CITY OF SUNRISE FLORIDA

SAWGRASS WATER TREATMENT PLANT

CONCENTRATE DISPOSAL SYSTEM REHABILITATION

PERMIT No. 0129008-05-UC/0129008-03-UO

September 29, 2010

MWH

MWH

BUILDING A BETTER WORLD

October 5, 2010

Mr. Joseph May, P.G.
Program Manager
Florida Department of Environmental Protection
Underground Injection Control Division
400 North Congress Avenue
West Palm Beach, Floridan 33401

Subject: City of Sunrise Sawgrass Injection Well CW-1 and Dual Zone Monitor Well DZMW-1, Class I Injection Well UIC Permit 0129008-005-UC/0129008-003-UO, Concentrate Disposal System Rehabilitation Report

Dear Mr. May:

In accordance with the above permits MWH is pleased to submit the Sawgrass Water Treatment Plant Concentrate Disposal System Rehabilitation Report for the City of Sunrise injection well (CW-1) and associated dual zone monitor well (DZMW-1). The City of Sunrise requests authorization to resume operation of the injection well following acceptance of the Rehabilitation Report submittal.

PERMIT HISTORY

Florida Department of Environmental Protection (FDEP) Permit 0129008-001-UC was issued to the City of Sunrise for construction of CW-1 and DZMW-1 on May 28, 1998. The injection and monitor well were constructed by May 14, 1999. Operational testing was approved by FDEP on October 5, 1999. The Operational Testing permit was re-issued on July 23, 2001, (0129008-002-UC) and the expiration data was extended to July 2004 by letter on December 31, 2001. FDEP authorized the initiation of operational testing April 15, 2002 and testing started in May 2002. The operating permit (0129008-003-UO), based on testing information collected between May 2, 2002, and April 30, 2003, was subsequently approved on June 2004.

REHABILITATION

The City requested a Minor Modification on December 28, 2006. The purpose of the Minor Modification was to allow the rehabilitation and testing of CW-1 and DZMW-1. The Minor Modifications was approved under FDEP Permit 0129008-004-UO on June 5, 2008. Revisions to the original rehabilitation plan required the submittal of an application for a Major Modification to the Operating Permit. The Major Modifications was approved under FDEP Permit 0129008-005-UC (CW-1 & DZMW-1) on January 8, 2010. An operating permit renewal application for the City of Sunrise injection system also was submitted on April 6, 2009 and is awaiting the results contained herein to complete the renewal information.

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The Sawgrass Water Treatment Plant Concentrate Disposal System Rehabilitation Report provides details on the initial loss of pressure and subsequent activities to re-establish CW-1 and DZMW-1 to full operation condition. Mechanical Integrity Testing (MIT) performed following rehabilitation indicated that CW-1 is mechanically intact. The video survey of DZMW-1 following rehabilitation indicated that the upper and lower monitor zones had been re-established at the historic depths and water qualities. Injection testing in CW-1 set the injection capacity of the well at 5,100 gallons per minute (10 feet per second) with a wellhead pressure of approximately 55 pounds per square inch.

During the MIT in CW-1, a piece of wood "Fish" was discovered wedged against one side of the final casing between the base of the new FRP tubing and the old steel injection tubing that was left attached to the final casing. The most recent video survey of the Fish, performed on August, 9, 2010, following the short-term injection test, shows the top of the Fish has fallen over and now spans the opening. The City of Sunrise has requested a recommendation from Youngquist Brothers, Inc. for remedy. Discussion of the Fish is not included in the attached report and is being treated as a separate item outside of rehabilitation efforts so as not to delay the close out of the Major Modification permit and the renewal of the operation permit. A copy of the video showing the Fish in its current position is attached to this letter and is being provided to the Tallahassee, Florida FDEP office as well.

Also attached to this letter is a summary of the Supplementary Special Conditions from the Major Modification Permit (0129008-005-UC) with guidance to the appropriate report locations where each piece of information can be found. This document is provided to facilitate review.

Following review of the attached report, please call me at (954) 851-1507 with any questions or comments you may have, or if you require additional information.

Yours truly,

MWH

Susan Bodmann, P.G., PMP
Principal Hydrogeologist

Attachments: Permit Guidance Specific Conditions
After Injection Test 4x4 Obstruction Video

cc: TAC Distribution List
MWH Project File 1570903/3.1.6

SUPPLEMENTARY SPECIFIC CONDITIONS
From Permit No. 0129008-005-UC
Response locations are provided in "BLUE" type to facilitate review of the information contained in this report.

8. Modification and Testing Requirements

a. The four permanent surficial aquifer monitoring wells located near the corners of the pads constructed for CW-1, identified as Pad Monitoring Wells (PMWs), shall be sampled as follows:

1) During the modification and associated testing phases, the PMWs shall be sampled weekly for chlorides (mg/L), specific conductance (µmhos/cm or µS/cm), temperature and water level (relative to the North American Vertical Datum of 1988 [NAVD 88]).

2) The PMWs shall also be sampled for total dissolved solids (mg/L) when specifically requested by the Department. The results of the PMW analyses shall be submitted to the Department within 30 days of the completion of the activity. A summary sheet from the FDEP Southeast District is attached for your use when reporting the above information (Attachment 1). The PMWs shall be retained in service throughout the modification and testing phases of the project. Upon completion of modifications and testing, the permittee may submit a request to the Department for cessation of sampling followed by capping, or plugging and abandonment of these wells.

Pad Monitor well sampling was suspended based on FDEP's March 25, 2010 approval. Pad Monitor wells have been capped pending completion of permitting process.

NOTE: "b" through "e" are omitted since no response was required.

f. Department approval is required prior to the following stages of testing:

1) Mechanical integrity testing – **Notification of MIT February 18, 2010**
2) Short-term injection test – **Submittal of Injection Test Request April 29, 2010**
3) Return of CW-1 to service – **Current Submittal**

h. The geophysical logging program for CW-1 shall at a minimum include:

1) Temperature logs shall be run after each stage of cementing of the annular space in CW-1, between the existing 24-inch steel final casing and the newly emplaced fiberglass reinforced plastic (FRP) injection tubing, to identify the top of the cement.

2) Cement bond logs (CBLs) shall be run:

a) Inside the 16-inch FRP tubing, prior to placement of cement in the annular space, for background purposes; and

b) After cementing the annular space between the 16-inch FRP tubing and the 24-inch OD final casing, between 48 and 72 hours after the completion of annular space cementing activities.

3) After the completion of annular space cementing activities, the following logs shall also be run (in addition to the final CBL noted above):

a) A temperature log, to be run between 48 and 72 hours after the completion of annular space cementing activities; and

b) A video survey, to be performed from land surface to the bottom of the well, including a side view inspection of the base of the tubing and the area of the new packer.

Temperature Logs and cement bond logs are presented in Appendix G

i. Mechanical integrity of the injection well shall be determined pursuant to Rules 62-528.300(6)(b)2. and 62-528.300(6)(c), F.A.C.

1) Mechanical integrity of the injection well shall include:

a) A pressure test of the new tubing:

(1) The pressure test of the new tubing shall be accepted if tested at 1.5 times the operating pressure at which the well is to be permitted. A test tolerance of not greater than + or - 5% must be certified by the engineer of record.

(2) Verification of pressure gauge calibration must be provided to the Department representative at the time of the test and in the certified test report.

b) A radioactive tracer survey (RTS) of the final casing, TV survey, and temperature log.

2) The Department shall be notified at least 72 hours prior to all testing for mechanical integrity.

3) All testing for mechanical integrity must be initiated during normal business hours, Monday through Friday.

MIT results are discussed in Section 3.3 and Pressure test results are provided in Appendix C and Geophysical Logs are provided in Appendix G. Meter calibration certificates for the pressure test are provided with the test log in Appendix C and Flow meter and Iodine Assay certificates are provided in Appendix G with the Radioactive Tracer Survey logs.

9. Reporting Requirements for Modifications and Testing

a. All reports and other submittals required to comply with this permit shall be signed by a person authorized under Rules 62-528.340(1) or (2), F.A.C.

b. Weekly progress reports shall be submitted throughout the modification period for CW-1. These reports, which may be submitted by electronic mail, shall be submitted within 72 hours of the end of the period of record and shall include at a minimum the following information:

Weekly progress reports were submitted throughout the rehabilitation of both wells. The Final weekly progress report was submitted April 19, 2010.

c. The short-term injection test request shall contain the following justifications:

1) Cement bond logs and interpretation.
2) Final downhole television survey with interpretation.

The short-term injection test was submitted to FDEP on April 29, 2010 and short-term injection was approved on May 11, 2010.

10. Requirements for Returning Injection Well CW-1 to Service:

a. The return of CW-1 to service under this permit shall not commence without written authorization from the Department.

This document is a written request to return CW-1 to service under the current timely submittal of the operation permit application.

b. Prior to approving the return of CW-1 to service, the following items must be submitted with a request for Department authorization to return CW-1 to service, for Department review and approval:

1) A final construction and testing report on modifications made to CW-1 and DZMW-1, including but not limited to the following:

a) Geophysical logs for CW-1 and DZMW-1, with interpretations, for all work completed under the minor modification to permit (under FDEP File No. 0129008-004-UO) and this major modification to permit.

Geophysical Logs are presented in Appendix G and interpretations are provided

b) A copy of the television survey(s) of CW-1 and DZMW-1 with interpretation.

Television surveys and survey logs of the CW-1 24-inch final casing and 16-inch FRP injection tubing and DZMW-1 6.625-inch final FRP casing are provided in Appendix B with survey interpretation in section 2.

c) Certification of mechanical integrity and interpreted test data, including the results of all mechanical integrity testing performed upon completion of CW-1 modifications. The mechanical integrity testing program shall include TV survey, pressure test, radioactive tracer survey (RTS), and temperature log.

A description of CW-1 mechanical integrity testing and the interpretation of the test data is provided in Section 3. The video survey of CW-1 is provided in Appendix B, copies of the signed pressure test logs are provided in Appendix C and the high resolution temperature and the Radioactive Tracer Surveys are provided In Appendix G.

d) Results of the short-term injection test with interpretation of the data. Injection Well CW-1 shall first be tested for integrity of construction, and shall be followed by a short term injection test of such duration to allow for the prediction of operating pressure. For a minimum of 12 hours, the injection test rate shall be no less than the maximum rate at which injection is to be authorized (for a return to service). Pressure/water level data from the injection zone and both monitoring zones shall be recorded continuously for at least 24 hours before the test and at least 24 hours following the test. The following data shall be recorded, analyzed, and reported for the duration of the injection test, i.e., all data should encompass the entire background, injection and recovery periods:

- injection flow rate, in MGD, with all injection periods recorded (CW-1)
- injection wellhead pressure, in psig (CW-1).
- pressure with no flow (shut-in pressure in psig; CW-1)
- monitoring well pressures (DZMW-1 upper and lower zones)

The results of the short-term injection test are provided in Appendix L and a discussion of the testing and test results are provided in Section 3.4.

2) An indication of the anticipated maximum pressure and flow rate at which the well will be operated under normal and emergency conditions.

The maximum operating pressure is anticipated to be approximately 55 psi at a flow rate averaging around 5,100 gallons per minute based on the results of the short-term injection test detailed in Section 3.4.

3) Certification of completion of well construction (all modifications to CW-1 & DZMW-1).

Certificates of completion for both CW-1 and DZMW-1 are provided in Appendix H along with signed and sealed record drawings and pressure and flow meter calibration certificates.

4) Surface equipment (including piping, pressure gauges and flow meters, and all appurtenances) completion certified by the Engineer of Record.

Signed and sealed record drawings and pressure and flow meter calibration certificates are provided in Appendix H.

5) Updated operation and maintenance (O & M) manual, including a description of surge and water hammer control and emergency discharge management plan procedures. The emergency discharge system must be fully constructed and operational (ready to operate) prior to approval of operational testing.

Section 9 of the City's O&M Manual detailing injection system facilities has been updated to reflect the current conditions of the system.

6) Calibration certificates for all new and re-installed pressure gauges and flow meters.

Flow meter calibration certificates are provided in Appendix H.

7) Signed and sealed record "as-built" engineering drawings of all modifications to the injection/monitoring well system including all well construction (CW-1 and DZMW-1), subsurface and surface piping and equipment, and appurtenances.

Signed and sealed record drawings are provided in Appendix H.

8) Background water quality data from the upper and lower monitor zones, analyzed for primary and secondary drinking water standards (62-550, F.A.C.) and minimum criteria parameters (62-520, F.A.C.) as attached (Attachment 2).

Background water quality data from the upper and lower monitor zones is provided in Appendix K.

9) Other data obtained during well construction needed by the Department to evaluate whether the well will operate in compliance with Department Rules. [Rule 62 -528.450 (3)(a)3.i., F.A.C.].

Other data obtained during injection well and monitor well rehabilitation is provided in the Appendix and discussed in the report.

c. All pressure gauges and flow meters shall be installed on DZMW-1 prior to placing this well into service as a dedicated monitoring well for CW-1. All pressure gauges and flow meters at CW-1 shall also be fully operational prior to initiating injection activities at the site.

DZMW-1 gauges and flow meters are installed. On October 1, 2010, the City discovered that one of the monitor zone pumps was not working. FDEP recorded the discovery during their inspection of the injection well system that day. The pump should be repaired by October 15, 2010.

d. Prior to Department authorization to place CW-1 back into service with a fully functional dual zone monitoring well, the permittee shall contact the UIC Section of the Department, Southeast District, to arrange a site inspection. The inspection will determine if the conditions of the minor and major modifications to permit have been met, and to verify that the injection well system (the injection well and associated monitoring well) is fully operational. During the inspection, emergency procedures and reporting requirements shall be reviewed.

An inspection of the injection system was conducted on October 1, 2010 by Mark Silverman, P.G., FDEP. The action items resulting from the inspection were:

- **Clearly label the Injection Well CW-1**
- **Repair the DZMW-1 Lower Zone sample pump**

Both items are being remedied by the City.

11. Operating and Reporting Requirements Upon Returning CW-1 to Service:

a. Upon receipt of written authorization from the Department [**S.C. 10.a.**], the operation of the injection well system shall be subject to the following conditions:

1) All conditions specified in the FDEP operation permit, No. 0129008-003-UO, under which CW-1 had been operating prior to the initiation of repairs under the minor and major modifications to permit, with the exception of the annulus pressure parameters required under S.C. 3.c.1)a) which are no longer required in the Monthly Operating Reports (MORs).

The City of Sunrise is in timely submittal of an application to renew Permit No. 0129008-003-UO. The City's application should be complete with this current construction report submittal.

2) An additional (i.e., interim) pressure test to demonstrate internal mechanical integrity of the injection well shall be conducted midway between the standard 5-year full mechanical integrity tests. A plan describing the interim pressure test procedures shall be submitted to the Department's Southeast District and Tallahassee offices for approval at least 90 days prior to the interim pressure test date noted above. Pursuant to Rule 62-528.430(2)(b)2.a., F.A.C., the final report for the demonstration of internal mechanical integrity for the injection well shall be submitted within 3 months of the completion date for the interim pressure test.

The City's financial responsibility submittal and updated O&M address the interim pressure test to demonstrate the mechanical integrity of the injection well.

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Concentrate Injection Well CW-1
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Acknowledgements

MWH would like to acknowledge the entire project team involved in the research and added to the collective technical resources for the preparation of this report. The work and reviews provided by the following firms and colleagues were critical to successful completion of this detailed report titled *Concentrate Disposal System Rehabilitation Report, September 2010.*

City of Sunrise
Hector Castro, Former Utilities Director
Timothy Welch, Acting Utilities Director
Tamira Coffman, P.M.
Ted Petrides, P.E.
Frank Valoria, P.E.
Greg Sutherland
Alan Miller, I&C
Jordan Ethan, Laboratory
Doug Kerwin, WTP
Karl Thompson, WWTP

Youngquist Brothers Inc.
Jim Brantley, President
Ed McCullers, P.M.
Brett Youngquist
Paul McCullers

FDEP
Mark Silverman, P.G.
Joseph May, P.G.

TAC
Steven Anderson/South Florida Management District
George Heuler/FDEP, Underground Injection Program
Garth Hinckle/Broward County Environmental Protection Department
Ron Reese/US Geological Survey
Nancy Marsh/EPA Region IV

MWH
Harold Aiken, P.E.
Neil Johnson, P.G.
John Largey, P.G.
Brian LaMay, P.E.
Susan Bodmann, P.G.

Certifications

"I certify under penalty of law that this document, the *Concentrate Disposal System Rehabilitation Report* and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Timothy Welch, P.E.
Acting Director of Utilities
City of Sunrise

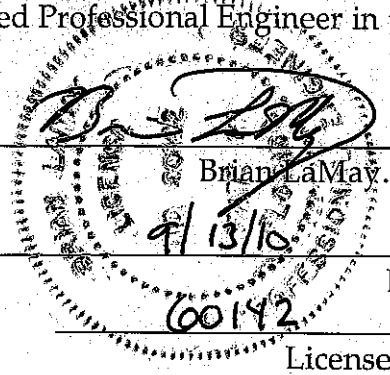
9-20-10
Date

Certifications

PROFESSIONAL ENGINEER

MWH Americas, Inc.

The engineering features contained in the *Concentrate Disposal System Rehabilitation Report, 2010* were prepared by, or reviewed by, a Licensed Professional Engineer in the State of Florida.



Brian LaMay., P.E

9/13/10

Date

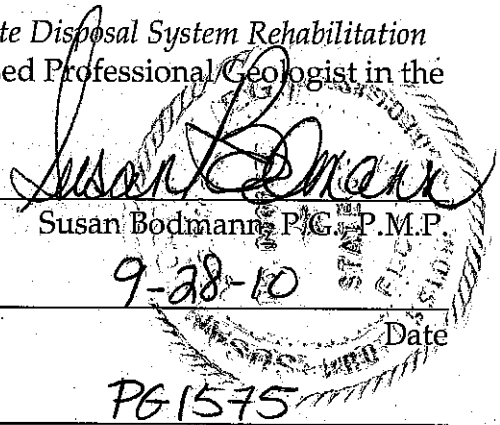
60142

License No.

PROFESSIONAL GEOLOGIST

MWH Americas, Inc.

The hydrogeological features contained in the *Concentrate Disposal System Rehabilitation Report, 2010* were prepared by, or reviewed by, a Licensed Professional Geologist in the State of Florida.



Susan Bodmann, P.G., P.M.P.

9-28-10

Date

PG1575

License No.

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APPENDICES

1.0 Background

1.1 Introduction

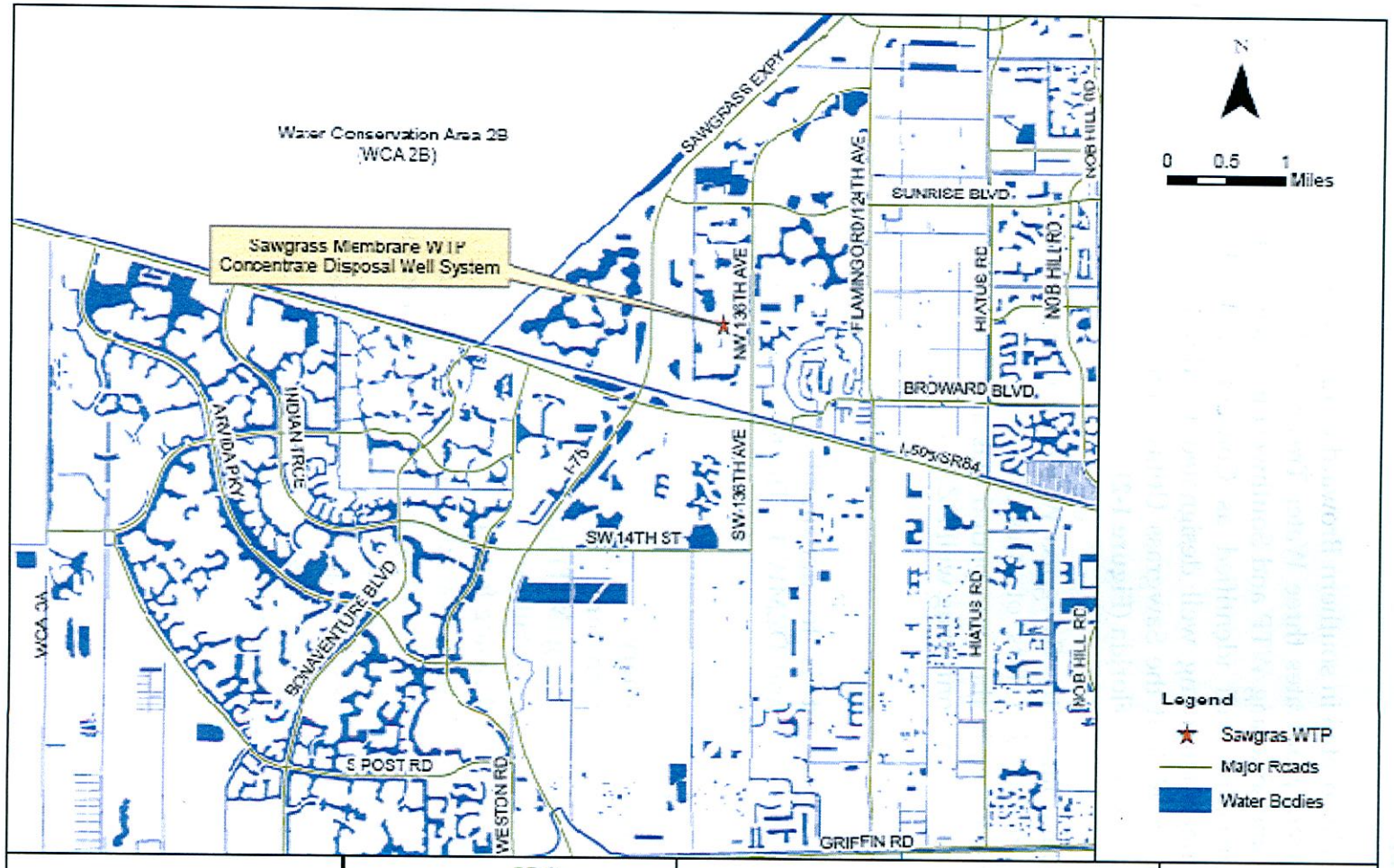
The City of Sunrise is located in southern Broward County, Florida, as shown in **Figure 1-1**. The City currently operates three Water Treatment Plants: Sawgrass membrane WTP, Springtree lime softening WTP and Southwest lime softening WTP. One Class I industrial deep injection well identified as Concentrate Well 1 (CW-1) and one associated dual-zone monitoring well designated DZMW-1 are associated with the Sawgrass membrane WTP at the Sawgrass Utility Complex located at 777 Sawgrass Corporate Parkway, Sunrise, Florida (**Figure 1-2**).

In early 2006, monitoring of the Sawgrass Water Treatment Plant (WTP) concentrate disposal system identified a loss of pressure from the annular space of CW-1. Unrelated, but discovered in the same period was an equalization of pressures in the two zones of the associated monitoring well DZMW-1.

1.2 Purpose

The purpose of this report is to document the activities associated with the rehabilitation of wells CW-1 and DZMW-1. The following information is included in this report:

- Permitting history
- CW-1 construction summary
- DZMW-1 construction summary
- Mechanical Integrity Testing (MIT) history
- Description of CW-1 tubing failure
- Description of DZMW-1 casing failure
- Description of methods used to acquire and analyze the data
- Documentation of the approved casing setting depths and monitoring zones
- Identification of confinement above the injection zone
- Demonstration of mechanical integrity of the injection well
- Results of a short term injection test
- Recommendation for continued operation



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CITY OF SUNRISE FLORIDA

City of Sunrise
Sawgrass WTP
Concentrate Well System

Figure 1-1

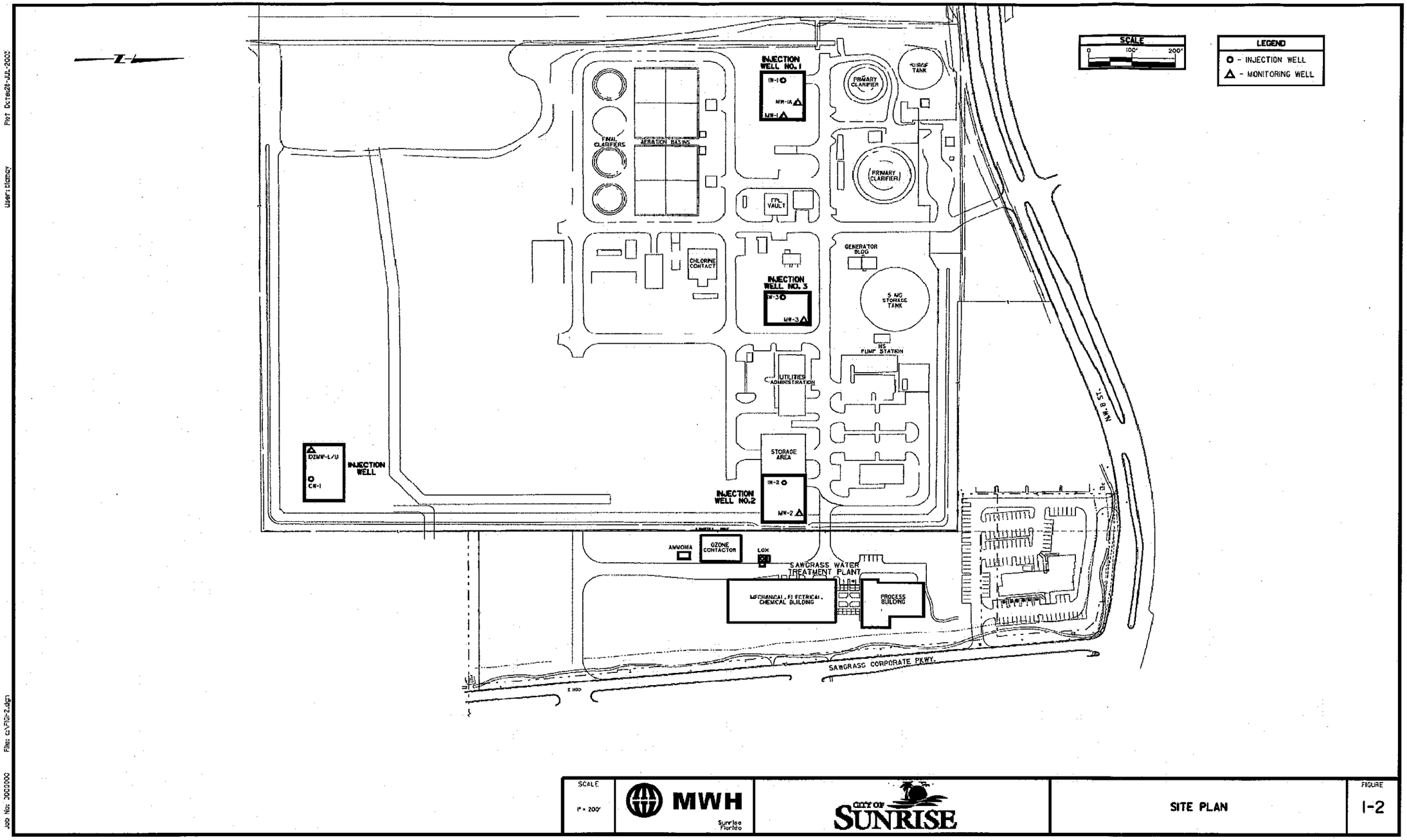


Figure 1-2 Site Map

1.3 Permitting History

FDEP Permit 129008-001-UC was issued to the City of Sunrise for construction of one Class I Industrial injection well and a dual-zone monitor well on May 28, 1998. The injection and monitor well were constructed by May 14, 1999. Operational testing was approved by FDEP on October 5, 1999. The Operational Testing permit (0129008-02-UC) was re-issued on July 23, 2001, and the expiration date was extended by letter to July 2004 on December 31, 2001. FDEP authorized the initiation of operational testing April 15, 2002, and testing started in May 2002. The operating permit (0129008-03-UO), based on testing information collected between May 2, 2002, and April 30, 2003, was subsequently approved on June 2004.

The City requested a Minor Modification on December 28, 2006. The purpose of the Minor Modification was to allow the rehabilitation and testing of CW-1 and DZMW-1. FDEP forwarded a request for information (RFI) which was received on March 30, 2007. Supplementary correspondence was submitted to FDEP on April 6, 2007, April 12, 2007, and May 22, 2007, in addition to a response to the RFI submitted on July 5, 2007. FDEP issued a second RFI dated September 20, 2007, and a response to the RFI was submitted to FDEP on November 5, 2007. The Minor Modification was approved under FDEP Permit 0129008-004-UO on June 5, 2008. Revisions to the original rehabilitation plan required the submittal of an application for a Major Modification to the Operating Permit. The Major Modification was approved under FDEP Permit 0129008-005-UC (CW-1 & DZMW-1) on January 8, 2010. Copies of the permits and modifications are included in **Appendix A.**

1.4 Construction Summaries

1.4.1 Concentrate Well CW-1

Injection well CW-1 was designed and constructed to industrial standards including injection tubing, positive seal packer, and a pressurized fluid filled annular space around the tubing. The concentrate disposal well was constructed with a 20-inch outside diameter (OD), 0.500-inch thick carbon steel tubing installed within a 24-inch 0.500-inch wall thickness steel casing. The 24-inch diameter casing was set to a depth of 3,040 feet below land surface (bls). The 20-inch injection tubing was installed within the final casing to a depth of 3,030 feet bls using a YBI positive seal packer. The well was completed with a nominal 24-inch diameter open borehole extending from the bottom of the final casing to approximately 3,400 feet bls. A summary of the CW-1 casing depths and materials is presented in **Table 1-1.** The CW-1 construction details are presented on **Figure 1-3**

All available construction, geophysical logging and testing program data is documented in *Sawgrass Water Treatment Plant Concentrate Disposal System, City of Sunrise, Drilling and Testing Report, August 1999* Volumes I and II.

Table 1-1 CW-1 Original Construction Casing Summary

Casing String	Diameter (Inches)		Casing Thickness (Inches)	Casing Material	Casing Depth (Feet)
	Inside	Outside			
Conductor	53.25	54.00	0.375	Steel	190
Surface	43.25	44.00	0.375	Steel	1,030
Intermediate	33.25	34.00	0.375	Steel	2,020
Final Casing	23.00	24.00	0.500	Steel	3,040
Injection Tubing	19.00	20.00	0.710	Steel	3,030
Total Depth	n/a	n/a	n/a	n/a	3,400

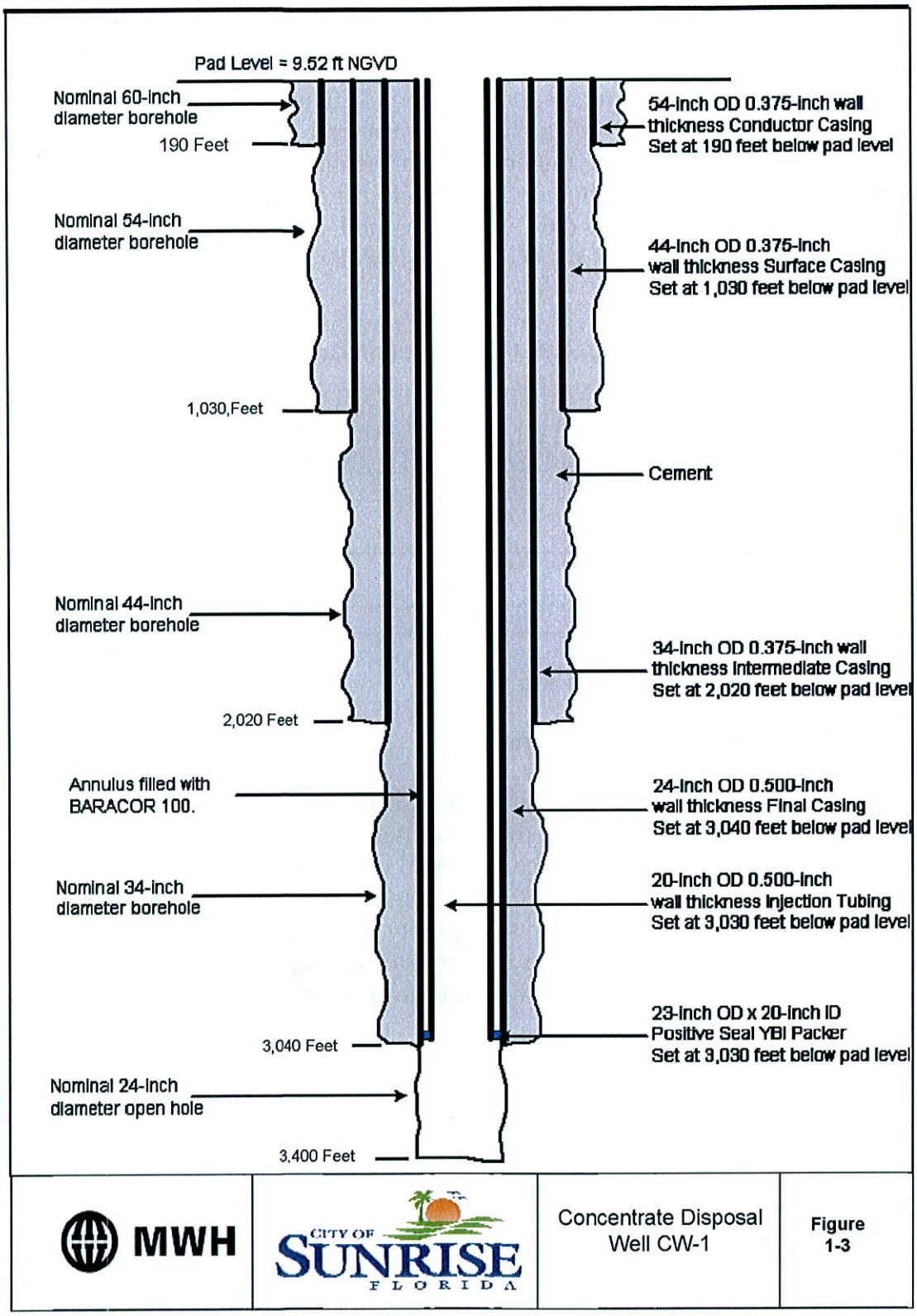


Figure 1-3 CW-1 Original Construction Details

1.4.2 Dual Zone Monitor Well DZMW-1

Well DZMW-1 is located approximately 50 feet west of CW-1. The original construction of DZMW-1 positioned the upper monitor zone between 1,620 and 1,690 feet bls. The lower monitor zone was positioned between 1,950 and 1,980 feet bls. A summary of the DZMW-1 casing depths and materials is presented in **Table 1-2.** The DZMW-1 construction details are presented on **Figure 1-4.** All available construction, geophysical logging, and testing program data is documented in *Sawgrass Water Treatment Plant Concentrate Disposal System, City of Sunrise, Drilling and Testing Report, August 1999* Volumes I and II.

Table 1-2 DZMW-1 Construction Casing Summary

Casing String	DIAMETER (Inches)		CASING THICKNESS (inches)	CASING MATERIAL	CASING DEPTH (feet)
	Inside	Outside			
Surface	19.25	20.00	0.375	Steel	190
Intermediate (Upper Monitor Zone)	13.25	14.00	0.375	Steel	1,620
Final Casing (Lower Monitor Zone)	5.50	6.63	0.562	Steel	1,950
Total Depth	n/a	n/a	n/a	n/a	1,980

1.5 Mechanical Integrity Testing

1.5.1 CW-1 Mechanical Integrity Testing

Mechanical Integrity Testing (MIT) has been performed on CW-1 to verify the internal and external well integrity over the permitted period. The testing has included pressure testing in the annular space and final casing, cement bond logs, temperature, and Radioactive Tracer Surveys (RTS) in CW-1. These logs are designed to give an indication of the borehole hydraulic seal quality, the potential for upward migration of injection fluids, and to identify the existence of casing leaks. Additionally, the logs coupled with a video survey of the well interior provide background information with which to evaluate future MITs.

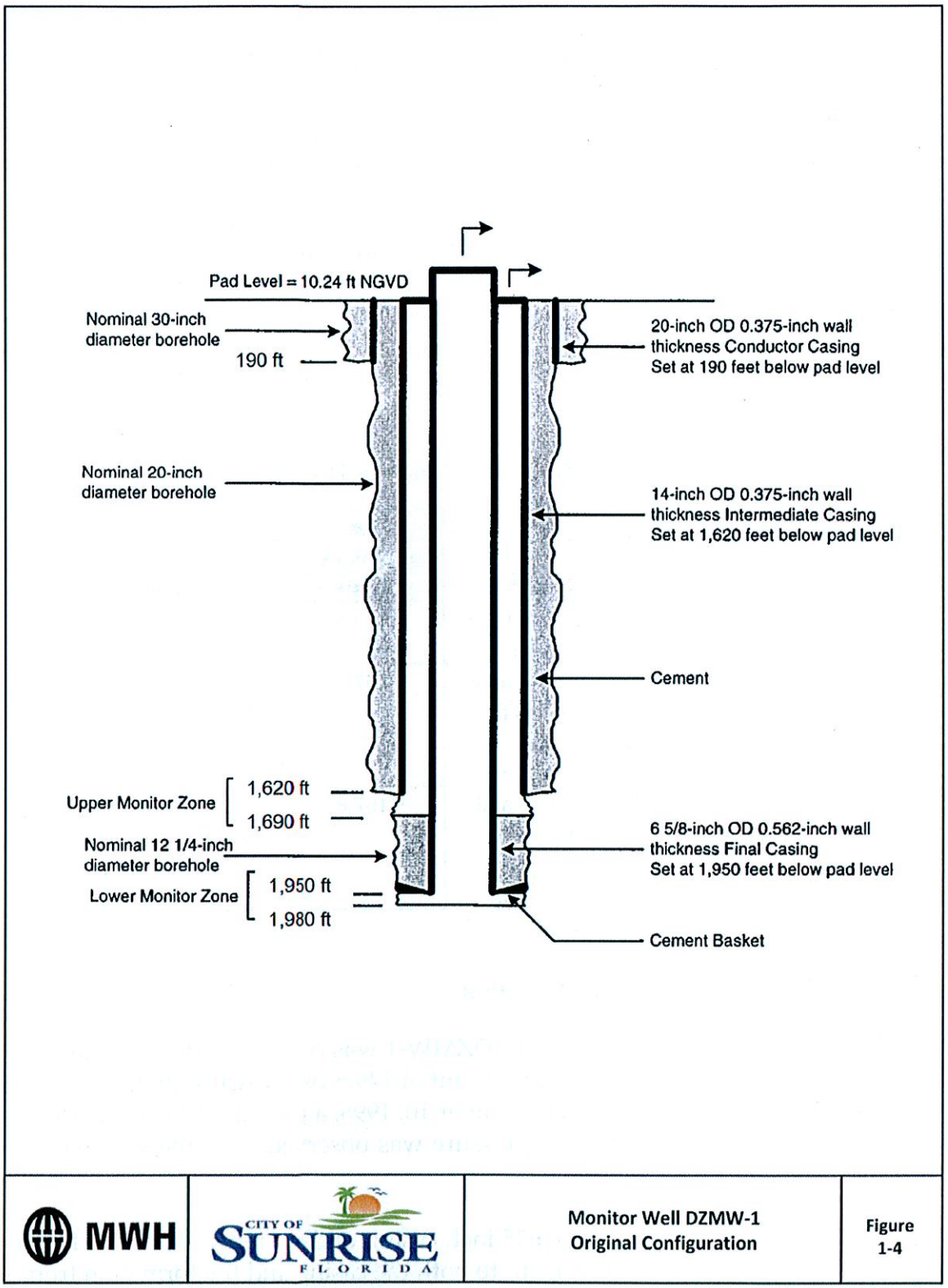


Figure 1-4 DZMW-1 Original Configuration

Interpretations of the mechanical integrity logs for both the injection and monitor wells after completion of construction are included in the *Sawgrass Water Treatment Plant Concentrate Disposal System, City of Sunrise, Drilling and Testing Report, August 1999* and the *Operational Testing Request UIC Permit 0129008-001-UC, May 1999.* These two reports also describe the demonstration of confinement, the location of the base of the USDW (approximately 1,920 feet bpl), and the capacity of the well to receive injection fluids.

In 2003, a regularly scheduled, 5-year MIT was performed on CW-1 to demonstrate continued integrity. The testing results and interpretations were provided to the FDEP in the *Sunrise Utility Complex Injection Well System, Mechanical Integrity Testing Report, Injection Wells IW-1, IW-2, IW-3, and CW-1, September 2003.* The results of the testing demonstrated that CW-1 continued to exhibit internal and external mechanical integrity. The results of the pressure tests conducted as part of the MIT testing of CW-1 are presented in **Table 1-3.**

Table 1- 3 CW-1 MIT Pressure Test Results

Date	Purpose	Method	Test Pressure (psi)	Pressure Test Results
11/9/1998	Construction	Tubing tested with single packer	159.0	Pass 0.3% decrease over one hour
11/17/1998	Construction	Final Casing and tubing tested by pressurizing annular space:	157.0	Pass 0.6% decrease over one hour
6/21/2003	5 Year MIT	Final Casing and tubing tested by pressurizing annular space:	157.8	Pass 1.9% decrease over one hour

1.5.2 DZMW-1 Mechanical Integrity Testing

Pressure testing of the 14-inch casing in DZMW-1 was conducted on December 2, 1998. There was a 2.9-percent decrease from an initial 149.5 psi pressure that was within the five-percent limit set by FDEP. On December 10, 1998, a pressure test was performed in the 6.625-inch casing. No change in pressure was observed from the starting pressure of 151 psi.

A sector bond log was run on the 6.625-inch casing on December 28, 1998. The results indicated a good bonding of the cement to both the casing and the formation from 1,610 feet bls to 1,958 feet bls. The oxygen activation log or Water Flow Log (WFL) was run on DZMW-1 on January 12, 1999, after the 6.625-inch casing was cemented. The WFL

was used to verify the integrity of the cement seal between the upper and lower monitor zones and confirm that no fluid is moving vertically behind the casing in the cemented interval. The logging results indicated hydraulic isolation between the upper and lower monitoring zones. A summary of the casing pressure tests conducted during the construction of DZMW-1 is presented in **Table 1-4.**

Table 1-4 DZMW-1 Casing Pressure Testing Results

Date	Purpose	Method	Test Pressure (psi)	Pressure Test Results
12/2/1998	Construction	Casing tested with single packer	149.5	Pass 2.9% decrease over one hour
12/10/1998	Construction	Casing tested with single packer:	151.0	Pass 0.0% change over one hour

1.6 CW-1 Tubing Failure

On April 3, 2007, at approximately 4:30 p.m., the injection well pressure increased from approximately 33 psi to 45 psi and the flow rate decreased from approximately 2,100 gpm to approximately 1,400 gpm. The concentrate booster pumps switched on to compensate for the increase in head and the system continued pumping at 2,100 gpm. City staff checked the wellhead valve and verified that it was open at 100 percent. The annular pressure maintained a positive differential before and after the pressure increase. The system remained online until 11:00 a.m. on April 4, 2007, at which time the concentrate flows were diverted to the headworks of the Wastewater Treatment Plant.

The City's consultant, MWH, visited the site on April 5, 2007, to review the monitoring data and discuss the event with plant operations staff. The well was placed back into service at 1:50 p.m. that day to evaluate the system pressures under varying flow conditions. It appeared that the injection tubing and annular pressures remained approximately 12 psi higher than they were prior to April 3, 2007.

On April 6, 2007, the City reported in writing to the FDEP of an unexplained increase in injection pressures that occurred on April 3, 2007. On April 25, 2007, a video survey was performed by Youngquist Brothers, Inc., from land surface to 1,176 feet bls. The City's Consultant, MWH, witnessed the performance of the video survey. A separation of the injection tubing was observed from 72 to 122 feet bls. The camera was unable to pass an obstruction in the tubing at 1,176 feet bls. A copy of the video was included as an attachment to the letter.

1.7 DZMW-1 Casing Failure

The City received a Notice of Non-Compliance letter dated April 7, 2006, from the FDEP Water Facilities Compliance/Enforcement Environmental Manager. The notice indicated that during the 2005 Annual Compliance Evaluation Inspection (CEI), it was observed that the DZMW-1 upper and lower monitor zones were exhibiting identical pressure readings.

In a response letter dated June 20, 2006, the City concurred with the Department's statement that the differential between the two zones had decreased from around 2 psi at the initiation of system operation to approximately 0.1 psi. The City indicated that it anticipated a drilling contractor would be necessary to address the condition of CW-1 and that the contractor could also potentially replace the DZMW-1 lower monitor zone steel casing with fiberglass reinforced plastic (FRP) casing.

On December 28, 2006, the City submitted an application for minor modification to FDEP Permit 0129008-004-UO to the Department. The City proposed pressure testing the DZMW-1 final steel casing. If the results of the pressure test demonstrated a leak in the final steel casing, the casing was to be milled out and replaced with new FRP casing. The Minor Modification was approved by the Department on June 5, 2008.

2.0 Well Rehabilitation

2.1 Introduction

The City received Department approval and a Minor Modification of the Operation Permit on June 5, 2008. The purpose of the Minor Modification was to allow the rehabilitation and testing of CW-1 and DZMW-1. A copy of the Minor Modification is presented in **Appendix A**.

This section of the report describes the rehabilitation activities for CW-1 and DZMW-1. The locations of CW-1 and DZMW-1 at the City of Sunrise Sawgrass site are shown on **Figure 1-2.** A summary of the construction activities for each well was prepared for each shift in the form of a daily shift report. The daily shift reports have been previously submitted to the Department and the TAC with the Weekly Summary Reports.

2.2 Work Plan

The application for Minor Modification submitted to the Department included a project work plan, which identified an outline to implement a remedy to the concentrate injection well with the intention of making modifications to the plan as site specific conditions warranted.

The work plan originally called for recovery of the YBI positive seal packer inner mandrel. As described below, several attempts at recovering the inner mandrel were unsuccessful. The existing YBI positive seal packer was to be reused and the annular space between the final 24-inch casing and the 16-inch FRP tubing to be filled with a pressurized mixture of water and anti-corrosive fluid. After failing to release the YBI packer inner mandrel, observing the condition of the final casing, and with conceptual approval by FDEP on December 17, 2008, it was decided to proceed with a cemented annular space. Changing the plan from a fluid filled to cement-filled annular space required the submittal of a request for a Major Modification to the Operating Permit with a request for an Alternative Design be made. The Major Modification was approved under FDEP Permit 0129008-005-UC (CW-1 & DZMW-1) on January 8, 2010. A Copy of the Major Modification is presented in **Appendix A**.

Rehabilitation of DZMW-1 originally included milling out the existing final casing between the bottom of the upper monitor zone and the top of the lower monitor zone, 1,690 to 1,950 feet bls. As described later in this report, milling of the steel casing over this interval was not successful. With Department concurrence, a whipstock was installed permitting a new borehole to be established between the upper and lower monitor zones for the installation of the replacement FRP casing

Rehabilitation of the two wells included the following activities associated with general site work, rehabilitation of injection well CW-1 and rehabilitation of dual-zone monitor well DZMW-1:

General Site Work

- Shallow Monitor Well Water Quality Samples
- Mobilization of Equipment
- Discharge Containment

Injection Well CW-1

- Remove steel injection tubing
- Video Survey the 24-inch OD final casing:
- Pressure Test the 24-inch OD final casing:
- Install the new injection tubing
- Set the quad seal cementing packer
- Fill the annular space with cement
- Video survey FRP
- Pressure test FRP
- Reinstall wellhead
- Radioactive Tracer Survey (RTS) of the final casing
- Conduct short term injection test

Monitor Well DZMW-1

- Suppress the artesian head prior to dismantling wellhead
- Video Survey the 6.625-inch OD final steel casing
- Pressure test the 6.625-inch OD final steel casing
- Mobilize drill rig over the well.
- Remove the 6.625-inch OD final steel casing to the bottom of the lower monitor zone
- Pressure test the 14-inch diameter upper monitor zone casing
- Install whipstock
- Drill new borehole between upper and lower monitor zones
- Conduct geophysical logging and video survey
- Install final FRP casing and cement in place
- Conduct cement bond log
- Video survey the FRP final casing
- Pressure test the FRP final casing
- Reinstall the wellhead

The configurations of CW-1 and DZMW-1 following the completion of rehabilitation activities are presented as **Figures 2-1** and **2-2.** After completing all well modification, the City placed DZMW-1 back into service and requested FDEP approval to conduct a short term injection test on CW-1.

2.3 General Site Work

2.3.1 Shallow Monitor Wells

Prior to beginning and throughout construction activities, the four (4) existing shallow monitor wells (SMWs) were sampled for water quality on a weekly basis. The locations of the shallow monitor wells are shown on **Figure 1-2.** Sampling and analyses were conducted weekly throughout the project to monitor the water quality of the surficial aquifer for potential impact from rehabilitation activities. Water quality analysis consisted of the following parameters: specific conductance, pH, chloride concentration, temperature, and water level. The results of the lab analyses presented in tabular and graphical formats were included with the weekly summary reports. No long-term adverse affects to the surficial aquifer system were observed as a result of construction activities.

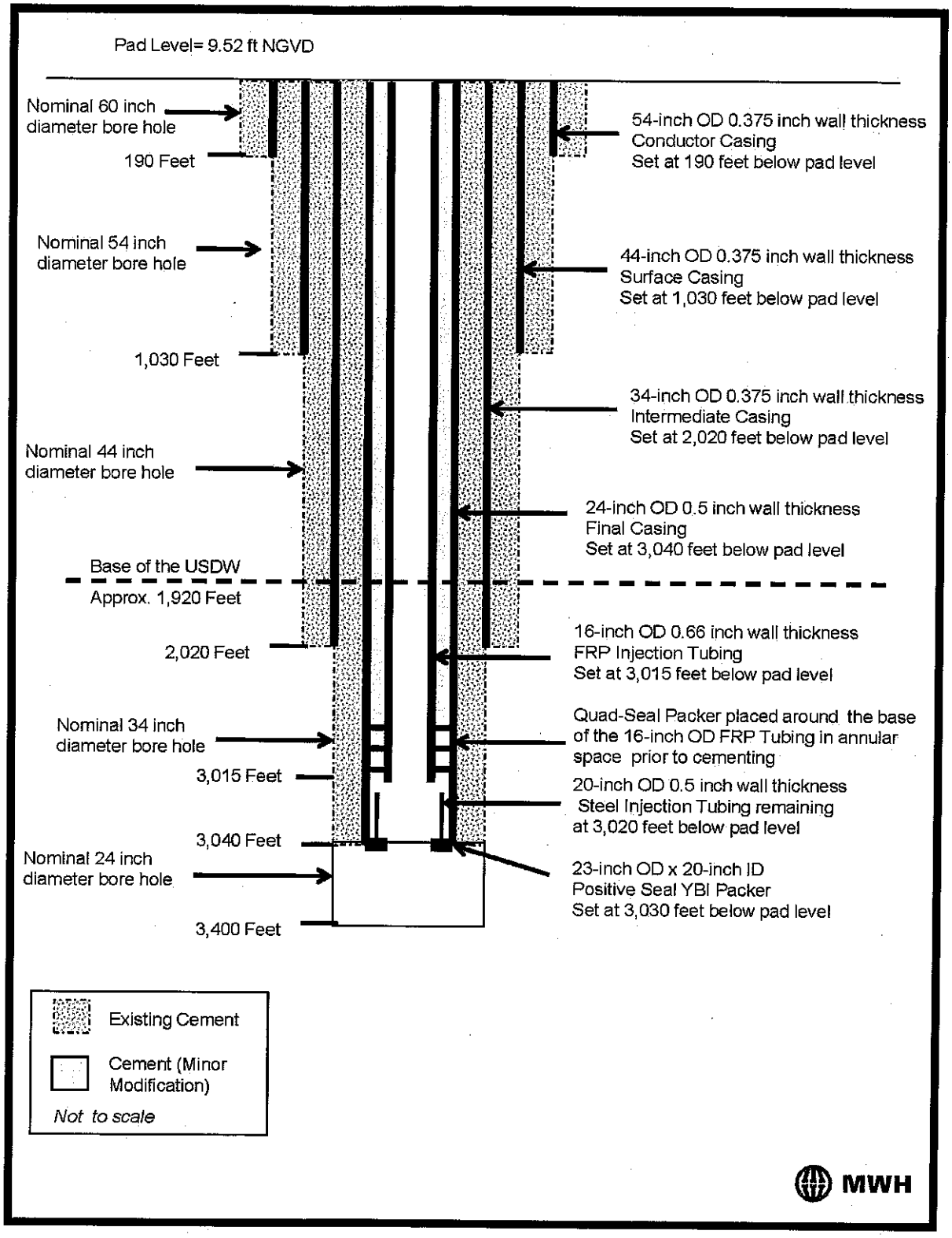


Figure 2- 1 Injection Well CW-1 Rehabilitation Details

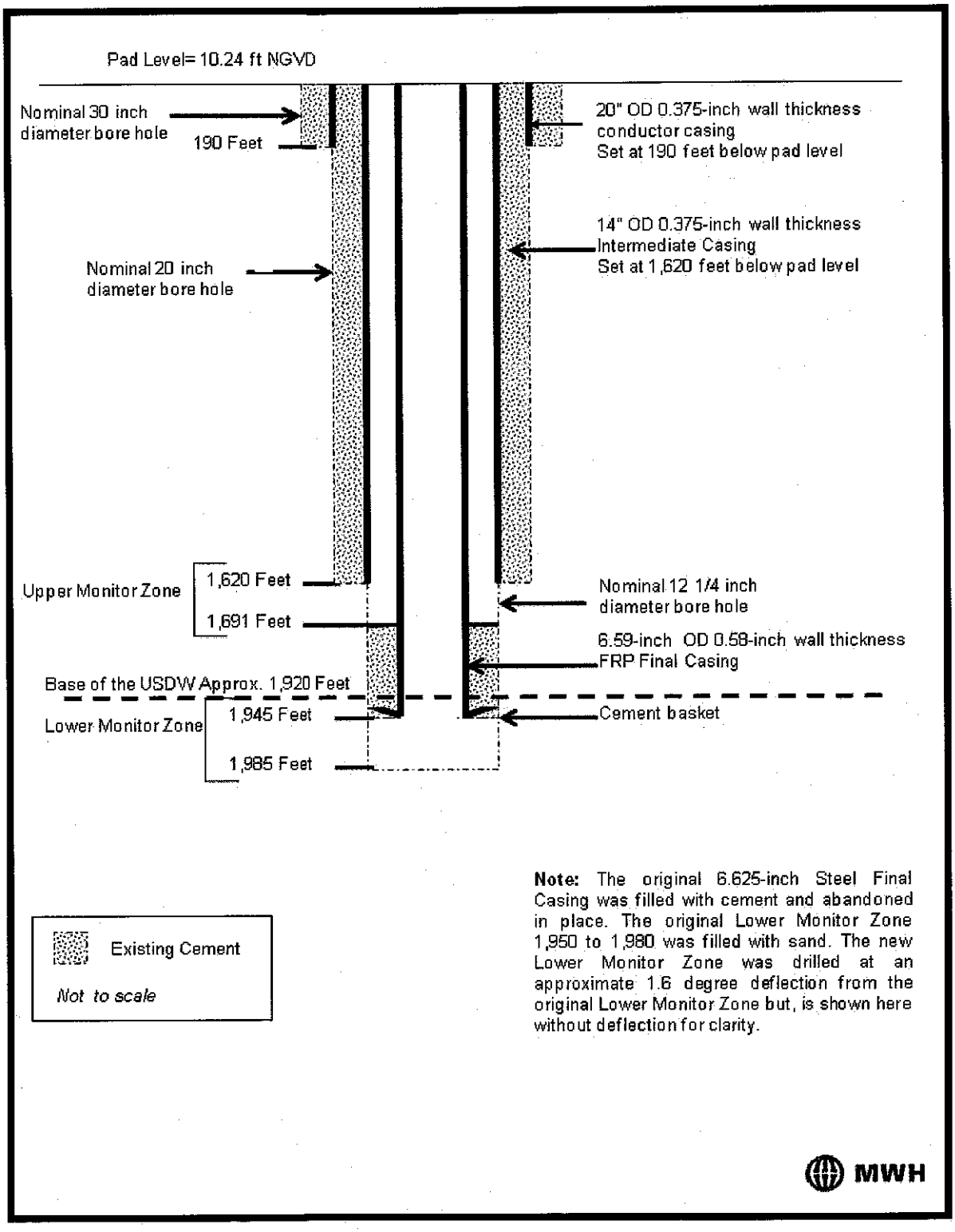


Figure 2-2 Monitor Well DZMW-1 Rehabilitation Details

2.3.2 Mobilization of Equipment

The Contractor mobilized the drilling rig, testing, and other necessary tools and equipment to the project site. Equipment setup included all necessary removal and replacement of the containment pad wall fence and dismantling of the existing associated wellhead piping, instrumentation, and equipment. Mobilization was completed on July 30, 2008.

2.3.3 Discharge Containment

Equipment was maintained to direct discharges from the well during testing and repair work into the existing scavenger tank system that ultimately discharges to the injection well system.

2.4 Injection Well CW-1 Rehabilitation

2.4.1 Steel Injection Tubing Removal

All flow to the well was ceased and the artesian head was suppressed using salt prior to the dismantling of the existing wellhead and mobilization of a drill rig over the well. Removal of the existing 20-inch steel injection tubing was initiated on August 4, 2008, with the removal of the top-most 71 feet of tubing. As of October 10, 2009, a total of 2,339 feet of 20-inch injection tubing had been removed from CW-1. Repeated attempts did not result in the recovery of additional tubing.

On October 21, 2008, the contractor attempted to cut the tubing approximately two feet above the YBI packer using a Baker Hughes casing cutter. No tubing was recovered after the attempted casing cut. A video survey conducted on October 24, 2008, did not reveal any cut in the 20-inch tubing. Several more unsuccessful attempts were made to recover additional sections of the 20-inch injection tubing.

On October 31, 2008, an attempt was made to dislodge the inner mandrel of the 20-inch tubing YBI positive seal packer. An explosive string shot was positioned at a predetermined location and detonated as the tubing was held in tension. The packer did not release. It was later determined that the string shot was detonated above the YBI packer.

Additional efforts to remove the remaining 30 feet of 20-inch tubing and the inner mandrel of the YBI packer were unsuccessful. On November 6, 2008, two additional explosive string shots were positioned at the center of the YBI packer and detonated. Neither the YBI packer nor any addition tubing was recovered as a result of the string shots.

Two additional attempts were made to cut the casing on November 11 and 13, 2008. These attempts were not successful. On November 18, 2008, the use of casing jacks resulted in the recovery of about 20 feet of injection tubing leaving approximately 8 feet of tubing and the YBI packer inner mandrel in place. In order to prevent potential damage to the 24-inch casing and the final casing cement seal, the decision was made to abandon the YBI packer and the remaining 8 feet of tubing.

2.4.2 Video Survey of 24-Inch OD Final Casing

On November 19, 2008, a video survey of the interior of the 24-inch diameter final casing was conducted. The survey revealed that the final casing had been affected by activities associated with removal of the injection tubing. Vertical gouges of varying prominence were observed over various intervals. The gouges were apparently the result of lugs/centralizers of the injection tubing riding against the final casing as they were removed from the well.

The top of the remaining 20-inch diameter injection tubing was located at a depth of 3,024 feet bls. The top of the YBI positive seal packer was identified at 3,034 feet bls. The YBI packer appeared to be fully intact with the inner mandrel properly seated within the outer mandrel. A section of the injection tubing that had fallen back downhole was located at 3,077 feet bls. The video survey was terminated at a depth of 3,284 feet bls at which point the borehole was bridged over. The video survey and the corresponding video log are included in **Appendix B**.

2.4.3 Pressure Test of 24-Inch OD Final Casing

On December 17, 2008, a hydrostatic pressure test was conducted on the 24-inch diameter final casing. Based on the conditions observed during the video survey the center line of the single packer used to conduct the test was positioned at a depth of 3,016 feet bls. A temporary wellhead was placed on the well for use during pressure testing. A calibrated pressure gauge was mounted on the temporary wellhead. A copy of the calibration certificate was submitted to FDEP prior to testing.

The final casing was internally pressurized to 150.0 psi. A pressure decrease of 1.5 psi was observed over the 60-minute test period. This decrease represents a 1.0-percent change in the original pressure, which is within the allowable change of 5 percent. Upon conclusion of the pressure test, the pressure held on the casing was bled-off and the fluid was discharged, collected, measured, and recorded.

A copy of the test gauge certification records and results of the hydrostatic pressure test are contained in **Appendix C**.

2.4.4 FRP Injection Tubing Installation

Nominal 16-inch (15.8-inch OD pipe with a nominal ID of 14.48 inches and wall thickness of approximately 0.66 inches) Red Box® 1250 filament-wound fiberglass pipe manufactured by Future Pipe Industries, Inc. was installed to a depth of 3,014 feet bls. The replacement injection tubing has an internal pressure rating of a minimum of 1,250 psi. The tubing is manufactured with long threaded and coupled connections that are precision-lathe cut and factory milled. Prior to shipping, the tubing was tested to an internal pressure rating of a minimum of 1,250 psi for a minimum of 5 seconds. Tubing job identification numbers were verified with the inspection certificates prior to installing the tubing. Copies of the tubing inspection certificates are presented in **Appendix D**.

2.4.5 Quad Seal Packer

A YBI Quad Seal cementing packer was installed at the base of the 16-inch diameter injection tubing. The 16-inch injection tubing is seated on the packer. A copy of the packer specifications is presented in **Appendix E**. A detailed drawing showing the position of the quad seal packer in relationship to the abandoned-in-place YBI positive seal packer is shown **Figure 2-3.**

2.4.6 Annular Space

In accordance with the Major Modification, the annular space between the nominal 16-inch diameter FRP and the 24-inch final casing was filled with cement. Cementing records are provided in **Appendix F**.

After securing the quad seal cementing packer, the annular space was filled with cement in seven stages. The lower 267 linear feet (2,745 to 3,012 feet bls) was filled with neat cement. The remaining annular space was filled with an 8-percent gel mixture. A cement top temperature log was conducted after each cementing stage. A copy of the merged cement top temperature logs is presented in **Appendix G**.

On February 8, 2010, a background cement bond log was performed in the injection well 16-inch FRP tubing before cementing. The tubing was then cemented and a final cement bond log was conducted on February 22, 2010. The logs were then compared and showed the presence of cement behind the 16-inch injection tubing. The cement bond logs conducted in CW-1 demonstrated that there is a good cement seal around the 16-inch diameter tubing and that there are no channels or conduits that would allow fluid movement adjacent to the tubing.

Mechanical integrity testing of CW-1 is discussed in Section 3.

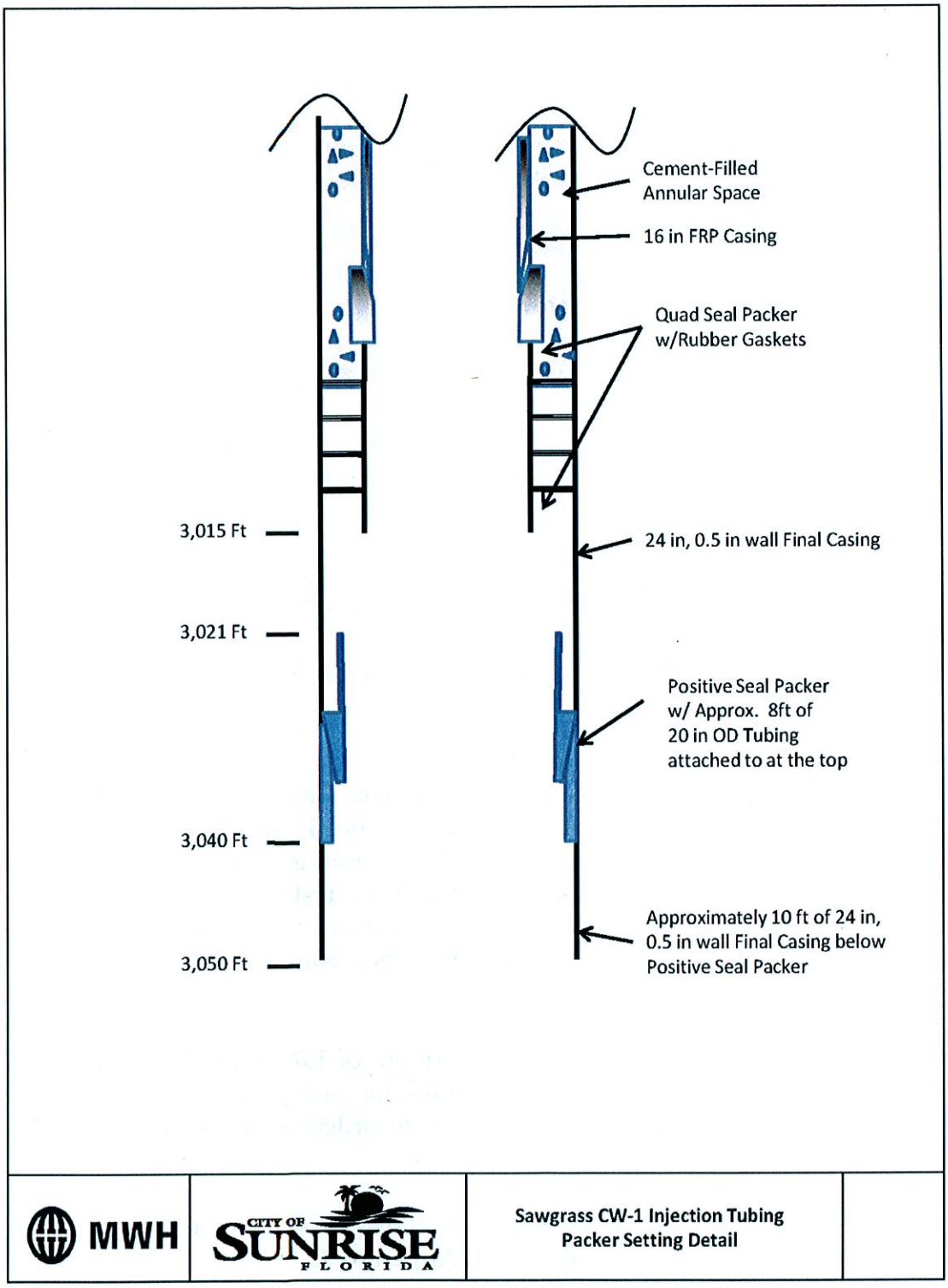


Figure 2-3 CW-1 Injection Tubing Packer Setting Detail

2.4.7 Reinstall Wellhead

Following the completion of rehabilitation activities, the wellhead was replaced. A modified wellhead was reinstalled to incorporate the new tubing and to eliminate the no longer necessary annular pressure system. Associated piping and instrumentation was modified as required to fit the new wellhead configuration. The signed and sealed record drawings and completion certificates are presented in **Appendix H**.

2.5 Monitor Well DZMW-1 Rehabilitation

2.5.1 6.625-inch Casing Video Survey

On December 8, 2008, the DZMW-1 lower monitor zone artesian head was suppressed and the well head removed. The existing 6.625-inch diameter steel lower monitor zone casing was cleaned using a casing brush. After brushing, a temporary header was installed and the casing was flushed with potable water in order to obtain a clear view during the video survey.

On December 12, 2008, a video survey of the interior of the 6.625-inch diameter final casing was conducted. The survey revealed the general condition of the casing to be poor. Several potential holes in the casing were observed during the survey. The video survey and the corresponding video log are included in **Appendix B**.

2.5.2 6.625-inch Steel Casing Pressure Test

On December 12, 2008, a hydrostatic pressure test was conducted on the 6.625-inch diameter DZMW-1 final casing. A temporary wellhead was placed on the well for use during pressure testing. Based on the conditions observed during the video survey, the center line of the single packer used to conduct the test was positioned at a depth of 1,117 feet bls. The casing was pressurized to 100 psi. After five minutes, the casing pressure was 88 psi, a decrease of 12 percent. The casing pressure was recorded as 56 psi after 21 minutes, a decrease of 44 percent.

The packer was repositioned to a centerline depth of 1,087 feet bls and the casing was again pressurized to 100 psi. After two minutes, the casing pressure had decreased five percent to 95 psi. The casing pressure was recorded as 45 psi after 30 minutes, a decrease of 55 percent.

The results of the pressure tests exceeded the allowable change of 5 percent. A copy of the hydrostatic pressure test is contained in **Appendix C**.

2.5.3 Lower Monitor Zone Casing Removal

Following the casing pressure test a drilling rig was positioned over DZMW-1. Preparations for removal of the lower monitor zone casing were initiated on January 5, 2009. To prevent contamination of the lower monitor zone during casing removal operations the open hole was filled with silica sand from the total depth of the well, 1,980 feet bls, to approximately 1,938 feet bls, 12 feet above the 6.625-inch casing seat. The final casing between the upper and lower monitor zones (1,691 to 1,938 feet bls) was filled with neat cement.

On January 9, 2009, a casing cutter was lowered into the 6.625-inch final casing. The existing steel final casing was cut at a depth of 1,690 feet bls. By January 13, 2009, 1,690 feet of tubing had been removed from the well.

The contractor began milling out the cemented casing between the upper and lower monitor zones on January 19, 2009. Milling of the remaining 0.500-inch wall thickness final casing proceeded very slowly. As of January 30, 2009, milling operations had proceeded to a depth of 1,696 feet bls for a total of 6 feet of casing having been removed. Milling operations were suspended at this point, pending approval of an alternative method.

2.5.4 14-inch Casing Pressure Test

On February 17, 2009, a hydrostatic pressure test was conducted on the 14-inch diameter upper monitor zone casing. The center line of the single packer used to conduct the test was positioned at a depth of 1,612 feet bls. A temporary wellhead was placed on the well for use during pressure testing. A calibrated pressure gauge was mounted on the temporary wellhead.

The 14-inch diameter upper monitor zone casing was internally pressurized to 50.0 psi. A pressure decrease of 1.2 psi was observed over the 60-minute test period. This decrease represents a 2.4 percent change in the original pressure, which is within the allowable change of 5 percent. Upon conclusion of the pressure test, the pressure held on the casing was bled-off and the fluid discharged, collected, measured, and recorded.

A copy of the test gauge certification records and results of the hydrostatic pressure test are contained in **Appendix C**.

2.5.5 Revised Rehabilitation Plan

In preparation for milling out the 6.625-inch casing located between the upper and lower monitor zones, the lower monitor zone had been filled with silica sand and the casing filled with neat cement. Milling out of the casing over the interval of 1,691 to 1,938 feet bls proved to be very difficult, time consuming, and expensive. An

alternative approach to completing the DZMW-1 rehabilitation was proposed to the FDEP.

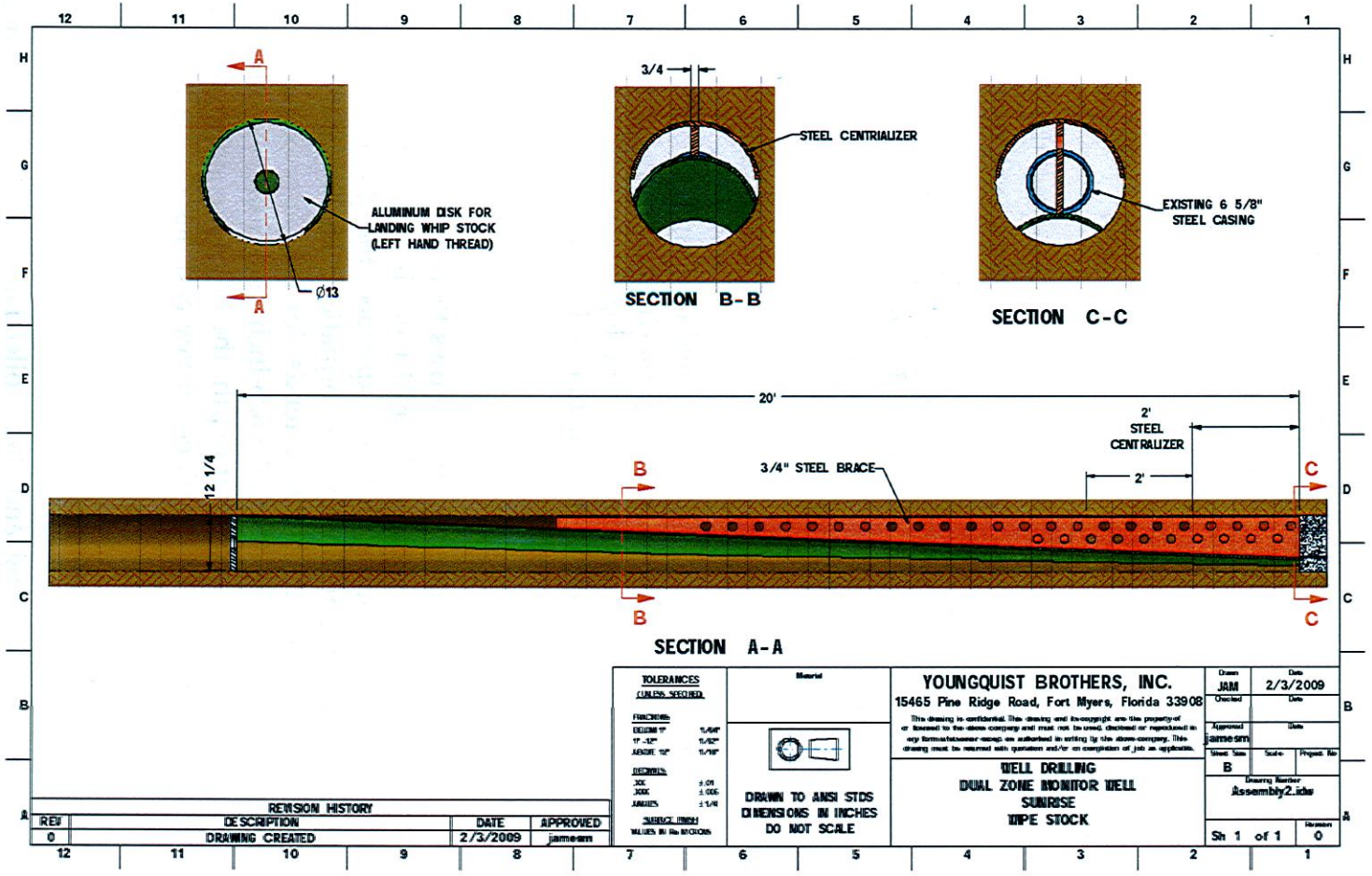
The proposed revisions to the rehabilitation plan included the following activities:

- Installation of a whipstock at the top of the existing 6.625-inch casing at 1,690 feet bls.
- Use whipstock to initiate deviation of the borehole.
- Drill a 12.25-inch diameter hole next to the existing lower monitor zone casing to a depth of approximately 1,985 feet bls.
- Conduct deviation surveys at 30-foot intervals between 1,690 and 1,780 feet bls to determine borehole inclination. If inclination is maintained at or below 3 degrees to 1,780 feet bpl, the inclination surveys will be performed every 60 feet to 1,985 feet bpl.
- Caliper, and dual-induction logs and a video survey will be performed from land surface to the total depth of the well.
- Install new 6.625-inch Red Box FRP will be installed with a YBI standard 10"x 14" External Casing Packer-ISP completion packer.
- Conduct a background CBL in the FRP.
- Cement the casing in place using the tremie method. A temperature log will be conducted after each stage.
- Conduct a final CBL on the FRP.
- Conduct a video survey of the 6.625-inch casing and open hole.
- Develop the upper and lower monitor zones and collect samples for laboratory analysis.

On February 17, 2009, the Department approved the revised rehabilitation work plan for DZMW-1. A copy of the approval letter is located in **Appendix A.**

2.5.6 Whipstock

A whipstock is an inclined plane placed within a borehole oriented in the direction the well is intended to take. The whipstock used to "kick off" the new DZMW-1 borehole was designed and manufactured by the contractor. A diagram of the whipstock used in DZMW-1 is presented as **Figure 2-4.** The whipstock was lowered on 2.375" Hydril tubing screwed into an aluminum left-hand threaded box to allow the tubing to be unscrewed from the whipstock. The bottom of the whipstock was positioned at 1,696 feet bls. The whipstock was cemented in place with 1.5 barrels of neat cement. The top of the cement was tagged at 1,675 feet bls. The contractor began drilling a 12.25-inch diameter hole using the reverse air method on February 25, 2009. The bit was initially advanced slowly to allow the whipstock to initiate the deviation. The borehole was drilled to a total depth of 1,985 feet bls



gure 2- 4 Whipstock Details

2.5.7 Geologic Samples

Samples of formation cuttings were collected and analyzed during drilling. Circulation time (the time required for drilled cuttings to reach the surface) was calculated to ensure that accurate sample depths were recorded. A geologic description of each sample was entered into a lithology log. The limestone cuttings were classified in accordance with the scheme of Dunham (1962). The samples collected during the drilling of the new borehole showed excellent correlation with the log generated during the initial construction. The descriptions of cuttings recovered from the new borehole are presented **Appendix I**.

2.5.8 Deviation Surveys

The first deviation survey was conducted about 30 feet below the bottom of the whipstock at a depth of 1,720 feet bls. Additional deviation surveys were conducted at depths of 1,750; 1,780; 1,840; 1,900; and 1,960 feet bls. The average deviation of the borehole was approximately 1.5 degrees below 1,690 feet bls with a maximum recorded deviation from vertical of 1.75 degrees. Based on this information, the new lower zone will be within approximately 8 lateral feet of the original lower zone. The results from the deviation surveys are presented in **Appendix J**.

2.5.9 Geophysical Logging

A caliper log and dual-induction log were performed on March 5, 2009, in the newly drilled pilot hole, adjacent to the existing 6.625-inch steel casing. Copies of the geophysical logs are presented in **Appendix G**. The logs show similar traces to those performed on December 5, 1988, during construction of DZMW-1

2.5.10 Video Survey

A borehole video performed on March 5, 2009, shows that the 14-inch final casing and the upper monitor zone between 1,620 and 1,670 feet bls are in good condition for continued monitoring. The reaming process expanded the diameter of the upper monitor zone without damaging or raveling the formation. The top of the whipstock is located at approximately 1,670 feet bls and extends down to approximately 1,692 feet bls. Cement from the annulus of the original 6.625-inch steel casing is visible to a depth of approximately 1,720 feet bls. Below that depth, the holes are sufficiently separated that no cement is visible. A copy of the video survey and description is presented in **Appendix B**.

2.5.11 Lower Monitor Zone FRP Casing

Following the completion of drilling and data collection, a casing seat request was submitted to the Department on March 6, 2009. A depth of 1,945 feet bls was proposed

for the lower monitor zone 6.625-inch FRP casing setting depth. The lower monitor zone was proposed to be established between 1,945 and 1,985 feet bls. The original lower monitor zone was between 1,950 and 1,980 feet bls. The casing seat request also proposed establishing the upper monitor zone between bottom of the 14-inch diameter casing (1,620 feet bls) and the top of the whipstock (1,670 feet bls). The original upper monitor zone was between 1,620 and 1,690 feet bls. The casing seat request was approved by the Department on March 16, 2009. A copy of the FDEP approval letter is presented in **Appendix A**.

2.5.12 FRP Casing Installation

Nominal 6.625-inch diameter FRP casing (6.59-inch OD pipe with a nominal ID of 5.43 inches and wall thickness of approximately 0.58 inches) Red Box® 2500 filament-wound (FRP) manufactured by Future Pipe Industries, Inc. was installed to a depth of 1,945 feet bls. The replacement final casing has an internal pressure rating of a minimum of 2,500 psi. The casing is manufactured with long threaded connections that are precision-lathe cut and factory milled. Prior to shipping, the casing was tested to an internal pressure rating of a minimum of 2,500 psi for a minimum of 5 seconds. Casing job identification numbers were verified with the inspection certificates prior to installing the tubing. Copies of the casing inspection certificates are presented in **Appendix D**. The tubing was seated using an external cementing packer coupled to the bottom of the FRP casing. A copy of the packer specifications is presented in **Appendix E**.

2.5.13 Cementing

The external cementing packer was inflated through the FRP casing. The casing was cemented in place from 1,945 to 1,691 feet bls in four stages using the tremie method. A temperature log was conducted after each cement stage and is provided in **Appendix G**. The cementing records are presented in **Appendix F**.

2.5.14 FRP Pressure Testing

On March 18, 2009, a hydrostatic pressure test was conducted on the lower monitor zone casing. The 6.625-inch diameter lower monitor zone casing was internally pressurized to 50.0 psi. A pressure decrease of 0.2 psi was observed over the 60-minute test period. This decrease represents a 0.4-percent change in the original pressure, which is within the allowable change of 5 percent. Upon conclusion of the pressure test, the pressure held on the casing was bled-off and the fluid discharged, collected, measured, and recorded. After the conclusion of the pressure test the casing was pressurized to 370 psi. As designed, the increased pressure caused the packer bottom cap pins to shear providing access to the lower monitor zone. A copy of the test gauge certification records and results of the hydrostatic pressure test are contained in **Appendix C**.

2.5.15 Video Survey

A video survey of the 6.625-inch FRP casing and the reestablished lower monitor zone was conducted on March 20, 2009. The survey shows that the new final FRP casing and the lower monitor zone between 1,945 and 1,985 feet bls are in excellent condition for continued monitoring. A copy of the video survey and description is presented in **Appendix B**.

2.5.16 Cement Bond Log

On March 19, 2009, a cement bond log was performed in the monitor well 6.625-inch FRP casing. The cement bond log conducted in DZMW-1 demonstrated that there is a good cement seal around the 6.625-inch diameter casing and that there are no channels or conduits that would allow fluid movement adjacent to the casing. A copy of the 6.625-inch FRP casing cement bond log is included in **Appendix G**.

2.6 Reinstall Wellhead

Following the completion of rehabilitation activities, the wellhead was replaced. A modified wellhead was reinstalled to incorporate the new FRP final casing. Associated piping and instrumentation was modified as required to fit the new wellhead configuration. The signed and sealed record drawings and completion certificates are presented in **Appendix H**.

3.0 Final Testing

3.1 General

The DZMW-1 upper and lower monitor zones were developed and background water quality samples were collected. The samples were analyzed for primary and secondary drinking water parameters and minimum criteria as listed in the Major Modification.

After the injection well CW-1 rehabilitation activities were completed, the injection well was tested for mechanical integrity. Mechanical integrity testing (MIT) included a hydrostatic pressure test of the injection tubing, a temperature log, a video survey, a radioactive tracer survey (RTS) and a short-term injection test.

3.2 Background Water Quality

The DZMW-1 upper and lower monitor zones were reestablished over the intervals of 1,620 to 1,691 and 1,945 to 1,985 feet bls, respectively. These intervals are similar to but not identical to the original upper monitoring zone interval of 1,620 to 1,690 feet bls and lower monitoring zone interval of 1,950 to 1,980 feet bls. The wellheads for both zones were replaced and flow meters and pressure gauges were calibrated. Calibration certificates are included in **Appendix H**. In order to reestablish the "natural" or background quality of the water, samples were collected from the upper and lower monitor zones. Prior to sampling, the upper and lower monitor zones were developed. After development, a minimum of three well volumes was purged before the samples were collected. The samples were analyzed for a variety of constituents to establish the background quality of the water. A summary of the laboratory results is presented in **Table 3-1**. Background water quality laboratory analytical results of the samples collected from the upper and lower monitor zone of DZMW-1 are presented in **Appendix K**. The initial construction water quality for the upper zone appears to correspond to the current water quality results. The water quality results for the lower zone shows that the zone has freshened as indicated in the analysis of water quality for the DZMW-1 lower zone previously submitted to FDEP on March 8, 2010 in response to questions concerning the Operation Permit Application water quality analysis.

Table 3-1 DZMW-1 Upper and Lower Monitor Zone 2010 vs 1998 Background Water Quality

		Upper Zone		Lower Zone	
Parameter	Units	5-21-10	12-21-98	5-21-10	12-21-98
Conductivity	umhos/cm	5,760	NR	12,500	NR
Chloride	mg/L	1,610	1,650	3,890	8,070
TDS	mg/L	3,510	3,390	6,590	15,560
Sulfate	mg/L	562	786	770	968
Ammonia	mg/L	0.367	0.50	0.139	0.26
TKN	mg/L	0.629	0.68	0.686	5.68
Phosphorus	mg/L	NR	0.09	NR	0.10
pH	s.u	7.61	8.3	7.76	7.44
Temperature	degrees C	22.3	NR	22.1	NR
Potassium	mg/L	NR	NR	NR	NR
Nitrate	mg/L	<0.500	<0.01	<0.500	<0.01
Iron	mg/L	0.234	0.098	0.0983	0.462

TDS – Total Dissolved Solids
TKN – Total Kjeldahl Nitrogen
mg/L - milligrams per liter
s.u.- standard units
mg/L - milligrams per liter
NR – Not Reported

3.3 Mechanical Integrity Testing

In accordance with FAC Rule 62-528, the injection well was tested for mechanical integrity. Testing consisted of a hydrostatic pressure test of the injection tubing, a high resolution temperature log, a television survey and a radioactive tracer survey (RTS). The hydrostatic pressure test was conducted at a pressure at least 50 percent greater than the maximum allowable operating pressure to confirm injection tubing integrity. The temperature log identifies temperature variations in the well. The television survey provides visual verification of the injection tubing integrity. The RTS provides data on the external mechanical seal of the casing. The following describes the testing methods, results of the testing, and an interpretation of the data collected during the mechanical integrity tests.

3.3.1 Hydrostatic Pressure Testing

On February 23, 2010, the CW-1 16-inch diameter injection tubing was internally pressurized to 157.5 psi. A pressure decrease of 3.5 psi was observed over the 60-minute test period. This decrease represents a 2.3-percent change in the original pressure, which is within the allowable change of 5 percent.

A copy of the test gauge certification records and results of the hydrostatic pressure test are contained in **Appendix C**.

3.3.2 Injection Well Temperature Log

On March 5, 2010, a temperature log was conducted on CW-1 from the surface to a depth of 3,350 feet bls. The temperature log recorded an increase in temperature from 67.7 degrees Fahrenheit at land surface to 84.8 degrees Fahrenheit at 120 feet bls. From 120 to 600 feet bls, the temperature gradually increased to 86.0 degrees Fahrenheit. Between 600 and 610 feet bls, a decrease to 85.4 degrees Fahrenheit was observed. From 610 to 1,175 feet bls, the temperature was gradually decreased to 84.5 degrees. Between 1,175 and 1,180 feet bls, a decrease to 84.0 degrees Fahrenheit was noted followed by a gradually decreasing trend to 81.5 degrees Fahrenheit at 1,740 feet bls. Between 1,740 and 1,750 feet bls, the temperature decreased to 80.1 degrees Fahrenheit followed by a gradual increase to 83.7 degrees Fahrenheit at 2,320 feet bls. From 2,320 to 2,800 feet bls, the temperature decreased gradually to 73.4 degrees Fahrenheit. The recorded temperature increased gradually to 81.7 degrees Fahrenheit at a depth of 3,130 feet bls where a rapid decrease to 73.1 degrees Fahrenheit was recorded. From 3,140 to 3,240 feet bls, the temperature remained generally constant at about 73 degrees Fahrenheit. From 3240 to 3,350 feet bls, the bottom of the logged interval the temperature decreased to 64.9 degrees Fahrenheit. The rapid temperature changes recorded at 600, 1,175, 1,740, and 2,320 feet bls, correlate very well with the tops of several cementing stages. A copy of the temperature log is presented in **Appendix G**.

3.3.3 Injection Well Video Survey

A video survey of the CW-1 injection tubing and open hole was performed on February 24, 2010. The survey was performed from pad level to a depth of 3,354 feet bls. Water clarity was generally good, enabling the camera to capture clear images of final casing, casing seat and open hole section. The survey revealed that the injection tubing was in excellent condition. During the video survey a piece of nominal 4-inch by 4-inch wood approximately eight feet long was observed on the side of the 24-inch final casing between the bottom of the FRP tubing at 3,018 ft bls and the top of the abandoned 20-inch tubing at 3,026 ft bls. A copy of the television survey is located on a DVD at the end of the report. A description of the observations is included in **Appendix B**.

An additional video survey will be conducted after the short term injection test of the well and 80 days or more after performance of the RTS to re-identify the location of the fish following the injection test. A copy of the survey and a description of the observations will be forwarded to the Department under separate cover.

3.3.4 Injection Well Radioactive Tracer Survey

On March 5, 2010, an RTS was conducted on CW-1. A description and interpretation of the RTS is presented in the following text. Youngquist Brothers, Inc., Geophysical Logging Division conducted a background Gamma Ray Log (GRL) and a casing collar locator (CCL) on February 24, 2010. The background GRL, which was "memorized", was reprinted on each "out of position" logging run to serve as a means of comparison. A schematic diagram of the

logging tool is represented at the top of the radioactive tracer survey log. Each logging run is identified at the top of the log. The logging tool ejector was calibrated to 0.25 millicuries (mCi) per second discharge, and the reservoir was loaded with 6 mCi of radioactive Iodine-131. Copies of the flowmeter calibration certificate and tracer (Iodine-131) assay are presented in **Appendix G** with a copy of the CW-1 RTS log. A sketch of the RTS tool is included with the RTS log.

The first test conducted (TEST #1) injected at a rate of 46 gallons per minute (gpm) using potable water. The test was conducted by positioning the tracer ejector five feet above the bottom of the casing, setting the recorder in the time drive mode, and ejecting a 2.0 mCi slug of tracer material. After 13 minutes, no indication of tracer material was observed by the top, middle, or bottom detector. The RTS tool was then moved approximately 12 feet up hole. No indication of tracer material was observed by any of the detectors indicating a failed tracer ejection. TEST #1 was restarted positioning the tracer ejector five feet above the bottom of the casing, setting the recorder in the time drive mode, and ejecting a 2.0 mCi slug of tracer material. The readings from the middle gamma ray detector began to increase from background within 45 seconds of ejection. The readings from the bottom detector increased from background approximately three minutes and 44 seconds after ejection. No increase in gamma detection by the top gamma ray detector was seen during the 60-minute monitoring period. The tools were then logged out of position (LOP #1) to a depth of 2,840 feet bls. The results of the log out of position showed no indication of tracer material movement up hole. The final casing was then flushed with potable water. Following the flushing, an out of position log was conducted (LAF #1) from below the casing to 2,840 feet bls. This log shows that no tracer material had moved up behind the casing. These results are interpreted as providing evidence that the cement seal is sound and there are no channels behind the casing.

A second test (TEST #2) was conducted at an injection rate of 45 gpm. This test also used potable water as the injection fluid. The tracer ejector was positioned five feet above the bottom of the casing and the recorder was placed in the time drive mode. A 2.0 mCi slug of tracer material was then ejected. The readings from the middle gamma ray detector began to increase from background within 33 seconds of ejection. The readings from the bottom detector increased from background approximately three minutes and 30 seconds after ejection. No detection of the tracer material was seen at the upper gamma ray detector any time during 30 minutes of time drive monitoring. The tools were logged out of position (LOP #2) to a depth of 2,840 feet bls after the 30-minute test period. The middle and bottom detector readings increased as the tool was moved out of position. This increase is attributed to a small leak from the ejector port which is positioned above the middle and bottom detectors. No detection of the tracer material was seen at the upper gamma ray detector any time during the log out of position. The results of the log out of position showed no indication of tracer material movement up hole. The injection casing was then flushed with potable water. Following the flushing, a final background and log after flush were conducted (FINAL GAMMA RAY) on the total depth of the well. This log shows that all tracer material had been flushed out of the casing because the gamma ray levels on all three

detectors returned to background levels. These results are interpreted as providing evidence that the external integrity is sound. The background logs were recorded over traces of the initial background log and showed excellent repeatability on all detectors. It also depicts where the remaining tracer material was dumped (3,340 feet bls).

3.3.5 MIT Conclusions

Based on the results of the temperature logs, hydrostatic pressure tests, video surveys and radioactive tracer survey, CW-1 has been demonstrated to have mechanical integrity.

3.4 Injection Test

On July 13, 2010, a controlled short term injection test was conducted on CW-1 using treated effluent from the City's waste water treatment facility and concentrate from the City's water treatment plant. The test consisted of a background phase, a pumping phase, and a recovery phase. The test was conducted by the City. The CW-1 wellhead pressure, injection rate and the DZMW-1 instrumentation upper and lower monitor zone pressures were measured and recorded using the facility's instrumentation. The inline venturi flow meter in CW-1 was found to be in error and a strap-on type flowmeter (GE Sensing Model PT878) was installed for testing and future operation until the venture meter can be repaired or replaced. The strap-on meter was linked into the I&C for the CW-1 so that the well flow can be monitored from the control room at the WTP. Copies of the calibration certificates for pressure and flow DZMW-1 and CW-1 meters are provided in **Appendix H**.

Background monitoring was initiated at 0700 hours on July 12, 2010. During the background monitoring period, fluids were pumped down CW-1 at rates ranging from 29 to 386 gpm. After the background monitoring phase was completed, the injection test was started at 0640 hours on July 13, 2010. The test was conducted for approximately 10.5 hours at an average rate of 5,145 gpm (7.4 MGD at 9.7 ft/sec). An attempt was made to increase the flow to the injection well to about 6,340 gpm (9.1 MGD at 12 ft/sec) for the final 1.5 hours of the injection test. The City was not able to achieve the higher injection rate. The wellhead pressure was closely monitored and not allowed to exceed two-thirds of the casing pressure test value of 157 psi (105 psi). After the pumping phase of the test was concluded, recovery readings were recorded for a period of greater than 24 hours starting at 1905 hours on July 13, 2010.

Injection flow rate, CW-1 wellhead pressure, DZMW-1 upper monitor zone pressures, and lower monitor zone pressures recorded by the City over all three phases of the test (background, pumping, and recovery) are presented in **Appendix L**. **Figure 3-1** presents the data recorded during the injection test. Tide and barometric data is also located in **Appendix L**.

The CW-1 wellhead pressure was approximately 11 psi before the start of the test. The maximum recorded CW-1 wellhead pressure during the test was approximately 66 psi. All CW-1 wellhead pressure readings are within the allowable two-thirds of the pressure test (i.e., approximately 100 psi) conducted on the 16-inch diameter injection tubing. A summary of the injection rates and wellhead pressures is presented in **Table 3-2.**

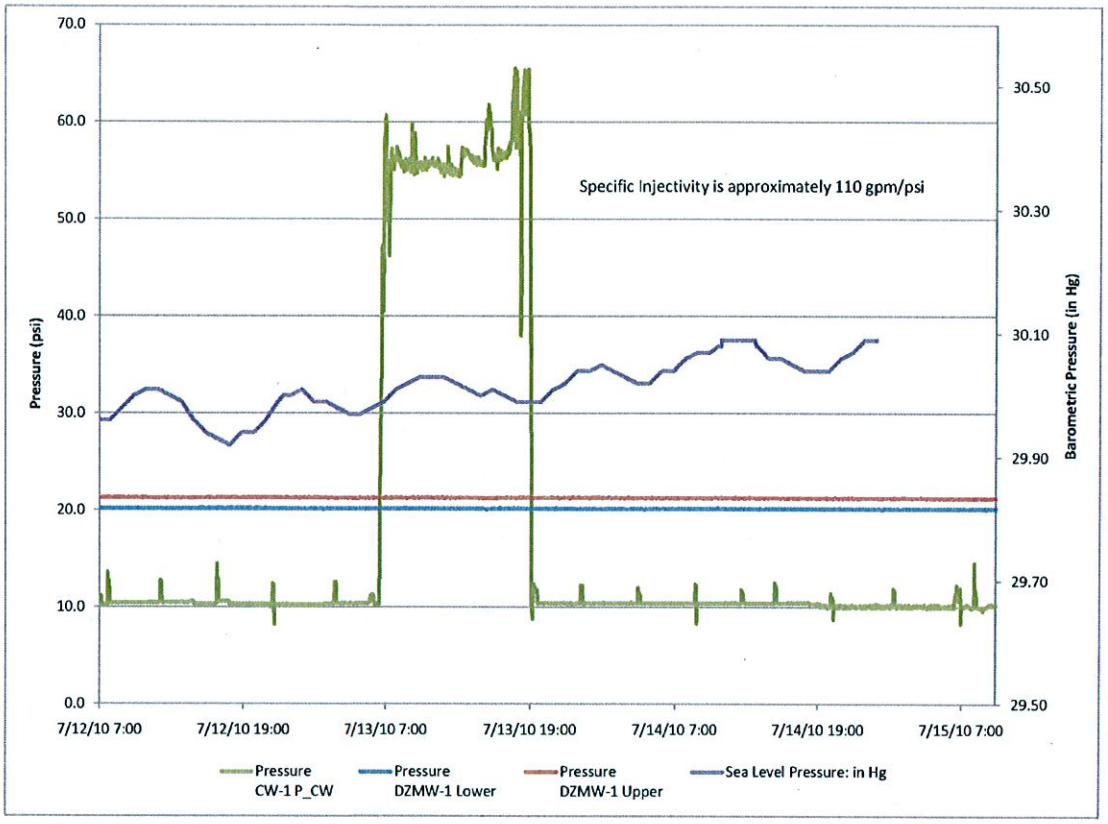


Figure 3-1 Summary of Injection Test Data

Table 3-2 CW-1 Injection Test Summary

Injection Rate (gpm)	Wellhead Pressure (psi)	Specific Injectivity (gpm/psi)
5,145	55	117

3.4.1 Injection Test Findings and Conclusions

Figures illustrating the data collected are presented below. **Figure 3-2** presents the CW-1 wellhead pressure and injection flow rate.

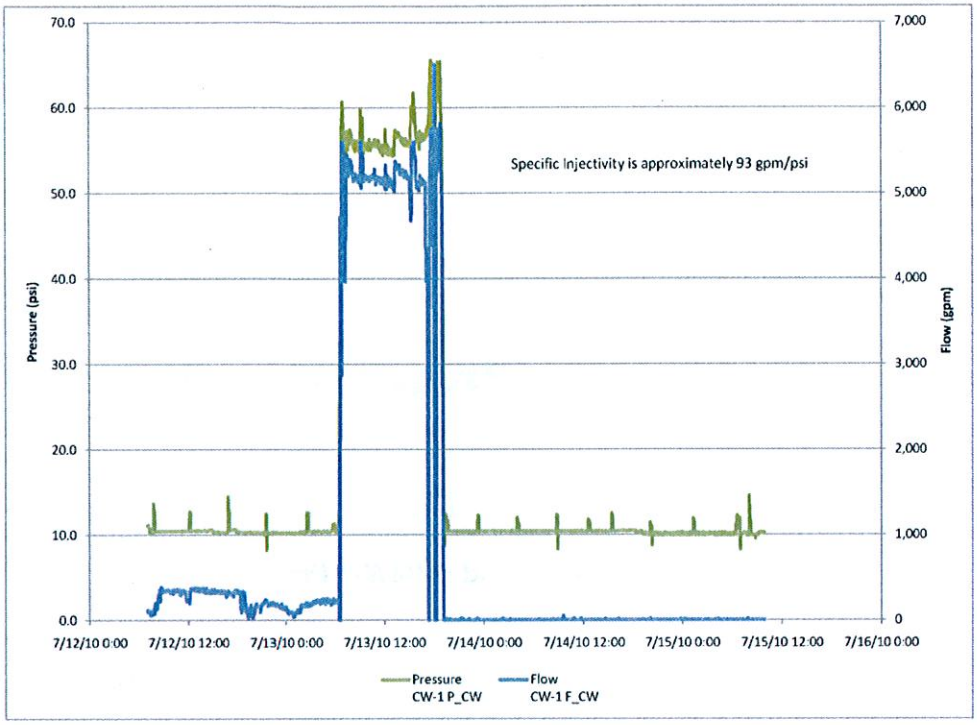


Figure 3-2 CW-1 Flow and Pressure

As the pumping phase of the injection test was initiated, the wellhead pressure increased from approximately 11 psi before the start of the test to 55 psi as the flow stabilized at approximately 5,400 gpm.

Monitor well DZMW-1 upper and lower monitor zone pressures remained generally static over the duration of the test as shown on **Figure 3-3.** As shown in **Figures 3-4** and **3-5,** the upper and lower monitor zone pressure changes correlate very well with the tide and barometric data. The upper monitor zone pressure changes do not appear to have been influenced by the injection activities.

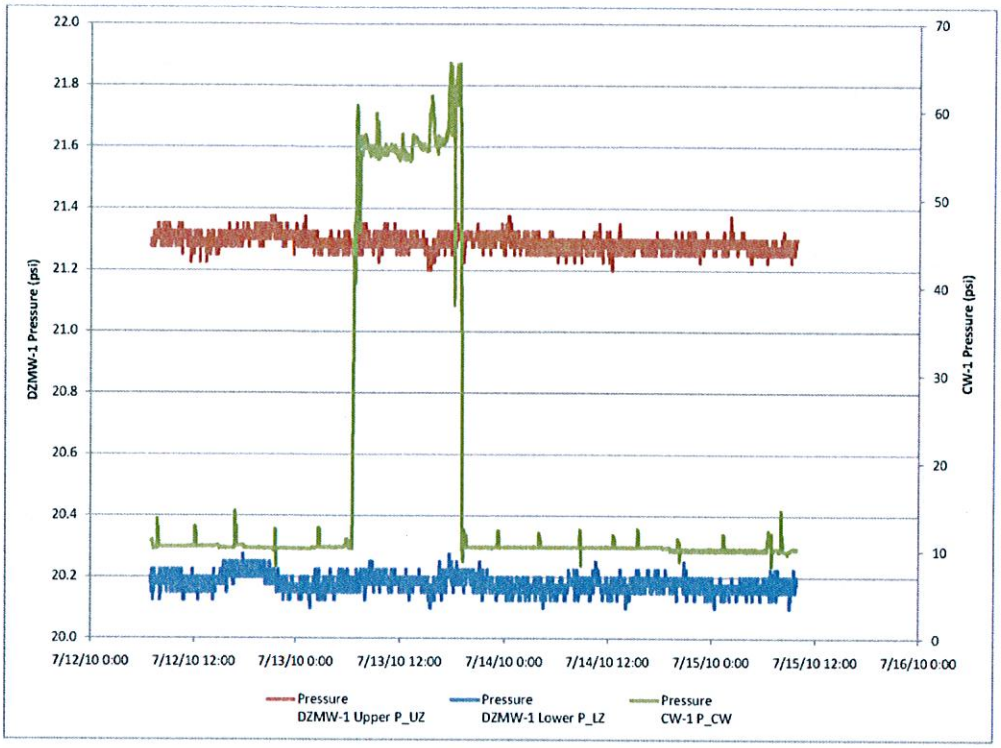


Figure 3-3 CW-1 and DZMW-1 Pressures

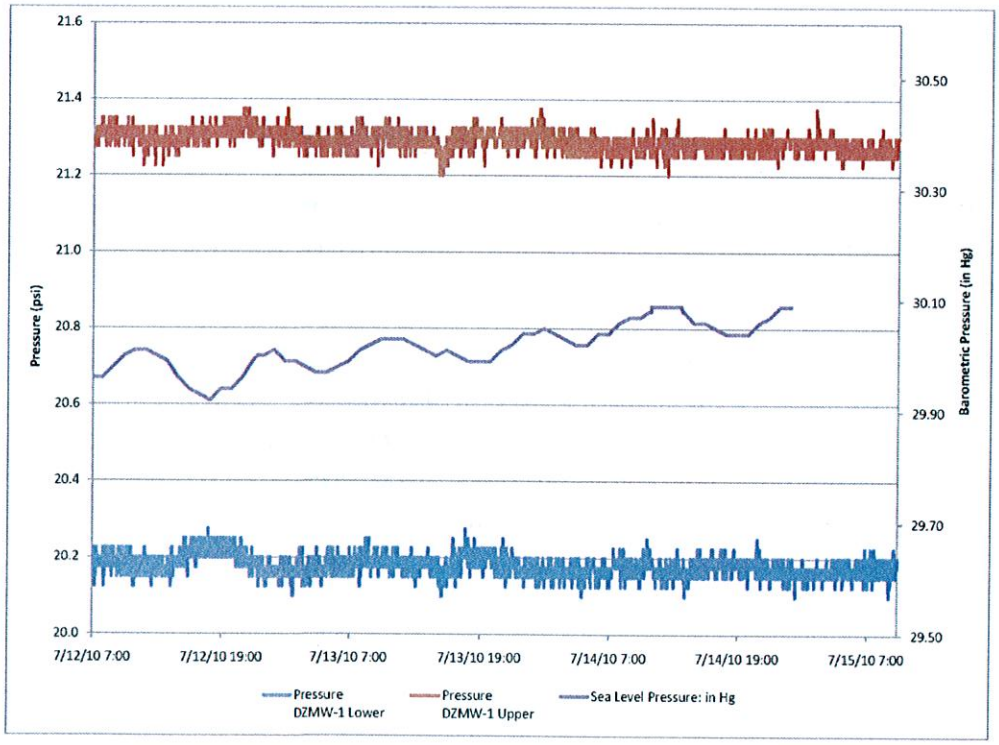


Figure 3-4 DZMW-1 and Barometric Pressures

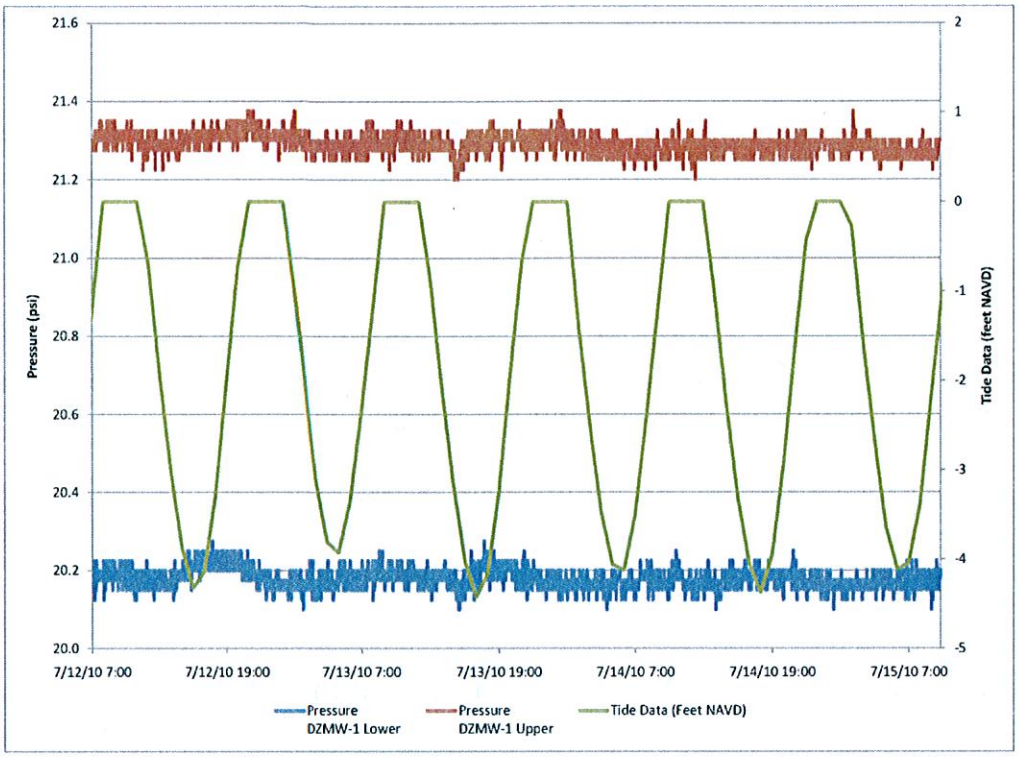


Figure 3-5 DZMW-1 and Tide Data

The City's Operation and Maintenance (O&M) Manual was updated to reflect the re-habilitated configuration of both CW-1 and DZMW-1 following the completion of the short-term injection test. A copy of the updated O&M Manual is provided in **Appendix M.**

3.5 Conclusions

The following summarizes the conclusions of this report.

CW-1 Conclusions

- A cement bond log performed in the CW-1 16-inch FRP tubing showed the presence of cement behind the 16-inch injection tubing and demonstrated that the cement seal around the 16-inch FRP tubing will prevent fluid movement behind the tubing.

- MIT performed (video survey, hydrostatic pressure test, high resolution temperature log and radioactive tracer survey) in the CW-1 injection tubing demonstrated the mechanical integrity of CW-1.

- The injection zone is capable of a flowrate of 9.7 feet per second, based on a sustained injection flow of 5,145 gpm (7.4 MGD) for 10.5 hours.

- The injection pressure for a sustained flow rate of 9.7 feet per second is approximately 55 psi which will not promote fractures in the injection zone or confining sequences.

DZMW-1 Conclusions

- A cement bond log performed inside the rehabilitated DZMW-1 6.625-inch FRP casing demonstrated that the cement seal around the 6.625-inch diameter casing will prevent fluid movement behind the casing.

- A hydrostatic pressure test conducted in the DZMW-1 re-established lower monitor zone casing indicated a pressure decrease of 0.2 psi over a 60-minute test period representing a 0.4 percent change which is within the 5 percent pressure change allowed by rule.

- A video survey of the 6.625-inch FRP casing and the re-established lower monitor zone in DZMW-1 shows that the new final FRP casing and the lower monitor zone between 1,945 and 1,985 feet bls are in excellent condition.

- Collected background water samples indicated that the upper and lower monitor zones of DZMW-1 have been re-established.