

## APPENDIX P-5 – SAMPLING WELL NO. 1 AND NO. 2 DRILLING AND TESTING REPORT

The purpose of the planned monitoring well program was to confirm the depth of the USDW at the project site and installation of the required monitoring well for sampling during operation of the permitted injection well. The original plan as approved by ODEQ, included the drilling of a sampling well to a depth of approximately 1,000 feet and the installation of a 450-foot monitoring well. These wells were planned to be located between 75 and 100 feet northeast of WDW-1. During the beginning of site activities, spatial requirements for both a workover rig at WDW-1 and the water well rig required repositioning of the sampling well to be located southwest of WDW-1.

### Sampling Well No. 1

Sampling Well No. 1 is located approximately 123.5 feet SW of WDW-1 and drilling began on July 26, 2001. A 12.25-inch borehole was advanced to 30 feet and 29 feet of 10.75-inch (outside diameter) casing was installed. The annulus space was grouted on the morning of July 26, 2001. A 9.5-inch borehole was then advanced to a total depth of 1,010 feet bgs and geophysical logging was conducted on the open borehole (See Appendix P-3 of this attachment). Following completion of the logging, 1,007.5 feet of 5.5-inch (outside diameter) casing was installed. The annulus space was then pressure grouted on August 4, 2001 using 500 sacks of cement, 4% gel, 3% calcium chloride and ¼ pound per sack Flocele mixed at 14.1 pounds per gallon.

On August 8, 2001, two attempts were made with a cement bond log (Environ-Log, Inc.) but the results suggested that the instrument was faulty. On August 9 and 10, 2001, a second set of cement bond logs was conducted by Baker-Atlas. Because pressure was held on the casing during the cement curing procedure, two cement bond logs were completed: at equilibrium; and with 1,000 psi applied to the casing. The results from both tests confirmed that a good cement seal had been achieved and that good isolation exists between the proposed sampling zones (copies of the logs are included in Appendix P-3 of this attachment).

Based on the interpretation of the downhole geophysical logs (dual induction/SP, gamma ray, and open hole caliper) four zones were identified as potentially fluid-bearing. These zones are presented in Table 1 below.

**Table 1 - Perforation Zones for Sampling Well No.1**

<b>Planned Perforation Zones (in feet from WDW-1 rig table = 17 feet above bgs)</b>	<b>Planned Perforation Zones – Corrected (in feet bgs)</b>	<b>Perforation Intervals Based on SW#1 Logs (in feet bgs)</b>	<b>Actual Perforation Zones (in feet bgs)</b>
390 – 430	372 – 412	372 to 412 (appears dry)	Not Perforated
690 – 720	672 – 702	672 to 702 (potential zone)	Not Perforated
760 – 800	742 – 782	742 to 782	Not Perforated
910 – 960	892 – 942	892 to 942	891 to 944

A geologic log of the borehole for Sampling Well No. 1 is presented in Appendix P-3 of this attachment.

On August 10, 2001 the zone between 891 to 944 feet bgs was perforated at a rate of six shots per foot and development of the zone continued through the morning of August 12, 2001. Table 2 shows the field parameters measured and the total volume purged from the well (approximately 18,200 gallons). After approximately 35 hours of pumping, a fluid sample was collected and analyzed for Total Dissolved Solids (TDS). Duplicate samples were collected and show that TDS in fluids from the perforation zone (891 to 944 feet bgs) ranged between 3,980 to 4,000 mg/l. Because this level of TDS was below 10,000 mg/l, the work plan was modified to drill a second well to lower depths.

### **Sampling Well No. 2**

Sampling Well No. 2 is located approximately 95 feet SW of WDW-1 and drilling began on August 14, 2001. A 12.25-inch borehole was advanced to 50 feet bgs and 50 feet of 10.75-inch (outside diameter) casing was installed. The annulus space was grouted on the morning of August 14, 2001. Beginning on August 25, 2001 a 9.5-inch borehole was then advanced to a total depth of 1,453 feet bgs (1,464 feet log depth which is 11 feet above bgs) and geophysical logging was conducted on the open borehole (See Appendix P-3 of this attachment). In order to confirm that the second well was installed to a sufficient depth below the lowermost USDW, fluid samples from 1,395.2 feet were obtained with an open-hole Formation Multi-Tester Tool. These samples indicated formation waters containing 103,000 mg/l TDS from the 1,380-Foot Sand, ensuring that the well was below any USDWs. Following completion of the logging and confirmation that the hole was within tolerance limits (deviation survey), 1,448 feet of 5.5-inch (outside diameter) casing was installed below ground surface and each joint was tightened to 2000 psi. The annulus space was then pressure grouted on September 4, 2001 with both lead and tail cement mixtures. The lead cement mix consisted of 230 sacks of cement, 4% gel, 3% calcium chloride and ¼ pound per sack Flocele mixed at 14.1 pounds per gallon. The tail cement mix consisted of the same percentage of additives with 280 sacks and mixed at 14.7 pounds per gallon.

On September 8, 2001, cement bond logs were conducted by Baker-Atlas, Both without pressure applied and with up to 1000 psi pressure applied to the inside of the 5.5-inch casing. The results from both tests confirmed that a good cement seal had been achieved and that good isolation exists between the proposed sampling zones (copies of the well logs are located in Appendix P-3 of this attachment). Based on the interpretation of the downhole geophysical logs (dual induction/SP, gamma ray, and open hole caliper) four zones were identified as potentially water-bearing. The deep resistivity curve was evaluated for indication of significant differing water compositions (based on shifts to higher resistivities) and an estimate of potential water quality was made for each zone. Selection of sampling intervals was “fine-tuned” in the anticipated proximity of the lowermost USDW (anticipated to be just above or below the 1,125-Foot Sand). These zones are presented in following table (Table 2).

**Table 2 - Perforation Zones for Sampling Well No. 2**

<b>Sand Zone (in feet below WDW- 1 rig table = +17 feet bgs )</b>	<b>Perforation Zones (in feet from SW#2 rig table = +11 feet bgs)</b>	<b>Perforation Zones – Corrected (in feet bgs)</b>	<b>Water Quality Results Total Dissolved Solids (in mg/l) Field duplicate results also given</b>
<b>1,050</b> = 1,023 – 1,081			Not Perforated
<b>1,125</b> = 1,104 – 1,133	1,108 – 1,126	1,097-1,115	8,530 – 8,410
<b>1,150</b> = 1,149 – 1,179	1,140 – 1,153 1,160 – 1,171	1,129 – 1,142 1,149 – 1,160	19,800 – 19,600
<b>1,200</b> = 1,197 – 1,247	1,198 – 1,214 1,234 – 1,243 1,253 – 1,270 Adjusted with SW#2 logs	1,187 – 1,203 1,223 – 1,232 1,242 – 1,259	39,400 – 41,200
<b>1,300</b> = 1,291 – 1,363			Not Perforated
<b>1,380</b> = 1,371 – 1,409	1,369 – 1,378 1,383 – 1,404	1,358 – 1,367 1,372 – 1,393	89,700 – 92,600
<b>1,380</b>	Baker Atlas Formation Tester	1 gallon retriever	103,000 – 103,000

A geologic log of the borehole for Sampling Well No. 2 is presented in Appendix P-3 of this attachment.

On September 8, 2001 the 1,380-Foot Sand zone (1,358 to 1,367 and 1,372 to 1,393 feet bgs) was perforated at a rate of six shots per foot. This zone was perforated in order to confirm the preliminary findings of water quality from the Formation Multi-tester Tool. Development and sampling of the 1,380 foot sand zone was completed on September 9<sup>th</sup>. Because TDS values of the fluids from this sand zone were greater than 10,000 mg/l (see Table 2 above), the perforated zone was grouted on September 11 (at 1130 hours) from the bottom of the hole (1,420 feet bgs) to 1,336 bgs.

On September 11, 2001 (at 2100 hours) the 1,200-Foot Sand zone (1,187 to 1203, 1223 to 1,232 and 1,242 to 1,259 feet bgs) was perforated at a rate of six shots per foot. Development and sampling of the 1,200 foot sand zone was completed on September 12<sup>th</sup>. Because TDS values of the fluids from this sand zone were greater than 10,000 mg/l (see Table 2 above), the perforated zone was grouted from on September 13 (at 0800 hours) from 1,336 feet bgs to 1,169.5 feet bgs.

On September 13, 2001 (at 1730 hours) the 1,150-Foot Sand zone (1,129 to 1,142 and 1,149 to 1,160 feet bgs) was perforated at a rate of six shots per foot. Development and sampling of the 1,150 foot sand zone was completed on September 14<sup>th</sup>. Because TDS values of the fluids from this sand zone were above 10,000 mg/l (see Table 2 above), the perforated zone was grouted on September 14<sup>th</sup> (at 1000 hours) from 1,169.5 to 1,121 feet bgs.

On September 15, 2001 (at 1000 hours) the 1,125- Foot Sand zone (1,097 to 1,115 feet bgs) was perforated at a rate of six shots per foot. Development and sampling of the 1,125 foot sand zone was completed on September 18<sup>th</sup>. This sand zone was purged until dry 3 times (September 16, 17 and 18<sup>th</sup>) and sampled at the end of the third well evacuation event (September 18<sup>th</sup>). TDS values of the fluids from this sand zone were less than 10,000 mg/l (see Table 2 above).

Based on the data presented on Table 2 above, ODEQ considers the 1,125-Foot Sand zone to be the base of the USDW at the project area. Therefore, Sampling Well No. 2 is the required monitoring well with casing to a depth of 1,121 feet and a perforated (open) area from 1,097 to 1,115 feet bgs.