.80	23.38
		2W	2/16/2010	11:18	971.0	2530	NC	NC	U	U	NC	15	4550	1.88	7.08	0.38	-245.60	24.08
		3W/M	2/23/2010	12:13	1090.0	2620	1.4	3.56 ± 1.57 (2.11)	U	U	NC	20	4607	2.12	6.97	0.26	-219.70	24.64
		4W	3/2/2010	11:00	1010.0	2560	NC	NC	U	NA	NC	20	4582	1.79	7.05	0.22	-243.70	23.61
	Recovery	1W	3/9/2010	11:33	1040.0	2390	0.82 I	3.80 ± 1.49 (1.83)	U	U	NC	5U	4541	1.71	7.47	0.66	-239.30	23.80
		2W	3/16/2010	11:48	1020.0	2290	1.3	3.62 ± 1.43 (1.85)	U	U	NC	10	4615	1.19	6.99	0.50	-237.60	24.17
		3W	3/23/2010	12:24	1020.0	2380	1.4	8.10 ±4.64 (6.63)	U	U	NC	20	4659	0.52	6.96	0.39	-214.20	24.05
		4W/M	3/30/2010	10:56	1020.0	2600	0.50U	6.60 ± 1.84 (1.30)	U	U	NC	10	4601	0.65	6.95	0.37	-238.00	23.93
		End	4/7/2010	NC														

Table 1. Chemical Characteristics at ASR Well and Monitoring Wells During Cycle 1.

Notes:
U: Below Detection Limit
NC: not collected
NA: not analyzed
*: Requested Lab review
***: There was non-coliform interference in the samples which biased the Total Coliform value. The results reported were confirmed for values reported.

Frequency:
B : Baseline
W: Weekly
M: Monthly
End: Within 24 hours of shutting the system

Checked ______
Reviewed ______
Date 03/31/2010

Table 3 (cont.)

On January 19, 2010, a source water sample was collected and analyzed for all primary, secondary and minimum criteria drinking water standards,in fulfillment of permit requirements for the system. The results from this sampling event are presented on **Table 4**.

Monitor Wells

PBF-10R – During the recharge period, the TDS concentration of water collected from this well slowly declined from 5,170 to 4,250 mg/l – a decline of about 20% from the initial concentration. This indicated that there was some passage of canal water into this well, but that complete flushing of the aquifer in this area did not occur. The color of water recorded from this well always remained below detection limits, further supporting this observation. The ORP remained strongly negative, around -150.

PBF-14 - TDS concentration of water collected from this well slowly declined from 3,380 to 2,320 mg/l – a decline of about 30% from the initial recorded concentration. Conductivity declined from 6,024 to 4,317 umhos/cm - a decrease of about 30% from the initial readings. This indicated that there was a higher passage of canal water into this well when compared to PBF-10R, but complete flushing of the aquifer in this area did not occur. The color of water recorded from this well remained below detection limits again supporting that complete flushing of the groundwater at this location did not occur. The ORP remained negative, below -146.

PBF-11 - During the recharge period, the TDS concentration slowly increased from 2,350 to 2,540 mg/l – an increase of about 8% from the initial recorded concentration. Conductivity also indicated an increase when compared to initial readings, from 4,293 to 4,560 umhos/cm, an increase of about 6%. These values are within the range observed during the background monitoring phase and therefore, the changes are not considered significant. ORP remained consistently negative, below -160.

PBF-12 - During the recharge period, the TDS concentration and conductivity indicated no significant change from the initial recorded concentration at this well. This indicates that the well was not impacted by the injection of source water into the aquifer during recharge. The color of water recorded from this well remained below detection limits. The ORP remained negative, below -122.

PBS-11 – This well is completed near the base of the Surficial aquifer, which contains relatively saline water at this location. TDS concentration, during the recharge period, slowly declined from 2,660 to 2,330 mg/l – a decline 12.4% from the initial recorded concentration. Chlorides concentration also indicated a decline of 12.8%, from 1,170 to 1,020 mg/L. Conductivity readings, however, indicated no significant change from initial readings. Color of water recorded from this well slightly increased from 10 to 15 PCU. The ORP remained negative, around -150.

Table 4. Annual Source Water Characterization During Recharge Phase - Cycle 1

Permit # 153872-002-UC to operationally (cycle) test Hillsboro Aquifer Storage and Recovery (ASR) Project (HASR-ASR-1)

Facility name: Hillsboro ASR — Operator's name: Bruce Weaver
Permit Nº. 153872-002-UC — Sampler: Bruce Weaver / Lianne Ramos — Phase: Recovery

Sample ID	Method	Matrix	Parameter	Results	Units	PQL
HASR-W-RG-113W/11A	EPA 1631E	Water	Mercury	0.684	ng/L	0.50
HASR-W-RG-113W/11A	EPA 200.7	Water	Boron	66.8	ug/L	50.0
HASR-W-RG-113W/11A	EPA 200.7	Water	Calcium	67.2	mg/L	500
HASR-W-RG-113W/11A	EPA 200.7	Water	Iron	20.0U	ug/L	40.0
HASR-W-RG-113W/11A	EPA 200.7	Water	Lithium	25.0U	ug/L	50.0
HASR-W-RG-113W/11A	EPA 200.7	Water	Magnesium	12400	ug/L	500
HASR-W-RG-113W/11A	EPA 200.7	Water	Potassium	5440	ug/L	1000
HASR-W-RG-113W/11A	EPA 200.7	Water	Sodium	55.1	mg/L	1000
HASR-W-RG-113W/11A	EPA 200.7	Water	Strontium	1260	ug/L	10.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Aluminum	5.3U	ug/L	10.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Antimony	0.50U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Arsenic	1.3	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Barium	21.5	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Beryllium	0.050U	ug/L	0.10
HASR-W-RG-113W/11A	EPA 200.8	Water	Cadmium	0.050U	ug/L	0.10
HASR-W-RG-113W/11A	EPA 200.8	Water	Chromium	0.50U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Cobalt	0.50U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Copper	0.93U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Lead	0.50U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Manganese	3.5	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Molybdenum	0.85 I	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Nickel	0.68 I	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Selenium	0.50U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Silver	0.050U	ug/L	0.10
HASR-W-RG-113W/11A	EPA 200.8	Water	Thallium	0.50U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 200.8	Water	Zinc	2.5U	ug/L	5.0
HASR-W-RG-113W/11A	EPA 300.0	Water	Bromide	0.34	mg/L	0.10
HASR-W-RG-113W/11A	EPA 300.0	Water	Chloride	82.4	mg/L	5.0
HASR-W-RG-113W/11A	EPA 300.0	Water	Fluoride	0.36	mg/L	0.050
HASR-W-RG-113W/11A	EPA 300.0	Water	Nitrate as N	0.25	mg/L	0.050
HASR-W-RG-113W/11A	EPA 300.0	Water	Nitrite as N	0.025U	mg/L	0.050
HASR-W-RG-113W/11A	EPA 300.0	Water	Nitrogen, NO2 plus NO3	0.25	mg/L	0.050
HASR-W-RG-113W/11A	EPA 300.0	Water	Orthophosphate as P	0.25	mg/L	0.10
HASR-W-RG-113W/11A	EPA 300.0	Water	Sulfate	15.4	mg/L	5.0
HASR-W-RG-113W/11A	EPA 335.4	Water	Cyanide	0.0050U	mg/L	0.010
HASR-W-RG-113W/11A	EPA 350.1	Water	Nitrogen, Ammonia	0.44	mg/L	0.050
HASR-W-RG-113W/11A	EPA 351.2	Water	Nitrogen, Kjeldahl, Total	1.6	mg/L	0.50
HASR-W-RG-113W/11A	EPA 365.1	Water	Orthophosphate as P	0.0043	mg/L	0.0040
HASR-W-RG-113W/11A	EPA 365.3	Water	Phosphorus, Total (as P) LL	0.017	mg/L	0.0040
HASR-W-RG-113W/11A	EPA 504.1	Water	1,2-Dibromo-3-chloropropane	0.0050U	ug/L	0.021
HASR-W-RG-113W/11A	EPA 504.1	Water	1,2-Dibromoethane (EDB)	0.0064U	ug/L	0.010
HASR-W-RG-113W/11A	EPA 508.1	Water	Alachlor	0.032U	ug/L	0.19
HASR-W-RG-113W/11A	EPA 508.1	Water	Atrazine	0.020U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	Chlordane (Technical)	0.044U	ug/L	0.19
HASR-W-RG-113W/11A	EPA 508.1	Water	Endrin	0.0019U	ug/L	0.0094
HASR-W-RG-113W/11A	EPA 508.1	Water	Heptachlor	0.0057U	ug/L	0.038
HASR-W-RG-113W/11A	EPA 508.1	Water	Heptachlor epoxide	0.0028U	ug/L	0.019
HASR-W-RG-113W/11A	EPA 508.1	Water	Hexachlorobenzene	0.010U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	Hexachlorocyclopentadiene	0.011U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	Methoxychlor	0.013U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB, Total	0.094U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1016 (Aroclor 1016)	0.082U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1221 (Aroclor 1221)	0.027U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1232 (Aroclor 1232)	0.027U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1242 (Aroclor 1242)	0.048U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1248 (Aroclor 1248)	0.059U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1254 (Aroclor 1254)	0.022U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	PCB-1260 (Aroclor 1260)	0.062U	ug/L	0.094
HASR-W-RG-113W/11A	EPA 508.1	Water	Simazine	0.042U	ug/L	0.066
HASR-W-RG-113W/11A	EPA 508.1	Water	Toxaphene	0.57U	ug/L	0.94
HASR-W-RG-113W/11A	EPA 508.1	Water	gamma-BHC (Lindane)	0.0028U	ug/L	0.019
HASR-W-RG-113W/11A	EPA 515.3	Water	2,4,5-TP (Silvex)	0.035U	ug/L	0.20
HASR-W-RG-113W/11A	EPA 515.3	Water	2,4-D	0.017U	ug/L	0.10
HASR-W-RG-113W/11A	EPA 515.3	Water	Dalapon	0.38U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 515.3	Water	Dicamba	0.072U	ug/L	0.10
HASR-W-RG-113W/11A	EPA 515.3	Water	Dinoseb	0.050U	ug/L	0.20
HASR-W-RG-113W/11A	EPA 515.3	Water	Pentachlorophenol	0.0090U	ug/L	0.040
HASR-W-RG-113W/11A	EPA 515.3	Water	Picloram	0.050U	ug/L	0.10
HASR-W-RG-113W/11A	EPA 524.2	Water	1,1,1-Trichloroethane	0.25U	ug/L	0.50

Table 4.
Annual Source Water Characterization
During Recharge – Cycle 1.

Table 4. Annual Source Water Characterization During Recharge Phase - Cycle 1

HASR-W-RG-113W/11A	EPA 524.2	Water	1,1,2-Trichloroethane	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,1-Dichloroethene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,2,4-Trichlorobenzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,2-Dichlorobenzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,2-Dichloroethane	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,2-Dichloropropane	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,3-Dichlorobenzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	1,4-Dichlorobenzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Benzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Bromodichloromethane	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Bromoform	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Carbon tetrachloride	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Chlorobenzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Chloroform	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Dibromochloromethane	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Ethylbenzene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Methylene Chloride	0.44U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Styrene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Tetrachloroethene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Toluene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Total Trihalomethanes (Calc.)	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Trichloroethene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Vinyl chloride	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	Xylene (Total)	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	cis-1,2-Dichloroethene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 524.2	Water	trans-1,2-Dichloroethene	0.25U	ug/L	0.50
HASR-W-RG-113W/11A	EPA 525	Water	Benzo(a)pyrene	0.018U	ug/L	0.096
HASR-W-RG-113W/11A	EPA 525	Water	bis(2-Ethylhexyl)adipate	0.37U	ug/L	1.5
HASR-W-RG-113W/11A	EPA 525	Water	bis(2-Ethylhexyl)phthalate	0.48U	ug/L	1.9
HASR-W-RG-113W/11A	EPA 531.1	Water	Aldicarb	0.64U	ug/L	2.0
HASR-W-RG-113W/11A	EPA 531.1	Water	Aldicarb sulfone	0.35U	ug/L	2.0
HASR-W-RG-113W/11A	EPA 531.1	Water	Aldicarb sulfoxide	0.30U	ug/L	2.0
HASR-W-RG-113W/11A	EPA 531.1	Water	Carbofuran	0.32U	ug/L	2.0
HASR-W-RG-113W/11A	EPA 531.1	Water	Oxamyl	0.41U	ug/L	2.0
HASR-W-RG-113W/11A	EPA 547	Water	Glyphosate	0.86U	ug/L	6.0
HASR-W-RG-113W/11A	EPA 548	Water	Endothall	2.9U	ug/L	9.0
HASR-W-RG-113W/11A	EPA 552.2	Water	Dibromoacetic Acid	0.61U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 552.2	Water	Dichloroacetic Acid	0.61U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 552.2	Water	Haloacetic Acids (Total)	0.61U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 552.2	Water	Monobromoacetic Acid	0.61U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 552.2	Water	Monochloroacetic Acid	0.61U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 552.2	Water	Trichloroacetic Acid	0.61U	ug/L	1.0
HASR-W-RG-113W/11A	EPA 900.0m	Water	Gross Alpha	2.35U ± 0.943 (2.35)	pCi/L	
HASR-W-RG-113W/11A	EPA 903.1	Water	Radium-226	0.729U ± 0.484 (0.729)	pCi/L	
HASR-W-RG-113W/11A	EPA 904.0	Water	Radium-228	0.778U ± 0.372 (0.778)	pCi/L	
HASR-W-RG-113W/11A	EPA 908.0	Water	Total Uranium	0.778U ± 0.424 (0.778)	pCi/L	
HASR-W-RG-113W/11A	SM 2120B	Water	Apparent Color	60.0	units	5.0
HASR-W-RG-113W/11A	SM 2150B	Water	Temperature, Water (C)	40.2	deg C	
HASR-W-RG-113W/11A	SM 2150B	Water	Threshold Odor Number	1.0U	TON	1.0
HASR-W-RG-113W/11A	SM 2320B	Water	Alkalinity, Carbonate (CaCO3)	5.0U	mg/L	5.0
HASR-W-RG-113W/11A	SM 2320B	Water	Alkalinity, Hydroxide (CaCO3)	5.0U	mg/L	5.0
HASR-W-RG-113W/11A	SM 2320B	Water	Alkalinity, Total as CaCO3	189	mg/L	5.0
HASR-W-RG-113W/11A	SM 2320B	Water	Alkalinity,Bicarbonate (CaCO3)	189	mg/L	5.0
HASR-W-RG-113W/11A	SM 2540C	Water	Total Dissolved Solids	383	mg/L	5.0
HASR-W-RG-113W/11A	SM 2540D	Water	Total Suspended Solids	5.0U	mg/L	5.0
HASR-W-RG-113W/11A	SM 4500-H+B	Water	Temperature, Water (C)	18.4	deg C	0.010
HASR-W-RG-113W/11A	SM 4500-H+B	Water	pH at 25 Degrees C	7.8	Std. Units	0.10
HASR-W-RG-113W/11A	SM 4500-S2E	Water	Sulfide	1.0U	mg/L	1.0
HASR-W-RG-113W/11A	SM 4500-S2F	Water	Un-ionized Hydrogen Sulfide	1.0U	mg/L	1.0
HASR-W-RG-113W/11A	SM 4500-SiO2-	Water	Silica, Dissolved	11.1	mg/L	1.0
HASR-W-RG-113W/11A	SM 5310B	Water	Total Organic Carbon	22.0	mg/L	1.0
HASR-W-RG-113W/11A	SM 5540C	Water	Surfactants	0.12 I	mg/L	0.40

HASR-W-RG-113/11A: ASR Well, Cycle 1, Recharge Phase, 3rd weekly event and Annual Event

Table 3. Primary, Secondary and Minimum Criteria during Annual Event at the ASR Well.

Checked ______
Reviewed ______
Date 05/26/2010

Table 4 (cont.)

Storage Mode

Monitor Wells

PBF-10R – During the storage period, the TDS concentration of water collected from this well slowly declined from 3,320 to 2,910 mg/l – a decline of about 12.4% from the initial recorded concentration. Conductivity declined from 6,525 to 5,908 umhos/cm, a decrease of about 9% from the initial readings. This indicated that there was continued redistribution and dispersion of the canal water around this well due to density-driven flow. The color of water recorded from this well remained below detection limits. The ORP remained strongly negative, below -228. The arsenic concentration at this well remained below 1 part per billion (ppb) during the storage mode.

PBF-14 – The TDS concentration, during the storage period, continued to decline from 2,140 to 1,590 mg/l – a decline of about 25% from the initial recorded concentration. Conductivity declined from 3,648 to 2,981 umhos/cm, a decrease of about 20% from the initial readings. This indicated continued redistribution of the water around this well due to density-driven flow and dispersion. The color of water recorded from this well remained below detection limits. The ORP remained strongly negative, below -185. The arsenic concentration at this well remained below 2 ppb during storage.

PBF-11 - During the storage period, the TDS concentration and conductivity indicated no significant change from the initial recorded concentration; these results indicate that the well was not impacted during the storage period. The color of water recorded from this well increased from below detection limit to 15 PCU at the final weekly event. The ORP remained strongly negative, below -262. The arsenic concentration at this well remained below 1 ppb during storage.

PBF-12 - During the storage period, the TDS concentration decreased from 27,200 to 24,500 mg/l – a decline of approximately 10%. Chlorides also declined from 19,500 to 16,800 mg/L, a decline of 14% from initial recorded concentration. However, conductivity indicated no significant change from the initial concentration. The color of water from this well remained below detection limits. The ORP remained strongly negative, below -192. The arsenic concentration at this well remained below 5 ppb during storage.

PBS-11 - During the storage period, the TDS concentration and conductivity readings indicated no significant change when compared to initial recordings. Color of water recorded from this well indicated slight increase from 15 to 20 PCU. The ORP remained strongly negative, below -220.

Recovery Mode

First Flush Characterization

During the initiation of recovery, the water produced from the ASR well is typically turbid, as a result of the change in flow direction within the well casing and the aquifer and the open wellbore. Upon the initiation of recovery, a sample of this "first flush" water was collected and analyzed for a variety of metals and basic constituents, as presented on **Table 5**. The sample was collected on March 8, 2010. The first flush water was routed to a nearby quarry pit, where it was contained and kept separate from the Hillsboro Canal, in the event that the water did not meet Class III surface water quality standards. As presented on the table, most of the constituents were less than the applicable Class III surface water concentrations, with the exception of arsenic, beryllium, copper, iron and silver. The concentration of arsenic in the first flush sample yielded a concentration of 111 ppb. The water sample was not filtered, so these elevated concentrations could be reflective of suspended solids within the turbid water. After about 2 hours of recovery, the turbidity of the water declined substantially, and the recovered water was subsequently routed to the Hillsboro Canal via the intake/discharge structure.

ASR Recovered Water

Cycle 1 recovery began on March 8, 2010 and ended on April 7, 2010 and lasted for total of 31 days. During the recovery period, water produced from the ASR well was sampled weekly, as summarized on **Table 3**. A water sample was also collected on March 22 and analyzed for all primary, secondary and minimum criteria drinking water standards, as shown on **Table 6**. During the recovery period, the TDS concentration increased from 343 to 1,750 mg/L. Conductivity also indicated a corresponding increase from 621 to 3,988 umhos/cm.

The applicable standard that will be used for future limitation of recovery will be a conductivity of 1,275 umhos/cm, which was reached after about 8 days of recovery. If that standard were to be applied during this cycle, the calculated "recovery efficiency" of the system would have been approximately 20 percent.

The concentration of arsenic in the recovered water decreased substantially from 102 to 6.7µg/L over the duration of the 31-day recovery period. The ORP decreased from -77.70 to -133.20, becoming strongly negative by the end of this phase. There were no fecal or total coliform bacteria detected in any of the recovered water samples. The sulfate concentration in the water increased from 25.7 mg/L to 217 mg/L over the duration of the recovery period. The color of the water declined from 40 units to 10 units over the duration of the recovery period.

Monitor Wells

PBF-10R – During the recovery period, the TDS concentration of water collected from this well increased from 2,940 to 5,400 mg/l. The final TDS concentration was nearly identical to the TDS concentration recorded from this well prior to the initiation of cycle testing. This infers that the stored water was completely removed at this location during recovery. Conductivity also increased from 6,015 to 7,948 umhos/cm, an increase of about 32% from the initial readings. With the exception of one sampling event, the color of water recorded from this well always remained below detection limits. The ORP always remained strongly negative, below -252. The arsenic concentration at this well remained less than 1 ppb during the total duration of recovery.

Table 5 - Recovered Water Characterization During First Flush - Cycle 1
Permit # 153872-002-UC to operationally (cycle) test Hillsboro Aquifer Storage and Recovery (ASR) Project (HASR-ASR-1)

Facility name: Hillsboro ASR
Date: 03/08/2010 | Operator's name: Bruce Weaver | Cycle 1
Permit N°. 153872-002-UC | Sampler: Bruce Weaver / Lianne Ramos | Phase: Recovery

Sample ID	Method	Matrix	Parameter	Results	Units	PQL	Class III Surface Water Standards *
HASR-W-UVF-13FF	EPA 1631E	Water	Mercury	0.0106	ug/L	0.00050	0.012 ug/L
HASR-W-UVF-13FF	EPA 200.7	Water	Calcium	288.0	mg/L	0.5	
HASR-W-UVF-13FF	EPA 200.7	Water	Iron	**2.42**	mg/L	40.0	**≤ 1.0 mg/L**
HASR-W-UVF-13FF	EPA 200.7	Water	Magnesium	16000	ug/L	500	
HASR-W-UVF-13FF	EPA 200.7	Water	Potassium	6080	ug/L	1000	
HASR-W-UVF-13FF	EPA 200.7	Water	Sodium	57200	ug/L	1000	
HASR-W-UVF-13FF	EPA 200.8	Water	Aluminum	1170	ug/L	10.0	
HASR-W-UVF-13FF	EPA 200.8	Water	Antimony	0.68	ug/L	1.0	≤ 4,300 ug/L
HASR-W-UVF-13FF	EPA 200.8	Water	Arsenic	**111**	ug/L	1.0	**≤ 50 ug/L**
HASR-W-UVF-13FF	EPA 200.8	Water	Barium	1020	ug/L	10.0	
HASR-W-UVF-13FF	EPA 200.8	Water	Beryllium	**0.23**	ug/L	0.10	**≤ 0.13 ug/L**
HASR-W-UVF-13FF	EPA 200.8	Water	Cadmium	2.8	ug/L	0.10	≤ 0.76 ug/L
HASR-W-UVF-13FF	EPA 200.8	Water	Chromium	22.6	ug/L	1.0	≤ 0.01 mg/L
HASR-W-UVF-13FF	EPA 200.8	Water	Cobalt	1.3	ug/L	1.0	
HASR-W-UVF-13FF	EPA 200.8	Water	Copper	**100**	ug/L	1.0	**≤ 30.50 ug/L**
HASR-W-UVF-13FF	EPA 200.8	Water	Lead	2.4	ug/L	1.0	≤ 18.58 ug/L
HASR-W-UVF-13FF	EPA 200.8	Water	Manganese	36.6	ug/L	1.0	
HASR-W-UVF-13FF	EPA 200.8	Water	Nickel	13.5	ug/L	1.0	≤ 168.54 ug/L
HASR-W-UVF-13FF	EPA 200.8	Water	Selenium	2.0	ug/L	1.0	≤ 5.0 ug/L
HASR-W-UVF-13FF	EPA 200.8	Water	Silver	**0.079**	ug/L	0.10	**≤ 0.07 ug/L**
HASR-W-UVF-13FF	EPA 200.8	Water	Thallium	0.50U	ug/L	1.0	< 6.3 ug/L
HASR-W-UVF-13FF	EPA 200.8	Water	Vanadium	39.7	ug/L	1.0	
HASR-W-UVF-13FF	EPA 200.8	Water	Zinc	39.3	ug/L	5.0	≤ 387.83 ug/L
HASR-W-UVF-13FF	EPA 335.4	Water	Cyanide	0.0050U	mg/L	0.010	5.2 ug/L

Notes:
U: Below Detection Limit
* http://www.dep.state.fl.us/water/wqssp/classes.htm
Bold in red: result above Criteria for Surface Water Quality Classification - Class III Predominantly Fresh Water

Table 6. Annual Recovered Water Characterization - Cycle 1.

Permit # 153872-002-UC to operationally (cycle) test Hillsboro Aquifer Storage and Recovery (ASR) Project (HASR-ASR-1)

Facility name: Hillsboro ASR | Operator's name: Bruce Weaver | PM: Gregory Powell
Permit Nº. 153872-002-UC | Sampler: Bruce Weaver / Lianne Ramos | Phase: Recovery

Sample ID	Method	Matrix	Parameter	Results	Units	PQL
HASR-W-UVF-A13	EPA 1631E	Water	Mercury	0.000337 I	ug/L	0.00050
HASR-W-UVF-A13	EPA 200.7	Water	Boron	304	ug/L	50.0
HASR-W-UVF-A13	EPA 200.7	Water	Calcium	78800	ug/L	500
HASR-W-UVF-A13	EPA 200.7	Water	Iron	201	ug/L	40.0
HASR-W-UVF-A13	EPA 200.7	Water	Lithium	25.0U	ug/L	50.0
HASR-W-UVF-A13	EPA 200.7	Water	Magnesium	47200	ug/L	500
HASR-W-UVF-A13	EPA 200.7	Water	Potassium	14100	ug/L	1000
HASR-W-UVF-A13	EPA 200.7	Water	Sodium	300	mg/L	1000
HASR-W-UVF-A13	EPA 200.7	Water	Strontium	4170	ug/L	10.0
HASR-W-UVF-A13	EPA 200.8	Water	Aluminum	5.3U	ug/L	10.0
HASR-W-UVF-A13	EPA 200.8	Water	Antimony	0.50U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Arsenic	33.8	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Barium	17.8	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Beryllium	0.050U	ug/L	0.10
HASR-W-UVF-A13	EPA 200.8	Water	Cadmium	0.15	ug/L	0.10
HASR-W-UVF-A13	EPA 200.8	Water	Chromium	0.50U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Cobalt	0.50U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Copper	0.93U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Lead	0.50U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Manganese	1.8	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Molybdenum	163	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Nickel	4.8	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Selenium	0.50U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Silver	0.050U	ug/L	0.10
HASR-W-UVF-A13	EPA 200.8	Water	Thallium	0.50U	ug/L	1.0
HASR-W-UVF-A13	EPA 200.8	Water	Zinc	2.5U	ug/L	5.0
HASR-W-UVF-A13	EPA 300.0	Water	Bromide	1.5	mg/L	0.50
HASR-W-UVF-A13	EPA 300.0	Water	Chloride	467	mg/L	50.0
HASR-W-UVF-A13	EPA 300.0	Water	Fluoride	0.99	mg/L	0.25
HASR-W-UVF-A13	EPA 300.0	Water	Nitrate as N	0.12U	mg/L	0.25
HASR-W-UVF-A13	EPA 300.0	Water	Nitrite as N	0.12U	mg/L	0.25
HASR-W-UVF-A13	EPA 300.0	Water	Nitrogen, NO2 plus NO3	0.12U	mg/L	0.25
HASR-W-UVF-A13	EPA 300.0	Water	Orthophosphate as P	0.25U	mg/L	0.50
HASR-W-UVF-A13	EPA 300.0	Water	Sulfate	152	mg/L	25.0
HASR-W-UVF-A13	EPA 335.4	Water	Cyanide	0.0050U	mg/L	0.010
HASR-W-UVF-A13	EPA 350.1	Water	Nitrogen, Ammonia	0.34	mg/L	0.050
HASR-W-UVF-A13	EPA 351.2	Water	Nitrogen, Kjeldahl, Total	0.62	mg/L	0.50
HASR-W-UVF-A13	EPA 365.1	Water	Orthophosphate as P	0.0031 I	mg/L	0.0040
HASR-W-UVF-A13	EPA 365.3	Water	Phosphorus, Total (as P) LL	0.0023U	mg/L	0.0040
HASR-W-UVF-A13	EPA 504.1	Water	1,2-Dibromo-3-chloropropane	0.0048U	ug/L	0.019
HASR-W-UVF-A13	EPA 504.1	Water	1,2-Dibromoethane (EDB)	0.0060U	ug/L	0.0097
HASR-W-UVF-A13	EPA 508.1	Water	Alachlor	0.032U	ug/L	0.19
HASR-W-UVF-A13	EPA 508.1	Water	Atrazine	0.020U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	Chlordane (Technical)	0.044U	ug/L	0.19
HASR-W-UVF-A13	EPA 508.1	Water	Endrin	0.0019U	ug/L	0.0094
HASR-W-UVF-A13	EPA 508.1	Water	Heptachlor	0.0056U	ug/L	0.038
HASR-W-UVF-A13	EPA 508.1	Water	Heptachlor epoxide	0.0028U	ug/L	0.019
HASR-W-UVF-A13	EPA 508.1	Water	Hexachlorobenzene	0.010U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	Hexachlorocyclopentadiene	0.011U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	Methoxychlor	0.013U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB, Total	0.094U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1016 (Aroclor 1016)	0.082U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1221 (Aroclor 1221)	0.027U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1232 (Aroclor 1232)	0.027U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1242 (Aroclor 1242)	0.048U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1248 (Aroclor 1248)	0.058U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1254 (Aroclor 1254)	0.022U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	PCB-1260 (Aroclor 1260)	0.062U	ug/L	0.094
HASR-W-UVF-A13	EPA 508.1	Water	Simazine	0.041U	ug/L	0.066
HASR-W-UVF-A13	EPA 508.1	Water	Toxaphene	0.57U	ug/L	0.94
HASR-W-UVF-A13	EPA 508.1	Water	gamma-BHC (Lindane)	0.0028U	ug/L	0.019
HASR-W-UVF-A13	EPA 515.3	Water	2,4,5-TP (Silvex)	0.035U	ug/L	0.20
HASR-W-UVF-A13	EPA 515.3	Water	2,4-D	0.017U	ug/L	0.10
HASR-W-UVF-A13	EPA 515.3	Water	Dalapon	0.38U	ug/L	1.0
HASR-W-UVF-A13	EPA 515.3	Water	Dicamba	0.072U	ug/L	0.10
HASR-W-UVF-A13	EPA 515.3	Water	Dinoseb	0.050U	ug/L	0.20
HASR-W-UVF-A13	EPA 515.3	Water	Pentachlorophenol	0.0090U	ug/L	0.040
HASR-W-UVF-A13	EPA 515.3	Water	Picloram	0.050U	ug/L	0.10
HASR-W-UVF-A13	EPA 524.2	Water	1,1,1-Trichloroethane	0.25U	ug/L	0.50

Table 6.
Annual Recovered Water Characterization – Cycle 1.

Table 6. Annual Recovered Water Characterization - Cycle 1.

HASR-W-UVF-A13	EPA 524.2	Water	1,1,2-Trichloroethane	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,1-Dichloroethene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,2,4-Trichlorobenzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,2-Dichlorobenzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,2-Dichloroethane	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,2-Dichloropropane	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,3-Dichlorobenzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	1,4-Dichlorobenzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Benzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Bromodichloromethane	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Bromoform	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Carbon tetrachloride	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Chlorobenzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Chloroform	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Dibromochloromethane	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Ethylbenzene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Methylene Chloride	0.44U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Styrene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Tetrachloroethene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Toluene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Total Trihalomethanes (Calc.)	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Trichloroethene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Vinyl chloride	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	Xylene (Total)	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	cis-1,2-Dichloroethene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 524.2	Water	trans-1,2-Dichloroethene	0.25U	ug/L	0.50
HASR-W-UVF-A13	EPA 525.2	Water	Benzo(a)pyrene	0.018U	ug/L	0.096
HASR-W-UVF-A13	EPA 525.2	Water	bis(2-Ethylhexyl)adipate	0.37U	ug/L	1.5
HASR-W-UVF-A13	EPA 525.2	Water	bis(2-Ethylhexyl)phthalate	0.48U	ug/L	1.9
HASR-W-UVF-A13	EPA 531.1	Water	Aldicarb	0.64U	ug/L	2.0
HASR-W-UVF-A13	EPA 531.1	Water	Aldicarb sulfone	0.35U	ug/L	2.0
HASR-W-UVF-A13	EPA 531.1	Water	Aldicarb sulfoxide	0.30U	ug/L	2.0
HASR-W-UVF-A13	EPA 531.1	Water	Carbofuran	0.32U	ug/L	2.0
HASR-W-UVF-A13	EPA 531.1	Water	Oxamyl	0.41U	ug/L	2.0
HASR-W-UVF-A13	EPA 547	Water	Glyphosate	0.86U	ug/L	6.0
HASR-W-UVF-A13	EPA 548.1	Water	Endothall	2.9U	ug/L	9.0
HASR-W-UVF-A13	EPA 552.2	Water	Dibromoacetic Acid	0.61U	ug/L	1.0
HASR-W-UVF-A13	EPA 552.2	Water	Dichloroacetic Acid	0.61U	ug/L	1.0
HASR-W-UVF-A13	EPA 552.2	Water	Haloacetic Acids (Total)	0.61U	ug/L	1.0
HASR-W-UVF-A13	EPA 552.2	Water	Monobromoacetic Acid	0.61U	ug/L	1.0
HASR-W-UVF-A13	EPA 552.2	Water	Monochloroacetic Acid	0.61U	ug/L	1.0
HASR-W-UVF-A13	EPA 552.2	Water	Trichloroacetic Acid	0.61U	ug/L	1.0
HASR-W-UVF-A13	EPA 900.0m	Water	Gross Alpha	4.01 ± 2.32 (4.01)	pCi/L	
HASR-W-UVF-A13	EPA 903.1	Water	Radium-226	2.93 ± 1.30 (1.01)	pCi/L	
HASR-W-UVF-A13	EPA 904.0	Water	Radium-228	0.824U ± 0.425 (0.824)	pCi/L	
HASR-W-UVF-A13	EPA 908.0	Water	Total Uranium	2.14 ± 0.714 (0.514)	pCi/L	
HASR-W-UVF-A13	SM 2120B	Water	Apparent Color	20.0	units	5.0
HASR-W-UVF-A13	SM 2150B	Water	Temperature, Water (C)	40.3	deg C	
HASR-W-UVF-A13	SM 2150B	Water	Threshold Odor Number	1.0U	TON	1.0
HASR-W-UVF-A13	SM 2320B	Water	Alkalinity, Carbonate (CaCO3)	5.0U	mg/L	5.0
HASR-W-UVF-A13	SM 2320B	Water	Alkalinity, Hydroxide (CaCO3)	5.0U	mg/L	5.0
HASR-W-UVF-A13	SM 2320B	Water	Alkalinity, Total as CaCO3	167	mg/L	5.0
HASR-W-UVF-A13	SM 2320B	Water	Alkalinity,Bicarbonate (CaCO3)	167	mg/L	5.0
HASR-W-UVF-A13	SM 2540C	Water	Total Dissolved Solids	904	mg/L	20.0
HASR-W-UVF-A13	SM 2540D	Water	Total Suspended Solids	5.0U	mg/L	5.0
HASR-W-UVF-A13	SM 4500-H+B	Water	Temperature, Water (C)	18.2	deg C	0.010
HASR-W-UVF-A13	SM 4500-H+B	Water	pH at 25 Degrees C	8.4	Std. Units	0.10
HASR-W-UVF-A13	SM 4500-SiO2-D	Water	Silica, Dissolved	11.8	mg/L	1.0
HASR-W-UVF-A13	SM 5310B	Water	Total Organic Carbon	630	mg/L	10.0
HASR-W-UVF-A13	SM 5540C	Water	Surfactants	0.070 I	mg/L	0.20

PBF-14 - During the recovery period, the TDS concentration significantly increased from 1,630 to 2,810 mg/l. The final TDS concentration was slightly less than the TDS concentration recorded from this well prior to the initiation of cycle testing. This infers that the stored water was mostly, but not completely removed at this location during recovery. Conductivity also showed an increase from 3,045 to 4,859 umhos/cm, an increase of 60% from the initial readings. The color of water recorded from this well remained below detection limits. The ORP remained strongly negative, below -221. The arsenic concentration at this well remained less than 2 ppb during the total duration of recovery.

PBF-11 - During the Recovery period, the TDS concentration indicated a slight increase from 2,290 to 2,420 mg/L, an increase of approximately 5% from the initial recorded concentration. Conductivity indicated no significant change from the initial recorded concentration. The color of water recorded from this well decreased from 35 PCU to below detection limit at the final weekly event during Recovery Phase. The ORP remained strongly negative, below -282. The arsenic concentration at this well remained less than or equal to 1 ppb during the total duration of recovery.

PBF-12 - During the Recovery period, the TDS concentration at this well increased from 25,200 to 29,000 mg/l – an increase of approximately 15%. Conductivity indicated no significant change from the initial recorded concentration for the storage phase. This indicates that the well was not significantly impacted by the injection of source water in the aquifer. The color of water recorded from this well remained 5 PCU or below, further supporting this observation. The ORP remained strongly negative, below -206. The arsenic concentration at this well remained less than 5 ppb during the total duration of recovery.

PBS-11 - During the recovery period, the TDS concentration slightly increased from 2,390 to 2,600 mg/l, an increase of 9%. Conductivity readings indicated no significant change when compared to initial recordings. Color of water recorded from this well varied from below detection limit to 20 PCU. The ORP remained strongly negative, below -214.20. The arsenic concentration at this well remained less than 2 ppb during the total duration of recovery.

Mercury Evaluation

Total mercury (THg) and methyl-mercury (MeHg) levels from the recharged and recovered water are comparable to mercury levels within surface water collected from District Stormwater Treatment Area (STA) downstream monitoring locations collected over the 11-year period of record (1998-2009). THg levels are also well below the Florida Class III water quality standard of 12 ng/L for THg. There is no water quality standard for MeHg. There is no statistical difference in THg and MeHg levels between recovered and recharged water (Student's t-test; $p = 0.90$, $t = 0.13$ [THg]; $p = 0.70$, $t = 0.40$ [MeHg]). Lastly, the percent MeHg ((MeHg/THg)*100) level for both recharged and recovered water is similar to data collected at STA downstream monitoring locations. Percent MeHg is an indicator of MeHg bioaccumulation potential. Therefore, based on these results there does not appear to have been an issue with THg or MeHg in recharged or recovered water for the Hillsboro ASR well during this cycle.

Ecotoxicological Data

In order to evaluate the potential toxicity of the source water used for the Cycle 1 recharge, the source water was sampled and tested using the permit-required aquatic toxicity species as well as short chronic tests used as part of the Ecotox Program for the Regional ASR Study. Once Cycle 1 recovery was initiated, permit-required toxicity testing was conducted.

Source Water

During the recharge period, a water sample was tested to evaluate the potential acute toxicity of the source water. The aquatic species required to be tested by the ASR permit were the water flea (*Ceriodaphnia dubia*) and the bannerfin shiner (*Cyprinella leedsi*). Ninety-six-hour acute static renewal tests were conducted using five source water concentrations and a laboratory control. All test organisms survived all the test concentrations and controls, indicating that the source water had no acute toxic effects on the species tested. These tests were conducted using a source water grab sample collected on February 1, 2010.

In addition to the acute tests, the following longer-term (Ecotox Program) tests were conducted on the source water:

- 96-hour chronic non-renewal definitive growth test using the green algae (*Selenastrum capricornutum*);
- 7-day chronic static renewal definitive survival and reproduction test using the waterflea (*C.; dubia*); and
- 7-day chronic static renewal definitive survival test using the fathead minnow (*Pimephales promelas*).

The algal and fathead minnow tests using source water showed no quantifiable toxicity. The waterflea chronic test using source water showed no effect on survival, but the source water affected the reproduction of the waterfleas. The effect was a lower number of young being produced by the waterfleas in dilutions of the source water as compared to the laboratory controls. The IC25 observed was 46.16 percent source water.

Cycle 1 Recovered Water

The recovered water was tested according to the permit requirements. Eight samples were collected. The permit requires acute toxicity tests using the waterflea (*C. dubia*) and the bannerfin shiner (*C. leedsi*). The initial 4 tests (routine toxicity tests) were conducted using grab samples of recovered water collected on the following schedule (as required by the ASR permit):

- Sample 1 -- Day 2 of recovery;
- Sample 2 – collected when the daily specific conductance measurement of the recovered water increases by one-third of the difference between Day 2 and 1,275 µmhos/cm;
- Sample 3 – collected when the daily specific conductance measurement of the recovered water increases by two-thirds of the difference between Day 2 and 1,275 µmhos/cm; and
- Sample 4 -- was collected when the daily specific conductance measurement reached 1,360 µmhos/cm.

Recovered water samples were collected every four to six days until the end of the recovery period; four additional samples were collected. Sampling dates, conductivity and test results are presented in **Table 7**. All recovered water samples showed no quantifiable acute toxicity and met the permit requirements. Calcium, magnesium and chloride concentrations were measured for the last two recovered water samples collected and these data are also included in Table 1.

Conclusions and Recommendations

- Equipment testing during Cycle 1at the Hillsboro ASR pilot project indicates that the facility is operating as designed. The system operated successfully with occasional visits for monitoring and routine maintenance.
- Modification of the filtration units was required prior to the initiation of the cycle. Adjustment to the disinfection system intensity was also required during the cycle.
- During recharge, the ASR wellhead pressure remained below 60 pounds per square inch (psi)
- Water quality data from the storage-zone monitoring wells indicated that canal water mixed and diffused with groundwater at distances of 330 and 1,000 feet away from the ASR well. Wells completed above and below the storage zone indicated little if any impacts from water emplaced within the storage zone.
- The recovery efficiency for Cycle 1 was approximately 20 percent. Further improvement in the recovery efficiency is anticipated during subsequent cycles, as a target storage volume is developed.
- Water recovered from the system displayed no toxic effects and did not generate elevated levels of mercury.
- Water recovered from the ASR well exhibited an arsenic concentration of 111 parts per billion (ppb) during the first flush, but declined to less than 10 ppb over

TABLE 7
TOXICITY TEST RESULTS AND ASSOCIATED CONDUCTIVITY AT POINT OF DISCHARGE (AS MEASURED BY GOLDER AT TIME OF SAMPLING)

HILLSBORO ASR CYCLE 1 RECOVERY

Test	Collection Date	Conductivity (µS/cm)	Recovered Water Concentration	% Survival *Ceriodaphnia dubia*	% Survival *Cyprinella leedsi*
1	3/9/2010	773	Control	100	80
			6.25%	100	80
			12.50%	100	85
			25%	100	80
			50%	100	60
			100%	100	85
			LC50	**>100%**	**>100%**
2	3/11/2010	933	Control	100	100
			6.25%	100	100
			12.50%	100	100
			25%	100	100
			50%	100	95
			100%	100	100
			LC50	**>100%**	**>100%**
3	3/13/2010	1,136	Control	95	100
			6.25%	100	100
			12.50%	95	100
			25%	100	100
			50%	100	100
			100%	100	100
			LC50	**>100%**	**>100%**
4	3/15/2010	1,360	Control	95	100
			6.25%	100	100
			12.50%	100	100
			25%	95	100
			50%	100	100
			100%	100	100
			LC50	**>100%**	**>100%**
5	3/19/2010	1,802	Control	95	100
			6.25%	100	100
			12.50%	100	100
			25%	95	100
			50%	100	100
			100%	100	100
			LC50	**>100%**	**>100%**
6	3/25/2010	2,645	Control	100	100
			6.25%	100	100
			12.50%	100	95
			25%	100	100
			50%	100	100
			100%	95	100
			LC50	**>100%**	**>100%**
7	3/31/2010	3,501	Control	100	95
			6.25%	95	100
			12.50%	100	100
			25%	100	100
			50%	100	100
			100%	95	100
			LC50	**>100%**	**>100%**
			Calcium	84.9	mg/L
			Magnesium	69.5	mg/L
			Chloride	2,070	mg/L
8	4/6/2010	4,370	Control	100	100
			6.25%	100	85
			12.50%	100	95
			25%	95	100
			50%	100	90
			100%	100	90
			LC50	**>100%**	**>100%**
			Calcium	91.5	mg/L
			Magnesium	85.9	mg/L
			Chloride	1,000	mg/L

Source: Golder Associates Inc. and Hydrosphere Research, 2010.

the duration of the recovery period. The concentration of arsenic in all of the monitoring wells remained below 10 ppb during the entirety of Cycle 1.

Based on these findings, the following recommendations are made:

- Continue testing the system with Cycle 2, which will consist of 90 days of recharge followed by recovery until the pre-set conductivity of 1,275 umhos/cm is reached.
- Depending upon the results from Cycle 2, a reduced level of monitoring may be justified, particularly at the monitoring wells that showed little if any hydraulic or water quality effects of operation of the ASR well.