

**Colorado Oil and Gas Conservation Commission**

**Monitor Wells Summary Report**

**May 2014**

**4M Project Monitoring Program**

**Archuleta and La Plata Counties**

**Colorado**

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## 1.0 INTRODUCTION

This report summarizes Colorado Oil and Gas Conservation Commission (COGCC) 4M Project monitoring well program activities and well pressure monitoring data through January 1, 2014 for Archuleta and La Plata Counties. Monitoring work was performed by COGCC staff, Norwest Corporation, and Resource Hydrogeologic Services, Inc. on behalf of the COGCC. Activities completed during this reporting period included one field inspection tour of all accessible wells for general maintenance of all systems at all locations. Following this, several follow-up site specific visits were completed to make repairs to minor leaks at wellheads and malfunctioning data collection instrumentation. Also conducted in 2013 was automated well pressure monitoring and data transmission to In-Situ® Data Center, online data retrieval, data analysis, and summary report preparation. Well pressure measurements recorded by data loggers in each monitoring well are available to all interested parties upon request.

The COGCC 4M Project monitoring well program includes 17 wells at 11 monitoring well sites. Figure 1-1 (following page) shows the location and name of all eleven monitoring well sites and individual site monitoring well names in accordance with the following well nomenclature.

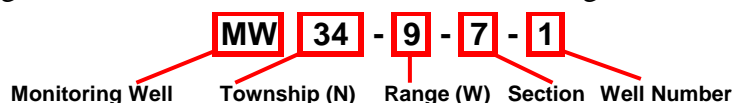


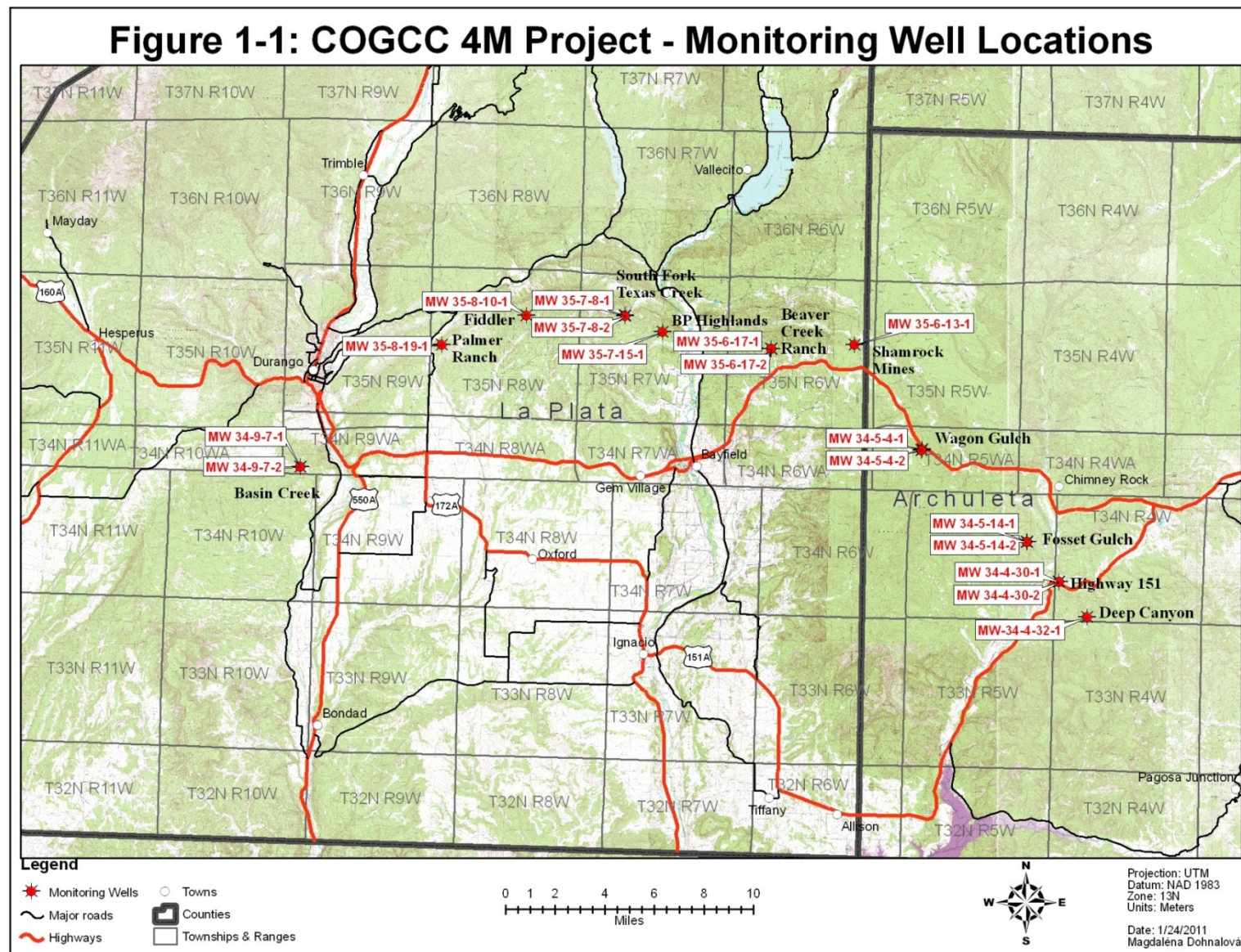
Table 1-1 lists the 4M project monitoring sites and wells by county, project phase and initiation date.

**Table 1-1**  
**4M Project Monitoring Well Program Phases**

| County    | Site Name           | Well Name                    | Project/Phase | Phase Initiation Date |
|-----------|---------------------|------------------------------|---------------|-----------------------|
| Archuleta | Wagon Gulch         | MW 34-5-4-1<br>MW 34-5-4-2   | 4M/Archuleta  | October 2008          |
|           | Fosset Gulch        | MW 34-5-14-1<br>MW 34-5-14-2 |               |                       |
|           | Highway 151         | MW 34-4-30-1<br>MW 34-4-30-2 |               |                       |
|           | Deep Canyon         | MW 34-4-32-1                 |               | June 2010             |
| La Plata  | Basin Creek         | MW 34-9-7-1<br>MW 34-9-7-2   | 3M/La Plata   | January 2001          |
|           | S. Fork Texas Creek | MW 35-7-8-1<br>MW 35-7-8-2   |               |                       |
|           | Beaver Creek Ranch  | MW 35-6-17-1<br>MW 35-6-17-2 |               |                       |
|           | Shamrock Mines      | MW 35-6-13-1                 |               |                       |
|           | Palmer Ranch        | MW 35-8-19-1                 | 4M/La Plata   | October 2009          |
|           | Fiddler             | MW 35-8-10-1                 |               |                       |
|           | BP Highlands        | MW 35-7-15-1                 |               |                       |

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Table 1-2 lists monitoring well site locations and individual well completion details. Table 1-3 lists the depth and type of pressure transducers used in each monitoring well. Appendix A includes a chronology of monitoring well installation, operation and maintenance activities for the January 2001 through December 2014 period of record.



**Figure 1-1**  
**COGCC 4M Project – Monitoring Well Locations**



**Table 1-2**  
**Monitor Well Completion Summary**

| Site Name              | Well ID      | Location (NAD 83)   | Construction Completion Date | Drilled Depth (ft bgs) | Cored Intervals (ft bgs)              | Casing Depth (ft bgs) | Casing Stickup (ft ags) | Well Casing Material                   | Perforated Interval in Coal seam(s) (ft bgs) | Log Type   | Logged Depth (ft bgs) | Log Date             |
|------------------------|--------------|---|------------------------------|------------------------|---------------------------------------|-----------------------|-------------------------|--|--|--|-----------------------|----------------------|
| Basin Creek            | MW 34-9-7-1  | 37.218482 N<br>107.887502 W                               | 01/28/01                     | 820                    |                                       | 802                   | 1                       | 2", Schedule 40 galvanized steel pipe  | 578 - 609                                    | gamma ray, bulk density, caliper, resistance   | 819                   | 01/27/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | 64" normal resistivity, 16" normal resistivity, sp   | 822                   | 01/27/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | temperature, differential temperature  | 822                   | 01/27/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | gamma ray, casing collar locator   | 763                   | 09/27/01             |
|                        | MW 34-9-7-2  | 37.218542 N<br>107.887442 W                               | 04/25/02                     | 570                    | 359 - 374 *<br>498 - 513<br>578 - 593 | 561                   | 1.5                     | 2.875" & 2.375", Oilfield steel tubing | 496 - 526                                    | gamma ray, casing collar locator   | 550                   | 05/02/02             |
| Palmer Ranch           | MW-35-8-19-1 | 37.292284 N<br>107.786741 W<br>(Estimated-survey pending) | 11/10/2009                   | 747                    | NA                                    | 738                   | 2.5                     | 4.5" 10#/foot                          | 623-628;634-637;640-657;662-671              | Open hole: gamma ray, bulk density, neutron, temperature, E-log, bore hole deviation and acoustical televiewer;<br>Cased hole: casing collar locator and gamma ray | 725                   | 11/6/09;<br>11/17/09 |
| Fiddler                | MW-35-8-10-1 | 37.311135 N<br>107.725623 W<br>(Estimated-survey pending) | 11/17/2009                   | 457                    | NA                                    | 457                   | 3                       | 4.5" 10#/foot                          | 174-190;220-226;276-291;354-363;378-380      | Open hole: gamma ray, bulk density, neutron, temperature, E-log, bore hole deviation and acoustical televiewer;<br>Cased hole: casing collar locator and gamma ray | 457                   | 10/16/09;<br>11/3/09 |
| South Fork Texas Creek | MW 35-7-8-1  | 37.312493 N<br>107.653315 W                               | 09/20/01                     | 486                    |                                       | 463                   | 1.6                     | 2", Schedule 40 galvanized steel pipe  | 403 - 416                                    | gamma ray, bulk density, caliper, resistance   | 485                   | 09/19/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | 64" normal resistivity, 16" normal resistivity, sp   | 485                   | 09/19/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | temperature, differential temperature  | 485                   | 09/19/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | gamma ray, casing collar locator   | 462                   | 09/27/01             |
|                        | MW 35-7-8-2  | 37.312443 N<br>107.653315 W                               | 09/21/01                     | 420                    | 410 - 425                             | 425                   | 1.6                     | 2", Schedule 40 galvanized steel pipe  | 235 - 241<br>254 - 258<br>264 - 274          | gamma ray, casing collar locator   | 420                   | 09/27/01             |
| BP Highlands           | MW-34-7-15-1 | 37.303663 N<br>107.625489 W<br>(Estimated-survey pending) | 10/10/2009                   | 276                    | NA                                    | 241                   | 2.5                     | 4.5" 10#/foot                          | 182-194                                      | Open hole: gamma ray, bulk density, neutron, temperature, E-log, bore hole deviation and acoustical televiewer;<br>Cased hole: casing collar locator and gamma ray | 276                   | 10/3/09;<br>10/9/09  |
| Beaver Creek Ranch     | MW 35-6-17-1 | 37.295393 N<br>107.546011 W                               | 04/04/02                     | 1,645                  | 1,457 - 1,467<br>1,564 - 1,572        | 1,631                 | 1.5                     | 2.875", Oilfield steel tubing          | 1,572 - 1,576<br>1,582 - 1,584               | 64" normal resistivity, 16" normal resistivity, sp   | 1,645                 | 04/03/02             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | temperature, differential temperature  | 1,640                 | 04/03/02             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | gamma ray, bulk density, caliper, resistance   | 1,643                 | 04/03/02             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | gamma ray, casing collar locator   | 1,618                 | 05/02/02             |
|                        | MW 35-6-17-2 | 37.295503 N<br>107.545901 W                               | 10/04/01                     | 1,550                  |                                       | 1,500                 | 2                       | 2", Schedule 40 galvanized steel pipe  | 1,437 - 1,449<br>1,458 - 1,472               | gamma ray, neutron   | 1,499                 | 10/10/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | temperature, 4Pi density   | 1,493                 | 11/14/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | signal amplitude, travel time \ D T, VDL   | 1,484                 | 11/14/01             |
|                        |              |   |                              |                        |                                       |                       |                         |  |  | gamma ray, casing collar locator   | 1,483                 | 11/27/01             |

\* Cored interval from initial well drilled, plugged and abandoned in February 2001.

**Table 1-2 (continued)**  
**Monitor Well Completion Summary**

| Site Name         | Well ID      | Location<br>(NAD 83)        | Construction<br>Completion<br>Date | Drilled<br>Depth<br>(ft bgs) | Cored<br>Intervals<br>(ft bgs) | Casing<br>Depth<br>(ft bgs) | Casing<br>Stickup<br>(ft ags) | Well Casing<br>Material          | Perforated<br>Interval in Coal<br>seam(s)<br>(ft bgs) | Log Type  | Logged<br>Depth<br>(ft bgs) | Log Date              |
|-------------------|--------------|-----------------------------|------------------------------------|------------------------------|--------------------------------|-----------------------------|-------------------------------|----------------------------------|---|---|-----------------------------|-----------------------|
| Shamrock<br>Mines | MW 35-6-13-1 | 37.299063 N<br>107.484969 W | 05/07/02                           | 627                          |                                | 606                         | 1.5                           | 2.375", Oilfield<br>steel tubing | 507 - 511<br>517 - 533<br>539 - 562                   | gamma ray, bulk density, caliper,<br>resistance   | 626                         | 05/06/02              |
|                   |              |                             |                                    |                              |                                |                             |                               |                                  |   | 64" normal resistivity, 16" normal<br>resistivity, sp   | 626                         | 05/06/02              |
|                   |              |                             |                                    |                              |                                |                             |                               |                                  |   | gamma ray, casing collar locator  | 626                         | 05/10/02              |
| Wagon Gulch       | MW-34-4-30-1 | 37.238958 N<br>107.433631 W | 10/2/2008                          | 938                          | NA                             | 927                         | 2.5                           | 4.5" 10.5#/foot                  | 821-833   | Open hole: gamma ray, bulk<br>density, neutron, temperature, E-<br>log, bore hole deviation and<br>acoustical televiewer;<br>Cased hole: casing collar locator<br>and gamma ray | 938                         | 10/2/08;<br>10/16/08  |
|                   | MW-34-4-30-2 | 37.238389 N<br>107.355340 W | 10/13/2008                         | 883                          | 749-779<br>810-818             | 833                         | 2.5                           | 4.5" 10.5#/foot                  | 752-767   | Open Hole: gamma ray, bulk<br>density, neutron, temperature, E-<br>log, bore hole deviation and<br>acoustical televiewer;<br>Cased hole: casing collar locator<br>and gamma ray | 883                         | 10/12/08;<br>10/16/08 |
| Fosset Gulch      | MW-35-5-14-1 | 37.186510 N<br>107.355270 W | 10/31/2008                         | 624                          | 480-506<br>524-532             | 618                         | 2.5                           | 4.5" 10.5#/foot                  | 482-502   | Cased hole: casing collar locator<br>and gamma ray  | 624                         | 11/14/08              |
|                   | MW-35-5-14-2 | 37.186550 N<br>107.355340 W | 10/22/2008                         | 660                          | NA                             | 660                         | 2.5                           | 4.5" 10.5#/foot                  | 525-534<br>548-551                                    | Open hole: gamma ray, bulk<br>density, neutron, temperature, E-<br>log, bore hole deviation and<br>acoustical televiewer;<br>Cased hole: casing collar locator<br>and gamma ray | 648                         | 10/22/08;<br>11/14/08 |
| Highway 151       | MW-34-4-30-1 | 37.163685 N<br>107.331061 W | 11/11/2008                         | 340                          | 226-247<br>266-287             | 330                         | 2.5                           | 4.5" 10.5#/foot                  | 218-22<br>231-241                                     | Open hole: gamma ray, bulk<br>density, neutron, temperature, E-<br>log, bore hole deviation and<br>acoustical televiewer;<br>Cased hole: casing collar locator<br>and gamma ray | 326                         | 11/16/09              |
|                   | MW-34-4-30-2 | 37.163631 N<br>107.331008 W | 11/7/2008                          | 330                          | NA                             | 330                         | 2.5                           | 4.5" 10.5#/foot                  | 268-277<br>292-301                                    | Open Hole: gamma ray, bulk<br>density, neutron, temperature, E-<br>log, bore hole deviation and<br>acoustical televiewer;<br>Cased hole: casing collar locator<br>and gamma ray | 326                         | 11/6/09;<br>11/16/09  |
| Deep Canyon       | MW 34-4-32-1 | 37.143311 N<br>107.309829 W | 5/18/2010                          | 895                          | NA                             | 880                         | 2.5                           | 4.5" 10.5#/foot                  | 752-761<br>763-765<br>804-813<br>836-838              | Open Hole: gamma ray, bulk<br>density, neutron, temperature, E-<br>log, bore hole deviation and<br>acoustical televiewer;<br>Cased hole: casing collar locator<br>and gamma ray | 880                         | 5/24/2010             |



**Table 1-3**  
**Monitor Well Pressure Transducers**

| Location               | Well ID      | Upper Transducer |                    | Lower Transducer |                    |
|------------------------|--------------|------------------|--------------------|------------------|--------------------|
|                        |              | Depth (ft bgs)   | Type and Rating    | Depth (ft bgs)   | Type and Rating    |
| Basin Creek            | MW 34-9-7-1  | 5                | LT 500 - 30 psia   | 570              | LT 500 - 300 psia  |
|                        | MW 34-9-7-2  | 5                | AT 200 - 100 psia  | 485              | LT 500 - 300 psia  |
| Palmer Ranch           | MW-35-8-19-1 | 3                | LT 500 - 500 psia  | 690              | LT 700 - 1000 psia |
| Fiddler                | MW-35-8-10-1 | 7.5              | LT 700 - 100 psia  | 390              | LT 700 - 1000 psia |
| South Fork Texas Creek | MW 35-7-8-1  | 5                | LT 500 - 30 psia   | 374              | LT 500 - 300 psia  |
|                        | MW 35-7-8-2  | 5                | LT 500 - 300 psia  | 232              | LT 500 - 300 psia  |
| BP Highlands           | MW-34-7-15-1 | 2                | LT 500 - 30 psia   | 204              | LT 500 - 500 psia  |
| Beaver Creek Ranch     | MW 35-6-17-1 | 6                | LT 500 - 300 psia  | 1,551            | LT 700 - 1000 psia |
|                        | MW 35-6-17-2 | 5                | LT 700 - 1000 psia | 1,408            | LT 700 - 1000 psia |
| Shamrock Mines         | MW 35-6-13-1 | 0                | LT 500 - 30 psia   | 512              | LT 500 - 300 psia  |
| Wagon Gulch            | MW-34-4-30-1 | 2.3 (ft ags)     | LT 700 - 1000 psia | 840              | LT 700 - 1000 psia |
|                        | MW-34-4-30-2 | 2.5              | LT 700 - 1000 psia | 763              | LT 700 - 1000 psia |
| Fosset Gulch           | MW-35-5-14-1 | 2.3 (ft ags)     | LT 700 - 1000 psia | 510              | LT 700 - 1000 psia |
|                        | MW-35-5-14-2 | 2.3 (ft ags)     | LT 700 - 1000 psia | 560              | LT 700 - 1000 psia |
| Highway 151            | MW-34-4-30-1 | 2.3 (ft ags)     | LT 500 - 30 psia   | 250              | LT 700 - 1000 psia |
|                        | MW-34-4-30-2 | 2.3 (ft ags)     | LT 700 - 1000 psia | 310              | LT 700 - 1000 psia |
| Deep Canyon            | MW-34-4-32-1 | 2.5              | LT 700 - 1000 psia | 846              | LT 700 - 1000 psia |

ft bgs = feet below ground surface; ft ags = feet above ground surface; LT = LevelTROLL®, AT = AquaTROLL®

## 2.0 LA PLATA COUNTY MONITORING WELL DATA SUMMARY

Well pressure was measured and recorded twice daily (12-hour interval) for the 7 monitoring well sites located in La Plata County, Colorado. Applicable well pressure and calculated water level data for the entire period of record for each monitoring well are plotted in annotated charts. The water level in a well is calculated using the depth of the lower transducer and the difference in pressure between upper and lower transducers. This calculation is applicable at sites where the water level in a well is above the lower pressure transducer and below the upper pressure transducer.

### 2.1 BASIN CREEK

Monitor well MW 34-9-7-1 has been monitored since November 29, 2001 and monitor well MW 34-9-7-2 has been monitored since May 24, 2002. Initial and ending monitoring well pressures and calculated water levels in the wells for each period of record are summarized in Table 2-1.

**Table 2-1**  
**Well Pressure Data Summary for Basin Creek Monitoring Wells**

| Well ID and Transducers | Period of Record   | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|--------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 34-9-7-1 Upper       | 11/29/01 to 1/1/14 | 11.46                                | 36.23                               | 24.77                             | 20.97                                | 244.83                              | -223.85                        |
| Lower                   |                    | 249.34                               | 177.12                              | -72.22                            |                                      |                                     |                                |
| MW 34-9-7-2 Upper       | 5/24/02 to 1/1/14  | 33.26                                | 13.31                               | -19.95                            | 50.27 (ft ags)                       | 40.10                               | -90.37                         |
| Lower                   |                    | 241.42                               | 205.90                              | -31.56                            |                                      |                                     |                                |

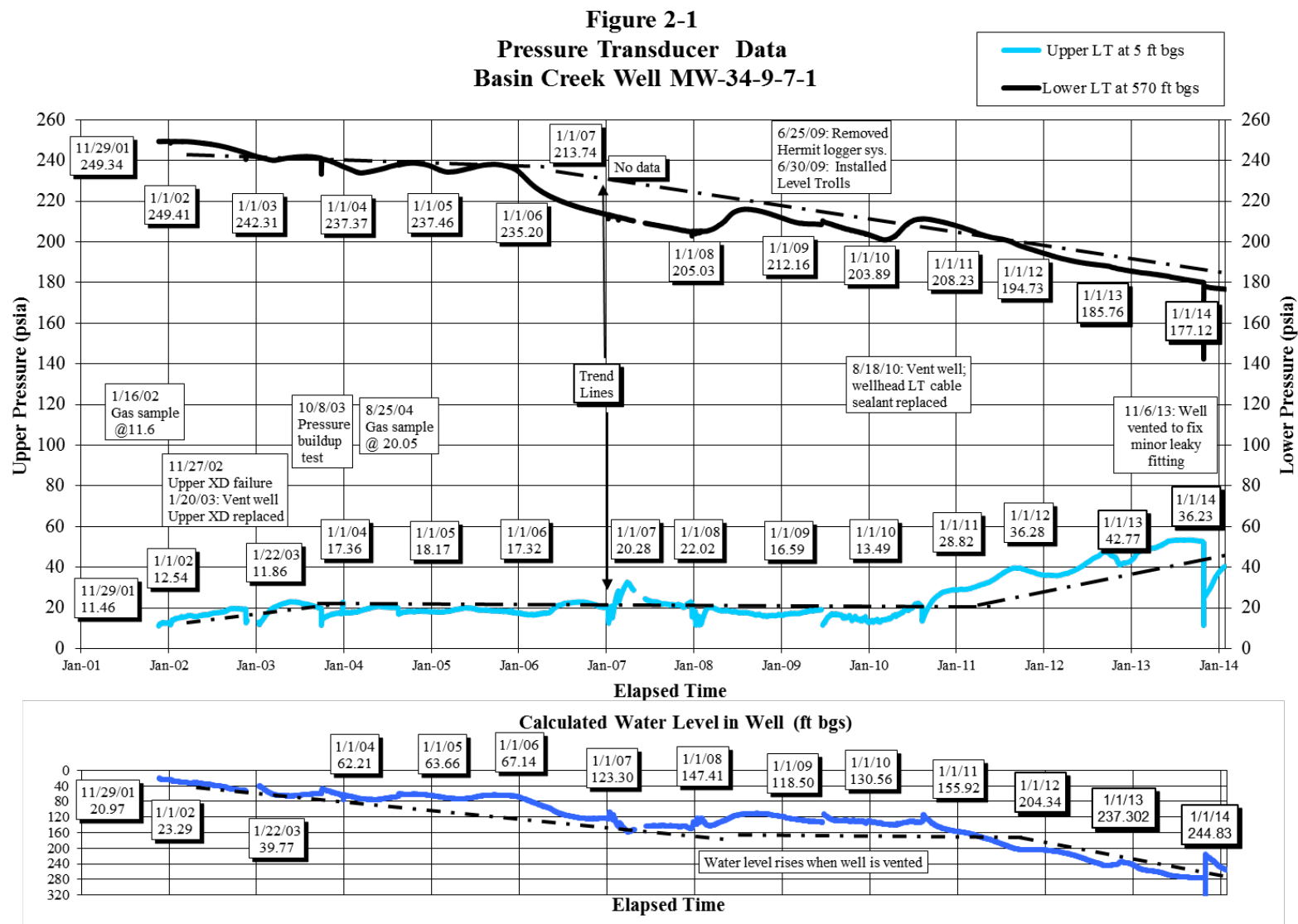
#### 2.1.1 MW 34-9-7-1

Figure 2-1 charts the upper and lower pressure transducer data and the calculated water level in the well. Table 2-1 and Figure 2-1 show a net increase of 24.77 psi in wellhead pressure for the entire 12-year period of record from November 29, 2001 (11.46 psia) to January 1, 2014 (36.23 psia). Figure 2-1 generally shows a pattern of minor seasonal fluctuations within an overall stable trend in wellhead pressure prior to wellhead cable gland seal replacement on August 18, 2010, followed by a rise in wellhead pressure to a recorded high of 53.42 psia on September 11, 2013. A very minor leak persisted so on November 6, 2013 the well was vented to allow a safe condition to repair leaking threads at the

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wellhead. Recovery of the wellhead pressure is now still slowly occurring following this wellhead venting.

In contrast to the wellhead pressure patterns, Table 2-1 and Figure 2-1 show a net decline of 223.85 feet in the calculated well water level and a corresponding net decline in downhole pressure of 72.22 psi for the period of record. Figure 2-1 also shows a pattern of slight seasonal fluctuations within the overall declining trend in the water level and corresponding downhole pressure for the period of record.



**Figure 2-1**  
**Pressure Transducer Data Basin Creek Well MW-34-7-1**

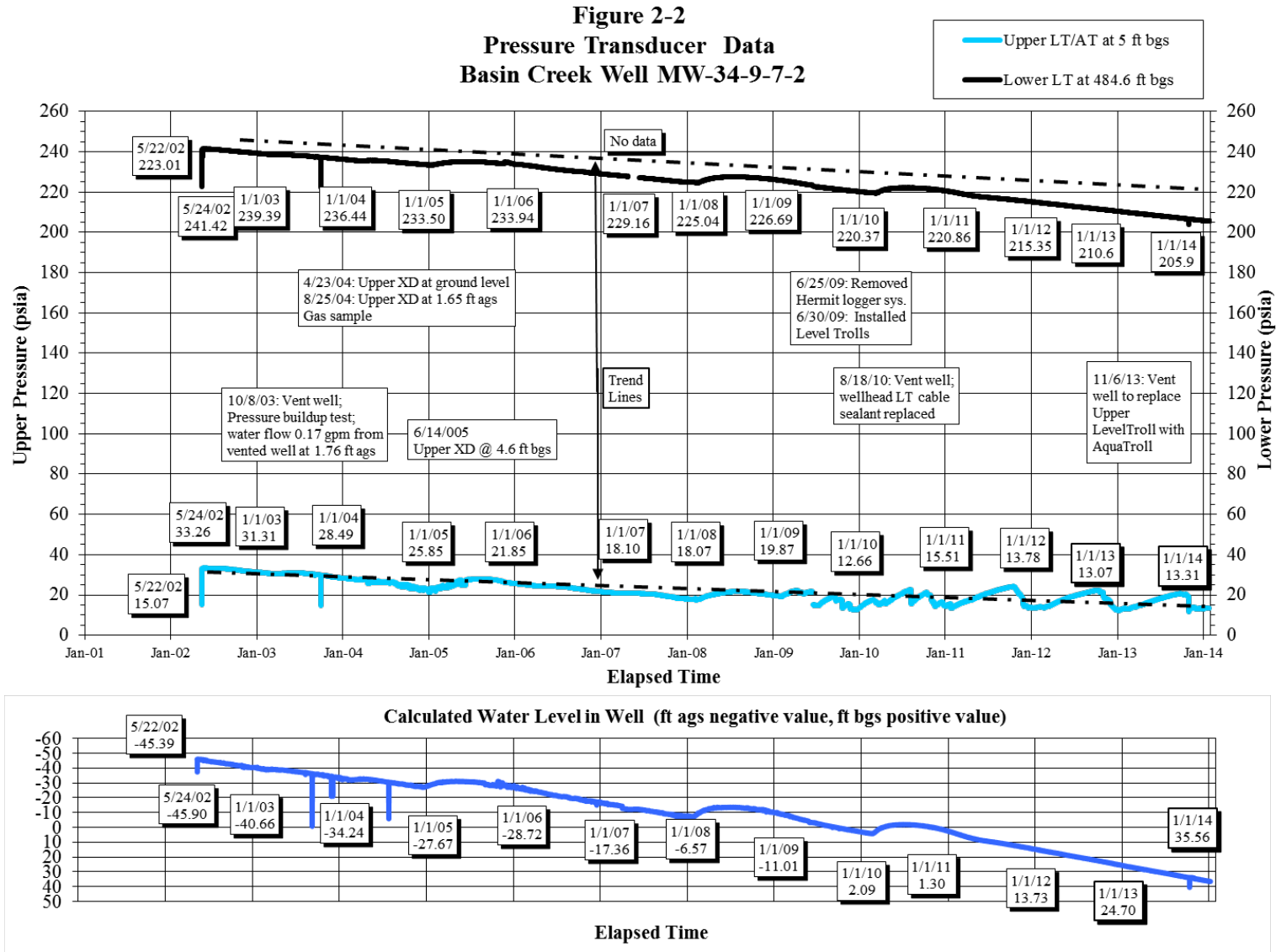
### 2.1.2 MW 34-9-7-2

Recorded pressure data and calculated water level for well MW-34-9-7-2 are charted on Figure 2-2. Initial and ending monitoring well pressures and apparent water level in the well are summarized in Table 2-1.

Figure 2-2 continues to show a trend of gradually declining wellhead pressure and minor seasonal fluctuations in downhole pressure within the overall declining trend for the period of record. As indicated in Table 2-1, there has been a net decline in well pressure of about 19.95 psi (wellhead) and 31.56 psi (downhole) for the 10.5-year period of record. Between February 18, 2008 and January 1, 2014, Figure 2-2 shows an apparent seasonal fluctuation within the overall declining well pressure trend.

A small amount of gas was released and artesian flow (~0.2 gpm) from the well consistently occurred each time the well was vented for maintenance during the period of record between 2002 and 2010. The pressure regime documented was relatively high pressure but low volume based on the head pressure versus artesian flow. Artesian flow from the well did not occur when the wellhead was vented on August 18, 2010 to replace the Level Troll wellhead cable Conax gland sealants. The final recorded upper transducer pressure in 2011 of 13.7 PSI was very near atmospheric pressure indicating the well was essentially in hydrostatic balance. The pressure fluctuations since early 2009 suggest that ambient surface temperatures may be affecting the gas pressure as measured by the upper transducer. In order to attempt to distinguish water pressure versus gas pressure being recorded by the upper transducer, the Level Troll was replaced by an Aqua Troll, which records specific conductance (SC) in addition to pressure and temperature. The concept was that if water was present at the Aqua Troll, it would record an SC value greater than zero. If a value of zero was recorded for SC, then a pressure greater than atmospheric pressure would be gas pressure only. The Aqua Troll was installed on November 6, 2013, but it appears by this time the static water level in this well had dropped from the near-surface balance of 2009-2011. Unless the water level decline trend reverses, the pilot test utilizing the Aqua Troll to determine the presence of water will not be successful. Data will be collected and interpreted in the first half of 2014 to assess if the Aqua Troll would be better suited at another location with a near-surface static water level.

Substantial water level decline has been documented in this well, going from artesian flowing with a calculated shut-in head of approximately 46 feet above ground surface just after construction to approximately 36 feet below ground surface on January 1, 2014. This calculated water level has been verified by a manual open-well water level measurement on November 6, 2013 of 40.20 ft bgs compared to a water level calculation using the lower Level Troll data within fifteen minutes on the same date of 40.46 feet below ground surface.



**Figure 2-2**  
**Pressure Transducer Data Basin Creek Well MW-34-9-7-2**



## 2.2 PALMER RANCH

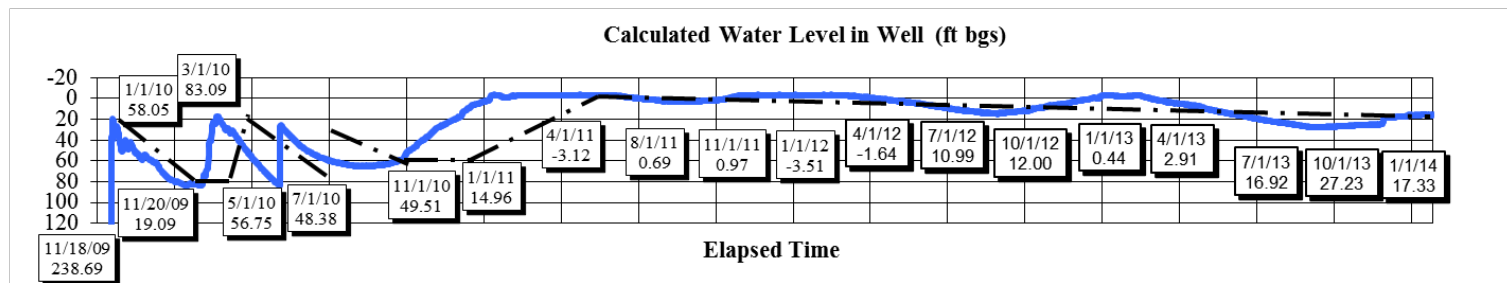
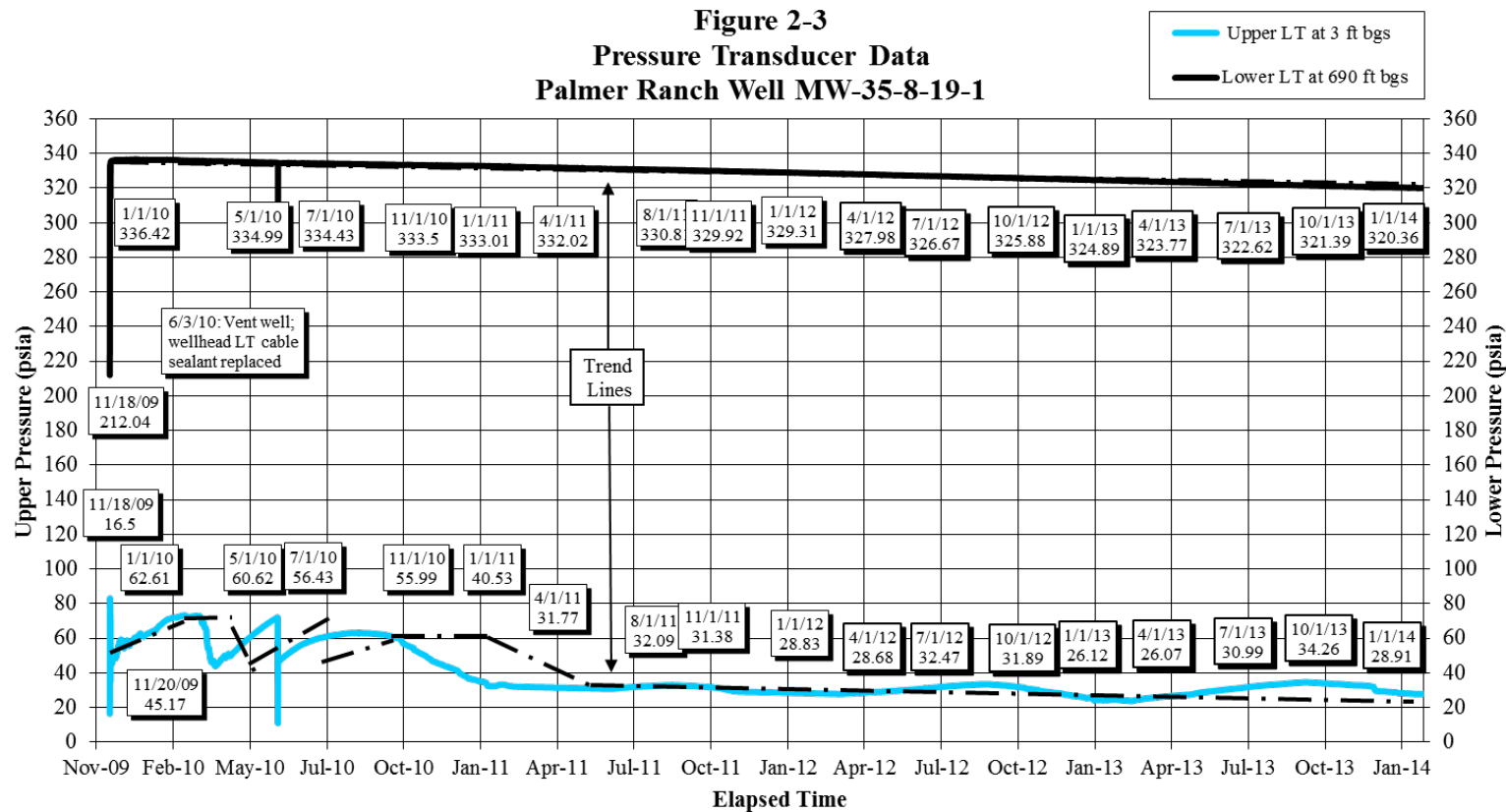
Monitor well MW 35-8-19-1 has been monitored since November 20, 2009. Initial and ending well pressures and calculated water level in the monitor well are summarized in Table 2-2 for the indicated period of record.

**Table 2-2**  
**Well Pressure Data Summary for Palmer Ranch Monitoring Well**

| Well ID and Transducers | Period of Record   | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|--------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 35-8-19-1 Upper      | 11/20/09 to 1/1/14 | 45.17                                | 28.91                               | -16.26                            | 19.09                                | 17.33                               | 1.76                           |
| Lower                   |                    | 335.86                               | 320.36                              | -15.50                            |                                      |                                     |                                |

Monitoring data for MW 35-8-19-1 are plotted in Figure 2-3. Since November 20, 2009, there has been seasonal fluctuation in wellhead pressure and an overall flat trend in downhole pressure. As summarized in Table 2-2 for the 2-year period of record, the net change in wellhead and downhole pressures are -16.26 psi and -15.50 psi respectively. The net change in the calculated water level in the well is an increase of 1.76 feet for the period of record.

Figure 2-3 shows an immediate water level rise in response to the drop in well pressure when the well was vented for maintenance on June 3, 2010, followed by a gradual, partial return of the wellhead pressure and water level to trends exhibited prior to June 3, 2010. By August 1, 2010, the wellhead pressure and water level reached about 64 percent of trends exhibited prior to June 3, 2010, then plateaued through late October, 2010. Figure 2-3 also shows a trend of water level rise in response to a steady drop in wellhead pressure between late October, 2010 and early February, 2011. The drop in wellhead pressure after October 2010 is likely due to an incomplete shut-in condition. A minor leak was detected at the wellhead during the 2011-2013 site inspections but not corrected because tightening the leaky pipe fitting would likely have caused more damage and further compromised the seal. Preparations will be made to attempt to seal the minor leak during the 2014 site visit if conditions warrant and allow a repair.



**Figure 2-3**  
**Pressure Transducer Data Palmer Ranch Well MW-35-8-19-1**

## 2.3 FIDDLER

Monitor well MW 35-8-10-1 has been monitored since November 17, 2009. Initial and ending well pressures and calculated water level in the monitor well are summarized in Table 2-3 for the indicated period of record.

**Table 2-3**  
**Well Pressure Data Summary for Fiddler Monitoring Well**

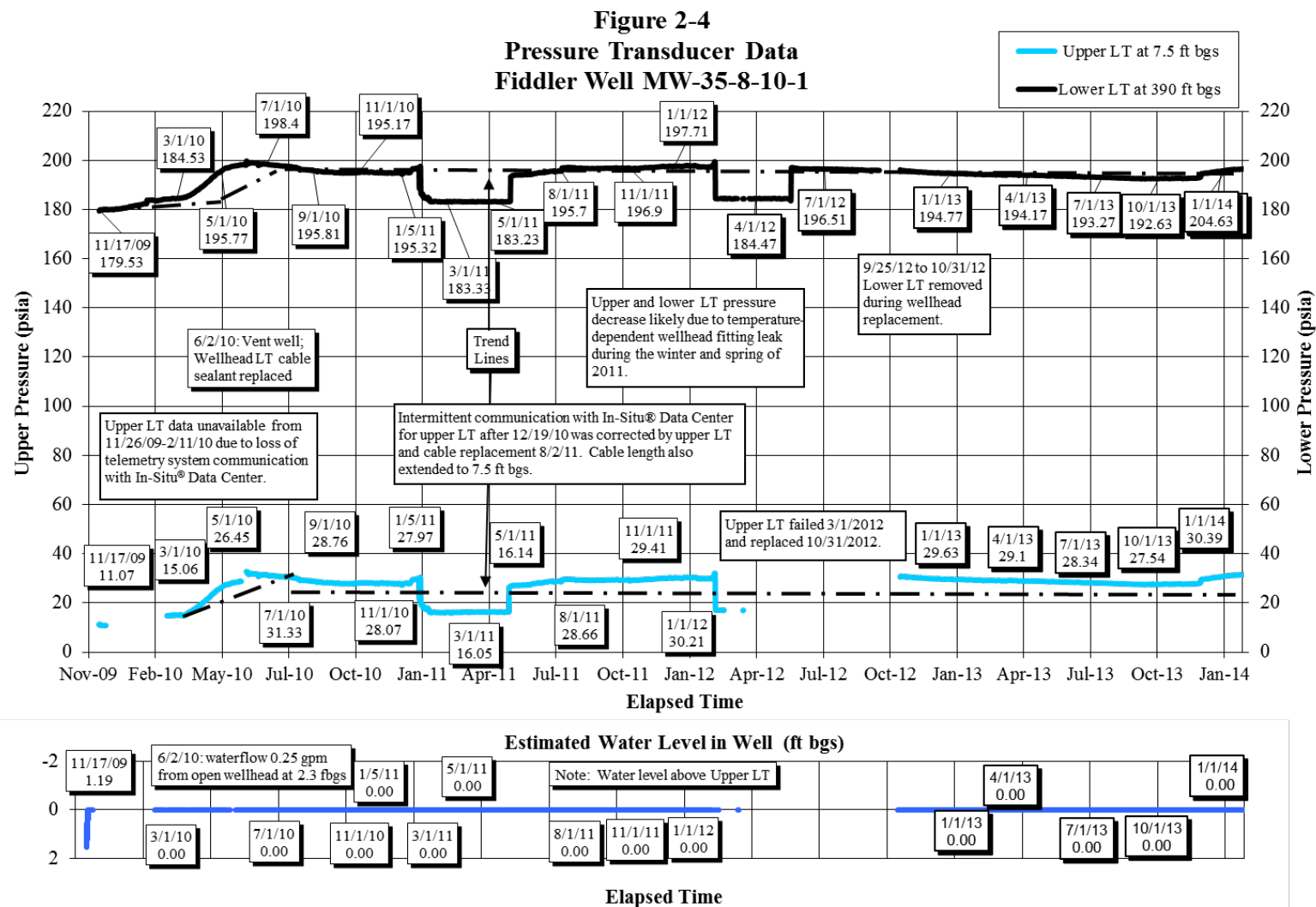
| Well ID and Transducers | Period of Record  | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs)                        | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|-------------------|--------------------------------------|-------------------------------------|-----------------------------------|---|-------------------------------------|--------------------------------|
| MW 35-8-10-1 Upper      | 2/18/10 to 1/1/14 | 14.84                                | 30.39                               | 15.55                             | Upper transducer under water at 7.5 ft below ground surface |                                     |                                |
| Lower                   |                   | 184.3                                | 195.45                              | 11.15                             |   |                                     |                                |

Monitoring data for MW 35-8-10-1 are plotted in Figure 2-4. The net change in wellhead pressure is 15.55 psi and the net change in downhole pressure is 20.33 psi for the 4-year period of record. As Figure 2-4 shows, both the wellhead pressure and downhole pressure steadily increased from installation on November 17, 2009 to early June, 2010. After a minor decrease in pressure both the wellhead pressure and downhole pressure have remained relatively stable from June, 2010 to January 1, 2013. An approximate 2 psi pressure spike followed by a slow continued increase in pressure began on December 10, 2013 and has continued through the period of record for both the upper and lower transducers. The effect does not seem to be related to temperature, as it remained relatively constant both at the wellhead and at depth during this period. It is possible that a nearby well or wells in the same completion interval may have been shut in on December 10, 2013 allowing local reservoir pressure to recover.

As noted on Figure 2-4 the lower Level Troll was removed during wellhead maintenance on September 25, 2012 and reinstalled on October 31, 2012. A net water level change was not calculated because the upper transducer is below the water level in the well. Figure 2-4 documents a natural flow rate from the well at a rate of 0.25 gallons per minute (gpm) when the well was vented for maintenance on June 2, 2010. At the time of the well inspection on October 31, 2012, the flow rate was measured at 0.14 gpm. For charting purposes, the water level in the shut-in well is estimated to be at or near ground surface above the upper pressure transducer (set at 7.5 ft bgs).

Also noted on Figure 2-4, telemetry system communication with the In-Situ® Data Center for the upper transducer was lost from November 26, 2009 through February 11, 2010 due to cable connection problem, and was intermittent from December 19, 2010 to January 1, 2011. The upper transducer and

cable were replaced during the 2011 well inspection and the cable length was extended from 3 ft bgs to 7.5 ft bgs. Additionally, a wellhead fitting leak during the winter and spring of 2011 through the summer of 2012 caused a pressure decrease observed on both the upper and lower transducers. Related to the freeze-thaw cycles the upper transducer failed again March 1, 2012. Inspection of the wellhead on June 6, 2012 revealed the minor water leak at an estimated flow rate of 0.1 to 0.2 gpm. The tubing head threading was cleaned in an attempt to achieve a pressure tight seal at the mandrel head, but both the rubber seals and threading had deteriorated significantly. Documentation was conducted for a later wellhead replacement. Souder Miller Associates supervised installation of the new wellhead on September 25, 2012, which required removal of all instrumentation from the well. Rather than reset the instrumentation at that time, it was planned to remain out of service until the well inspection conducted by COGCC, Norwest and In-Situ, Inc. on October 31, 2012. During that well inspection the upper transducer was replaced with a new 100 PSI Level Troll. Also as planned the lower transducer and cable was reset, however the new set depth was approximately 15 feet deeper than the previous set depth, so the proper offset has been incorporated into the lower transducer data in Figure 2-4.



**Figure 2-4**  
**Pressure Transducer Data Fiddler MW-35-8-10-1**

## 2.4 SOUTH FORK TEXAS CREEK

Monitor wells MW 35-7-8-1 and MW 35-7-8-2 have been monitored since November 29, 2001. Initial and ending well pressures and calculated water levels in the monitor wells are summarized in Table 2-4 for the indicated period of record.

**Table 2-4**  
**Well Pressure Data Summary for South Fork Texas Creek Monitoring Wells**

| Well ID and Transducers | Period of Record   | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs)                     | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|--------------------|--------------------------------------|-------------------------------------|-----------------------------------|--|-------------------------------------|--------------------------------|
| MW 35-7-8-1 Upper       | 12/01/01 to 1/1/14 | 13.79                                | 49.28                               | 35.49                             | 88.39  | 161.99                              | -73.60                         |
| Lower                   |                    | 144.47                               | 141.18                              | -3.29                             |  |                                     |                                |
| MW 35-7-8-2 Upper       | 1/15/02 to 1/1/14  | 91.32 <sup>1</sup>                   | 82.48                               | -8.84                             | Water level in well is >225 ft bgs with complete shut in |                                     |                                |
| Lower                   |                    | 91.91 <sup>1</sup>                   | 82.86                               | -9.05                             |  |                                     |                                |

<sup>1</sup> Both downhole and wellhead pressure are typically the same in MW 35-7-8-2 with complete shut in.

### 2.4.1 MW 35-7-8-1

Monitoring data for MW 35-7-8-1 are plotted in Figure 2-5. As summarized in Table 2-4, the net change in wellhead and downhole pressures is 35.49 psi and -3.29 psi respectively for the 13-year period of record. The net change in the calculated water level in the well is -73.60 feet.

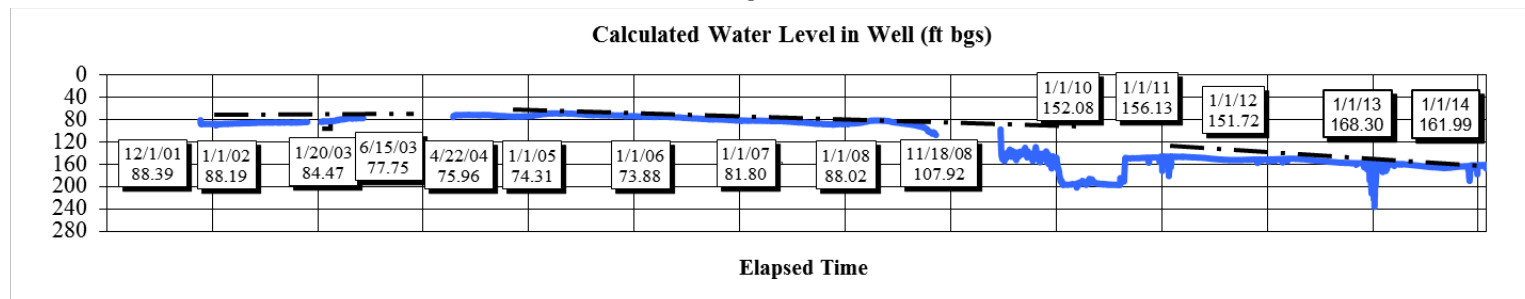
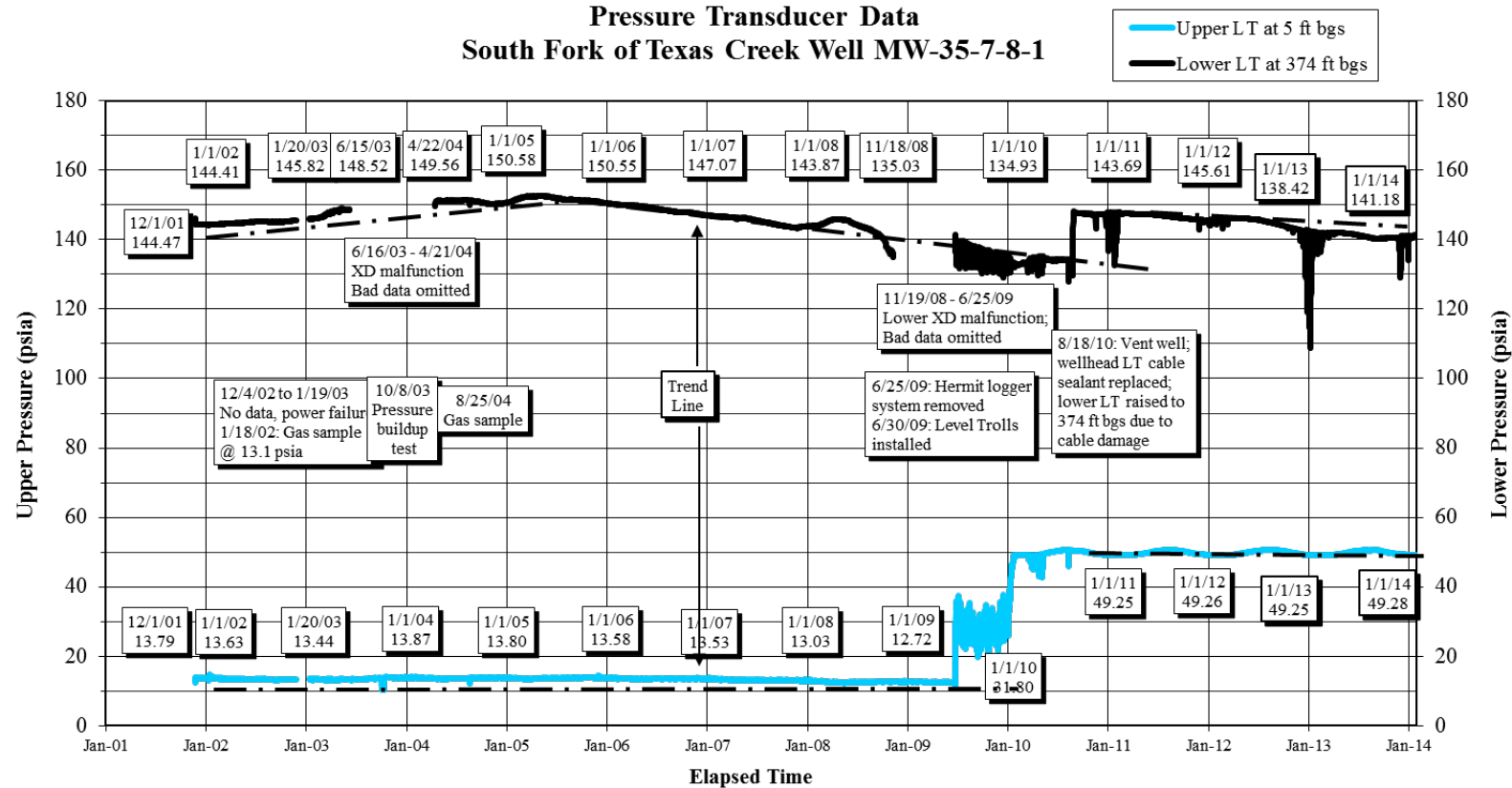
Figure 2-5 shows a relatively stable wellhead pressure (12 to 13.5 psia) prior to installation of the Level Troll instrument on June 30, 2009. After the transducer change-out, there was a build-up in wellhead pressure from 11.52 psia on June 30, 2009 to 33.76 psia on July 3, 2009 followed by frequent fluctuations in wellhead pressure ranging between 19 psia and 38 psia through January 18, 2010. Between January 19, 2010 and January 30, 2010, the wellhead pressure rose from 38 psia to 49 psia and then has remained fairly stable through January 1, 2014. The relatively stable wellhead pressure curve prior to June 30, 2009 is inconsistent with the fluctuating and notably higher pressure measurements recorded after June 30, 2009. Likewise, the lower Level Troll has recorded frequent downhole pressure fluctuations (between 129 and 142 psia) not previously observed in well pressure data prior to June 30, 2009. The higher well pressure regime since August 2010 may indicate complete well shut-in was not achieved until after the Level Troll cable wellhead seals were replaced on August 18, 2010. Some higher magnitude pressure fluctuations in the lower transducer began occurring in December of



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2012 and were continuing through the current period of record. These fluctuations will be monitored further in early 2014 and evaluated to determine if the lower transducer is malfunctioning and it is a candidate for replacement during the 2014 site visit.

**Figure 2-5**  
**Pressure Transducer Data**  
**South Fork of Texas Creek Well MW-35-7-8-1**



**Figure 2-5**  
**Pressure Transducer Data South Fork of Texas Creek Well MW-35-7-8-1**

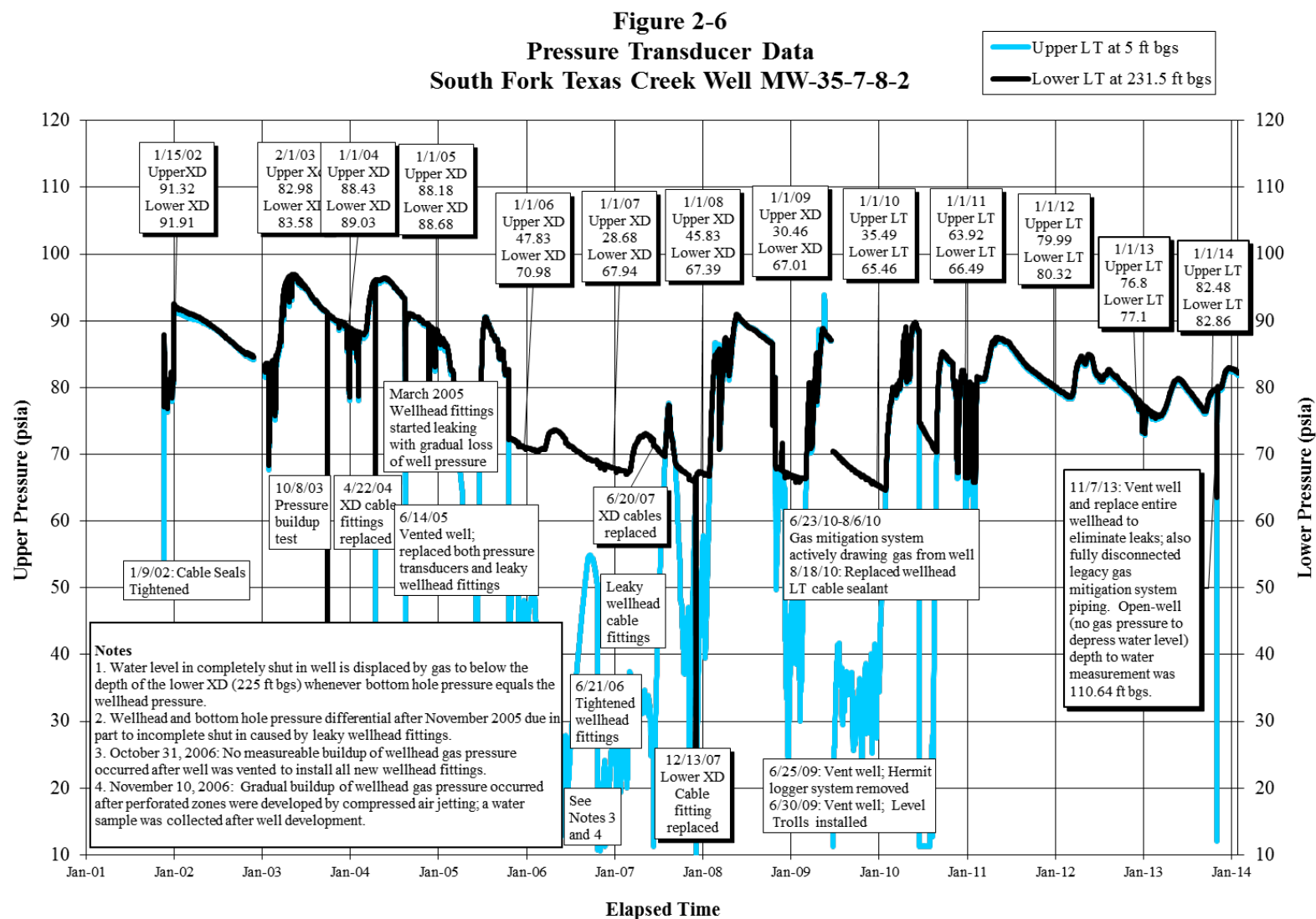
## 2.4.2 MW 35-7-8-2

Figure 2-6 charts the pressure data for well MW 35-7-8-2, which exhibits an entirely different pressure regime than the deeper monitoring well MW 35-7-8-1. Figure 2-6 shows nearly equal wellhead and downhole pressures for the period of record when the well is completely shut in. For example, wellhead and downhole pressures recorded on January 1, 2014 were 82.48 psia and 82.86 psia respectively under shut-in conditions. Based on the period of record to date, incomplete well shut-in is indicated whenever the well pressure drops below about 70 psia.

The production casing at well MW 35-7-8-2 was connected, via transition to PVC pipeline, into the South Fork gas mitigation system in June 2010 to test if there was enough gas in the well to supplement the larger-scale gas recovery and electrical generation system located along South Fork Texas Creek. The well was opened to the mitigation system on June 23, 2010. At 06:00 hours, the recorded wellhead and downhole pressures were about 88 psia. At 18:00 hours on June 23, 2010, the recorded wellhead pressure had dropped to 11.31 psia (atmospheric pressure) and the downhole pressure had dropped to about 74.8 psia. The well was removed from the gas mitigation system on August 6, 2010 due to lack of demonstrated performance. At that time, the recorded wellhead pressure was still about 11.3 psia and the downhole pressure was about 71 psia. The initial well pressure, 88 psia, was not sustained during system operation and there was no decrease in gas recovery system performance when the well was shut in on August 6, 2010. The well did not contribute enough gas to improve the gas recovery system operation. During a site specific follow-up trip on November 7, 2013, the entire wellhead was rebuilt to remove long-standing leaky fittings and achieve complete shut-in. At that time the wellhead piping originally installed to deliver gas to the South Fork gas mitigation system was fully decommissioned. The 1-inch PVC gas pipeline that terminates beside the MW 35-7-8-2 well pad was fitted with a 1-inch ball valve, closed and the handle was removed to deter tampering. The 1-inch pipeline did not contain any pressure at this stage of decommissioning.

Figure 2-6 shows a fairly rapid increase in well pressure after the well was shut in on August 18, 2010. The peak build-up pressure of about 85 psia on September 28, 2010 was followed by an erratic decline in well pressure. The inspection of the well in 2013 documented a minor fitting leak at that time; this was a consistent leak on a pipe fitting that has been attempted to be tightened in the past years, but required significant replacement of numerous wellhead fittings. The colder air temperatures occurring with early winter of 2012 and again in 2013 appeared to cause some erratic pressure fluctuations documented with the upper and lower transducers in Figure 2-6. This seemed to indicate that the leak was becoming more significant. On November 7, 2013 during a site specific follow-up trip that documented continued leakage on September 30, 2013. The well gas pressure was allowed to safely bleed down, with continuous gas detector monitoring. Both upper and lower Level Trolls were removed from the well and the wellhead was completely removed down to the 2-inch line pipe that is the well

casing extending up from the cement pad. The threads were reconditioned with a hand-operated 2-inch pipe die. The wellhead was reconstructed using all new carbon steel pipe fittings, with the exception of the Conax compression fittings secured around each Level Troll Rugged Cable, as they had not been documented as leaking. Several manual water level measurements were taken while the wellhead was open. Initially, the water level was recovering fairly quickly as the gas pressure had been vented. After approximately 2.5 hours open during the new wellhead installation, the water level was relatively static and measured 110.64 ft bgs. This is the static water level when no gas pressure is allowed to depress the water column in the well. As can be seen in Figure 2-6, the upper and lower Level Troll pressure readings diverge at this time indicating that for the short period following well shut-in the lower Level Troll was actually submerged in water. The lower Level Troll pressure reading was approximately 63.6 psia, which calculates to 111.06 ft bgs. This gives good confidence in the calculated versus measured water level in this well, given error in the assumption of barometric pressure which is not currently recorded at this location. To prevent damage to the existing lower Level Troll cable, the Conax compression fitting was not adjusted to offset the new wellhead's increased height above ground surface of 0.25 feet, so the new set depth is 231.25 ft bgs.



**Figure 2-6**  
**Pressure Transducer Data South Fork Texas Creek Well MW-35-7-8-2**

## 2.5 BP HIGHLANDS

Monitor well MW 34-7-15-1 has been monitored since November 19, 2009. Initial and ending well pressures and calculated water levels in the monitor well are summarized in Table 2-5 for the indicated period of record.

**Table 2-5**  
**Well Pressure Data Summary for BP Highlands Monitoring Well**

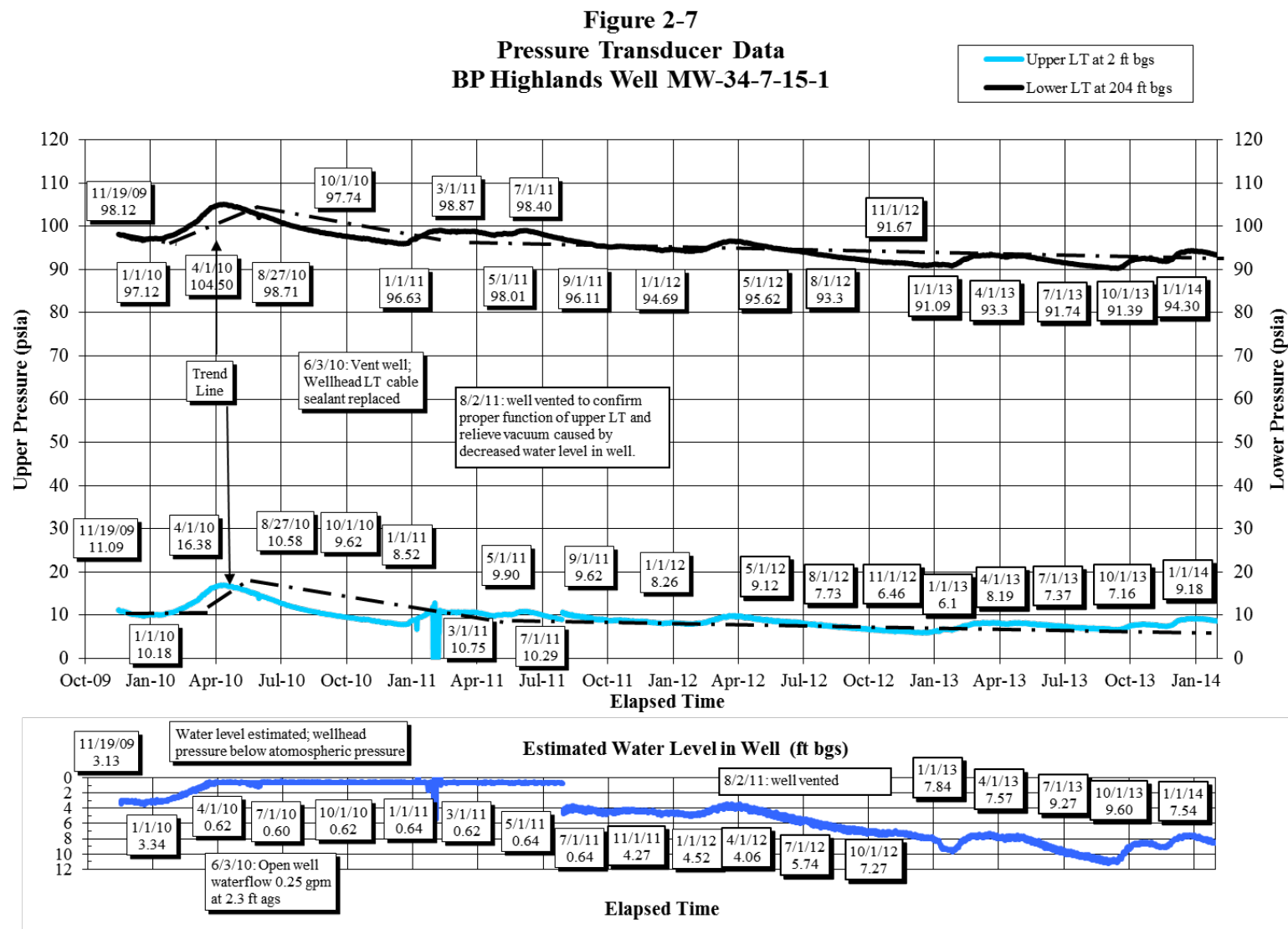
| Well ID and Transducers | Period of Record   | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|--------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 34-7-15-1 Upper      | 11/19/09 to 1/1/14 | 11.09                                | *9.18                               | -1.91                             | 3.13                                 | 7.54                                | -4.41                          |
| Lower                   |                    | 98.12                                | 94.30                               | -3.82                             |                                      |                                     |                                |

\* Well subject to a natural vacuum so upper transducer reports less than barometric pressure

Monitoring data for MW 34-7-15-1 are plotted in Figure 2-7. As summarized in Table 2-5 for the 4-year period of record, the net change in downhole pressures is a decrease of 3.82 psi. The wellhead pressure curve and the downhole pressure curve follow the same trend with an initial rise in pressure through April 1, 2010 then a steady decline through late December 2010. The net change in the calculated water level in the well is a decrease of 4.41 feet. As noted on Figure 2-7, water flowed from the well at a rate of 0.25 gallons per minute (gpm) when the well was vented for maintenance on June 3, 2010. For charting purposes, the water level in the shut-in well at that time was estimated to be slightly above ground surface with the upper transducer under water at 2 ft bgs.

The wellhead pressure started dropping below atmospheric pressure around August 12, 2010. This condition suggested either a potential problem with the upper transducer or a well pressure vacuum effect created in a completely shut-in well under declining water level conditions. A well instrumentation inspection and barometric pressure check conducted during each subsequent site visit through 2013 has confirmed the proper function of the upper transducer. Venting the well allowed for physical confirmation that the well was under vacuum pressure conditions.





**Figure 2-7**  
**Pressure Transducer Data BP Highlands Well MW-34-7-15-1**

## 2.6 BEAVER CREEK RANCH

Well MW 35-6-17-1 has been monitored since May 21, 2002 and well MW 35-6-17-2 has been monitored since November 30, 2001. Initial and ending well pressures and calculated water levels in the monitor wells are summarized in Table 2-6 for the indicated period of record. The access agreement to the Beaver Creek Ranch location expired following the August 2011 site inspection. COGCC staff is attempting to negotiate a new access agreement to continue full use including access for maintenance, however the lack of a new agreement prevented any site well inspections in 2013.

**Table 2-6**  
**Well Pressure Data Summary for Beaver Creek Ranch Monitoring Wells**

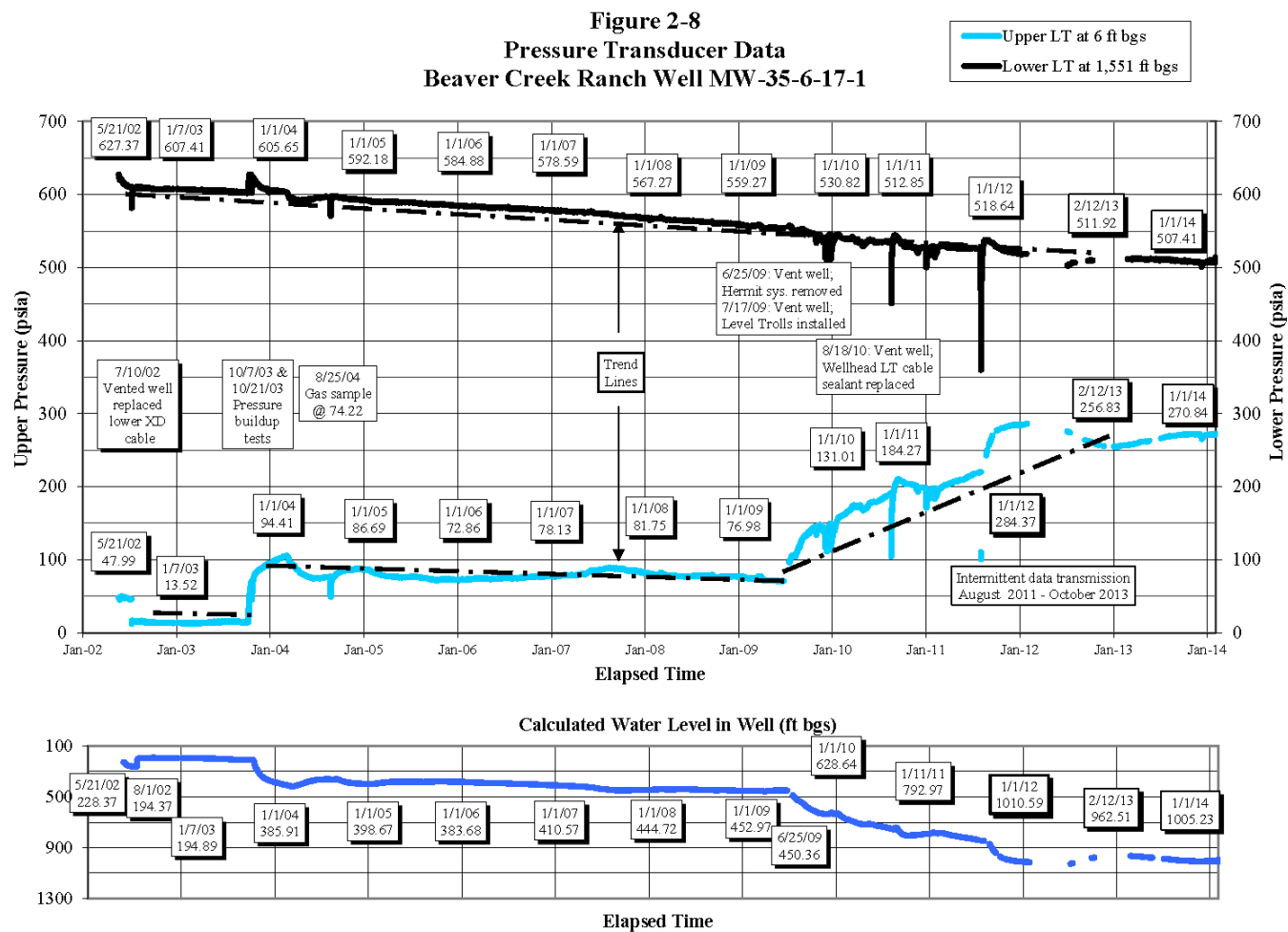
| Well ID and Transducers | Period of Record   | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|--------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 35-6-17-1 Upper      | 08/01/02 to 1/1/14 | 15.44                                | 270.84                              | 255.40                            | 194.37                               | 1005.23                             | -810.86                        |
| Lower                   |                    | 609.55                               | 507.41                              | -102.14                           |                                      |                                     |                                |
| MW 35-6-17-2 Upper      | 06/15/02 to 1/1/14 | 614.27                               | 445.64                              | -168.63                           | 1,377.64                             | 1378.11                             | 0.47                           |
| Lower                   |                    | 632.63                               | 458.51                              | -174.12                           |                                      |                                     |                                |

### 2.6.1 MW 35-6-17-1

Monitoring data for well MW 35-6-27-1 are charted on Figure 2-8. As shown in Table 2-6, the pressure regime for this well is different than the regime exhibited by well MW 35-6-17-2.

Table 2-6 and Figure 2-8 show a net increase of 255.40 psi in wellhead pressure, a net decline of 102.14 psi in downhole pressure and a corresponding net decline of 810.86 feet in the water level in the well for the entire approximate 11.5-year period of record. Figure 2-8 also shows a steady decline in bottom-hole pressure curve for the period of record, while the wellhead pressure curve shows two notable increases in the well pressure regime. Both increases in wellhead pressure suggest stimulation of gas flow into the well with corresponding declines in the water level occurred in response to venting the well in July 2003, June and July 2009 and August 2011. However, the most substantial cause for gas pressure increase during the period of record was the replacement of monitoring equipment and minimization of fittings leakage in July 2009. A significant leak was again repaired during the 2011 well inspection. These fittings and also an upper and lower transducer communication problem causing

intermittent data collection since the second half of 2011 will be investigated and repaired as necessary if this site is accessible in 2014.



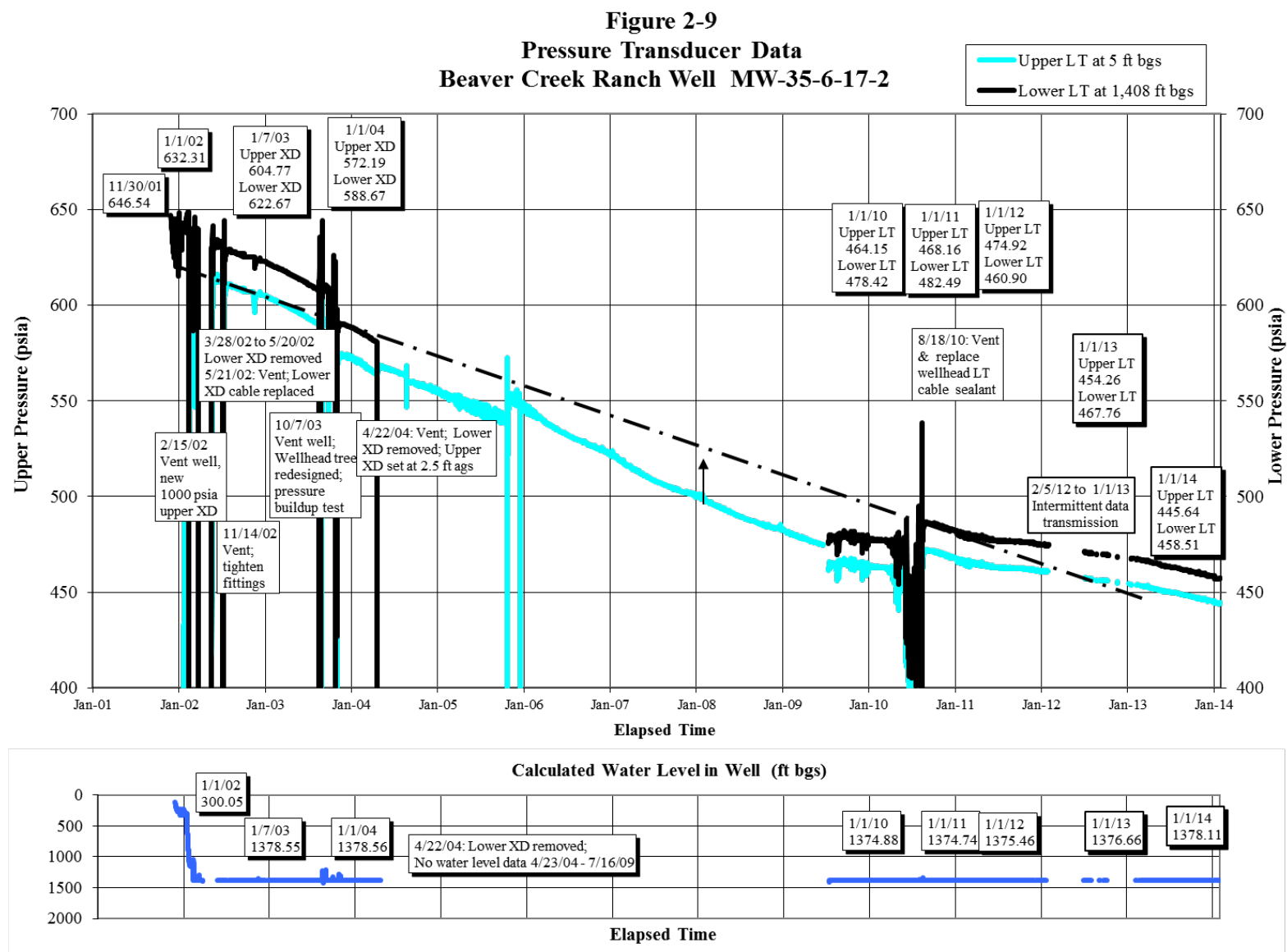
**Figure 2-8**  
**Pressure Transducer Data Beaver Creek Ranch Well MW-35-6-17-1**

## 2.6.2 MW 35-6-17-2

Wellhead pressure, downhole pressure, and calculated well water level data for well MW 35-6-17-2 are charted in Figure 2-9 and summarized in Table 2-6 for the period of record. Monitoring of downhole pressure was terminated after the lower transducer was removed from the well for the period of record between April 22, 2004 and June 25, 2009. The Hermit data logger and wellhead PXD pressure transducer were removed on June 25, 2009. New wellhead and downhole Level Trolls were installed in well MW 35-6-17-2 on July 17, 2009 to re-enable monitoring of both wellhead and downhole pressure regimes and the water level in the well.

Figure 2-9 shows the well pressure in a declining trend for the entire period record. There is a notable shift in the well pressure curve following the installation of Level Troll instruments on July 17, 2009, followed by erratic well pressure spikes associated with incomplete shut-in through August 17, 2010. After the well was vented August 18, 2010 to replace the Level Troll cable fitting sealants, there was a steady build-up of well pressure through early September 2010 followed by a return to a declining trend through December 2013. This may be a result of an incomplete shut-in condition as a small leak was found at a two pipe fittings on the wellhead during the 2011 inspection. The fittings were not tightened at that time due to concern of further damage to the fittings causing an increase in leak-off.

As shown on Figure 2-9, no water level data is available for the 6-year period of record when there was only one well pressure transducer. Well pressure data available after installation of wellhead and downhole Level Trolls on July 19, 2009 shows very little change in the water level.



**Figure 2-9**  
**Pressure Transducer Data Beaver Creek Ranch Well MW-35-6-17-2**



## 2.7 SHAMROCK MINES

Well MW 35-6-13-1 monitoring data are charted in Figures 2-10 and summarized in Table 2-7 for the entire 11.5-year period of record. Since there are no producing wells in close proximity to this area, this well is used to collect background data and has been monitored continuously since May 22, 2002.

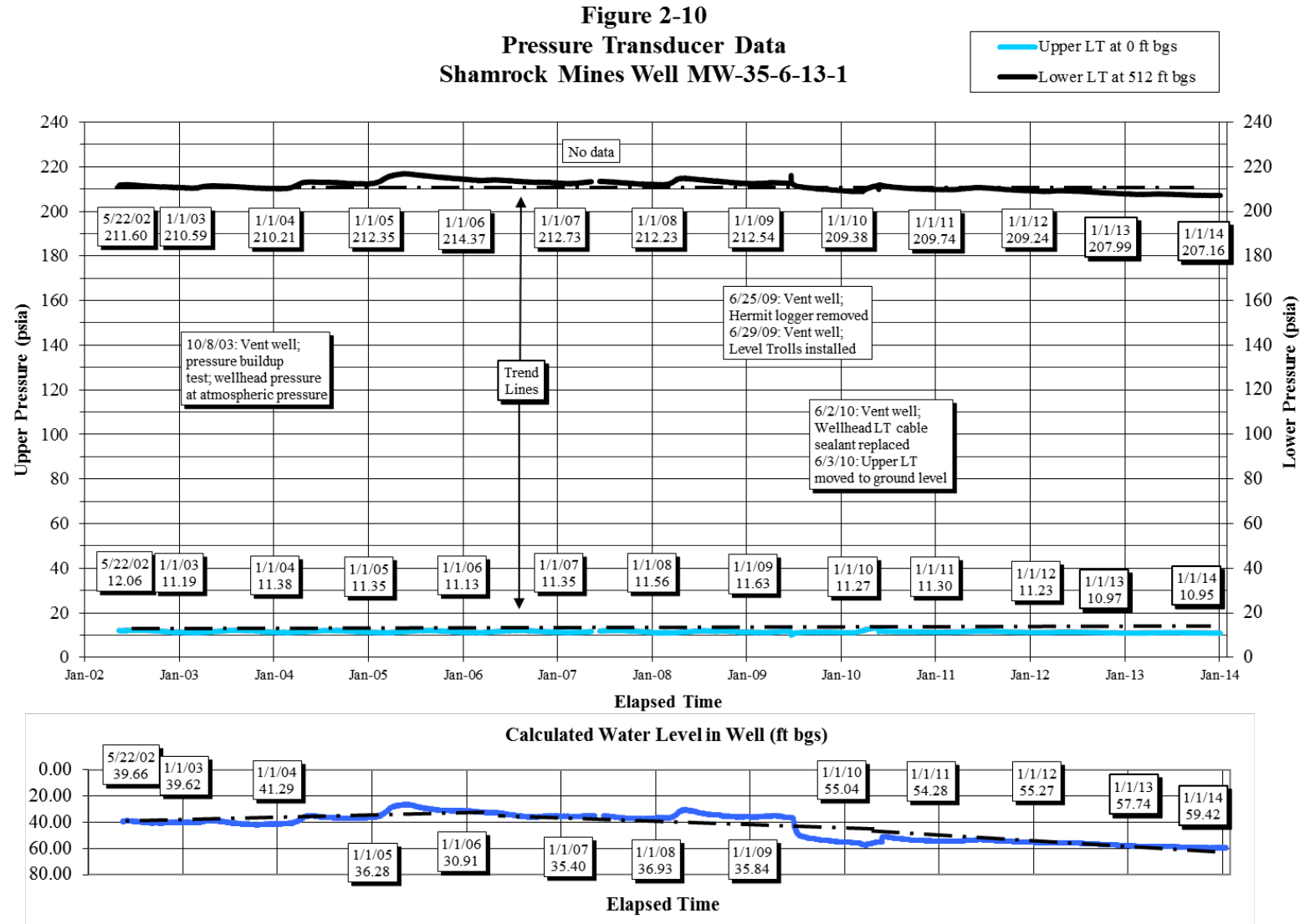
**Table 2-7**  
**Well Pressure Data Summary for Shamrock Mines Monitoring Well**

| Well ID and Transducers | Period of Record  | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|-------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 35-6-13-1 Upper      | 5/22/02 to 1/1/14 | 12.06                                | 10.95                               | Atmospheric Pressure              | 39.66                                | 59.42                               | -19.76                         |
| Lower                   |                   | 211.60                               | 207.16                              | -4.44                             |                                      |                                     |                                |

\* On May 26, 2005, the measured downhole pressure (216.89 psia) and calculated depth to water (26.53 ft) in well MW 35-6-13-1 were at their highest levels for the period of record.

Figures 2-10 shows the wellhead pressure regime continues to be at atmospheric pressure and fluctuates within a range of 2 psi (between 10 psia and 12 psia). During the months of April and May 2010, the wellhead pressure steadily increased to around 13.4 psia. Wellhead pressure returned to the historic atmospheric pressure trend after the Level Troll wellhead cable sealants were replaced on June 2, 2010.

Figure 2-10 also shows the downhole pressure and calculated water level in the well continued to exhibit an overall declining well pressure trend for the period of record since April 2005. With wellhead pressure equal to atmospheric pressure, fluctuation of downhole pressure is attributable to the fluctuation of the water level in the well.



**Figure 2-10**  
**Pressure Transducer Data Shamrock Mines Well MW-35-6-13-1**

### 3.0 ARCHULETA COUNTY MONITORING WELL DATA SUMMARY

Monitoring well pressure was measured and recorded twice daily (12-hour interval) at the 4 monitoring well sites located in Archuleta County, Colorado. Applicable well pressure and calculated water level data for the entire period of record for each monitoring well are plotted in annotated charts.

#### 3.1 WAGON GULCH

Monitor wells MW 34-5-4-1 and MW 34-5-4-2 have been monitored since December 2, 2008. Initial and ending monitoring well pressures and calculated water levels in the wells for the period of record are summarized in Table 3-1.

**Table 3-1**  
**Well Pressure Data Summary for Wagon Gulch Monitoring Wells**

| Well ID and Transducers | Period of Record   | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs)                         | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|--------------------|--------------------------------------|-------------------------------------|-----------------------------------|--|-------------------------------------|--------------------------------|
| MW 34-5-4-1 Upper       | 12/26/08 to 1/1/14 | 50.14                                | 19.75                               | -30.39                            | 650.74   | 293.14                              | 357.60                         |
| Lower                   |                    | 131.88                               | 256.69                              | 124.81                            |  |                                     |                                |
| MW 34-5-4-2 Upper       | 5/1/09 to 1/3/14   | 48.50                                | 50.85                               | 2.35                              | Upper transducer is under water at 2.5 ft below ground level |                                     |                                |
| Lower                   |                    | 391.07                               | 378.38                              | -12.69                            |  |                                     |                                |

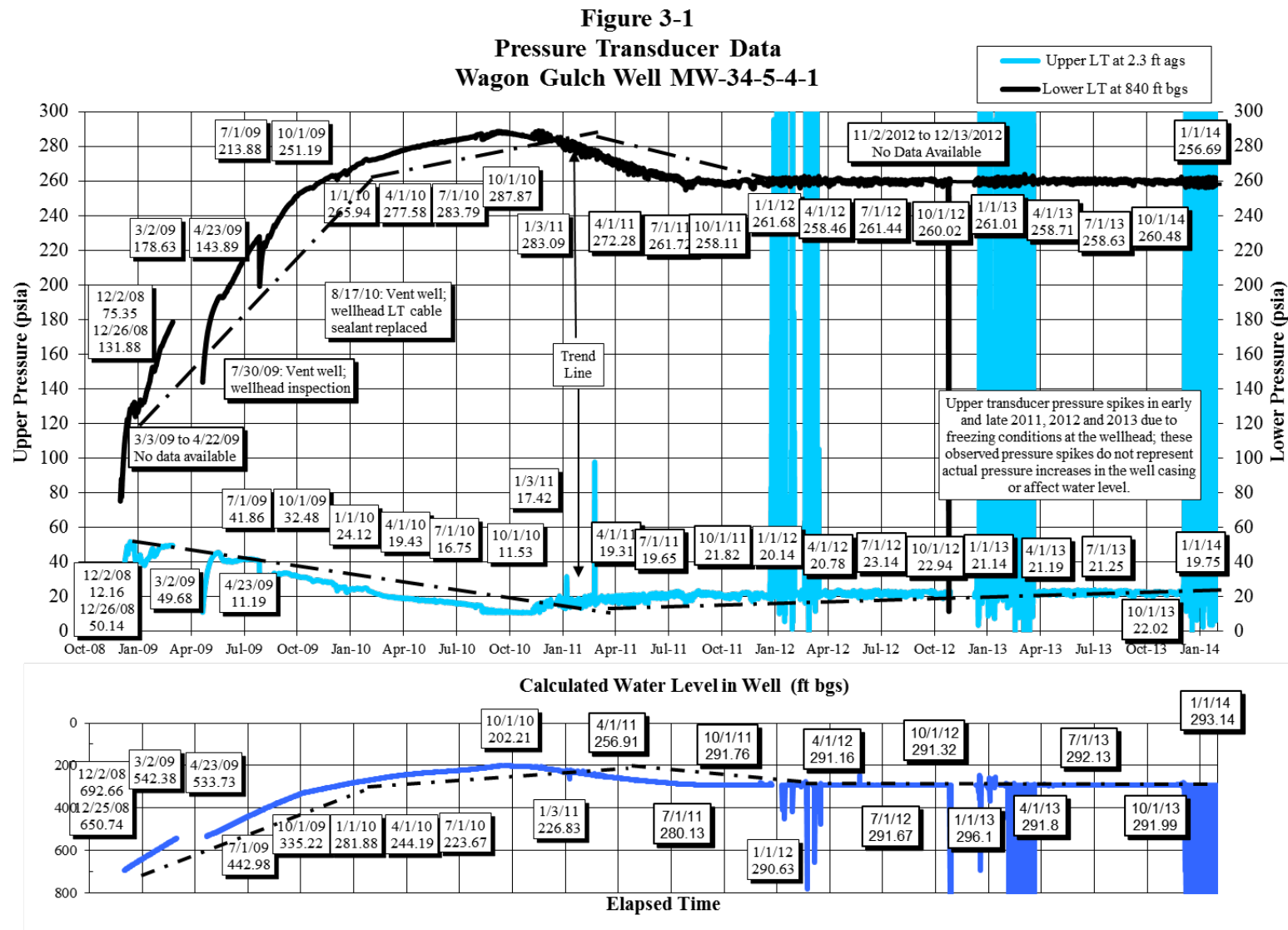
##### 3.1.1 MW 34-5-4-1

Figure 3-1 charts the upper and lower pressure transducer data and the calculated water level in the well. Although the well was shut in for monitoring on December 2, 2008, the wellhead pressure did not reach an initial stable pressure of about 50.1 psia until December 26, 2008, 24 days after shut-in. Table 3-1 and Figure 3-1 show approximately 30 psi net decline in wellhead pressure for the entire 5-year period of record from December 26, 2008 (50.14 psia) to January 1, 2014 (19.75 psia). Figure 3-1 shows the trend of decreasing wellhead pressure continued in 2010 until the trend reversed in mid-November 2010. Since that time, wellhead pressure has shown a steady linear increase of approximately 8.25 psi.

Table 3-1 and Figure 3-1 show a net increase in downhole pressure of 124.81 psi for the entire 5-year period of record from December 26, 2008 (131.88 psia) to January 1, 2014 (256.69 psia). The well pressure increase is primarily due to the 357.6 feet of net water level rise in the well since December 26, 2008. Figure 3-1 shows the trend of rising water level with corresponding increasing downhole pressure

continued in 2010 until the trend reversed in mid-September 2010. This may be related to the transducer cable sealant being changed on August 17, 2010 and possibly eliminating a partial shut-in condition. No leaks were detected during the site inspections in 2012. Between October 1, 2010 and December 31, 2010, Figure 3-1 shows the water level decreased about 21.2 feet while the downhole pressure decreased about 2.7 psia.

During the winters of 2011-2012, 2012-2013 and 2013-2014 pressure spikes in the upper transducer occurred due to the pressure transducer freezing within its deployment location in the wellhead 2.3 feet above ground surface. These are not actual increases in gas pressure within the well casing, but rather caused when the air volume next to the transducer inlet is trapped and then compressed by expanding frozen water condensate. When the 2011 well inspection was conducted at MW 34-5-4-1 the well was vented to ensure that the transducer would return to atmospheric pressure; this test successfully showed that the transducer continued to function properly and was not damaged. Equipment has not been available to lower the transducer to prevent it from freezing again. The transducer appears to have recovered after surface temperatures warmed each spring. The transducer has been inspected for damage in each subsequent site visit since this problem began in 2011 and continues to function properly when not subjected to a hard freeze. The transducer will be lowered below the freeze line during the 2014 site inspection if equipment is available and conditions allow.



**Figure 3-1**  
**Pressure Transducer Data Wagon Gulch Well MW-34-5-4-1**

### 3.1.2 MW 34-5-4-2

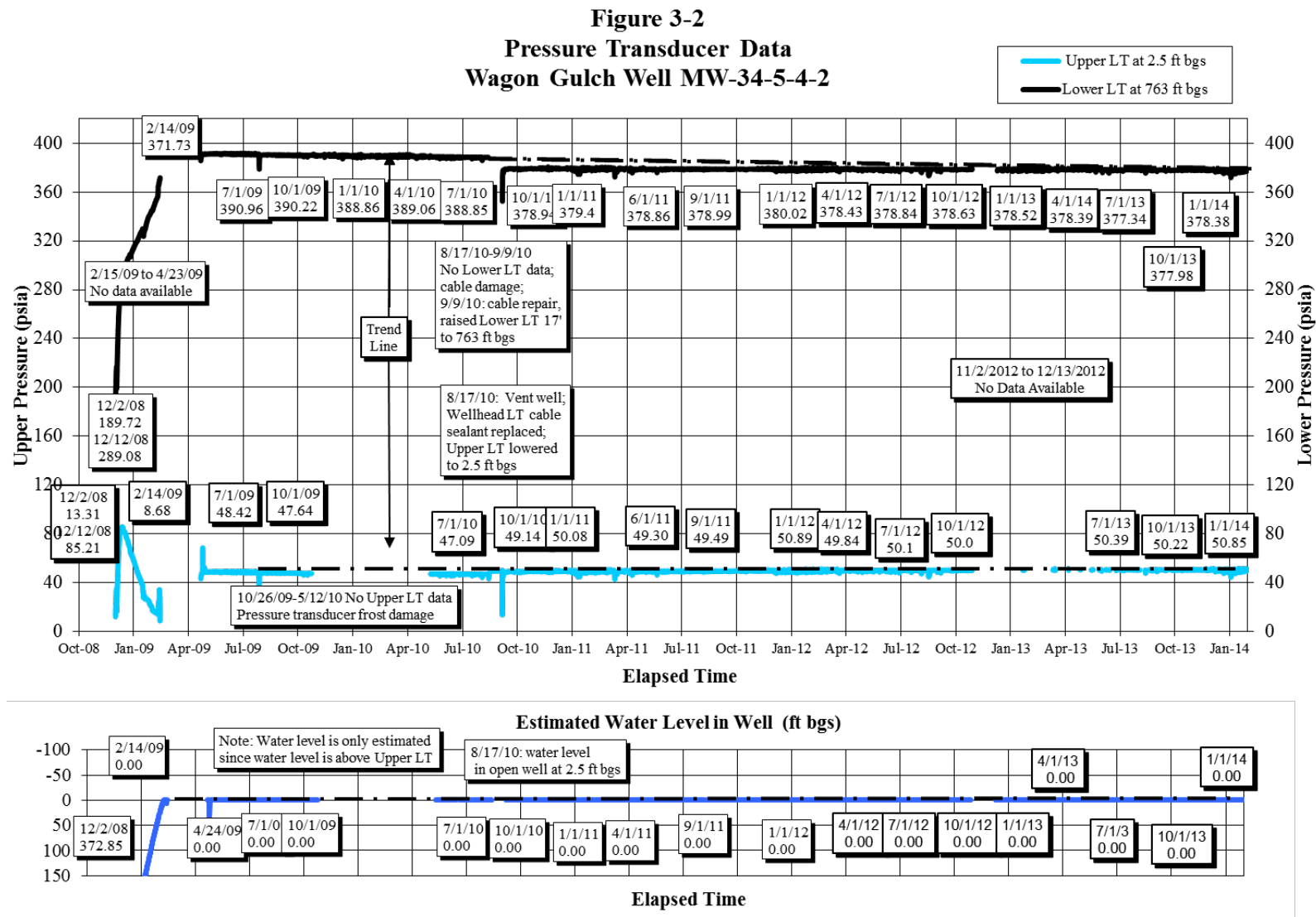
Figure 3-2 charts the upper and lower pressure transducer data and the estimated water level in the well. Although the well was shut in for monitoring on December 4, 2008, a well pressure build-up to a stable downhole pressure of about 391 psi and wellhead pressure of about 47-48 psia were not confirmed until May 2009. No data are available from February 15, 2009 to April 23, 2009 due to pressure transducer malfunction.

Figure 3-2 shows a relatively constant wellhead pressure of about 47 to 48 psia between April 24, 2009 and October 25, 2009. An erratic pressure spiking pattern between October 26, 2009 and May 12, 2010 suggested wellhead Level Troll pressure sensor freeze damage, so the data were omitted from Figure 3-2. Between May 13, 2010 and August 16, 2010 the wellhead pressure remained fairly constant at around 47 psia.

Freeze damage to the upper Level Troll pressure transducer sensor was confirmed after the well was vented on August 17, 2010. As noted on Figure 3-2, the water level inside the open wellhead was at a height of about 2.5 feet above ground level. The new upper Level Troll was changed from an external mount to an internal depth setting of 2.5 ft bgs on August 17, 2010 to protect the transducer sensor from freezing conditions. After well shut-in on August 17, 2010, Figure 3-2 shows a relatively rapid return of wellhead pressure to an average constant pressure of about 50 psia.

The lower Level Troll cable was damaged during replacement of Level Troll wellhead cable sealants on August 17, 2010. Cable repair performed on September 9, 2010 included raising the Level Troll 17 feet from 780 ft bgs to 763 ft bgs. As a result of this change, Figure 3-2 shows a shift in the downhole pressure curve to a corrected constant downhole pressure regime of 378 to 379 psia.

As noted above, the water level was inside the open wellhead at a height of about 2.5 feet above ground level on August 17, 2010. The wellhead pressure build-up after shut-in may reflect water and/or gas pressure build-up. For charting purposes, the water level in the shut-in well is estimated to be at or near ground surface above the upper Level Troll (set at 2.5 ft bgs). However, there is a possibility that the observed build-up in wellhead pressure is from gas pressure, which could result in a downward displacement of the water in the well to some level below the upper Level Troll. The current monitoring scheme for observing shut-in well pressure does not include the capability of determining the source(s) of wellhead pressure build-up in response to complete well shut-in. As an alternative, the upper transducer will be evaluated for the possibility of replacement with a pressure sensor that also records fluid conductivity, thereby detecting if the sensor is in fluid or air/gas. Based on the preliminary results of the test of the Aqua Troll at Basin Creek MW 34-9-7-2, this instrument may be a candidate for exchange with the upper Level Troll at Wagon Gulch MW 34-5-4-2 in 2014.



**Figure 3-2**  
**Pressure Transducer Data Wagon Gulch Well MW-34-5-4-2**

## 3.2 FOSSET GULCH

Monitor wells MW 34-5-14-1 and MW 34-5-14-2 have been monitored since December 4, 2008. Initial and ending monitoring well pressures and calculated water levels in the wells for the period of record are summarized in Table 3-2. Data loss occurred from 4/11/11 to 4/27/11 following damage caused during earlier pipeline construction adjacent to both monitoring wells damaged buried transducer cables linking the wells to the telemetry station. The cables were replaced on 4/27/12 and normal data collection and transmission resumed.

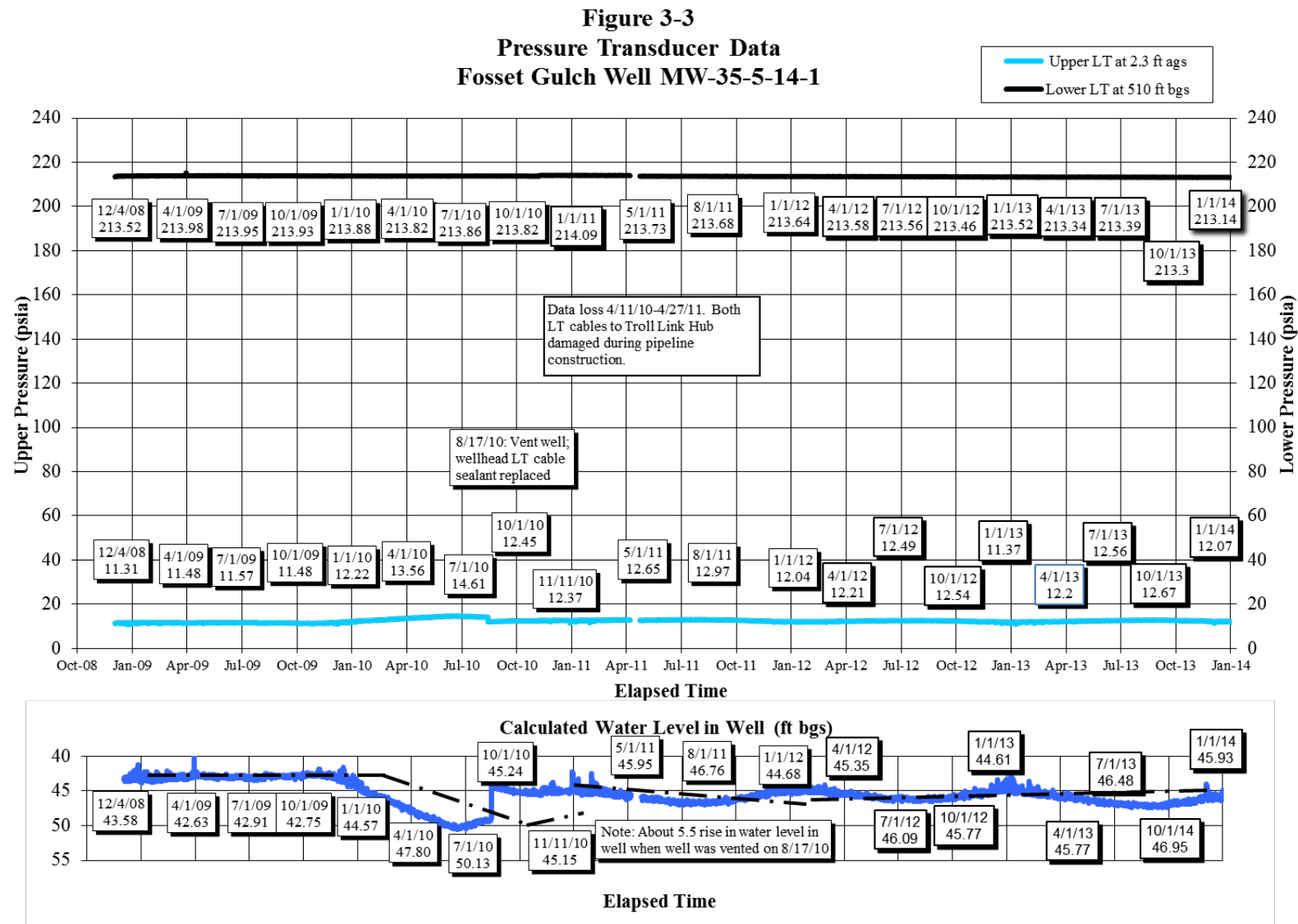
**Table 3-2**  
**Well Pressure Data Summary for Fosset Gulch Monitoring Wells**

| Well ID and Transducers | Period of Record  | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|-------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 34-5-14-1 Upper      | 12/4/08 to 1/1/14 | 11.31                                | 12.07                               | Atmospheric Pressure              | 43.58                                | 45.93                               | -2.35                          |
| Lower                   |                   | 213.52                               | 213.14                              | -0.38                             |                                      |                                     |                                |
| MW 34-5-14-2 Upper      | 12/4/08 to 1/1/14 | 11.35                                | 24.38                               | 13.03                             | 39.29                                | 58.89                               | -26.60                         |
| Lower                   |                   | 242.65                               | 241.50                              | -1.15                             |                                      |                                     |                                |

### 3.2.1 MW 34-5-14-1

Figure 3-3 charts the upper and lower pressure transducer data and the calculated water level in the well. Table 3-2 and Figure 3-3 show the wellhead pressure at atmospheric pressure prior to 2010 followed by a gradual increase in pressure through August 16, 2010 to 14.19 psia. Following the August 17, 2010 well maintenance event including venting, the wellhead pressure has remained relatively constant within a normal atmospheric pressure range through January 1, 2014. Figure 3-3 shows a stable downhole pressure trend (213.5-213.1 psia) for the entire period of record. Figure 3-3 also shows a stable water level averaging 43.0 ft bgs until November 2009, followed by a gradually declining water level trend through July 1, 2010 (50.13 ft bgs). The water level increased to 49.28 ft bgs until the well was vented on August 17, 2010. The water level immediately rose to 44.36 ft bgs when the well was vented on August 17, 2010, but has since followed apparent gentle seasonal fluctuation through January 1, 2014. Altogether, the upper and lower transducer pressures and thus the calculated water level have remained relatively constant since the venting event in August 2010.



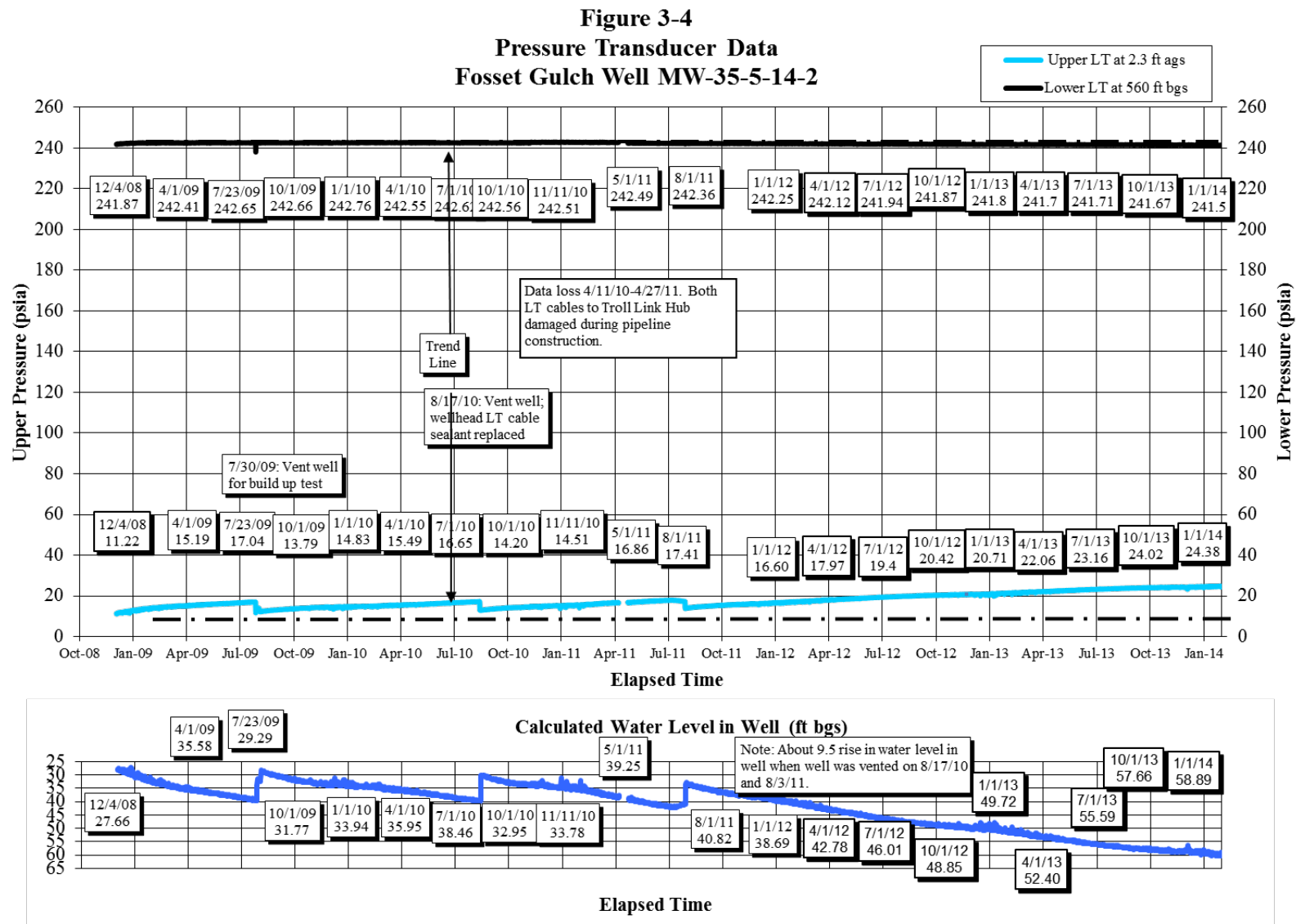


**Figure 3-3**  
**Pressure Transducer Data Fosset Gulch Well MW-35-5-14-1**

### 3.2.2 MW 34-5-14-2

Figure 3-4 plots the upper and lower pressure transducer data and the calculated water level in the well. Although the well was shut in for monitoring on December 4, 2008, wellhead pressure did not stabilize at about 17 psia until July 2009. Table 3-2 and Figure 3-4 show a net increase of about 13.03 psi in wellhead pressure for the period of record between December 4, 2008 (11.35 psia) and January 1, 2014 (24.38 psia). Figure 3-4 shows a stable downhole well pressure trend for the entire period of record, with fluctuations ranging between a minimum pressure of 241 psia to a maximum pressure of 242.8 psia. The downhole pressure was 241.5 psia on January 1, 2014.

Table 3-2 indicates a net water level drop of about 26.60 feet in the well as of January 1, 2014. However, Figure 3-4 shows that the wellhead pressure and water level on January 1, 2014 has continued at the same trend of increasing pressure and decreasing calculated water level without the annual venting of the wellhead. Although there is an immediate drop in wellhead pressure and corresponding rise in the water level each time the well is vented to the atmosphere, Figure 3-4 also shows the build-up in wellhead pressure takes approximately 12 months to return to the pressure exhibited prior to each venting event so unless required for servicing the instrumentation, the well will not be vented in attempt to determine the static wellhead pressure.



**Figure 3-4**  
**Pressure Transducer Data Fosset Gulch Well MW-35-5-14-2**

### 3.3 HIGHWAY 151

Monitor wells MW 34-4-30-1 and MW 34-4-30-2 have been monitored since December 3, 2008. Initial and ending monitoring well pressures and calculated water levels in the wells for the period of record are summarized in Table 3-3.

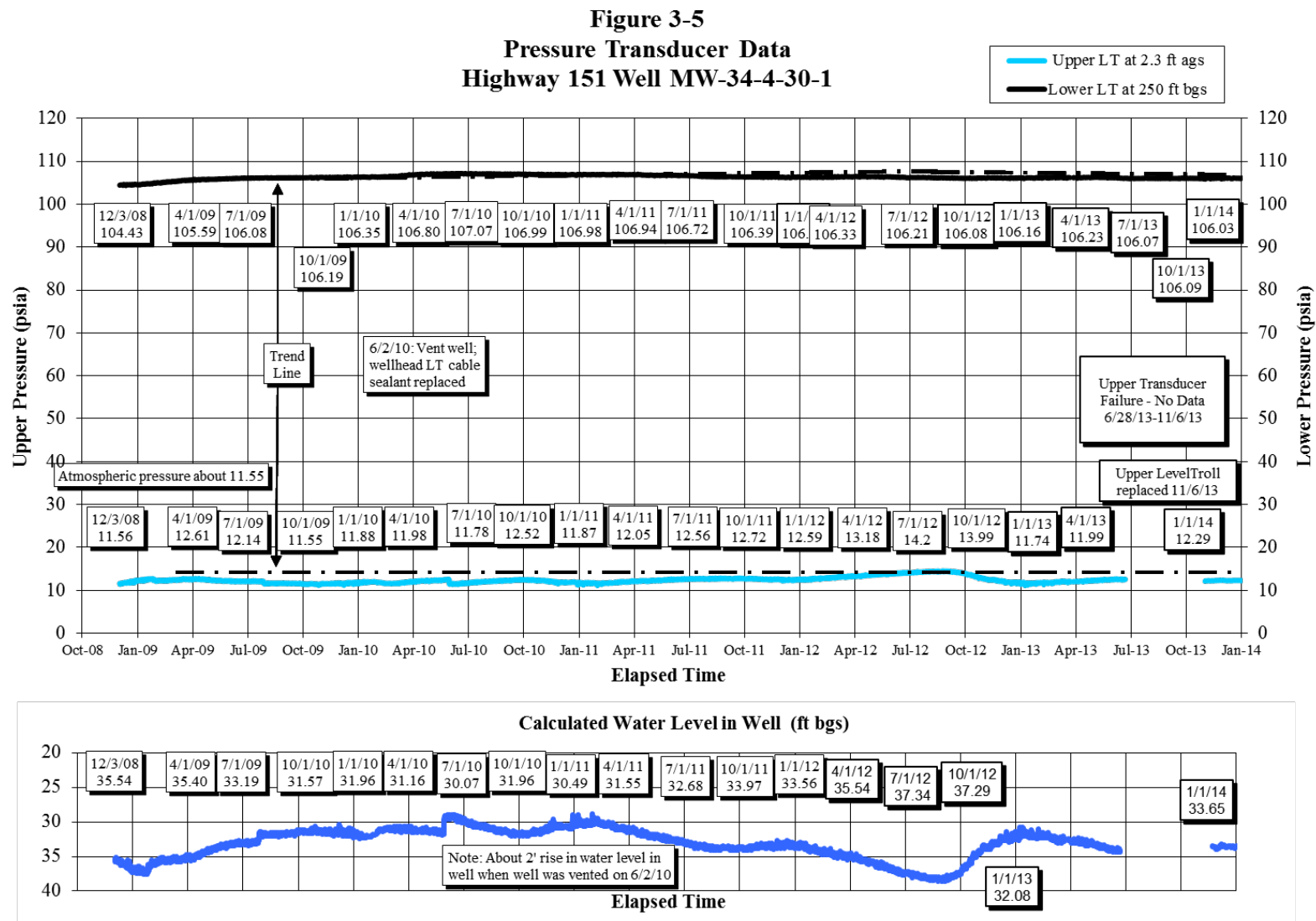
**Table 3-3**  
**Well Pressure Data Summary for Highway 151 Monitoring Wells**

| Well ID and Transducers | Period of Record  | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|-------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 34-4-30-1 Upper      | 12/3/08 to 1/1/14 | 11.56                                | 12.29                               | Atmospheric Pressure              | 35.54                                | 33.65                               | 1.89                           |
| Lower                   |                   | 104.43                               | 106.03                              | 1.60                              |                                      |                                     |                                |
| MW 34-4-30-2 Upper      | 12/3/08 to 1/1/14 | 13.18                                | 18.37                               | 5.19                              | 41.65                                | 54.41                               | -12.76                         |
| Lower                   |                   | 129.59                               | 129.11                              | -0.48                             |                                      |                                     |                                |

#### 3.3.1 MW 34-4-30-1

Figure 3-5 charts the upper and lower pressure transducer data and the calculated water level in the well. Table 3-3 and Figure 3-5 show a relatively stable well pressure regime with a stable wellhead pressure trend at atmospheric pressure, a stable downhole pressure trend of about 106-107 psia, and a stable water level trend of 32-37 ft bgs since August 2009. Spike fluctuations in both wellhead pressure and the calculated water level shown on Figure 3-3 correspond to the immediate loss of pressure when the well is vented (e.g., June 2, 2010), followed by a gradual return to the well pressure regime exhibited prior to venting the well.

In June 2013 the upper Level Troll began reporting pressure in the range of negative 25 psia. During the September 30, 2013 site visit diagnostics were conducted and it was determined that the transducer had malfunctioned and needed to be replaced. The Level Troll was replaced on a follow-up site visit on November 6, 2013. When the upper Level Troll was replaced and function tested it was found that the Troll NetHub port that this Level Troll was connected to had become inoperable. Data could still be measured and logged on the Level Troll, but could not be transmitted via the Troll Link 201 telemetry system. After troubleshooting the Troll NetHub circuit board on November 8, 2013 found it needed to be replaced, a new board was ordered from In-Situ, Inc. The new circuit board was successfully replaced on November, 26, 2013 and the entire Highway 151 station is again fully operable.

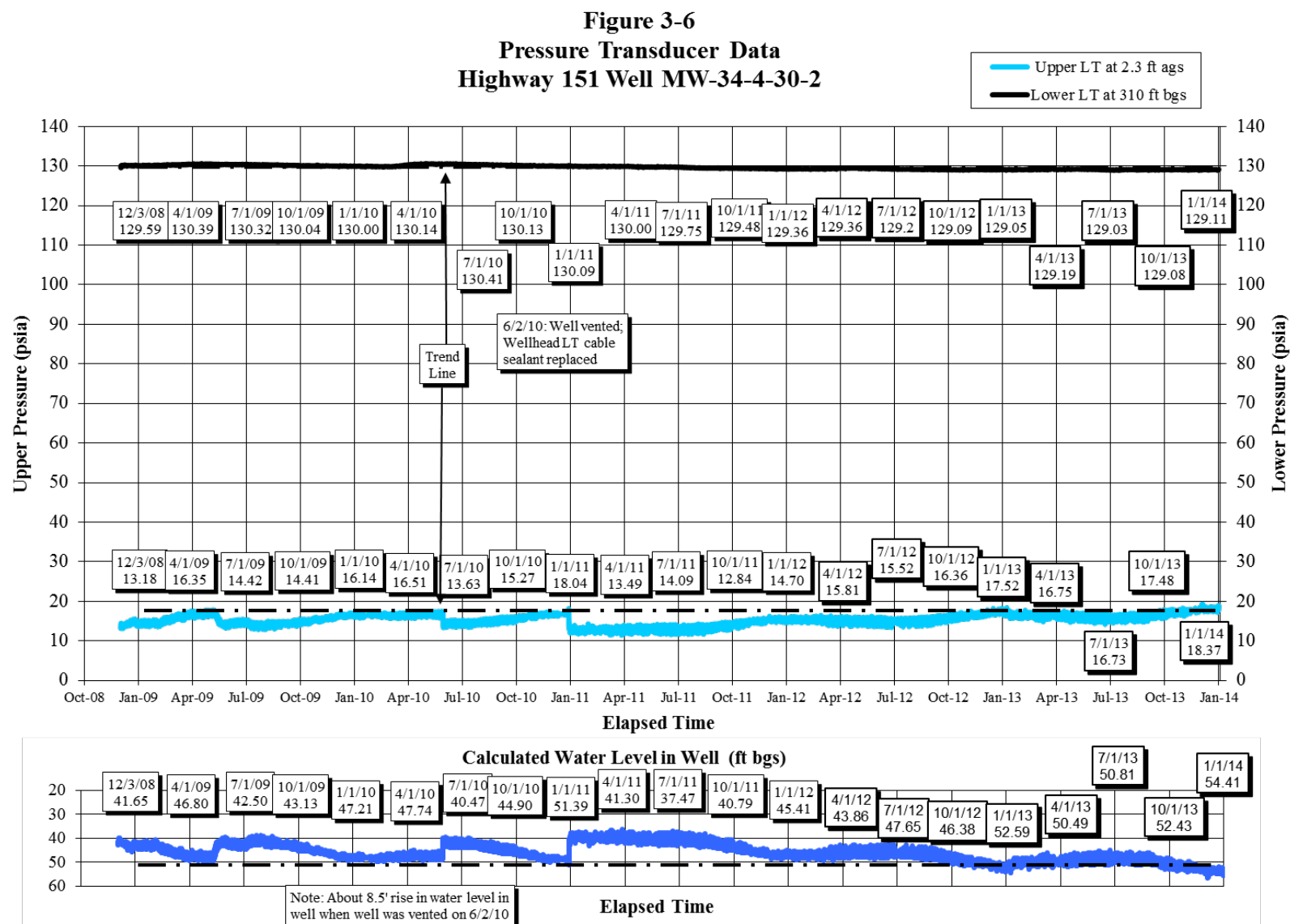


**Figure 3-5**  
**Pressure Transducer Data Highway 151 Well MW-34-4-30-1**

### 3.3.2 MW 34-4-30-2

Figure 3-6 charts the upper and lower pressure transducer data and the calculated water level in the well. Table 3-3 and Figure 3-6 shows a stable downhole pressure trend with 0.5 psi change from 129.59 psia on December 3, 2008 to 129.11 psia on January 1, 2014. In addition, there was a net wellhead pressure increase of 5.19 psi with a corresponding net water level decline of 12.76 feet for the entire period of record from December 3, 2008 (13.18 psia) to January 1, 2014 (18.37 psia).

Similar to the Well 34-4-30-1 pressure regime for the period record, spike fluctuations in both wellhead pressure and the calculated water level correspond to the immediate loss of pressure when the well is vented (e.g., June 2, 2010), followed by a gradual return to the well pressure regime exhibited prior to venting the well. This includes an event on 1/1/11 in which there was a sudden loss of wellhead pressure to approximately atmospheric pressure. No COGCC field activities occurred on this date, but the pressure response is similar to the venting that was intentionally conducted on June 2, 2010.



**Figure 3-6**  
**Pressure Transducer Data Highway 151 Well MW-34-4-30-2**

### 3.4 DEEP CANYON

Monitor well MW 34-4-32-1 has been monitored since June 2, 2010. Initial and ending well pressures and calculated water levels in the monitor well are summarized in Table 3-4 for the indicated period of record.

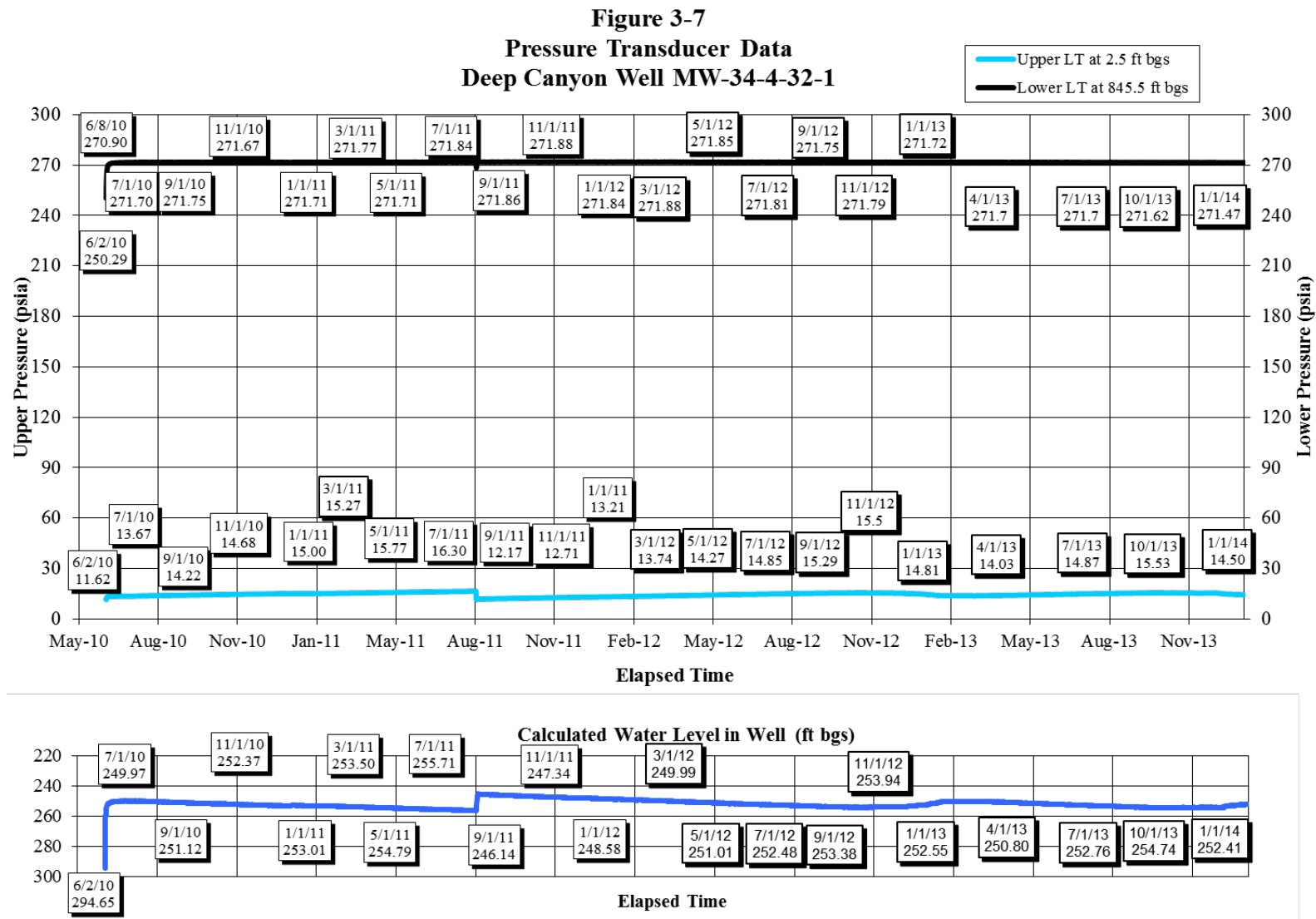
**Table 3-4**  
**Well Pressure Data Summary for Deep Canyon Monitoring Well**

| Well ID and Transducers | Period of Record | Initial Shut-In Well Pressure (psia) | Ending Shut-In Well Pressure (psia) | Net Change in Well Pressure (psi) | Initial Water Level in Well (ft bgs) | Ending Water Level in Well (ft bgs) | Net Change in Water Level (ft) |
|-------------------------|------------------|--------------------------------------|-------------------------------------|-----------------------------------|--------------------------------------|-------------------------------------|--------------------------------|
| MW 34-4-32-1 Upper      | 6/8/10 to 1/1/14 | 13.41                                | 14.50                               | 1.09                              | 251.21                               | 252.41                              | -1.20                          |
| Lower                   |                  | 270.90                               | 271.47                              | 0.57                              |                                      |                                     |                                |

#### 3.4.1 MW 34-4-32-1

Figure 3-7 charts the upper and lower pressure transducer data and the calculated water level in the well. Table 3-4 and Figure 3-7 show the well pressure initially stabilized on June 8, 2010, six days after the well was shut in for monitoring on June 2, 2010. Prior to shut-in on June 2, 2010, Figure 3-7 shows the wellhead pressure at 11.62 psia (atmospheric pressure), downhole pressure at 250.29 psia, and water level in the well at about 294 ft bgs. By June 8, 2010, wellhead pressure had increased 1.8 psi to 13.41 psia, bottom-hole pressure had increased 20.4 psi to 270.7 psia, and the water level in the well had risen about 43 ft to 252.21 ft bgs. Table 3-4 and Figure 3-7 also show a relatively stable well pressure regime for the 3.5 year period of record through January 1, 2014 with only a slight increase in well pressure and a corresponding net water level decrease of 1.2 feet in the well.





**Figure 3-7**  
**Pressure Transducer Data Deep Canyon Well MW-34-4-32-1**  
3-15

## **4.0 FUTURE WORK**

Future routine work will consist of periodic field checks of each monitoring system and remote retrieval of recorded pressure measurement data using the In-Situ Inc. TROLL<sup>®</sup> Link telemetry system and ISI Data Center. COGCC staff will schedule an inspection and testing of all wellhead components and instruments after the 2014 spring snowmelt period when all monitoring well sites are safely accessible.

As noted in the previous sections, several wells will be evaluated for wellhead fitting replacement to eliminate ongoing leaks. Several transducers will be evaluated for performance and recommended for replacement as necessary. This includes the possibility of replacement of one upper Level Troll at Wagon Gulch MW 34-5-4-2 with the Aqua Troll currently at Basin Creek MW 34-9-7-2 that can assist with confirmation of liquid verses gas/air presence. Finally, attempts will continue to gain a new access agreement for the Beaver Creek Ranch site in order to conduct required maintenance.

## **APPENDIX A**

### **4M PROJECT MONITOR WELL CHRONOLOGY**

| 4M Project Monitor Well Chronology |              |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
|------------------------------------|--------------|----------------------------------|---|---|--------|---|---|------------------------------------|--|--|--------|--|--|--|
| Location                           | Well         | 2001                             |   |   |        | 2002  |   |                                    |  |  |        |  |  |  |
|                                    |              | Jan                              | Sep   | Nov   | Dec    | Jan   | Feb   | Mar                                | Apr  | May  | Jun    | Jul  | Oct - Nov  | Dec  |
| Basin Creek                        | MW 34-9-7-1  | Jan. 24-28: Drill & install well | Sept. 27: Perforate well                                    | Nov. 28: Set up telemetry unit; replace bad xds cables    | Survey | Jan. 18: Tighten wellhead fittings; rewire telemetry sys                      | Replace telemetry 12v battery sys, In-Situ assist |                                    |  |  |        |  |  | Lost telemetry communication with data logger  |
|                                    | MW 34-9-7-2  |                                  |   |   |        |   |   |                                    | April 24-25: Drill & install well                      | May 5: Perforate well<br>May 9: Fish out cable<br>May 22: Install xds  | Survey |  |  |  |
| Palmer Ranch                       | MW-35-8-19-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
| Fiddler                            | MW-35-8-10-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
| South Fork Texas Creek             | MW 35-7-8-1  |                                  | Sept. 17-20: Drill/install well; Sept. 27: Perforate well   | Nov. 29: Set up telemetry unit; replace bad xd cables     | Survey | Jan. 18: Tighten wellhead fittings; rewire telemetry sys                      | Replace telemetry 12v battery sys, In-Situ assist |                                    |  | May 21: Ck for leaks   |        |  |  | Dec. 4: Data lost through end of year due to Hermit internal battery failure; lost telemetry communication with data logger<br>Dec 7: Tightened wellhead fittings            |
|                                    | MW 35-7-8-2  |                                  | Sept. 20-21: Drill/install well<br>Sept. 27: Perforate well | Nov. 29: Set up telemetry unit; replace bad xd cables     | Survey | Jan. 18: Tighten wellhead fittings  |   |                                    |  | May 21: Ck for leaks   |        |  | Oct 25: Vent well; replaced strain relief fittings; shut in well |  |
| BP Highlands                       | MW-34-7-15-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
| Beaver Creek Ranch                 | MW 35-6-17-1 |                                  |   |   |        |   | Replace telemetry 12v battery sys, In-Situ assist | Mar. 5-Apr 4: Drill & install well |  | May 2: Perforate well; May 20-21: Install xds  | Survey | July 10: Replace lower xd cable with unvented cable                                  |  | Dec 13: Insp by Raymond Const.- no wellhead gas leak; logger batt @ 0% capacity; modem problem<br>Dec. 19: Data lost through end of year due to bad data logger bkup battery |
|                                    | MW 35-6-17-2 |                                  | Sept. 22-Oct. 4: Drill/install well                         | Nov. 26: Perforate well<br>Nov. 27: Set up telemetry unit | Survey | Jan. 17 - Install new xd cables with SwageLok fittings; rewire telemetry unit |   |                                    | Apr 8: Pull lower xd cable; no data<br>Apr 8 to May 20 | May 21: Install unvented, heavy duty xd cable; shut in well  |        | Gas leak @ top bushing; July 10: Vent well & ck bushing seals; July 11: shut in well | Nov. 14: Vent well; replaced valve and reseal all connections    |  |
| Shamrock Mines                     | MW 35-6-13-1 |                                  |   |   |        |   |   |                                    |  | May 3-7: Drill/install well<br>May 10: Perforate well<br>May 20, 21: Install pad, telemetry & data logger systems, & xds | Survey |  |  | Lost telmetry communication with data logger   |
| Wagon Gulch                        | MW-34-4-30-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
|                                    | MW-34-4-30-2 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
| Fosset Gulch                       | MW-35-5-14-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
|                                    | MW-35-5-14-2 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
| Highway 151                        | MW-34-4-30-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
|                                    | MW-34-4-30-2 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |
| Deep Canyon                        | MW-34-4-32-1 |                                  |   |   |        |   |   |                                    |  |  |        |  |  |  |

| 4M Project Monitor Well Chronology |              |   |                               |   |  |  |   |  |  |
|------------------------------------|--------------|---|-------------------------------|---|--|--|---|--|--|
| Location                           | Well         | 2003  |                               |   |  |  | 2004  |  |  |
|                                    |              | Jan   | Feb - Apr                     | May - Jun   | Aug  | Oct - Dec  | Jan - Mar   | Apr  | Aug  |
| Basin Creek                        | MW 34-9-7-1  | Jan 20: New well 34-9-7-1 upper xd (30 psig, sn 7201); rewire pwr regultr; replace logger bkup lith. batt; re-flash modem memory; enable modem auto pwr-up        | Telemetry system malfunction  | May 20: Replace modem and cell phone                              | Aug 21: Vent both wells and tighten wellhead xd cable strain relief fittings | Oct 8: Conduct rapid blowdown & shutin test  |   |  | Aug 25: New data logger battery pack; vent well; gas sample                                      |
|                                    | MW 34-9-7-2  |   |                               |   | Aug 21: Vent both wells and tighten wellhead xd cable strain relief fittings | Oct 8: Conduct rapid blowdown & shut-in test   |   | Apr 23: vent well & raise upper xd from 5 fbgs to ground surface                       | Aug 25: vent well; raise upper xd to 1.65 ft above ground; gas sample                            |
| Palmer Ranch                       | MW-35-8-19-1 |   |                               |   |  |  |   |  |  |
| Fiddler                            | MW-35-8-10-1 |   |                               |   |  |  |   |  |  |
| South Fork Texas Creek             | MW 35-7-8-1  | Jan 20: rewire pwr regultr; replace logger bkup lith. batt; re-flash modem memory; enable modem auto pwr-up   | Telemetry system malfunction; | June 16: lower xd failed  |  | Oct 8: Well pressure buildup test  | No data reported for 6/16/03 to 4/22/04 - lower xd failed | Apr 22: vent well; temporarily replaced lower xd with 1000 psia xd                     | Aug 25: New data logger battery pack; vent well; tighten xd fittings; gas sample                 |
|                                    | MW 35-7-8-2  |   |                               | May 20: Replace modem and cell phone                              |  | Oct 8: Well pressure buildup test  |   | Apr 22: vent well; replaced strain relief fittings                                     | Aug 25: vent well; tighten xd fittings replace lwr 1000 psia xd with new 500 psia xd; gas sample |
| BP Highlands                       | MW-34-7-15-1 |   |                               |   |  |  |   |  |  |
| Beaver Creek Ranch                 | MW 35-6-17-1 | Jan 7 & Jan 21: No wellhead gas leak @ MW35-6-17-2<br>Jan 21: rewire pwr regultr; replace logger bkup lith. batt; re-flash modem memory; enable modem auto pwr-up | Telemetry system malfunction  | May 20: Replace modem and cell phone;                             |  | Oct 7 & 21: Well pressure buildup test   |   |  | Aug 24: New data logger battery pack; vent well; Aug 25: gas sample                              |
|                                    | MW 35-6-17-2 |   | Wellhead bushing leak         | May 20: Wellhead bushing leak; wellhead assembly to be redesigned | Aug 20: New flanged wellhead assembly; xd cable leak at swagelok fitting     | Oct 8 & 21: Well pressure buildup test; wellhead leaks @ pressure >570 psia;                           | Wellhead leaks @ pressure >570 psia                       | Apr 22: vent well/removed lower xd; attached upper xd externally to wellhead; no leaks | Aug 24: vent well; Aug 25: gas sample  |
| Shamrock Mines                     | MW 35-6-13-1 | Jan 21: rewire pwr regultr; replace logger bkup lith. batt; re-flash modem memory; enable modem auto pwr-up   | Telemetry system malfunction  | May 20: Replace modem and cell phone;                             | Aug 20: Modem pwr down; replaced 12v battery                                 | Oct 7: Replaced 12v battery pack<br>Oct 8: well pressure buildup tests<br>Oct 21: Replaced solar panel |   |  | Aug 24: New data logger battery pack; vent well, no gas to sample                                |
| Wagon Gulch                        | MW-34-4-30-1 |   |                               |   |  |  |   |  |  |
|                                    | MW-34-4-30-2 |   |                               |   |  |  |   |  |  |
| Fosset Gulch                       | MW-35-5-14-1 |   |                               |   |  |  |   |  |  |
|                                    | MW-35-5-14-2 |   |                               |   |  |  |   |  |  |
| Highway 151                        | MW-34-4-30-1 |   |                               |   |  |  |   |  |  |
|                                    | MW-34-4-30-2 |   |                               |   |  |  |   |  |  |
| Deep Canyon                        | MW-34-4-32-1 |   |                               |   |  |  |   |  |  |

| 4M Project Monitor Well Chronology |              |   |  |  |                                    |   |   |  |  |  |
|------------------------------------|--------------|---|--|--|------------------------------------|---|---|--|--|--|
| Location                           | Well         | 2005  |  |  | 2006                               |   |   | 2007   |  |  |
|                                    |              | Mar   | Jun  | Oct - Dec  | Jan                                | Jun -Nov  | Dec   | Jun  | Aug  | Nov - Dec  |
| Basin Creek                        | MW 34-9-7-1  |   | June 14: Inspection  |  |                                    | June 21: Inspection   |   | June 20: Inspection; replace logger battery; start new test                                    | Analog modem telemetry sys. off line; local telecom. service changed to digital by provider; Hermit logger data must be extracted to a PC on site. | Nov 12 & Dec 12: Inspection and Hermit logger data extraction  |
|                                    | MW 34-9-7-2  |   | June 14: Inspection; pressure gauge leaking; vented well (artesian flow < 0.5 gpm); lowered upper xd to 4.6 fbgs (under water); replaced gauge with plug |  |                                    | June 21: Inspection   |   |  |  |  |
| Palmer Ranch                       | MW-35-8-19-1 |   |  |  |                                    |   |   |  |  |  |
| Fiddler                            | MW-35-8-10-1 |   |  |  |                                    |   |   |  |  |  |
| South Fork Texas Creek             | MW 35-7-8-1  |   | June 13: Inspection; new data logger test started  |  |                                    | June 21: Inspection   |   | June 20: Inspection; replace logger battery; start new test                                    | See above  | Nov 12 & Dec 12: Inspection and Hermit logger data extraction  |
|                                    | MW 35-7-8-2  | Mar: Well pressure deviation from previous norm; possible wellhead leak or xd failure or decline in well gas pressure | June 13: Wellhead fitting leaks detected<br>June 14: Vented well and replaced both 500 psia xds; new data logger test started                            | Oct 25: Vent well; replaced strain relief fittings<br>Dec 7: Tightened wellhead fittings | Jan 3: Tightened wellhead fittings | June 21: Tightened wellhead fittings<br>October 31: Replaced all well head fittings<br>November 10: Developed well and water sample collected | Dec 11 &13: Tightened wellhead strain relief fittings | June 20: Wellhead fittings leak; vent well; replaced xd cables with rugged polyethylene cables |  | Dec 12: Wellhead strain relief cable fitting leak; vent well; installed Swaglok tube fitting on upper xd cable at wellhead |
| BP Highlands                       | MW-34-7-15-1 |   |  |  |                                    |   |   |  |  |  |
| Beaver Creek Ranch                 | MW 35-6-17-1 |   | June 13: Inspection  |  |                                    | June 21: Inspection   |   | June 20: Inspection; replace logger battery; start new test                                    | See above  | Nov 12 & Dec 12: Inspection and Hermit logger data extraction  |
|                                    | MW 35-6-17-2 |   | June 13: Inspection; slight leak detected from wellhead xd bushing   |  |                                    | June 21: Inspection; slight leak detected from wellhead xd bushing<br>October 31: Leaky wellhead xd bushing sealed                            |   |  |  |  |
| Shamrock Mines                     | MW 35-6-13-1 |   | June 13: Inspection  |  |                                    | June 21: Inspection   |   | June 20: Inspection; replace logger battery; start new test                                    | See above  | Nov 12 & Dec 12: Inspection and Hermit logger data extraction  |
| Wagon Gulch                        | MW-34-4-30-1 |   |  |  |                                    |   |   |  |  |  |
|                                    | MW-34-4-30-2 |   |  |  |                                    |   |   |  |  |  |
| Fosset Gulch                       | MW-35-5-14-1 |   |  |  |                                    |   |   |  |  |  |
|                                    | MW-35-5-14-2 |   |  |  |                                    |   |   |  |  |  |
| Highway 151                        | MW-34-4-30-1 |   |  |  |                                    |   |   |  |  |  |
|                                    | MW-34-4-30-2 |   |  |  |                                    |   |   |  |  |  |
| Deep Canyon                        | MW-34-4-32-1 |   |  |  |                                    |   |   |  |  |  |

| 4M Project Monitor Well Chronology |              |   |   |                        |                        |  |   |                |  |
|------------------------------------|--------------|---|---|------------------------|------------------------|--|---|----------------|--|
| Location                           | Well         | 2008  |   |                        |                        |  | 2009  |                |  |
|                                    |              | May   | Sep   | Oct                    | Nov                    | Dec  | Jun-Jul   | Oct            | Nov  |
| Basin Creek                        | MW 34-9-7-1  | May 6: Inspection and Hermit logger data extraction   | Sept 3: Inspection and Hermit logger data extraction  |                        |                        | Dec 10: Inspection and Hermit logger data extraction   | June 25: Inspection and Hermit logger data extraction, removal of data logger equipment from well<br>June 30: Installation of Level Troll data logger equipment |                |  |
|                                    | MW 34-9-7-2  |   |   |                        |                        |  |   |                |  |
| Palmer Ranch                       | MW-35-8-19-1 |   |   |                        |                        |  |   | Installed Well | Nov 18: Installed Level Troll data logger & telemetry system |
| Fiddler                            | MW-35-8-10-1 |   |   |                        |                        |  |   | Installed Well | Nov 17: Installed Level Troll data logger & telemetry system |
| South Fork Texas Creek             | MW 35-7-8-1  | May 6: Inspection and Hermit logger data extraction   | Sept 3: Inspection and Hermit logger data extraction  |                        |                        | Dec 10: Inspection and Hermit logger data extraction   | June 25: Inspection and Hermit logger data extraction, removal of data logger equipment from well<br>June 30: Installation of Level Troll data logger equipment |                |  |
|                                    | MW 35-7-8-2  | May 6: Inspection and Hermit logger data extraction; Slight leak at lower xd cable wellhead strain relief fitting | Sept 3: Inspection and Hermit logger data extraction; Very slight leak at lower xd cable wellhead strain relief fitting |                        |                        | Dec 10: Inspection and Hermit logger data extraction; Slight leak at lower xd cable wellhead strain relief fitting |   |                |  |
| BP Highlands                       | MW-34-7-15-1 |   |   |                        |                        |  |   | Installed Well | Nov 19: Installed Level Troll data logger & telemetry system |
| Beaver Creek Ranch                 | MW 35-6-17-1 | May 6: Inspection and Hermit logger data extraction   | Sept 3: Inspection and Hermit logger data extraction  |                        |                        | Dec 10: Inspection and Hermit logger data extraction   | June 25: Inspection and Hermit logger data extraction, removal of data logger equipment from well<br>June 30: Installation of Level Troll data logger equipment |                |  |
|                                    | MW 35-6-17-2 |   |   |                        |                        |  |   |                |  |
| Shamrock Mines                     | MW 35-6-13-1 | May 6: Inspection and Hermit logger data extraction   | Sept 3: Inspection and Hermit logger data extraction  |                        |                        | Dec 10: Inspection and Hermit logger data extraction   | June 25: Inspection and Hermit logger data extraction, removal of data logger equipment from well<br>June 30: Installation of Level Troll data logger equipment |                |  |
| Wagon Gulch                        | MW-34-4-30-1 |   |   | Oct 2: Installed Well  |                        | Dec 2: Installed Level Troll data logger equipment & telemetry system  |   |                |  |
|                                    | MW-34-4-30-2 |   |   | Oct 13: Installed Well |                        |  |   |                |  |
| Fosset Gulch                       | MW-35-5-14-1 |   |   | Oct 31: Installed Well |                        | Dec 4 :l Installed Level Troll data logger equipment & telemetry system  |   |                |  |
|                                    | MW-35-5-14-2 |   |   | Oct 22: Installed Well |                        |  |   |                |  |
| Highway 151                        | MW-34-4-30-1 |   |   |                        | Nov 11: Installed Well | Dec 3: Installed Level Troll data logger equipment & telemetry system  |   |                |  |
|                                    | MW-34-4-30-2 |   |   |                        | Nov 7: Installed Well  |  |   |                |  |
| Deep Canyon                        | MW-34-4-32-1 |   |   |                        |                        |  |   |                |  |

| 4M Project Monitor Well Chronology |              |   |   |  |  |   |  |  |
|------------------------------------|--------------|---|---|--|--|---|--|--|
| Location                           | Well         | 2010  |   |  |  |   | 2011   |  |
|                                    |              | May   | Jun   | Aug  | Sept   | Nov   | Apr  | Aug  |
| Basin Creek                        | MW 34-9-7-1  | May 18: Well Inspection   |   | Aug 18: Vented well; Replaced all wellhead LT cable Conax Teflon gland seals with Neoprene seals   |  |   |  | Aug 2: Well inspection   |
|                                    | MW 34-9-7-2  |   |   |  |  |   |  |  |
| Palmer Ranch                       | MW-35-8-19-1 | May 18: Not able to inspect well due to reclamation   | Jun 3: Vented well; Replaced both wellhead LT cable Conax Teflon gland seals with Neoprene seals  |  |  |   |  | Aug 2: Well inspection, minor leak at busing below Conax fitting                                 |
| Fiddler                            | MW-35-8-10-1 | May 18: Well Inspection   | Jun 3: Vented well; Replaced both wellhead LT cable Conax Teflon gland seals with Neoprene seals; TROLL® Link cables checked/connections cleaned                                  |  |  |   |  | Aug 2: Change out upper LT; Replaced upper LT cable  |
| South Fork Texas Creek             | MW 35-7-8-1  | May 18: Well Inspection; Tightened small leak on upper LT Conax fitting   |   | Aug 18: Vented well; Replaced both wellhead LT cable Conax Teflon gland seals with Neoprene seals; Lower LT raised from 390 fbgs to 374 fbgs due to cable damage |  |   |  | Aug 2: Well inspection   |
|                                    | MW 35-7-8-2  | May 18: Well Inspection; Tightened small leak on upper LT Conax fitting and ball plug; Ball plug fitting leak on lower LT | Jun 14-24: Well spliced into gas mitigation system<br>Jun 25: Gas mitigation system actively drawing gas from well  | Aug 6: Well shut in from gas mitigation system<br>Aug 18: Vented well; Replaced both wellhead LT cable Conax Teflon gland seals with Neoprene seals              |  |   |  | Aug 2: Well inspection   |
| BP Highlands                       | MW-34-7-15-1 | May 18: Not able to inspect well due to reclamation   | Jun 3: Vented well; Replaced both wellhead LT cable Conax Teflon gland seals with Neoprene seals  |  |  |   |  | Aug 2: Attempted to replace upper LT but fittings too tight; blowdown test showed LT OK          |
| Beaver Creek Ranch                 | MW 35-6-17-1 | May 18: Well Inspection; Tightened small leak on upper and lower LT cable Conax fitting                                   |   | Aug 18: Vented well; Replaced all wellhead LT cable Conax Teflon gland seals with Neoprene seals   |  |   |  | Aug 3: Slight leak in lower LT well head Conax 3/4" bushing and well head pressure gauge fitting |
|                                    | MW 35-6-17-2 | May 18: Well Inspection; Tightened hissing leak on upper LT cable Conax fitting; Small leak at fitting into flange        |   |  |  |   |  | Aug 3: Leak in with both Conax fitting 3/4" bushings   |
| Shamrock Mines                     | MW 35-6-13-1 | May 18: Well Inspection; No leaks; Tightened upper and lower LT cable Conax fitting                                       | Jun 2: Vented well; Replaced both wellhead LT cable Conax Teflon gland seals with Neoprene seals<br>Jun 3: Upper LT raised to ground level after removal of 4 ft of damaged cable |  |  |   |  | Aug 3: Well Inspection   |
| Wagon Gulch                        | MW-34-4-30-1 | May 18: Well Inspection; No leaks; Solar power instrument pool-cable conduit sealed                                       |   | Aug 17: Vented well; Replaced lower LT wellhead cable Conax Teflon gland seal with Neoprene seal   |  |   |  | Aug 3: blowdown; cleaned bushing   |
|                                    | MW-34-4-30-2 |   |   | Aug 17: Vented well; Replaced lower LT wellhead cable Conax Teflon gland seal with Neoprene seal; Upper LT external mount changed to down-hole mount 2.5 fbgs    | Sept 9: Vented well; raised lower LT from 780 fbgs to 763 fbgs due to cable damage |   |  | Aug 3: Well Inspection   |
| Fosset Gulch                       | MW-35-5-14-1 | May 18: Well Inspection; No leaks   |   | Aug 17: Vented well; Replaced both lower LT wellhead cable Conax Teflon gland seals with Neoprene seals  |  | Nov 11: Telemetry sys off-line; cable damage during pipeline construction | Apr 27: Surface transducer cables replaced; Telemetry system back online | Aug 3: Well Inspection; Tightened cable fitting  |
|                                    | MW-35-5-14-2 |   |   |  |  |   |  | Aug 3: Tightened leaky bull plug   |
| Highway 151                        | MW-34-4-30-1 | May 18: Well Inspection; No leaks   | Jun 2: Vented well; Replaced both lower LT wellhead cable Conax Teflon gland seals with Neoprene seals  |  |  |   |  | Aug 3: Well head inspection  |
|                                    | MW-34-4-30-2 |   |   |  |  |   |  |  |
| Deep Canyon                        | MW-34-4-32-1 | May 18: Well installed  | Jun 2: Installed Level Troll data logger equipment & telemetry system   |  |  |   |  | Aug 3: Well inspection; blowdown test  |



| 4M Project Monitor Well Chronology |              |   |   |  |   |
|------------------------------------|--------------|---|---|--|---|
| Location                           | Well         | 2012  |   |  |   |
|                                    |              | Jun   | Sep   | Oct  | Nov   |
| Basin Creek                        | MW 34-9-7-1  | June 6: Well inspection; no leaks or noticeable issues  |   |  | November 1: Minor leaks at bushings, left as is.                |
|                                    | MW 34-9-7-2  |   |   |  | November 1: Well inspection; All ok                             |
| Palmer Ranch                       | MW-35-8-19-1 | June 6: Well inspection; minor leak at bull plug  |   |  | November 1: Well inspection; All ok                             |
| Fiddler                            | MW-35-8-10-1 | June 6: Water leak at wingnut on well tubing head, clean and make-up wingnut, no leaks after repair   | September 25: Wellhead replacement by SMA to replace original leaking wellhead; all transducers taken out of service at this time | October 31: Reinstall LTs following wellhead replacement in September. Installed new In-Situ 100PSI LT 700 as upper LT.      |   |
| South Fork Texas Creek             | MW 35-7-8-1  | June 6: Well inspection, All OK   |   | October 31: Well inspection; Telemetry shack damaged approximately 2 ft above ground level to the right of east facing door. |   |
|                                    | MW 35-7-8-2  | June 6: Well inspection, leak at 2" bull plug   |   | October 31; minor leak on top of cross at tapped bull plug, minor leak that would require major rebuild                      |   |
| BP Highlands                       | MW-34-7-15-1 | June 6: Well inspection, All OK   |   | October 31: Well inspection; All ok  |   |
| Beaver Creek Ranch                 | MW 35-6-17-1 | No access to site, need new landowner access agreement  |   | No access to site, need new landowner access agreement   | No access to site, need new landowner access agreement          |
|                                    | MW 35-6-17-2 |   |   |  |   |
| Shamrock Mines                     | MW 35-6-13-1 | No access to site, new locked FS gate   |   |  | November 1: Well inspection; All ok                             |
| Wagon Gulch                        | MW-34-4-30-1 | June 6: Well inspection; All ok   |   |  | November 1: Well inspection: All ok                             |
|                                    | MW-34-4-30-2 |   |   |  |   |
| Fosset Gulch                       | MW-35-5-14-1 | June 6: Well Inspection; Tightened nut  |   |  | November 1: Well inspection: Replace dust cap with 2" bull plug |
|                                    | MW-35-5-14-2 | June 6: Well inspection; All ok   |   |  | November 1: Well inspection; All ok                             |
| Highway 151                        | MW-34-4-30-1 | June 6: Tightened bull plugs  |   |  | November 1: Well inspection; All ok                             |
|                                    | MW-34-4-30-2 |   |   |  |   |
| Deep Canyon                        | MW-34-4-32-1 | June 6: LT cable sprawled out on the ground within the stock fencing. Mud smeared on In-Situ enclosure housing batteries and solar converter (middle box). One LT cable pulled through strain relief on lowermost enclosure exposing single conductors (insulation intact). No wellhead issues observed |   |  | November 1: Well inspection; All ok                             |

| 4M Project Monitor Well Chronology |              |   |  |
|------------------------------------|--------------|---|--|
| Location                           | Well         | 2013  |  |
|                                    |              | Sep-Oct   | Nov  |
| Basin Creek                        | MW 34-9-7-1  | Oct 1: Well inspection, minor leak at threads between 2" tapped bull plug and Conax bushing will require removal and conditioning of threads.   | Nov 6: Vent well, repair damaged threads at 2" tapped bull plug, measure water level, shut-in.   |
|                                    | MW 34-9-7-2  | Oct 1: Well inspection, document materials needed to replace upper LT with AT, found substantial corrosion on negative battery post in the telemetry solar battery enclosure, cleaned post and tested voltage good at 14.4V | Nov 6: Vent well, replace upper LT with AT to allow water conductivity measurement and reset to same depth, measure water level, shut-in, function test AT OK  |
| Palmer Ranch                       | MW-35-8-19-1 | Oct 1: Well inspection; minor leak at threads between 2" tapped bull plug and Conax bushing will require removal and conditioning of threads  |  |
| Fiddler                            | MW-35-8-10-1 | Oct 1: Well inspection, All OK  |  |
| South Fork Texas Creek             | MW 35-7-8-1  | Sept 30: Well inspection, All OK  |  |
|                                    | MW 35-7-8-2  | Sept 30: Well inspection, minor gas leak at 2" side of tapped bull plug at entry to 2" tee will require wellhead rebuild due to numerous attempts to fix in the past.   | Nov 7: Vent well, remove upper and lower LTs, tear down wellhead, isolate old gas mitigation system 1" PVC pipeline, rebuild wellhead with all new pipe fittings, reinstall upper and lower LT's, measure water level, shut-in, function test LTs OK   |
| BP Highlands                       | MW-34-7-15-1 | Oct 1: No access due to road washout  |  |
| Beaver Creek Ranch                 | MW 35-6-17-1 | No access to site, need new landowner access agreement  |  |
|                                    | MW 35-6-17-2 |   |  |
| Shamrock Mines                     | MW 35-6-13-1 | Sept 30: Well inspection, All OK, access road needs brush cutting   |  |
| Wagon Gulch                        | MW-34-4-30-1 | Sept 30: Well inspection, All OK  |  |
|                                    | MW-34-4-30-2 | Sept 30: Well inspection, found loose RS485(+) wire in Troll NetHub responsible for intermittent telemetry communication of MW 34-5-4-2 upper LT, tightened connection  |  |
| Fosset Gulch                       | MW-35-5-14-1 | Sept 30: Well Inspection, All OK  |  |
|                                    | MW-35-5-14-2 | Sept 30: Well inspection, All OK  |  |
| Highway 151                        | MW-34-4-30-1 | Sept 30: Well inspection, troubleshoot malfunctioning upper LT and found it required replacement  | Nov 6: Vent well, replace bad upper LT, shut-in, function test LT OK, find Troll NetHub channel for this LT bad.<br>Nov 8: Troubleshoot Troll NetHub, requires replacement.<br>Nov 26: Replace Troll NetHub circuit board, function test telemetry OK. |
|                                    | MW-34-4-30-2 | Sept 30: Well inspection, All OK  |  |
| Deep Canyon                        | MW-34-4-32-1 | Sept 30: Well inspection, All OK  |  |