METHANE INVESTIGATION, MONITORING, AND MITIGATION PROGRAM REPORT

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EXECUTIVE SUMMARY

A proactive three phase plan has been developed and proposed to mitigate methane migration from CBM wells located in the Little Creek Field in Huerfano County, Colorado. Phase I involves aquifer data acquisition and characterization; initiation and testing of the proposed methane removal system and baseline data monitoring. Phase II involves the initiation of the proposed hydraulic barrier and full operation of methane removal system. Phase III involves long term methane removal from the Vermejo coal formation; remediation of shallow aquifer, and potential for final identification and plugging of methane migration pathway.

Phase III includes a strategy for de-gassing Vermejo coals in a controlled manner for future public utilization of the large fresh water aquifer. Colorado's population growth is expected to increase well into the future and as a result, additional groundwater resourced will be tapped. The large fresh water aquifer connected to the Vermejo coals has a high probability of being developed. When the aquifer becomes depleted either through natural processes or through future development of the aquifer for human uses, then the coals will again begin to desorp and gas migration to the uphole strata will resume unless the coals are de-gassed.

INTRODUCTION

Petroglyph Energy Inc. (Petroglyph) voluntarily and temporarily shut in its wells in Huerfano County on July 20, 2007 in an effort to develop and implement a program to investigate, monitor, and mitigate an increase of methane in ground water and methane seepage. Petroglyph and through contract, Norwest Questa Engineering (NQE), have been actively reviewing, analyzing, and evaluating all available data to determine the origins of the methane found in the shallower ground water aquifers. Petroglyph and NQE have also been creating a long-term

ground water and gas seep monitoring plan in addition to developing a field reactivation plan, which prevents significant adverse impacts to public health, safety, welfare, and environment while mitigating and providing remediation of methane in the impacted ground water.

Data has been collected through a cooperative effort between Petroglyph and its contractors, the landowners, and the Colorado Oil and Gas Conservation Commission (COGCC). The goals of the data collection were to:

- Supply detailed scientific and engineering data to provide a framework for determining the extent of the methane impacted ground water, its potential origins, mitigation, and remediation strategies.
- Develop an ongoing strategy for continued Coalbed Methane (CBM) operations of Petroglyph's wells in Huerfano County.

In previous communications between the COGCC and Petroglyph, data collection and proposed follow up has been termed the Methane Investigation, Monitoring, and Mitigation Program (Program).

INVESTIGATION

The Program area of interest (AOI) investigated roughly encompasses a rectangle located from T28S, R67W in the northwest corner to T29S, R66W in the southeast (**Figure 1**). A total of 66 water wells have been tested for methane. Methane concentrations observed in the wells completed in the shallow aquifers range from zero to as much as 98 percent (**Table 1**). Observation of methane is not unexpected since measurable amounts of methane have been documented in the Raton Basin shallow aquifers, some pre-dating CBM production [1, 2, 3]. However the volume, concentrations and composition of methane observed in a number of the tested wells is indicative of methane migration from the Vermejo Coals. Most of the high methane concentrations observed in the water wells are not associated with measurable gas

volumes, but involve visual indications of gas presence or indicate methane when gas is sampled directly from the well casing. However, in addition to high methane concentrations, several wells have exhibited the ability to flow gas at rates ranging from 11 – 100+ mcfd (**Figure 2**).

Of primary concern to all stakeholders is the origin of the methane found in the shallow aquifers. Gas composition and isotopic analysis have been shown to be useful in determining the origins of methane gas[3]. Compositional analysis is useful in determining the similarity of produced gases and their potential origins; while isotopic analysis is useful in determining whether the gas origin was either biogenic or thermogenic. Gas analysis has been performed on samples from Petroglyph's CBM wells and several shallow aquifer water wells (**Table 2**).

Examination of the gas composition and isotopic analysis suggests that the gas sampled from three of the flowing methane water wells and one of Petroglyph's CBM wells indicates similarities in composition and isotopic analysis (**Table 3** and **Figure 3**). Differences observed between the Bruington water well and the other analysis is believed to be related to the wells location and completion in coals located in the vicinity of the outcrop and previous mining activity (**Figure 4** and **Figure 5**). The similarities of the gas produced from the CBM well Rohr 09-10 and the methane from two of the gas flowing water wells, suggests vertical communication between the Vermejo coal and the shallow aquifers exists. A review of the potential pathways for vertical communication was undertaken.

POTENTIAL VERTICAL PATHWAYS

NATURAL GEOLOGIC VERTICAL PATHWAYS

Since methane has been observed historically in the shallow waters of the Raton Basin, various studies have been conducted to determine the extent and nature of potential vertical pathways.

These studies have been carried out in response to concerns that CBM development and the resulting necessity to dewater the coals prior to gas onset, may impact ground water quality and quantity in shallower water producing horizons. The COGCC completed an environmental baseline study in 2003 to document existing conditions, provide basis for addressing future impacts of CBM development, and monitor areas of concern within the basin.

The study[4] suggests the basin's extremely heterogeneous geologic framework would most likely preclude any natural vertical communication between the shallower aquifer and deeper coal horizons. The exception occurring in areas where there is close vertical and lateral proximity between domestic water wells and CBM well completions [4]. The shallow producing water wells within proximity of Petroglyph's CBM activity are typically drilled to a depth of less than 900 feet with most fewer than 500 feet. Such depths are typically greater than 800 feet above the upper coal completion interval in Petroglyph's CBM wells suggesting a large-scale natural vertical conduit for gas and water migration is unlikely. This is further supported in the fact the shallower aquifer exhibits a higher hydraulic head or pressure than the deeper coal aquifers, an indication they are not hydrologically connected [4]. The presence of natural conduits between the Vermejo coals and the shallow aquifer can not be completely dismissed and are not in this review. However, it is unlikely that large scale (field wide) natural conduits exits in light of the hydraulic head differentials observed.

EXISTING MINE/DRILL HOLES:

An inventory of existing coal mines and related features including core holes was prepared for the COGCC in 2001[5] for the purpose of identifying potential sources of methane gas at the surface. Relative to Petroglyph's CBM activity, most if not all, of the mines and core holes lay to the east along the northwest to southeast trending Vermejo and Raton outcrops. Almost every mine working map of the region shows that the extent of the mine was limited by one or more geologic features including igneous dikes, sills, and faults. This would suggest a potential

discontinuity in coal and barrier to communication between existing mining and basin ward CBM activity.

Nearly 1140 drill holes were identified in the inventory. The report suggests most of the drill holes spudded prior to 1978 were poorly reclaimed if reclaimed at all. These do have some potential for methane emissions although most of the holes were drilled along the main outcrop in an area where methane would have dissipated as a result of heavy mining activity.

To a certain extent, the report provides a baseline (at least near the outcrop) for known mine and drill hole gas emission points. Relative to Petroglyph's location, 22 emission points have been identified from the helicopter methane survey along the outcrop.

It is important to differentiate methane production near the outcrop in that it originates in water wells completed in coals such as the Bruington well and wells located to the west, such as the Vince Coleman well. The Vince Coleman well, which is completed in porous sandstones in the Poison Canyon formation, would not under ordinary operations, produce measurable volumes of methane. In contrast, wells completed in the coals (Bruington), although permitted and intended for use as water wells, actually act as CBM producers through dewatering the coals and causing gas desorption as these shallow aquifers are depleted through consumptive use by landowners. Methane production is further enhanced by increased water withdrawals as more shallow water wells are drilled and completed in the coals and the coal aquifers near the outcrop are depleted by consumptive use.

VERTICAL CONDUITS

The presence of high concentrations of methane in the shallow aquifers clustered around the highest cumulative producing CBM well suggests a conduit exists between the coals and the shallow aquifers. Typically this type of conduit is associated with problems with wellbores such

as casing leaks, improperly plugged and abandon wells, or poor cement coverage which artificially breakdown the natural barriers to flow.

Petroglyph has been diligently tracking down these potential conduits however, none have yet been found. Appendix A lists the wells that have been investigated, the techniques utilized, and their respective results. Petroglyph is continuing to investigate potential man-made conduits specifically researching if any unknown plugged and abandon well exists in the vicinity of the AOI, which could be the cause of the communication.

Another possibility is a geologic anomaly exists in this part of the field which is the pathway between the coals and the shallow aquifers. Although gas production was expected after increased water withdrawals in early 2006 from the coals, the initial gas production was expected to occur updip. Gas production as shown in **Figure 6**, has been especially strong downdip with Lively 03-10 having the highest cumulative gas production. Lively 03-10 is also located in the area of significant methane flows and high methane concentration in the shallow aquifers.

MONITORING

Petroglyph in conjunction with the COGCC has been actively monitoring both the shallow aquifer water wells and the CBM wells to gather data for the purpose of understanding the extent and nature of the communication, provide baseline data, and to provide a scientific and data driven framework to mitigate the communication.

In summary the monitoring work has included:

- **Pressure and Water Level Measurements**
    - Water well pressure measurement of 10 water wells using sounding tubes or downhole transducers

- CBM water well pressure measurement with downhole pressure transducers in 6 Vermejo coal wells, two of which are dedicated pressure monitoring wells
- Fluid level measurements in from fluid level shots and casing pressure measurements in 11 Vermejo coal wells

- **Methane Identification and Monitoring of Water Wells**
  - Initial gas sampling for potential methane in 66 water wells
  - Bi-weekly methane screening in 39 water wells
  - Monthly methane screening in 15 water wells.
  - Gas flow rate measurement and monitoring in 5 shallow water wells

- **Potential Vertical Pathways: Identification and Monitoring**
  - Braden head pressure monitoring of all 56 Vermejo CBM producers. All wells had zero pressure with the exception of the Lively 03-10 which had eight (8) psig which bled to zero in 5 seconds.
  - Successfully pressure tested casing at greater than 300 psig in both the Lively 03-10 and Lively 03-12 from surface to approximately 30 feet above the coal perfs.
  - Ran camera surveys in four oil and gas wells which have been converted to water wells and tagged the plug back total depth (PBTD) in each well. Gas samples were taken in one of the wells (Geommer Land Co. 1).
  - Re-entered two old P&A'd Oil and Gas wells (Lively 10-02 and the Dick Realty #1). No significant gas shows were noted during operations. Re-plugged the Dick Reality #1 well and left the Lively 10-02 as a monitoring well per the COGCC.
  - Helicopter Survey of AOI using laser methane detector (**Figure 7**).
  - Ground based verification of several newly found positive laser methane shows using hand held Remote Methane Leak Detector (RMLD) (**Figure 7**).

MITIGATION

CURRENT MITIGATION EFFORTS

Since the conduit for methane movement from the Vermejo coals to the shallow aquifers has not been located, mitigation efforts have been focused on removing the methane from the produced water stream at the affected water wells. The preferred outcome would be the identification and plugging of the conduit. Identifying the conduit is not possible without reactivation of the CBM wells. Reactivation of the CBM wells provides a large pressure transient and restarts fluid transfers between the affected shallow aquifers and the Vermejo coal aquifer.

In summary efforts to mitigate landowner issues with methane in water wells are as follows:

- Installed and/or provided home methane monitors for 10 land owners
- Petroglyph is supplying water to 7 land owners
- Installed methane vent systems on 5 water wells

Future migration of methane up from the coals to the shallow aquifer should be minimized since water removal from the coal aquifer was stopped on July 20th, 2007. The Vermejo coals are under saturated and the coal aquifer pressure has risen over 38 psi (87 feet) since the field was shut in thereby shutting down gas desorption (**Figure 8**). The CBM wells have no casing pressure with the exception of well Rohr 09-05. Petroglyph has not blown down Rohr 09-05 to maintain a source of CBM gas for testing. In addition to observed field data which indicates shutting in the field has stopped methane desorption, a field-wide calibrated numerical simulation also indicates shutting in the field results in shut down of methane desorption.

Since the actual placement of the liberated methane saturation in the reservoir and the methane storage capacity of the coals at any given point are unknown, it is still possible to have liberated

free gas saturation existing in the coals even after field shut in. However, all data supports that no new large amounts of methane are being liberated since field shut in.

Analysis and Evaluation of Available Data

Pressure data gathered by Petroglyph on shallow aquifer wells along with pressure data gathered for the Vermejo coal aquifers indicate large differentials (~500 ft) between the potentiometric head (P head) levels (**Figure 9**). This would suggest, as referenced above, a lack of large-scale vertical communication between the Vermejo coal aquifer and the shallow aquifers.

Although large field-wide natural vertical conduits for gas are unlikely, several conceptual simulations were set up to investigate the potential of gas to migrate vertically through buoyancy effects. Buoyancy effects are thought to be a method of gas migration which still maintains the observed vertical head differential of higher shallow aquifer pressure more than the underlying coals. The simulation results indicate this is possible. The results however indicate any upward methane seepage would be minimal and large-scale methane movement would require concurrent downward water movement, with eventual equalization of the coal and shallow aquifer water pressures. Model results are displayed in **Figures 10 – 12**.

Simulation results suggest that small-scale seeps of methane involving low volume and low concentrations of methane moving vertically upward are possible and may be observed with sensitive methane sensing equipment such as helicopter based methane-sensing surveys and could possibly be the source of some of the observed low volume and concentration methane seeps discovered. The conceptual simulations do not support large volumes or concentrations of methane being able to move vertically without subsequent pressure equalization of the communicated strata.

Gas analysis has been performed at selected wells in the AOI (**Figure 3**). The results of the analysis (

Table 3) strongly support that Vermejo CBM gas has migrated into the shallow aquifers. Actual migration amounts however vary greatly as shown in **Figure 2**, ranging from barely detectable to the ability to flow at rates greater than 10 mcfd. Mapping cumulative gas production from the Vermejo coals and the migration amounts as displayed in **Figure 6** show the strongest indications of methane migration are clustered around the highest cumulative gas production from the coals. This evidence strongly suggests a vertical conduit between the coals and the shallow aquifers, either natural or man made, exists somewhere in the vicinity.

FUTURE METHANE MONITORING AND MITIGATION PLANS

The presence of high methane concentrations and sustained volumes of produced methane indicate a conduit exists between the Vermejo coals and the shallow aquifer. At this time the nature of this conduit is unknown, it may be man-made or it may be a confined natural feature. If through further data gathering and monitoring the feature is found to be correctable via human intervention, then the mitigation program is straight forward. Elimination of the breach through the natural barriers will correct the methane migration. If the conduit is not correctable either because of mechanical difficulties in repairing the man-made breach or if the breach is a natural phenomenon, mitigation becomes more involved. Simply leaving the field shut-in will temporarily provides mitigation only as long as the large coal aquifer remains undisturbed. Colorado's population growth is expected to increase well into the future and as a result, additional groundwater resourced will be tapped. The large fresh water aquifer connected to the Vermejo coals has a high probability of being developed. When the aquifer becomes depleted either through natural processes or through future development of the aquifer for human uses, then the coals will again begin to desorp and gas migration to the uphole strata will resume.

Normally this could be handled through restriction of water production from the coal aquifer in the immediate vicinity of the CBM field. However in this case, the estimated size of the aquifer connected to the coals has been estimated to be approximately 300 billion barrels of water equivalent. Pressure connectivity has been observed from over two miles away from the Little

Creek Field at the Passow well. Additionally, water quality from the coal aquifers is quite good with low total dissolved solids (851 TDS). As water supply issues increase in the future in the Rocky Mountain west area, the potential for aquifer development outside of the immediate CBM area grows respectively. At some point water development could cause the reactivation of methane migration inside the AOI without the advantage of an obvious "cause and effect" relationship.

An alternate mitigation program would involve the controlled production of the Vermejo methane and subsequent management of the methane migration through active methods. This type of program has the advantage of removing the methane from the Vermejo coals in a controlled manner and thus reducing the potential for future methane migration in the future.

Continuing Methane Monitoring

Regardless of the mitigation plan, continued monitoring is required. The goals of the ongoing monitoring program would be to:

- Develop base line data of the extent of methane migration
- Determine whether the mitigation program is working through reductions in the amounts and concentrations of migrated methane in the shallow aquifers
- Prevent impacts to public health, safety, and welfare
- Provide additional data for use in determination and possible plugging of the conduit

Recommended Methane Monitoring Program

- Continued monitoring of flow rates on the wells displayed in **Table 4**
- Semi-annual monitoring of known, accessible gas seeps at dikes
- Monthly monitoring of known, accessible gas seeps along the outcrop
- Semi-annual monitoring of inaccessible gas seeps with helicopter survey
- Continued water well level monitoring of wells in **Table 5**

- Continued methane monitoring of wells in **Table 6**
- Drilling of a shallow monitoring well in NW SE SW Sec 3 29S 67W, lot 55. This well should be drilled, logged, and completed in a manner to allow for shallow aquifer identification, isolation, and extended flow testing (**Figure 13**)

Additionally, if a viable method of logging through casing can identify significant methane gas saturations in the shallow aquifers is found (Carbon Oxygen may be a candidate), then a logging program focused on the significant methane flow area should be initiated. Petroglyph is currently in discussions with geophysical logging companies exploring this possibility.

Future Mitigation Program

An active rather than a passive mitigation program is recommended. This program should provide the potential to identify and possibly shut down the flow conduit between the Vermejo coals and the shallow aquifers. The program should also isolate the significant methane migration area from the rest of the shallow aquifers and remove a significant amount of the migrated methane from the most impacted area of shallow aquifers, while simultaneously allowing the Vermejo coals to be degassed under controlled conditions.

The mitigation plan has been separated into surface, shallow aquifer, and Vermejo coal migration programs.

Surface Mitigation Program

The goals of the surface mitigation program are primarily to prevent the collection of explosive level methane in areas of human occupation. Providing adequate well ventilation systems along with methane monitors has been shown to be effective. Additionally, water should be provided to land owners whose wells run dry or produce significant volumes of methane during pumping.

Therefore extension of the current mitigation program for removing methane from produced water and monitoring is recommended.

SHALLOW AQUIFER MITIGATION PROGRAM

The goals of the shallow aquifer mitigation plan are to locate and plug the conduit (if possible), limit the extent of the affected aquifers, remove significant volumes of migrated methane, and eventually re-charge the shallow aquifers to help prevent future methane migration.

The best method for mitigation involves identifying the conduit and plugging it. The current nature of the conduit is unknown. The most obvious potential candidates, improperly P&A'd wells and potential casing leaks, have been investigated with no indications that they were the conduit. Monitoring and investigation are still continuing in an attempt to identify the conduit.

A three phased program has been proposed to mitigate the methane in the shallow aquifer.

- Phase I - Aquifer Data Acquisition, Aquifer Characterization And Baseline Data Monitoring
- Phase II - Initiation of hydraulic barrier and methane removal
- Phase III - Long term methane removal from Vermejo coals, remediation of aquifer, and potential methane conduit identification and plugging

PHASED SHALLOW AQUIFER MITIGATION PROGRAM

PHASE I: AQUIFER DATA ACQUISITION, AQUIFER CHARACTERIZATION AND BASELINE DATA MONITORING

This phase of the program entails the permitting, drilling, completion, testing and operation of a monitor well in NW SE SW Sec 3 29S 67W, Lot 55.; three or four methane removal wells; and approximately eight injection wells designed to create a hydraulic barrier to methane migration

in the shallow aquifer. The monitor well has been issued a permit by the State Engineer, and permit applications are pending with the State Engineer for the methane removal wells. An application has been submitted to the U.S. Environmental Protection Agency for authorization by rule of the hydraulic barrier wells as Class V underground injection wells. Data acquired by the installation and operation of these wells will be utilized to refine the characterization of the shallow aquifer that has been impacted by gas migration, including a simulation model. The withdrawal and injection of water from the shallow aquifer will be initiated, and the system will be tested and evaluated, along with an associated methane stripping system. Activities during this phase will also include monitoring of surrounding domestic water wells, as well as continued baseline monitoring of gas seeps along the outcrop of the Vermejo coal formation.

A component of the shallow aquifer mitigation program is the construction of hydraulic barriers to aid in the containment and removal of methane from the shallow aquifer. Hydraulic barriers have been used successfully in preventing seawater intrusion into fresh water aquifers and have been proposed for CBM [6, 7, 8].

Hydraulic barriers would be created through a circle of injection wells surrounding production wells located in the migration hot spot neighboring Lively 03-10 as illustrated in **Figure 14** and **Figure 15.** Injection creates a pressure wall which stops the spread of migrated methane and the interior producers strip the methane out of the water. The produced shallow aquifer water is recycled into the injectors. To initiate and maintain the hydraulic barrier, a relatively small amount of treated CBM produced water should be added to the injectors to support producing water wells outside of the hydraulic barrier. The exact amount of injectors and producers, along with makeup treated CBM water would be determined after aquifer testing and modeling.

Although limited data currently exists to accurately simulate the proposed hydraulic barrier, conceptual simulation using realistic aquifer properties showed the potential of hydraulic barriers to isolate methane in the aquifer and assist in its removal. The use of a hydraulic barrier and

interior gas stripping wells would allow the CBM wells to be produced, limit future methane migration outside of the current affected area, and provide for mitigation of the migrated methane currently existing in the shallow aquifer.

Proposed Data acquisition for monitoring well:

As part of the aquifer data acquisition the following data is to be collected from the monitoring well:

- Mud logging for lithology, gas and water bearing zone identification
- Open hole geophysical logging for aquifer characterization and completion interval selection including deep and shallow induction logs, gamma ray, neutron and density porosity
- Cased hole logging including a GR-CCL-CBL log and a cased hole neutron log for potential future time lapse gas saturation logging

After the monitoring well has been completed aquifer testing such as:

- Step rate tests
- 24-hr aquifer pump tests (more or less based on rate test)
- Monitor gas production
- Collect water quality sample including CFCs, boron isotopes, and dissolved methane
- Individual zones testing for hydraulic properties, fluid properties and pressures.
- Individual zone isolation and testing to isolate gas bearing zones.

During the well monitoring testing, selected surrounding domestic water wells will be monitored for interference to obtain higher quality spatial data for analysis of certain storage and transmissivity. Finally, long term pressure monitoring will be accomplished through installation of surface-readout downhole pressure monitoring equipment.

Drilling and completion of remaining mitigation wells: removal and hydraulic barrier wells

Data acquisition from the drilling and completion of the methane removal wells and hydraulic barrier wells will build upon data acquired from the Monitoring well and best practices. Similarly aquifer testing to that performed on the Monitoring well will be perform, again building upon previous acquired data and best practices. Once again surrounding methane removal wells, the monitoring well, hydraulic barrier wells and selected domestic water wells will be monitored during testing for interference to obtain higher quality spatial data.

Long term monitoring of the methane removal wells will include:

- Installation of surface-readout downhole pressure monitoring equipment if at all possible
- Continuous measurement and recording of gas and water flow rates if possible, otherwise minimum of weekly measurements.

Long term monitoring of the hydraulic barrier wells will include:

- Installation of surface-readout downhole pressure monitoring equipment if at all possible
- Continuous measurement and recording of water injection rates if possible, otherwise minimum of weekly measurements

Aquifer characterization

- Geophysical, hydrological, and fluid saturations will be incorporated into an aquifer model capable of being exported to simulation software.

- Simulation software at this stage will be utilized for preliminary fine tuning design of hydraulic barrier and aquifer remediation program. The simulation software will have the capability to track the dissolved and free methane plumes.

Baseline aquifer data monitoring

- Continued gas rate data from wells shown in **Table 4**
- Continued pressure monitoring of wells shown in **Table 5**
- Continued monitoring of wells shown in **Table 6**
- Dissolved methane content from select wells
- Boron and CFC data from select water wells.

Baseline outcrop monitoring

- Continued pressure monitoring of wells on the monthly schedule shown in Table 6
- Continued weekly gas rate data collection from Bruington well
- Semi-annual monitoring of outcrop with helicopter survey

PHASE II: INITIATION OF HYDRAULIC BARRIER AND METHANE REMOVAL

This program entails injecting water produced from the Vermejo coal formation into the hydraulic barrier wells. It is anticipated that Petroglyph would need to reactivate up to four of its CBM wells to obtain the necessary make-up water. With the addition of the Vermejo coal make-up water, the hydraulic barrier and the methane removal system would be in full operation. Continuous monitoring of water injection rates, downhole pressures, water production and methane removal rates will be conducted. Surrounding domestic water wells will be monitored for any increase or decrease in methane production, as will the gas seeps along the outcrop.

Continual updating and calibration of geologic and numerical models to refine design and optimize the aquifer remediation program would be undertaken utilizing the pressure, rate, and chemical data gathered during operations.

Phase III - Long Term Methane Removal from Vermejo Coals, Remediation of Aquifer, and Potential Methane Conduit Identification and Plugging

This program entails reactivation of all 52 Vermejo coalbed methane gas wells, and ongoing monitoring, as outlined for Phases I and II. It also entails ongoing calibration of the shallow aquifer simulation model, utilizing gas and water production, pressure and chemical data.

It is important to understand the rise in the Vermejo coal pressure coupled with under saturated coals will result in the delay of sustainable methane production from the coals. This delay will allow ample time for development of baseline trends for both the shallow aquifer mitigation program and for the potential identification of the methane conduit. Upon identification of the methane migration pathway, a plan for closure of such pathway, if technically feasible and economically practicable, shall be developed and submitted to the COGCC staff for approval.

Additionally, the potential of using produced water from the Vermejo coal formation to mitigate gas seepage along the outcrop will be assessed, as will the potential for installation of a gas collection system at the outcrop. Pressure observations at the Pearson and Meyers wells, which are believed to be in communication with coals, suggest a transmissivity barrier or baffle exists between the outcrop and the downdip CBM coals. Lower transmissivity would allow for water to be injected into the Vermejo coal seams near the outcrop and result in re-pressurization and lower methane desorption and emissions

If the CBM wells remain shut in and the Vermejo aquifer does not have a natural or man-made reduction in the P-head then the methane stored in the coals through adsorption will remain in

place and most likely any remaining free gas will either migrate up or become trapped in the coals geologically. Future methane migration will still be possible if the Vermejo aquifer becomes de-pressured.

Simulation modeling of the Vermejo coal aquifer and coals was previously performed by NQE in 2004. The results of that simulation study indicated that the size of the aquifer connected to the Vermejo coal in Little Creek and Bear Creek was 300 billion barrels of water equivalent. The size of the aquifer attached to the coals was not modified during a recent simulation update of the Little Creek and Bear Creek fields. The simulation study was successful in determining that increased water production was required for Petroglyph to initiate methane desorption and subsequent production. The 2004 simulation study was able to predict accurately the first methane production without any modifications after actual water production rates were added. Subsequent modifications to the simulation were made to include baffling of the gas flows from the dikes to more accurately match the counterintuitive downdip methane production observed. A large amount of baffling was required in the area currently seeing significant methane migration which may be indicative of a natural conduit.

The large size of the attached aquifer is also evident through the observation of pressure decline in the Passow well located approximately three miles north of the Lively 03-10 (SE, NE, Sec 22, T28S, R67W). The Passow well is completed in the Vermejo coals and has been shown to be in pressure communication with the Vermejo aquifer. The exact size and location of the connected aquifer is unknown. The produced water from the Vermejo aquifer is quite good and compares favorably with the shallow water wells as show in **Table 7**.

Future water requirements in the west may lead to this large aquifer being produced. The pressure history at the Passow well indicates it is likely future production of this aquifer, even miles away, can lead to the lowering of the P head and the strong potential the Vermejo coals

will again undergo desorption, and gas migration will resume. This time, migration would occur without an obvious "cause and effect" or infrastructure to isolate or mitigate the migration.

Allowing the Vermejo CBM to be produced during Phase III, under controlled conditions would remove methane and lessen the future potential migration of methane. It would also allow for continuing testing and analysis whereby the nature and extent of the conduit could be studied and possibly isolated and plugged.

TABLES

Table 1 Methane Concentrations Observed in Shallow Aquifer Wells

Permit #	Owner	CH4 %
236272	Houghtling	98%
267694	Coleman	97%
181278	Bounds	97%
256504	Hopke	93%
257994	Barrett	81%
239657	Smith	69%
244403	Bergman	58%
238689	Angely	36%
252931	Derowitsch	31%
169043	Burge	29%
84108-A	McPherson	0%
271136	May	0%
269435	Goacher	0%
264581	Ireland	0%
260097	Dee	0%
258815	Goodwin	0%
257113	Masters	0%
255929	Conley	0%
253317	Gonzalez	0%
250369	Martin	0%
240947	Wolahan	0%
235516	Colorado Suitzer	0%
235292	Kerman	0%
230582	Willis	0%
222539	Lively	0%
216732	Petroglyph (3)	0%
215706	Brice	0%
215323	Petroglyph (4)	0%
215322	Petroglyph (1)	0%
215322	Petroglyph (2)	0%
193521	Ping	0%
192203	Rankins	0%
145915	Carsella	0%
123144	Searle	0%
93386	Lowery	0%

Table 2 Total Gas Composition Analysis of Selected CBM Wells and Shallow Aquifer Wells

Sample ID	Total Gas Composition					
Well Name	N2 / Air Conc. (mole %)	CO2 Conc. (mole %)	H2S Conc. (mole %)	C1 Conc. (mole %)	C2 Conc. (mole %)	Specific Gravity (Air = 1.0)
Rohr 09-10	1.08	0.20	nd	98.57	0.01	0.561
Rohr 09-10 #1	1.22	0.03	0.00	98.73	0.01	0.560
Smith WW #1	1.70	0.00	0.00	98.26	0.02	0.561
Coleman WW #1	1.44	0.00	0.00	98.53	0.02	0.560
Bruington WW #1	1.94	0.05	0.00	97.98	0.01	0.563
Goemmer Land Co #1	21.67	0.05	0.00	72.67	0.04	0.676
Lively 03-12	1.32	0.11	nd	98.45	0.018	0.561

Table 3 Isotope Analysis of Selected CBM Wells and Shallow Aquifer Wells

Sample ID		Stable Carbon Isotopes		BTU Content	
Well Name	Sampling Date	□^{13}C Methane (‰)	□ D of Methane	Total Gas (BTU/ft3)	Hydrocarbon Gas (BTU/ft3)
Rohr 08-01		-48.2	-227.4		
Rohr 09-10	7/24/2007	-48.7	-232.9	1,000	
Rohr 09-10 #1		-49.4		998	1,011
Rohr 09-10 #2		-49.5			
Smith WW #1		-49.4		994	1,011
Smith WW #2		-49.4			
Coleman WW #1		-49.3		996	1,011
Bruington WW #1		-52.5		990	1,010
Bruington WW #2		-52.4			
Bounds WW	6/22/2007	-48.5	-227.9		
Coleman WW	6/21/2007	-50.0	-232.7		
Goemmer Land Co #1	8/15/2007	-45.6	-212	737	
Lively 03-12	7/24/2007	-51.1	-238.5	999	

Table 4 Gas flow rate monitoring wells

Landowner	Permit No.	Latitude	Longitude	Frequency
Smith	239657	37.55338	-104.88480	Continuous
Coleman	267694	37.53800	-104.87781	Continuous
Jerry Angely	238689	37.54220	-104.87776	Weekly
Bounds	181278	37.52176	-104.87707	Weekly
Bruington	210526	37.63560	-104.83334	Weekly

Table 5 Aquifer water wells with scheduled pressure monitoring

Landowner	Permit No.	Latitude	Longitude	Frequency
Chaves	270552	37.57957	-104.81924	Bi-Weekly
Cramer	222294	37.53561	-104.75757	Monthly
Dee	260097	37.56606	-104.88792	Bi-Weekly
Higgins	259122	37.56234	-104.82644	Bi-Weekly
Hurley	203536	37.59149	-104.80284	Bi-Weekly
Masters	257113	37.53691	-104.88568	Bi-Weekly
Roloff	274468	37.58113	-104.84504	Bi-Weekly
Ryerson	254577	37.57669	-104.84330	Bi-Weekly
Snow	192144	37.53408	-104.76103	Monthly
White	219376	37.50503	-104.73027	Monthly
Bergman	244403	37.55237	-104.87160	Continuous
Barrett	257994	37.55500	-104.88347	Continuous
Bounds	181278	37.52176	-104.87707	Weekly
Vince Coleman	267964	37.53800	-104.87781	Continuous

Table 6 Aquifer water wells with scheduled gas monitoring

Landowner	Permit No.	Latitude	Longitude	Frequency
Barrett	257994	37.55237	-104.87160	Bi-Weekly
Bergman	244403	37.55500	-104.88347	Bi-Weekly
Brice	215706	37.54945	-104.85560	Bi-Weekly
Burge	169043	37.53804	-104.86540	Bi-Weekly
Coleman	267694	37.53800	-104.87781	Bi-Weekly
Conley	255929	37.57053	-104.86431	Bi-Weekly
Cordova	3155	37.63779	-104.83884	Bi-Weekly
Derowitsch	252931	37.54858	-104.87098	Bi-Weekly
Goacher	269435	37.57260	-104.85188	Bi-Weekly
Golden Cycle Land (Goemmer)	16861-F	37.54336	-104.86545	Bi-Weekly
Gonzalez	253317	37.56535	-104.89466	Bi-Weekly
Goodwin	258815	37.55699	-104.84003	Bi-Weekly
Hentschel	249181	37.57008	-104.83272	Bi-Weekly
Hopke	256504	37.54090	-104.88253	Bi-Weekly
Houghtling	236272	37.54573	-104.88787	Bi-Weekly
Ireland	264581	37.55676	-104.84513	Bi-Weekly
Johnson	205195	37.61873	-104.81495	Bi-Weekly
Kerman	235292	37.56650	-104.87465	Bi-Weekly
Lively	222539	37.55854	-104.87910	Bi-Weekly
Martin	250369	37.57026	-104.89881	Bi-Weekly
May	271136	37.55191	-104.85455	Bi-Weekly
McEntee	193520	37.62490	-104.82584	Bi-Weekly
McPherson	84108-A	37.53769	-104.90106	Bi-Weekly
Meyer	248862	37.58213	-104.81896	Bi-Weekly
Rohr	84106	37.54431	-104.89277	Bi-Weekly
Searle	123144	37.56669	-104.86342	Bi-Weekly
Sharp	246775	37.57828	-104.83199	Bi-Weekly
Smith	239657	37.55338	-104.88480	Bi-Weekly
Speh	267695	37.58158	-104.86160	Bi-Weekly
Tobyas	248983	37.58752	-104.81880	Bi-Weekly
Willis	23582	37.52631	-104.86073	Bi-Weekly
Wolahan	240947	37.57060	-104.89163	Bi-Weekly

Table 7 Water Quality Comparison CBM Produced Water and Surface Water Wells

Sample Type	Conductivity (uS/cm)	TDS (mg/L)	Bicarbonate (mg/L)	Bromide (ug/L)	Chloride (mg/L)	Sulfate (mg/L)	Calcium (mg/L)	Sodium (mg/L)
Production Wells Average	1,237	851	591	590	50	39	3	316
Water Wells Average	1,069	752	592	142	25	37	7	298

FIGURES

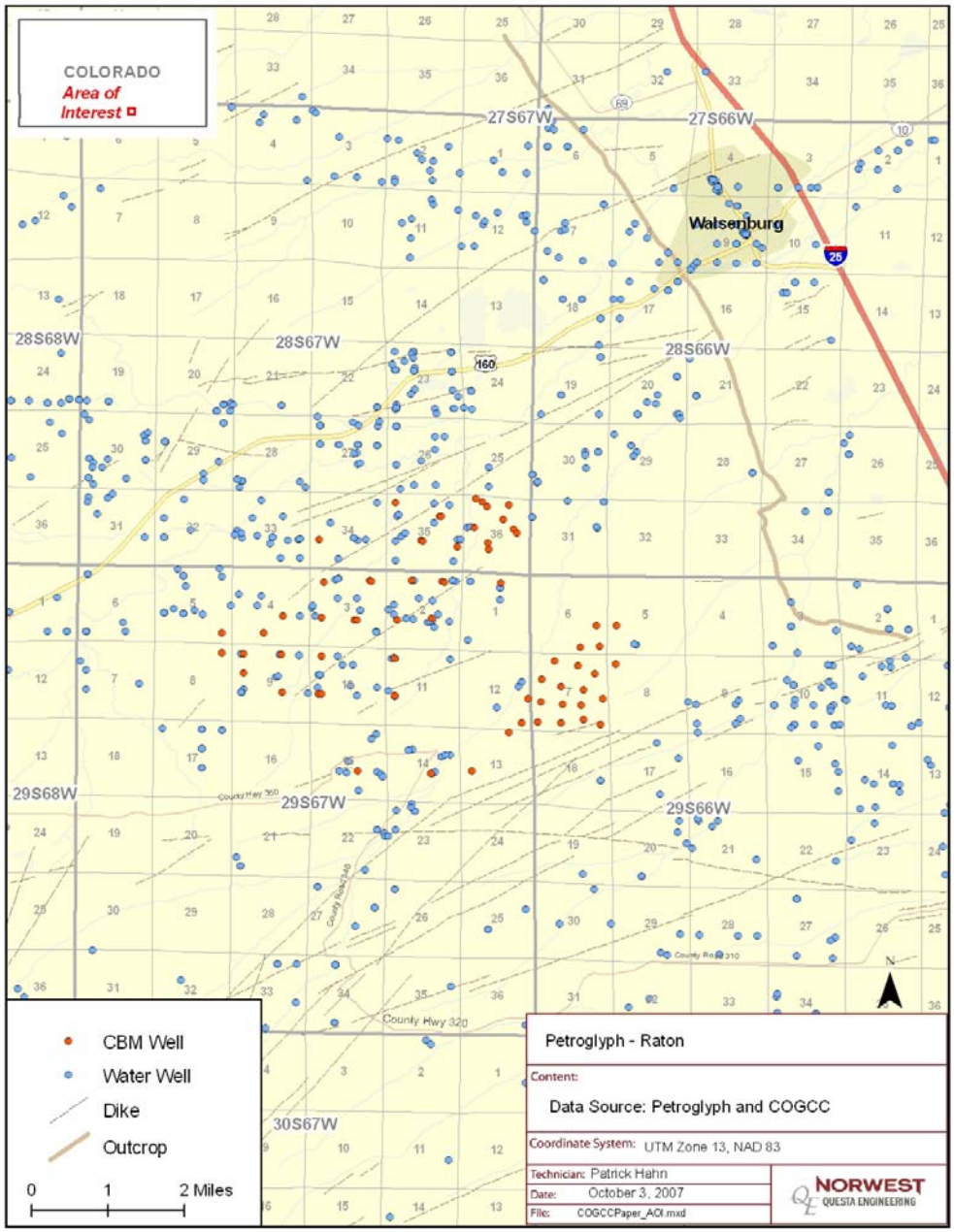

Figure 1 Area of Interest (AOI)
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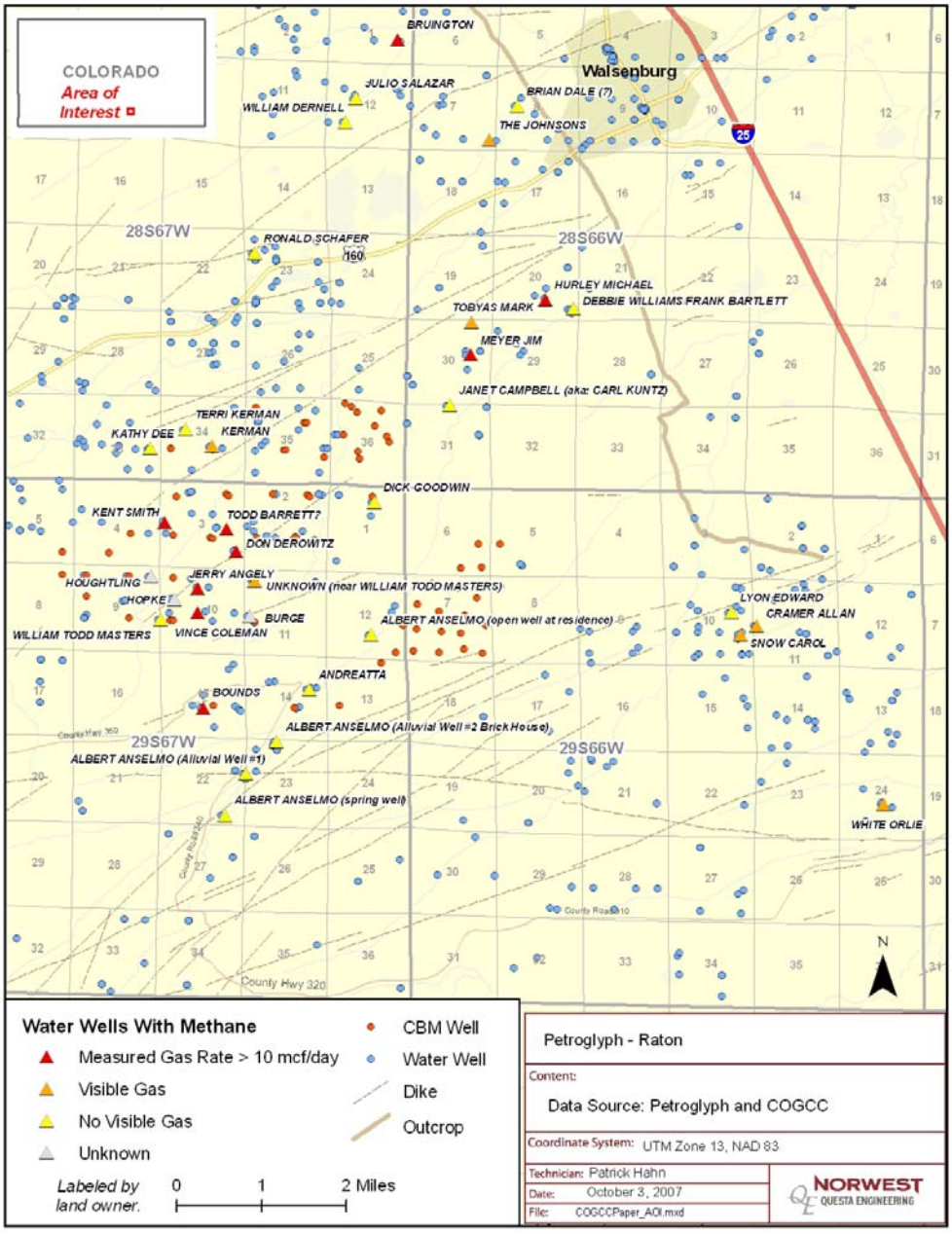

Figure 2 Water wells with Measurable Methane and Associated Flow Rates
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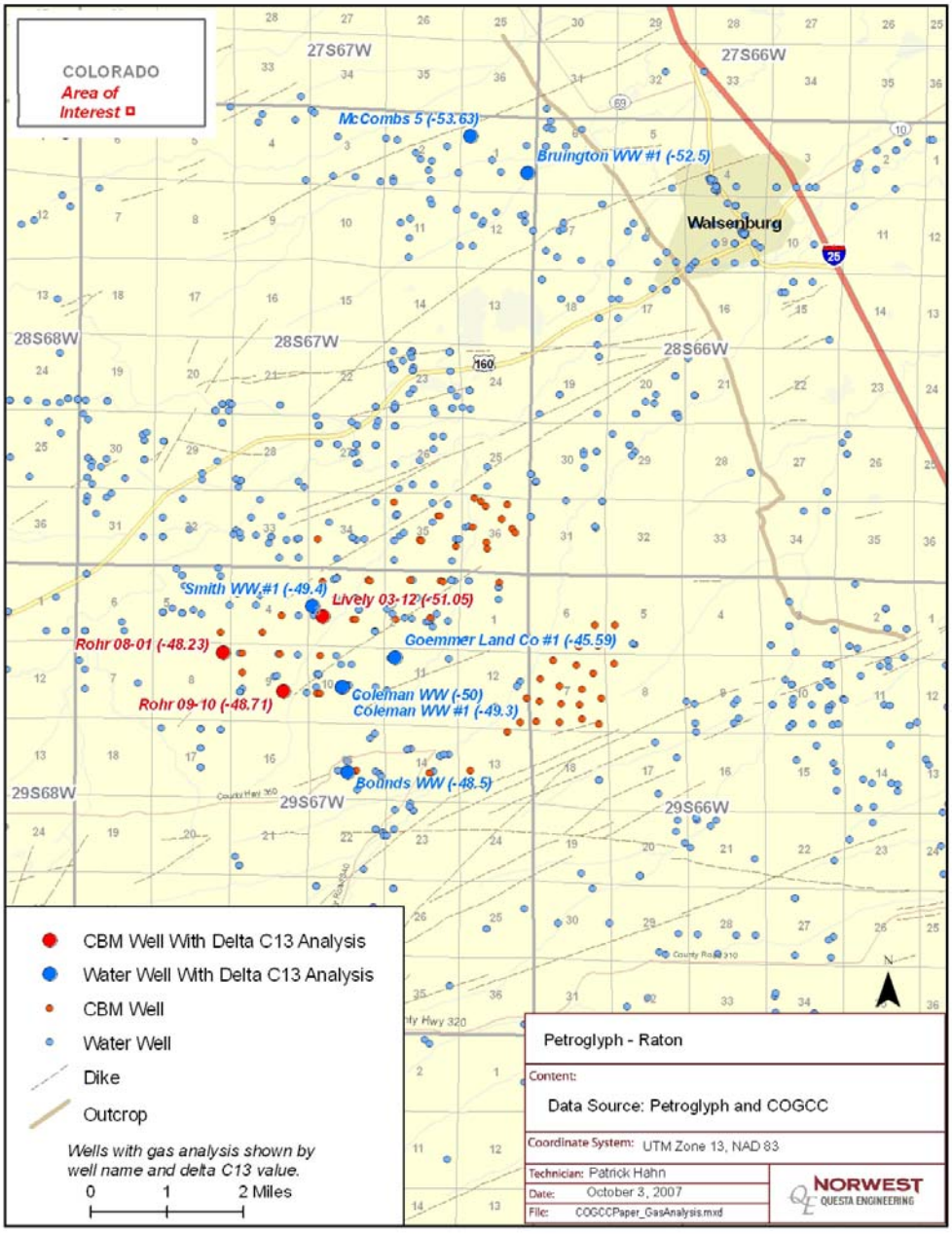

Figure 3 Map of Isotope Analysis of Shallow Aquifer and Vermejo Coal Aquifer
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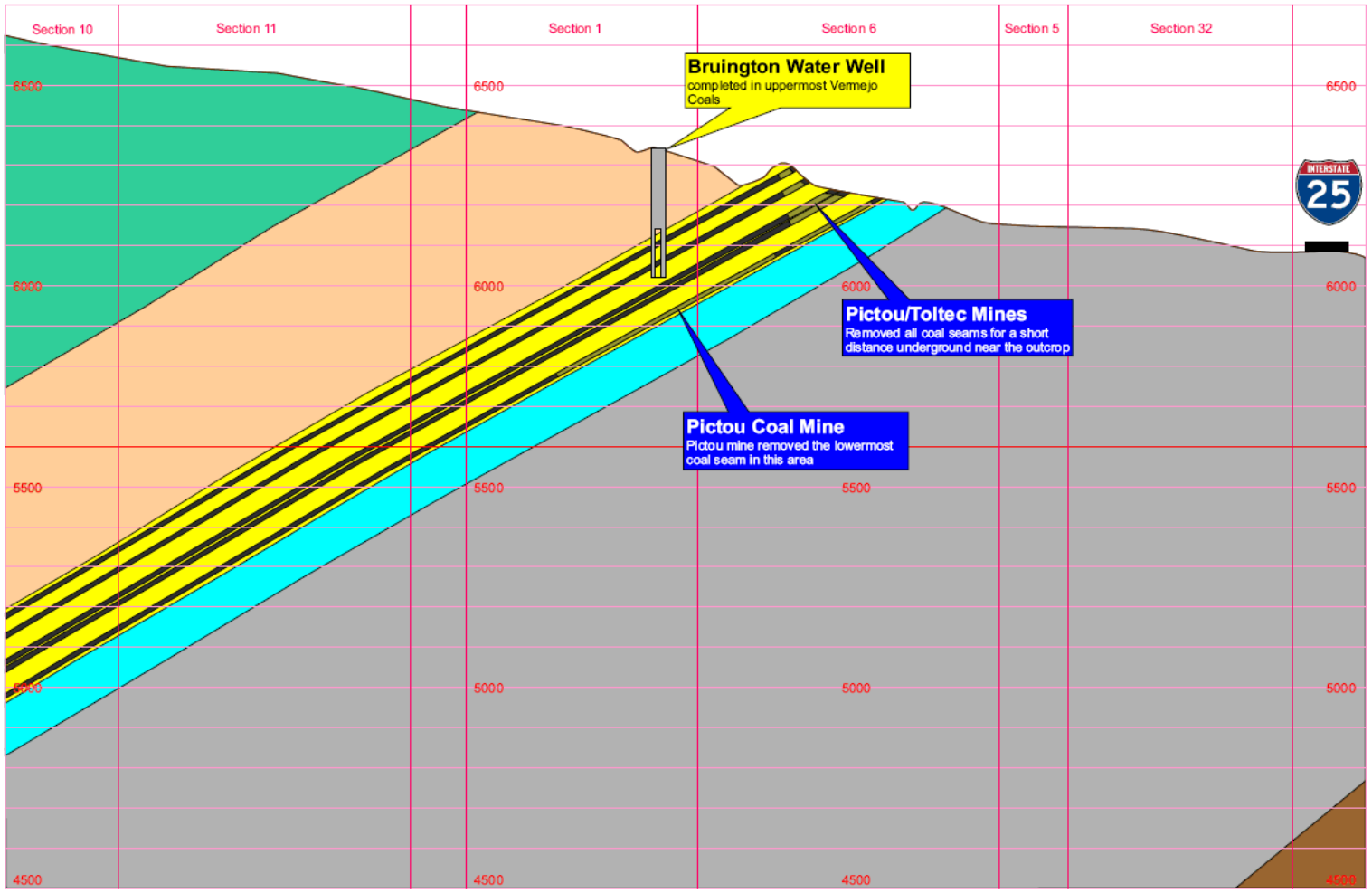

Figure 4 Cross-section of Bruington Water Well Completion and relationship to Coals and Previous Mining Activity

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Figure 5 Location of Bruington Well and Outcrop

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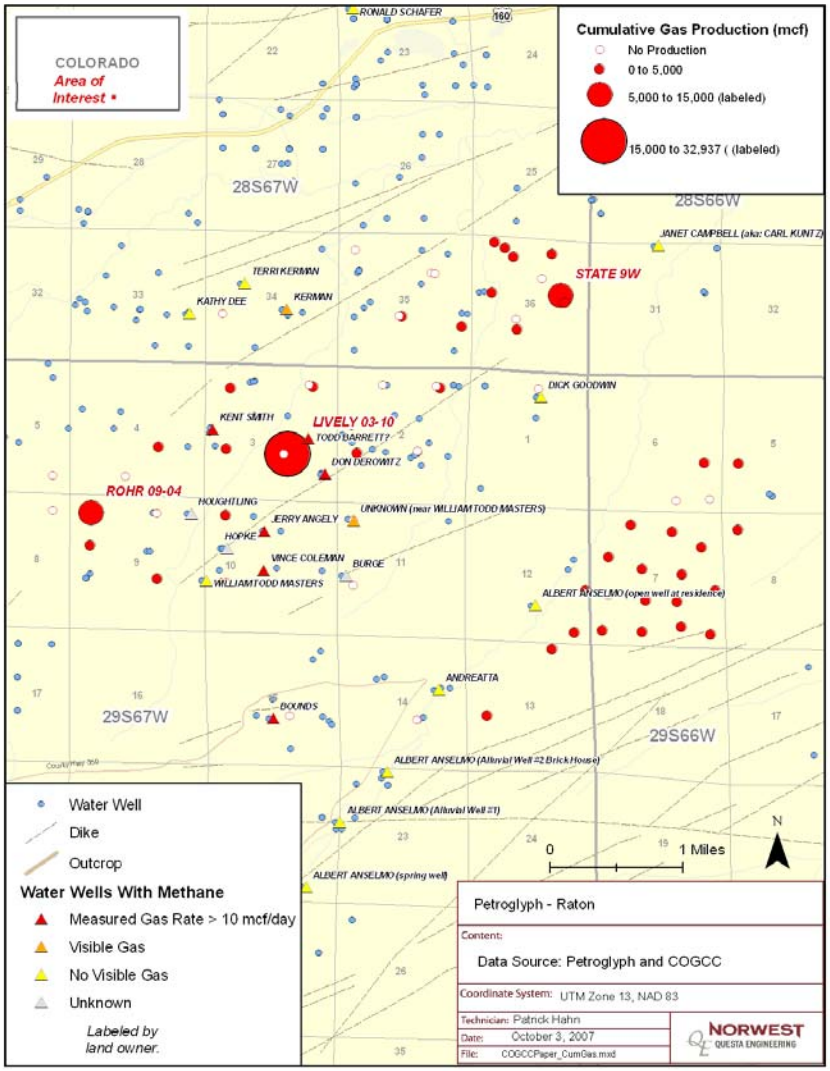

Figure 6 Location of CBM Producers with Cumulative Gas Produced and High Methane Flow Rate Water Wells

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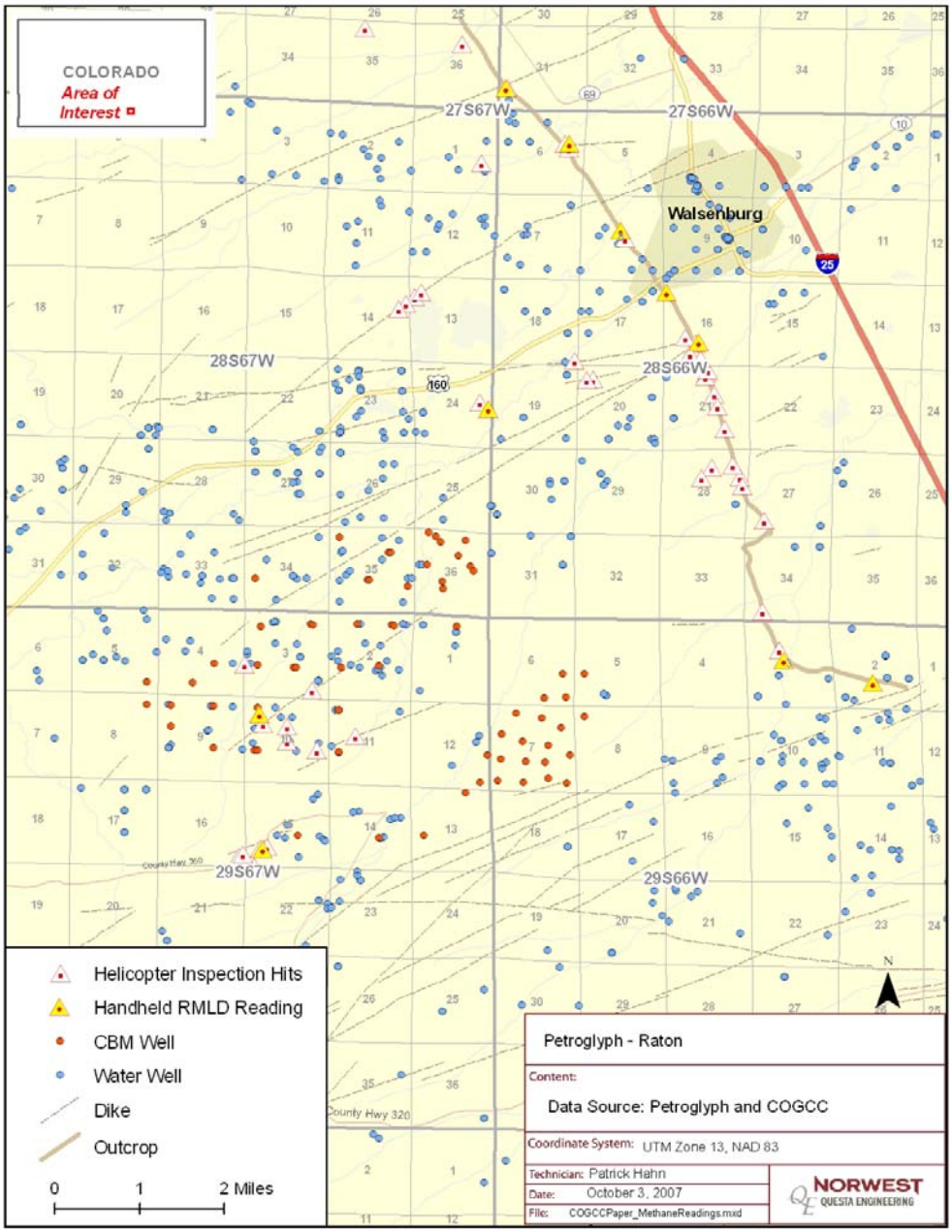

Figure 7 Helicopter Survey Methane Hits and RMLD Methane Readings
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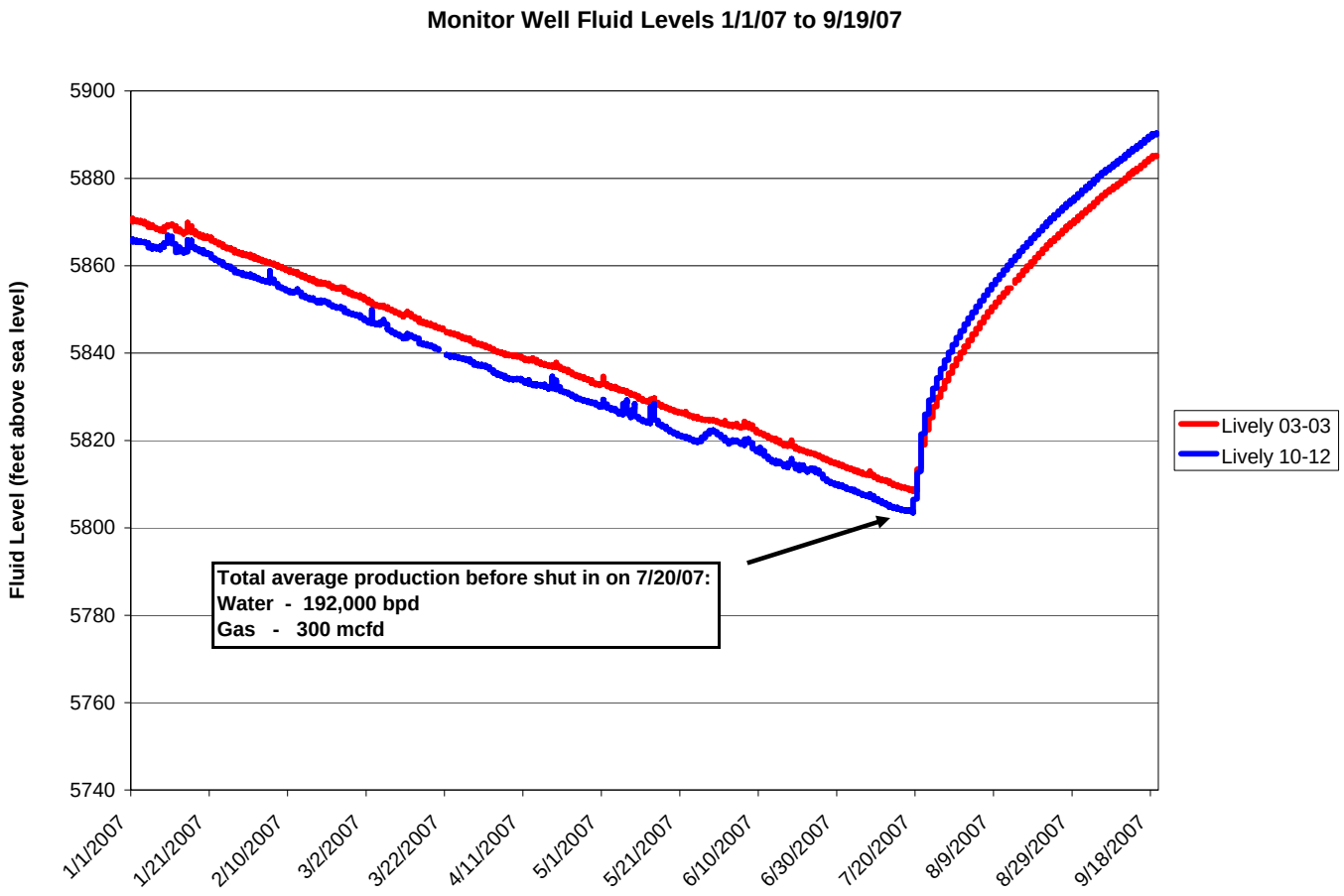

Figure 8 Observed Rise in Vermejo Coal Aquifer P head after Field Shut In

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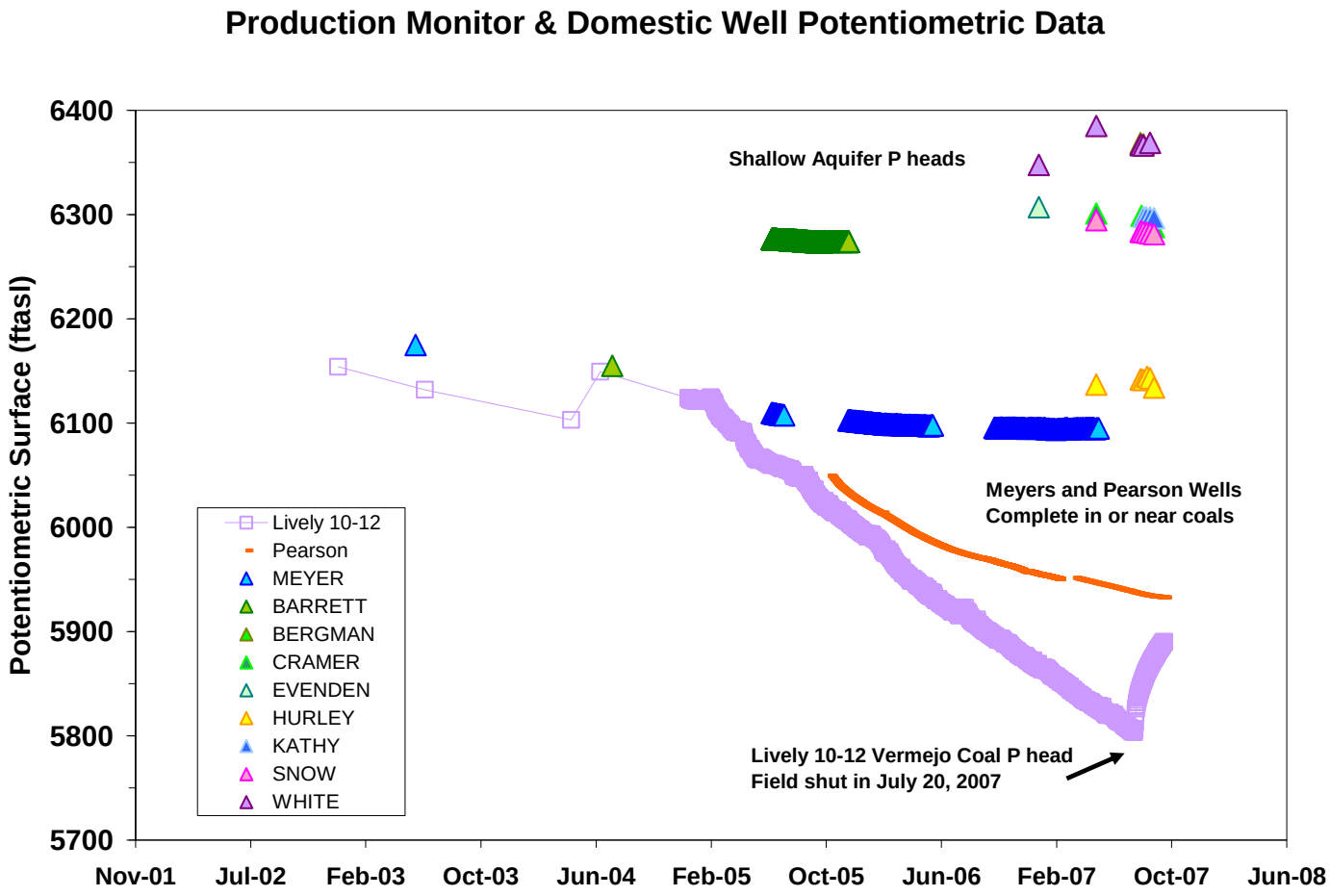

Figure 9 Observed P head difference between Vermejo Coal Aquifers and Shallow Aquifers

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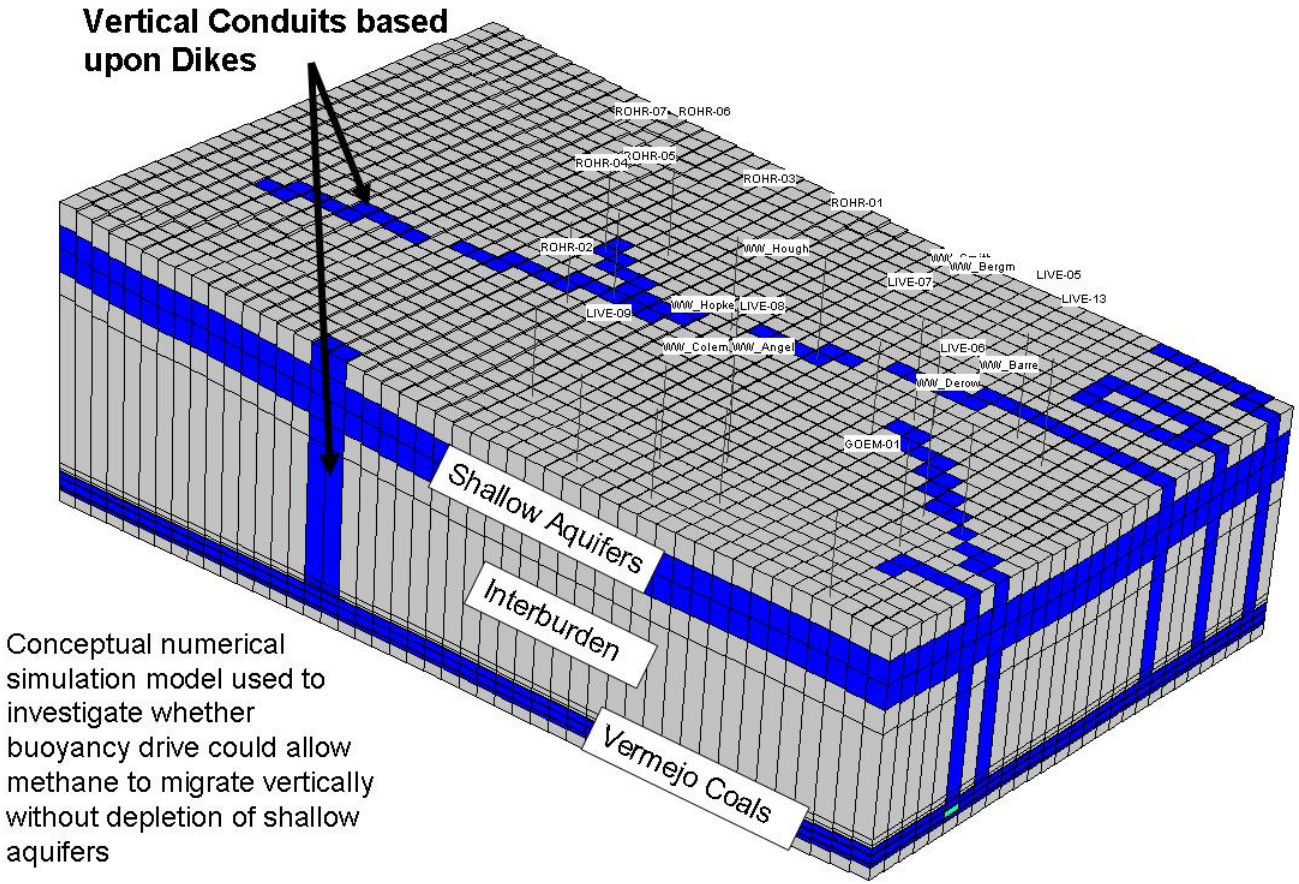

Figure 10 Vertical Conduits and Model Geometry of Buoyancy Simulation
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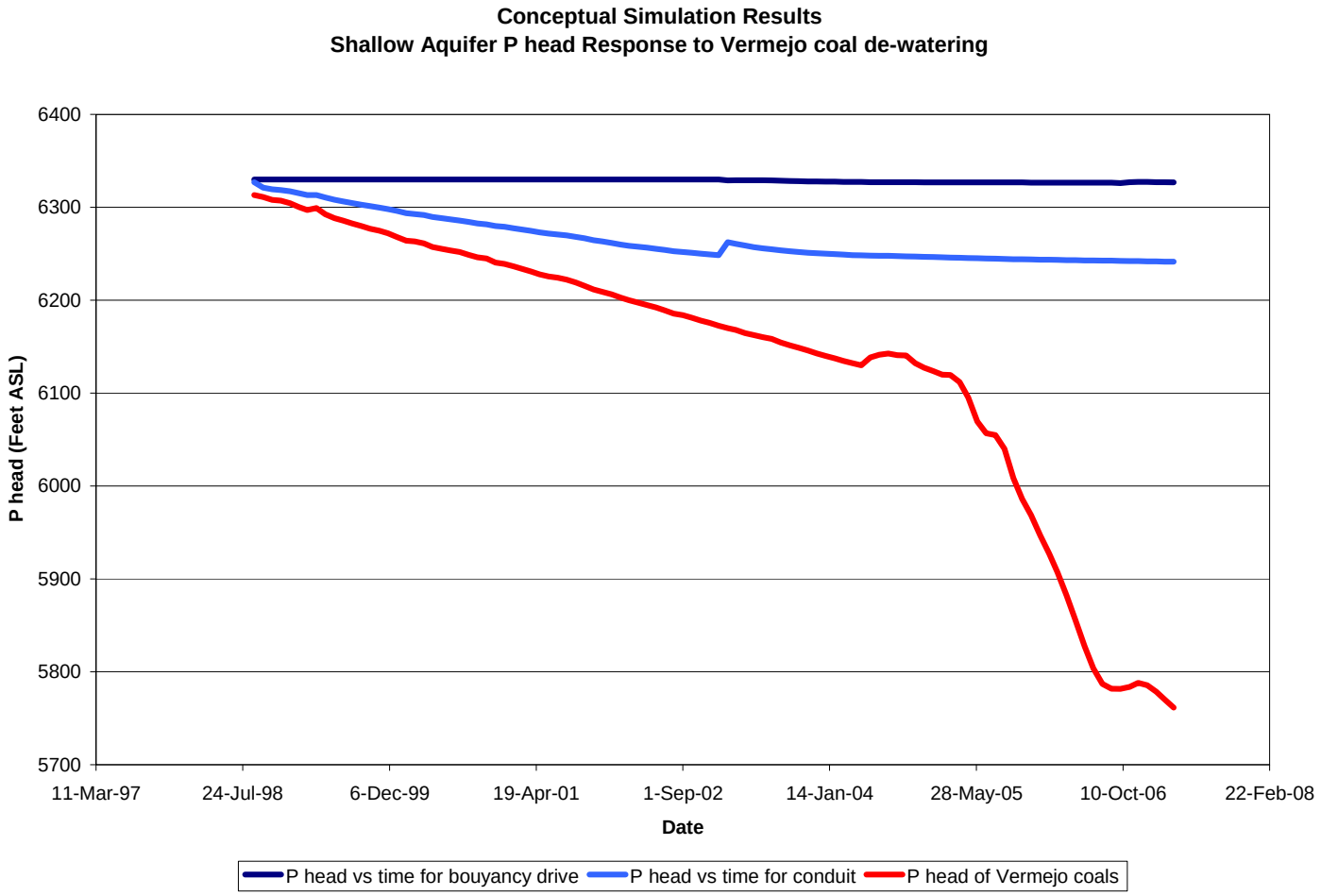

Figure 11 P head results from Buoyancy Simulation

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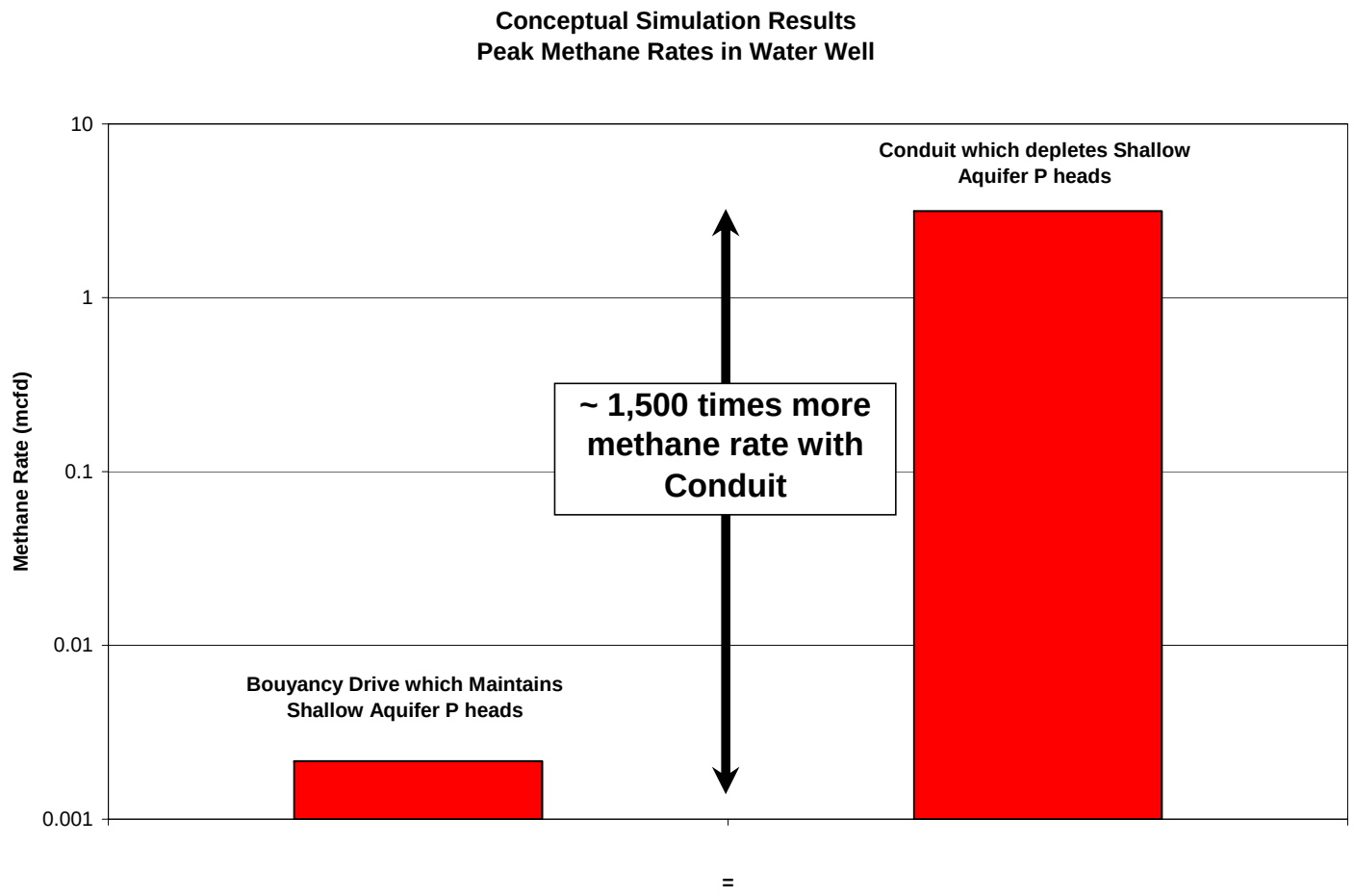

Figure 12 Comparison of Buoyancy Simulation Methane Flow Rate and Conduit Methane Flow Rate

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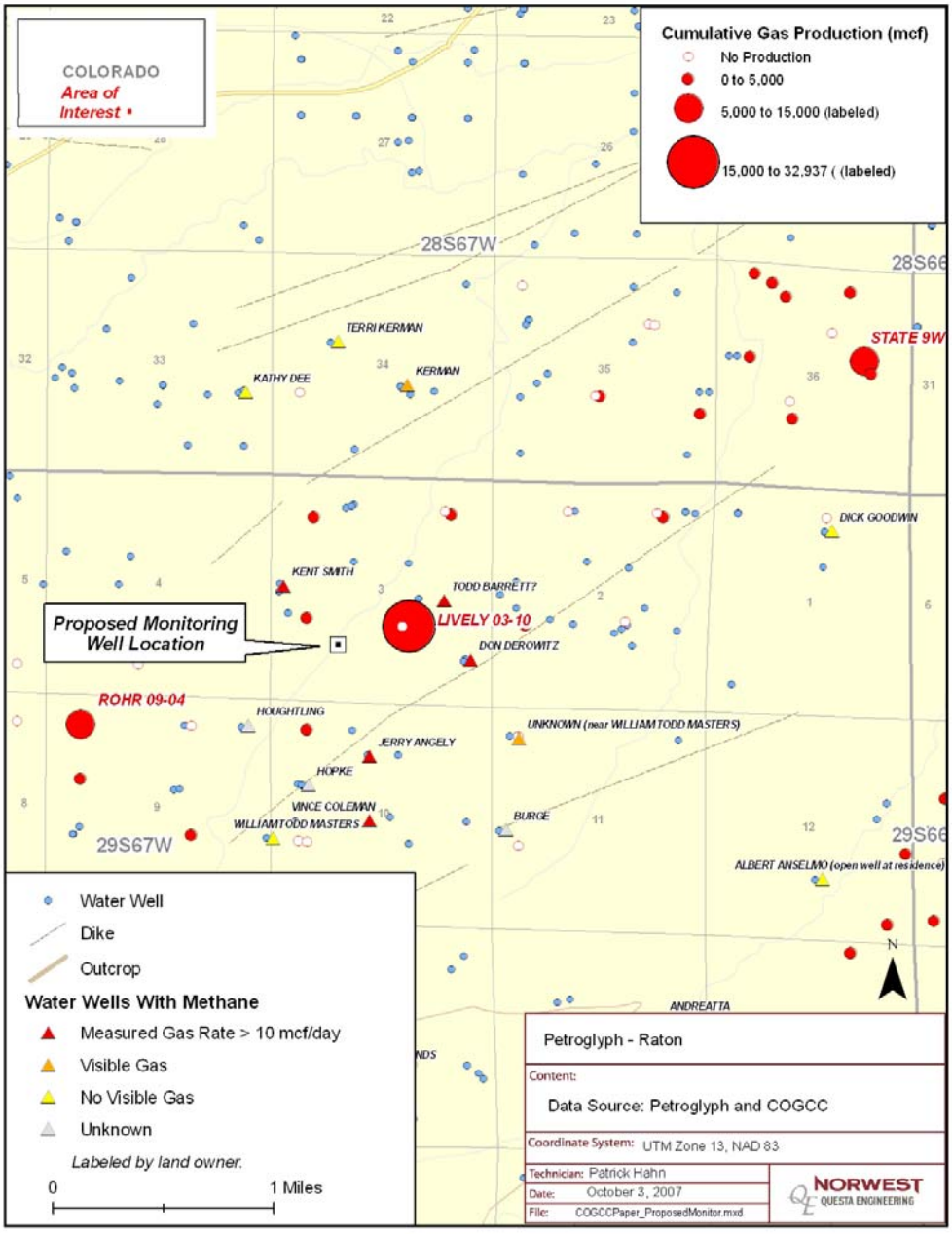

Figure 13 Proposed Location for Shallow Aquifer Monitoring and Testing Well
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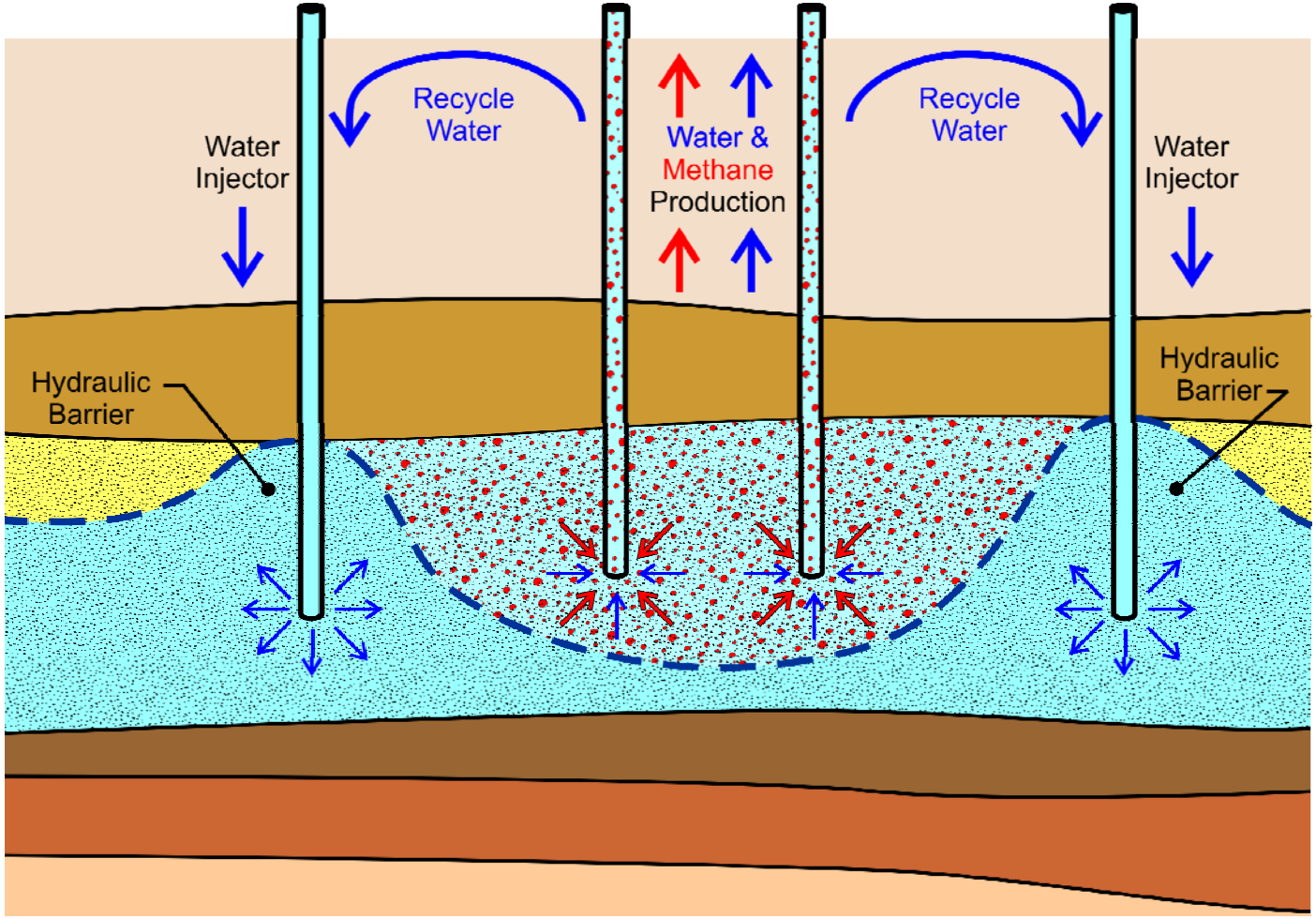

Figure 14 Illustration of Hydraulic Barrier in Cross-Section View

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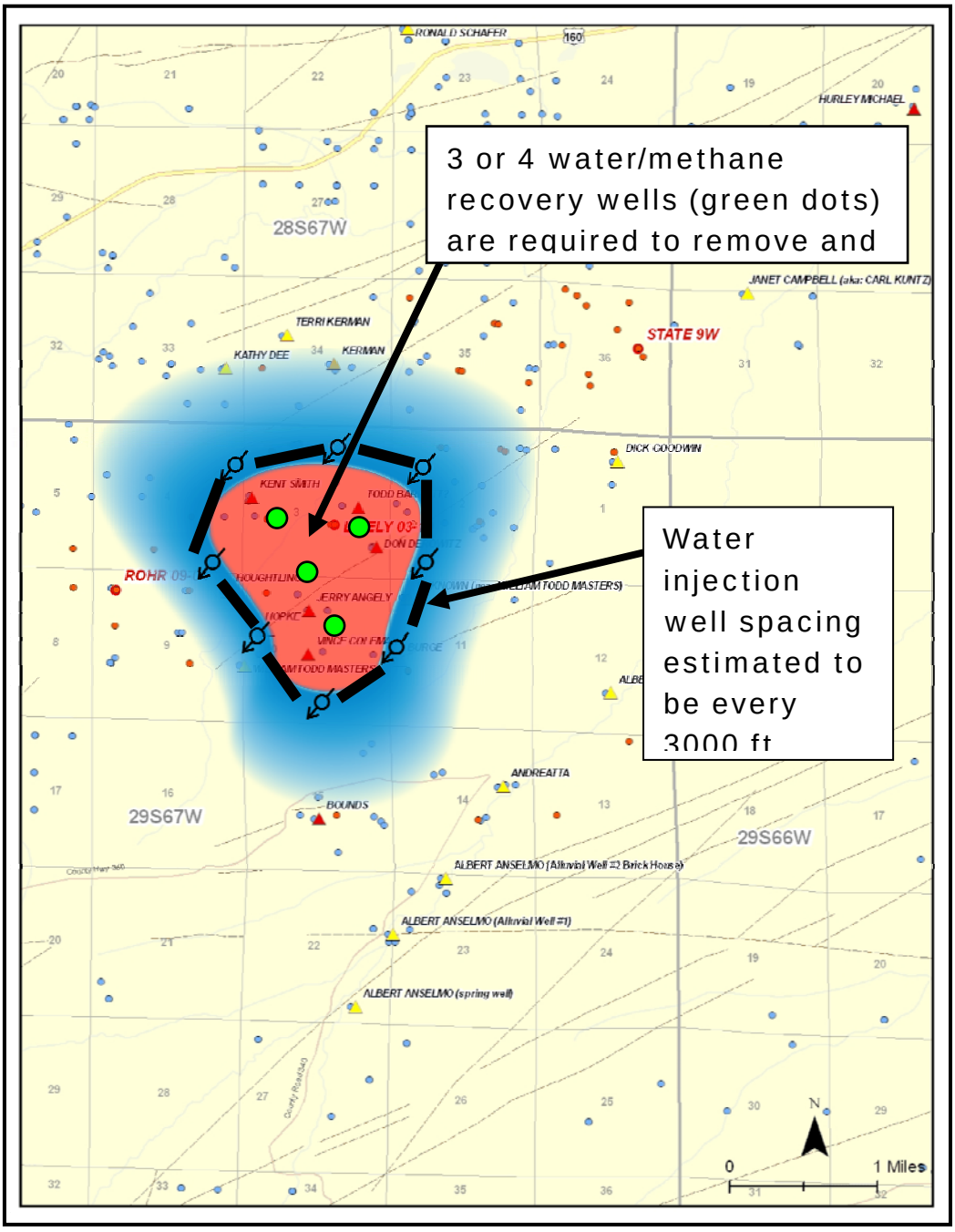

Figure 15 Illustration of Hydraulic Barrier in Map View

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APPENDIX A

Proposed Action Items	Actual Action Items
1. P&A'd Oil and Gas Wells: Petroglyph will re-enter the following plugged and abandoned wells: • Lively #10-02, 05-055-06148, NWNE10, T29S R67W • Dick Realty #1, 05-055-05027, SENE3, T29S R67W	**1. Petroglyph re-entered and re-plugged old P&A'd Oil and Gas Wells including:** The **Lively 10-02** was P&A'd due to lost circulation and stuck drill pipe in 1998, leaving 1545 feet of drill pipe in the hole. Re-entry began 8/1/07 with the target plugging depth of 1050 feet. Following are the results: • Drill/wash to top of fish (4 1/2" dp at 375') with 7 7/8" bit. • Drill down along side drill pipe with 3 7/8" bit. Could not go deeper then 764' drilling/washing along old drill pipe. Attempted to go deeper than 764' for three consecutive days without success. • No significant gas shows. (See Appendix B) • The well will be used as a monitor well per the COGCC's direction and plugged at an unknown later date. • Currently, the 8 5/8" casing is approximately 1 foot above ground level with a pressure containing cap, valve and pressure gage. The **Dick Realty #1** re-entry began 8/6/07 with the target plugging depth of 1800 feet. Following are the results: • It took (5) 12 hr. days to wash/drill to 1400' with a 7 7/8" bit. • No significant gas shows. (See Appendix B). • Due to the lack of significant gas shows and due to the significant expense of washing down this well, the COGCC agreed that 1400' would be an acceptable plugging depth. • The deepest sand that could likely be tapped for a water source is at 1100' Cement from 1400 ft to 30 ft. with 3 stage cement job. (126 sks from 1400' to 1080', 256 sks from 1080' to 422'. 160 sks from 422' to 30'). Cut off 4' below GL and plug with 4 sks at top of casing. **Due to the lack of significant gas shows during re-entry, it appears there is no significant gas migration into affected water sands and thus, these wells are not the source of gas entering the water sands.

2. Test oil and gas wells converted to water wells; Petroglyph will contact water well owner and obtain permission to: • Pull pump and tubing • Check for gas; if gas is present collect sample and run for gas composition and stable isotope analysis. • Tag plug and measure depth of plug. • Run video camera and check perforated interval and casing integrity. • Run cement bond log (based on review of well completion records). • Install pressure transducers and or collect water level measurements and casing pressures. For the following wells: • **Goemmer Land Co 1**, 05-055-06004, #16861 F, NWNW Section 11, T29S R67W (also identify zone where gas is entering well). • **Stan Searle 1**, 05-055-06060, #260097, (Kathy Dee) NESE 33 T28S R67W. • **Searle 1**, 05-055-06086, #222539, (aka Lively 03-03) NENW 3, T29S R67W. • **Ferdinand B. Rohr 1**, 05-055-05012, #84106 (aka Rohr #1) NWNE 9 T29S R67W.	**2. Petroglyph Monitored Oil and Gas Wells Converted to Water Wells** • **Goemmer Land Co 1**, 05-055-06004, #16861 F, NWNW Section 11, T29S R67W There is no pump in this well. A camera survey was run 8/13/07 showing the FL @ 984', TD @ 2110. Gas bubbles could be seen migrating up the water column in the well bore. A CBL is planned to be run the week of 8/27/07. A down hole pressure gage will not be installed because the historical pressure data in this well precisely tracks the pressure data of the Lively 10-02 and Lively 03-03 which both currently have down hole gages installed and are recording pressure data. The COGCC is monitoring for gas weekly in this well. • **Stan Searle** 1, 05-055-06060, #260097, (Kathy Dee) NESE 33 T28S R67W. Katherine Dee granted permission to monitor this well 7/31/07. Weber Water pulled the pump 8/2/07. The pump was at 424' and had earthen debris on it. Weber Water is storing the pump. A camera survey was run 8/13/07 showing 8 5/8" casing to 224', open hole from 224'to 424' (TD?) and water level at at 344'. Down hole well conditions preclude a CBL. Norwest Applied Hydrology (NAH) personnel are monitoring FL weekly. COGCC is currently monitoring for gas weekly. No gas has been detected. This well is not a likely source of gas migrating into the water sands. • **Searle 1**, 05-055-06086, #222539, (aka Lively 03-03) NENW 3, T29S R67W. A down hole pressure gage has been recording data since March 2003. A camera survey was run 8/14/07 showing a FL @ 800', PBTD @ 2133 (in 5 ½" casing). A 4/15/98 CBL estimates top of cement at 1620'. Vermejo coals are isolated. Raton coals are not isolated. A quasi-bradenhead test indicated zero to very little pressure on backside of 5 1/2" casing. Gas was detected in annulus but diminished as it was open to the atmosphere. Based on the CBL and bradenhead test, this well is not a source of gas migration into the water sands. COGCC is currently monitoring for gas weekly. Pressure data is presented later in the report. • **Ferdinand B. Rohr 1,** 05-055-05012, #84106 (aka Rohr #1) NWNE 9 T29S R67W. Weber Water pulled the pump 8/6/07. A camera survey was ran 8/14/07 showing a FL at 459', 7" casing to 650' (PBTD?). Water in well was too black to see side of casing. The fluid level is at historical fluid level. TD precludes CBL. Per Ferdinand Rohr records, PBTD should have been at 990' and water level at 465'. **Camera survey DVDs of the above 4 wells will be provided when available.

3. Gas Production Wells: Petroglyph will obtain bottomhole pressure build-up and or shoot fluid levels and measure casing pressure for select wells.

3. Pressure Build-Up Data Results from Production Wells

- The **Lively 10-12, 05-055-06150** and **Searle 1, 05-055-06086, #222539, aka Lively 03-03** have served as monitor wells and have had down hole pressure gages installed in them for approximately 4 years. PBU data from these wells represents the build-up of the Vermejo coal reservoir.
- The large capacity production wells have down hole pressure sensors (See Appendix B).

Well Name	API #
ROHR 04-14	05055062910000
ROHR 08-01	05055062920000
ROHR 09-04	05055062900000
ROHR 09-05	05055062890000

- Pressure build-up data was derived from shooting fluid levels and recording casing pressure for the following production wells. Resolution of the fluid level shots is approximately 15 ft. (See Appendix B)

Well Name	API #
LIVELY 02-02	05055061560000
LIVELY 02-12	05055061510000
LIVELY 03-01	05055061600000
LIVELY 03-10	05055061460000
LIVELY 03-12	05055061470000
LIVELY 10-04	05055061490000
ROHR 04-10	05055061660000
ROHR 09-10	05055061650000
STATE 36-02	05055061790000

		STATE 36-05	05055061610000	

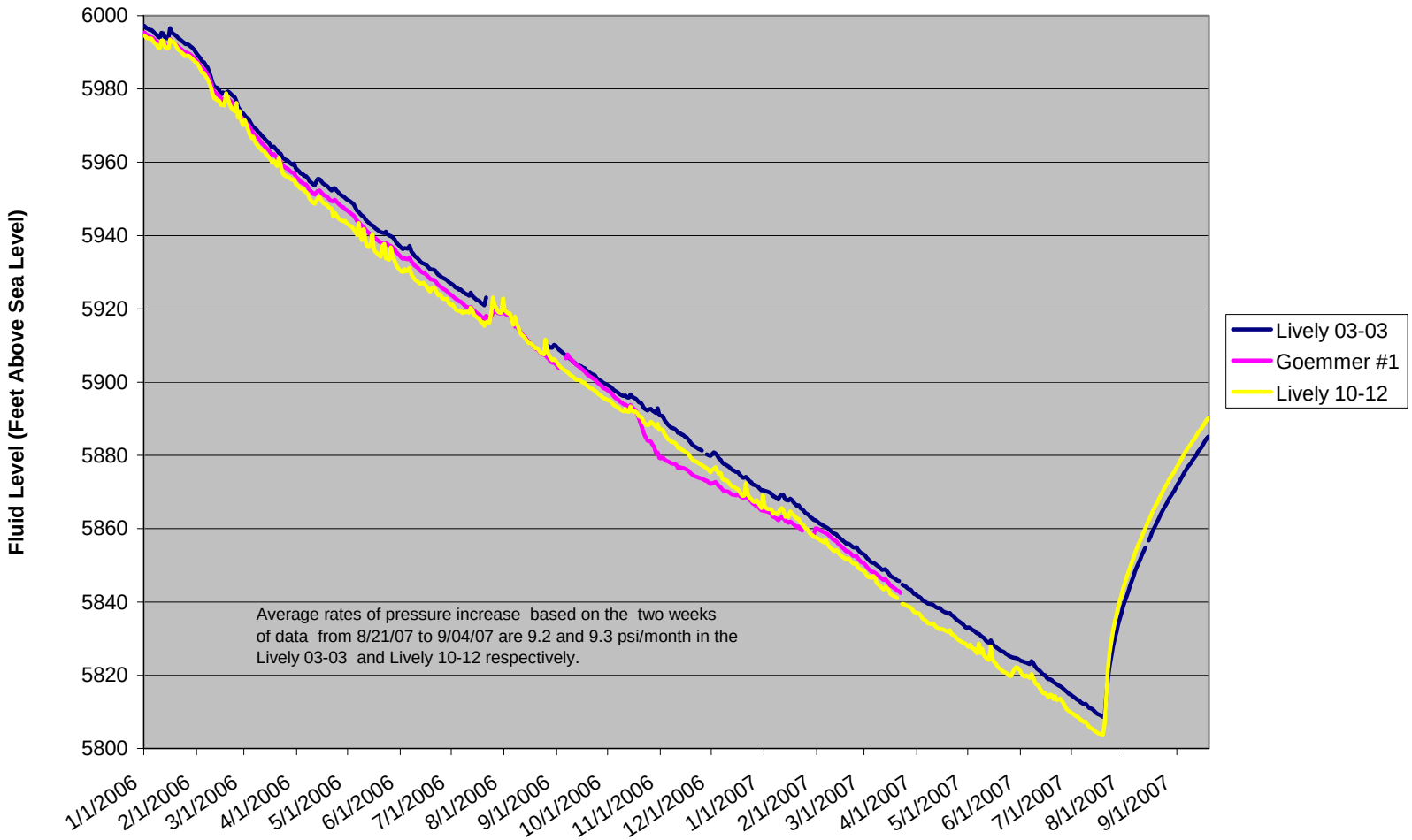
4. Water Well Monitoring a. Petroglyph will check fluid levels for select wells and install pressure transducers with recorder or data logger (as allowed by water well owners). Water delivery may be required during testing. b. Petroglyph will install gas flow meters for select wells for continuous gas monitoring or use an alternative method to estimate gas flow. c. COGCC will screen for methane in currently known impacted wells. Take initial reading at shut-in and then weekly. Include screening inside house and other structures where gas could accumulate. d. COGCC will screen for methane in other water wells in T29SR67W; Sections 1, 2, 3, 4, 9, 10, 11, 12, 14, and 15; and T28S, R67W; Sections 34, 35, and 36 but will need assistance from Petroglyph for the long-term continuation of this activity.	**4. Water Well Monitoring Results** **Bergman WW, Permit # 244403.** Petroglyph was given permission to monitor weekly. No pump in well. Installed downhole pressure gage 8/9/07. Ten days of pressure data indicate the water level is static at 317 ft below surface. COGCC is monitoring gas weekly. **Barrett WW, Permit # 257994.** Petroglyph was given permission to monitor water well. A down hole pressure gage was installed 7/20/07 before Petroglyph wells were shut-in. A down hole pressure gage was installed and recorded data from 6/2305 to 11/30/05. Since Nov 2005 well FL has dropped approx 39 ft. Four weeks of current data indicate FL is dropping 0.6 ft/month. COGCC is monitoring gas weekly. **Angely WW, Permit # 238689**. Petroglyph was given permission to install a sounding tube and monitor FL weekly. The sounding tube was installed 8/20/07. FL 475'. NAH did not want to sound well due to gas flow. COGCC monitoring gas. **Goemmer Land Company #1.** See Monitoring of Oil and Gas Wells Converted to Water Wells (Appendix B). **Burge WW, Permit # 169043.** Petroglyph has not been able to contact the Burges. **Bounds WW, Permit # 181278.** Petroglyph has made a good faith effort to negotiate an agreement with the Bounds, allowing Petroglyph to monitor FL and gas flow in their water well but has failed to do so as of 8/27/07. **Masters WW, Permit # 257113.** Petroglyph was given permission to install a sounding tube and monitor FL weekly. Waiting on Weber Water to install sounding tube. COGCC is monitoring gas weekly. Master's original water well has not been plugged per telecon. with Todd Masters. **Smith WW, Permit # 239657.** Weber Water installed well vent at Petroglyphs expense, 8/22/07. Gas flow was measured 8/23/07. Flow was 6" WC through 1" orifice, 63 mcfd. COGCC is monitoring gas weekly. Petroglyph will measure gas flow weekly or install a Barton recorder for continuous measurement. **Derowitsch WW, Permit # 252931.** Weber Water installed well vent system at Petroglyphs's expense. COGCC is monitoring gas weekly. **Coleman WW, Permit # 267694.** Petroglyph reimbursed Vince Coleman for costs associated with

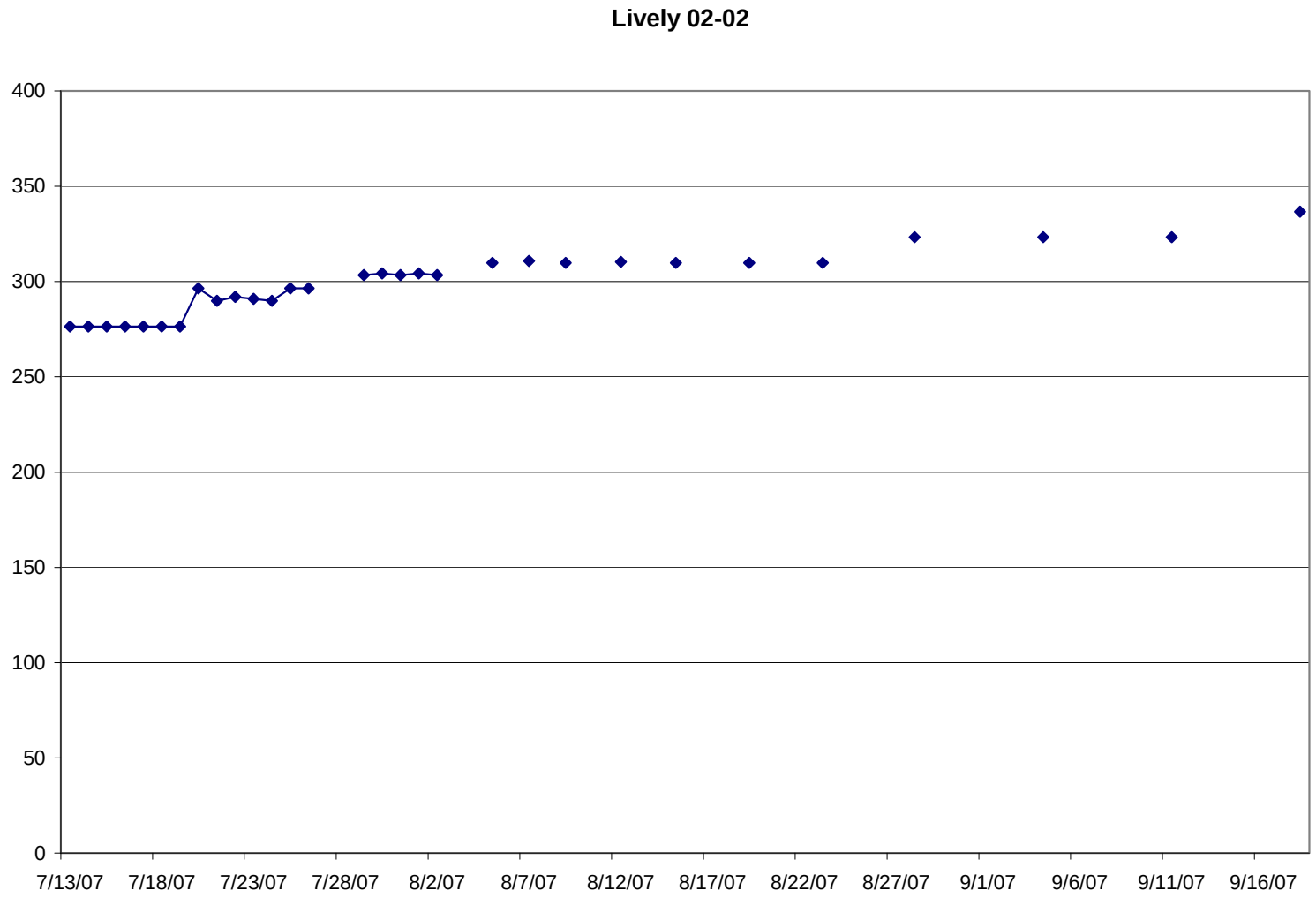
e. COGCC will review well records for the second (initial) Masters water well. This well was drilled to a depth of 700+ feet and it may never have been plugged.	installing new CBM water well pump and vent system. Petroglyph will monitor gas flow on an irregular schedule due to the Coleman's not living at their residence. Significant gas flows only after the well pump starts. COGCC is monitoring gas weekly. **Bruington WW, Permit # 210526.** This well is in the NE SE Sec 1, 28S 67W, appears to be located over an abandoned coal mine and not near the above water wells. The Bruington's contacted Petroglyph 11/6/06, informing that the well at their weekend/ vacation home went dry 10/14/06. Per the Bruingtons the well would pump water 10/14/06 but would not pump water 10/28/06. They had the well pulled and found one foot of water and gas was venting out the casing. Petroglyph inspected 11/6/06 and found well pulled, took cap off of well and could see gas vapors and checked positive with gas sniffer. Petroglyph called Mrs. Bruington and she instructed how to get to the pressure tank under the house. Petroglyph personnel shut the valve between pressure tank and house water system, opened drain valve at tank and found no water or gas. The well cap was propped open cap so gas could vent to atmosphere. On 8/16/07 Peter Gintautas (COGCC) grabbed a gas sample and estimated gas flow at over 100 mcfd. Petroglyph inspected well 8/17/07 and found well venting much more than in Nov 2006. On 8/21/07 Petroglyph installed vent system on water well. Petroglyph measured gas flow 8/22/07 at 87 mcfd gas flow through 1" orifice. Petroglyph will measure gas flow weekly. **Meyer WW, Permit # 248862.** This water well is located SW NE Sec 31 28S 66W. A down hole pressure gage was installed in this well 6/24/05. The water level has dropped approximately 17 ft. in 2 years. Petroglyph will continue monitoring water level and checking for methane. See chart in Appendix B. **Screening additional water wells for methane.** Petroglyph has contracted NAH to screen additional water wells for methane not covered by the COGCC. (See Appendix B). Permit # Owner ANDREATTA 238689 ANGELY ANSELMO (Alluvial Well #1) ANSELMO (Alluvial Well #2 Brick House) ANSELMO (open well at residence) ANSELMO (spring well)

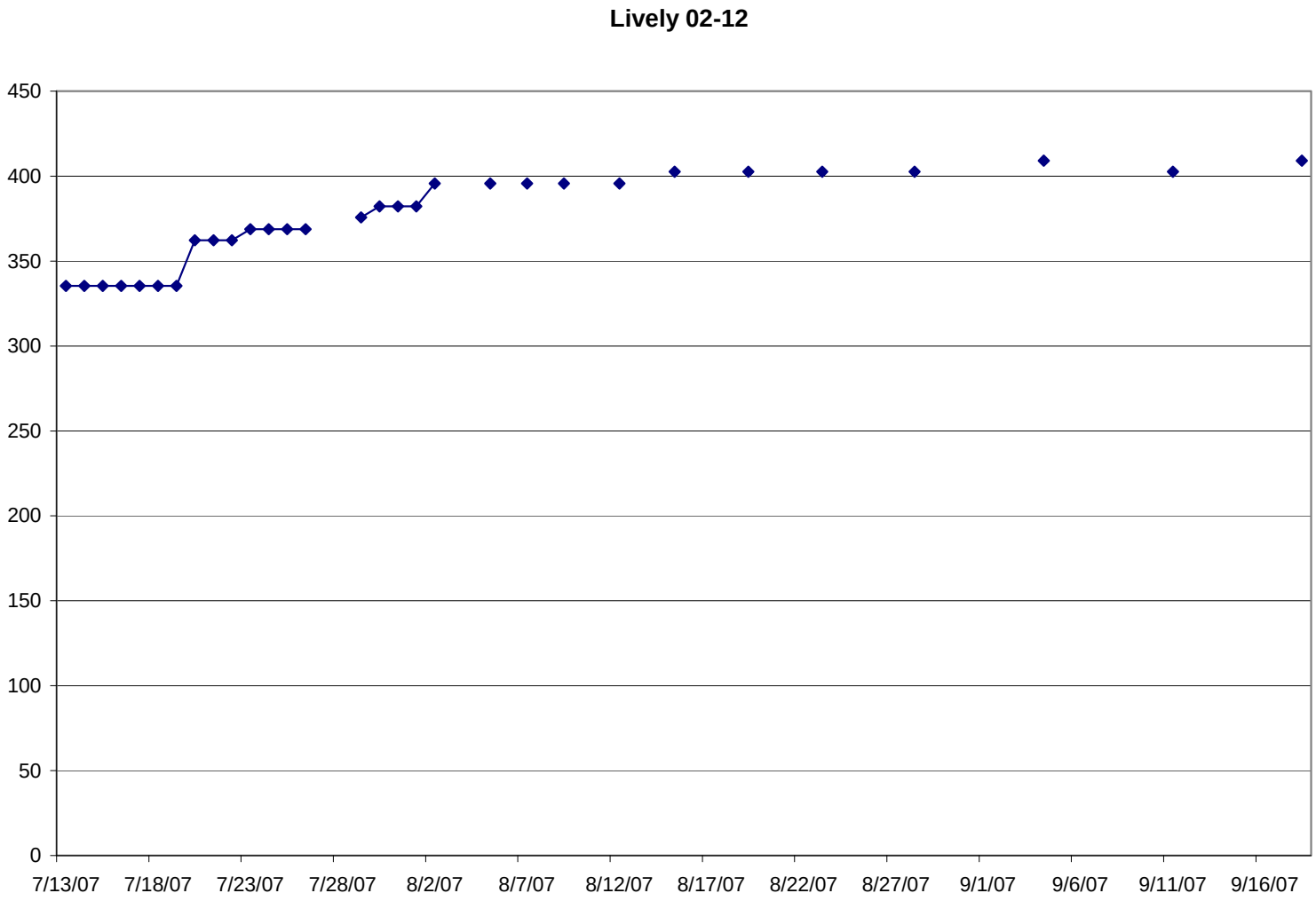
	257994 BARRETT 244403 BERGMAN BRUINGTON CAMPBELL CRAMER DALE DERNELL EVENDEN 203536 HURLEY JOHNSON LYON 257113 Masters 208708 McENTEE 248862 MEYER SALAZAR 121013 SCHAFER 239657 SMITH SNOW TOBYAS UNKNOWN UNKNOWN (near Jim Meyer) UNKNOWN (near WILLIAM TODD MASTERS) WHITE WILLIAMS/ BARTLETT • Wells will be checked weekly for methane. If the well has methane it will be checked weekly for an undetermined duration. If the well does not have methane the first week, it will be checked the second week. If still no methane is detected the wells will be checked monthly and weekly monitoring will resume if and when methane is detected. Water levels will be measured where possible.

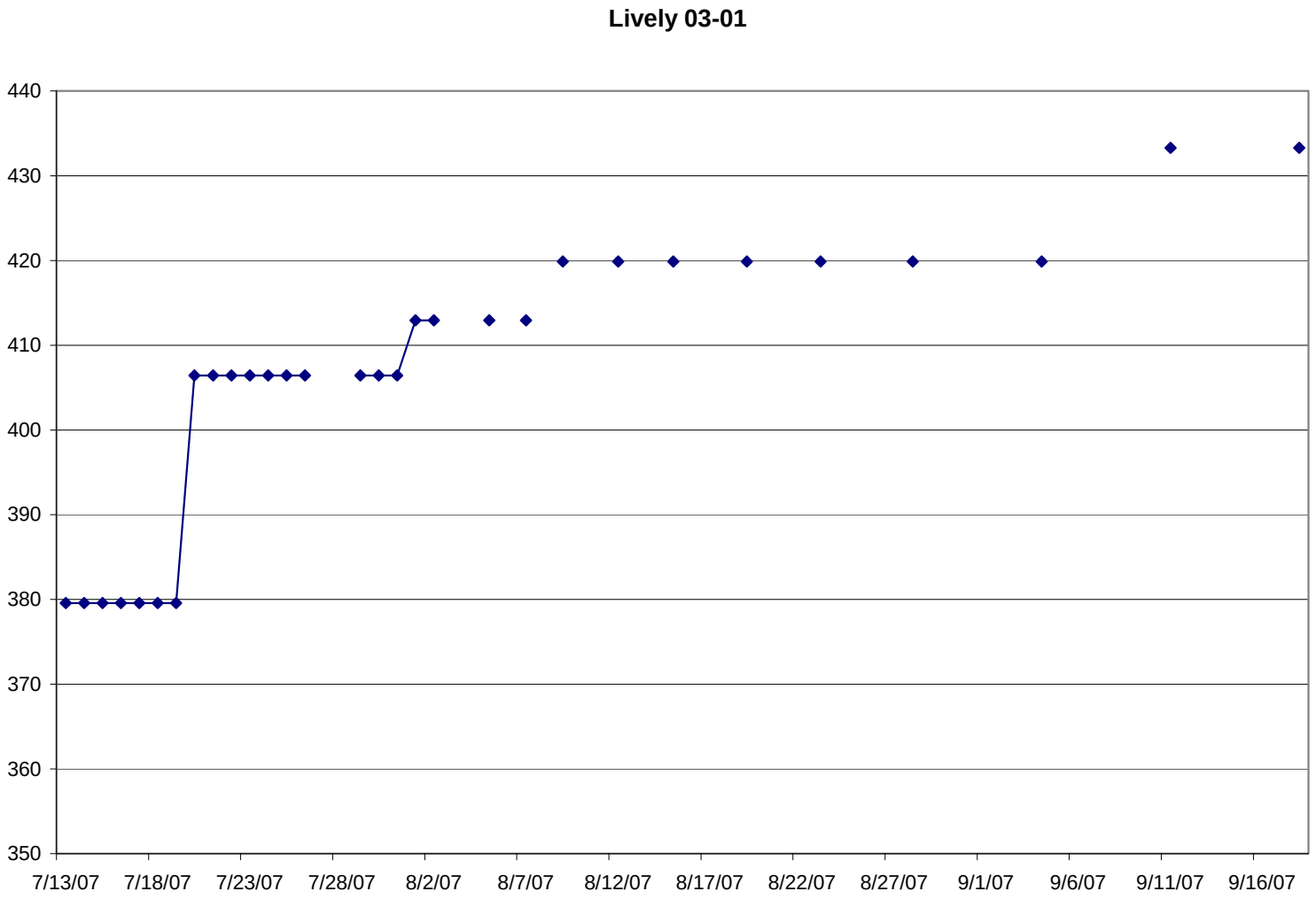
APPENDIX B

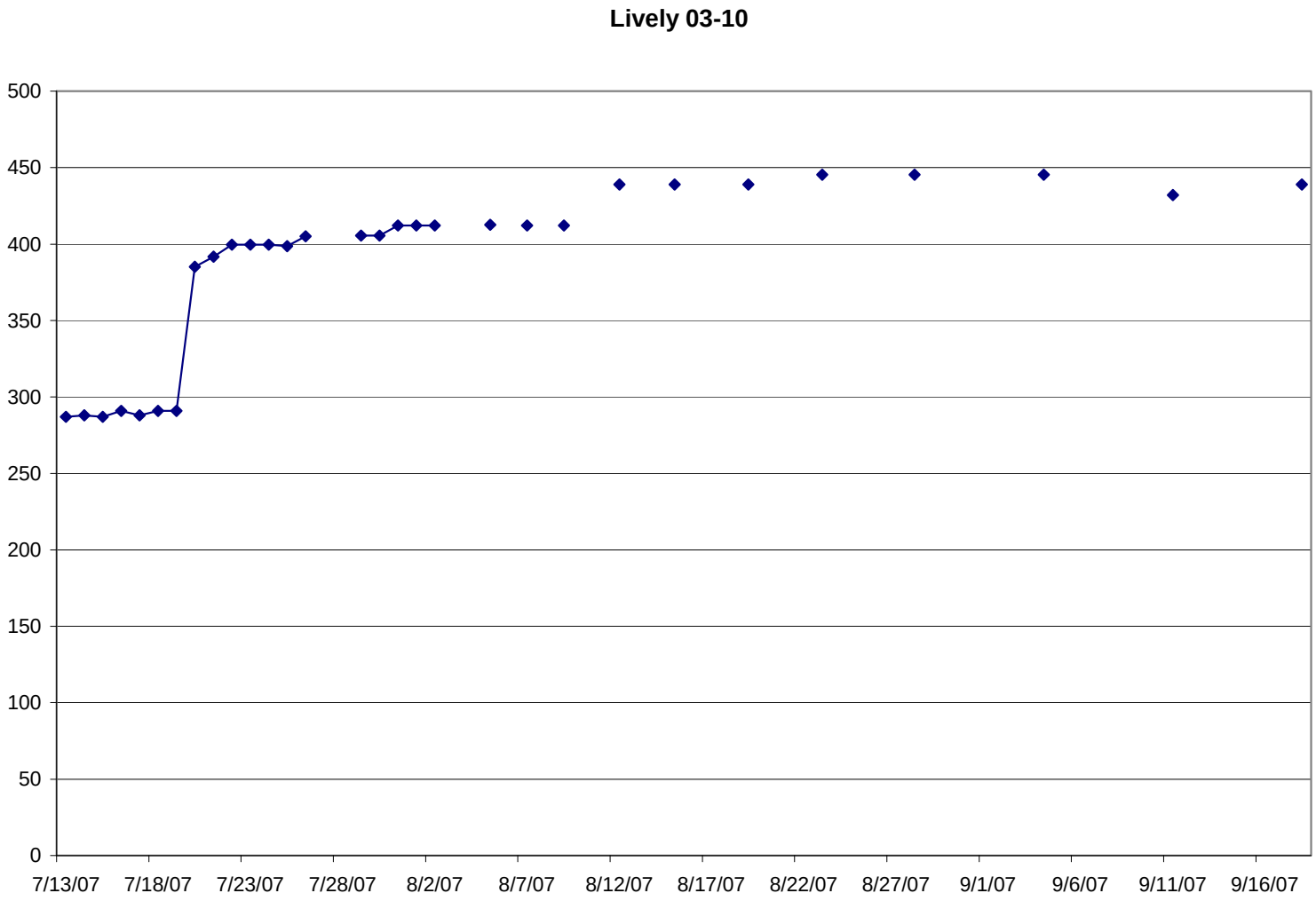
Monitor Wells Pressure Response from 1/1/06 to 9/19/07

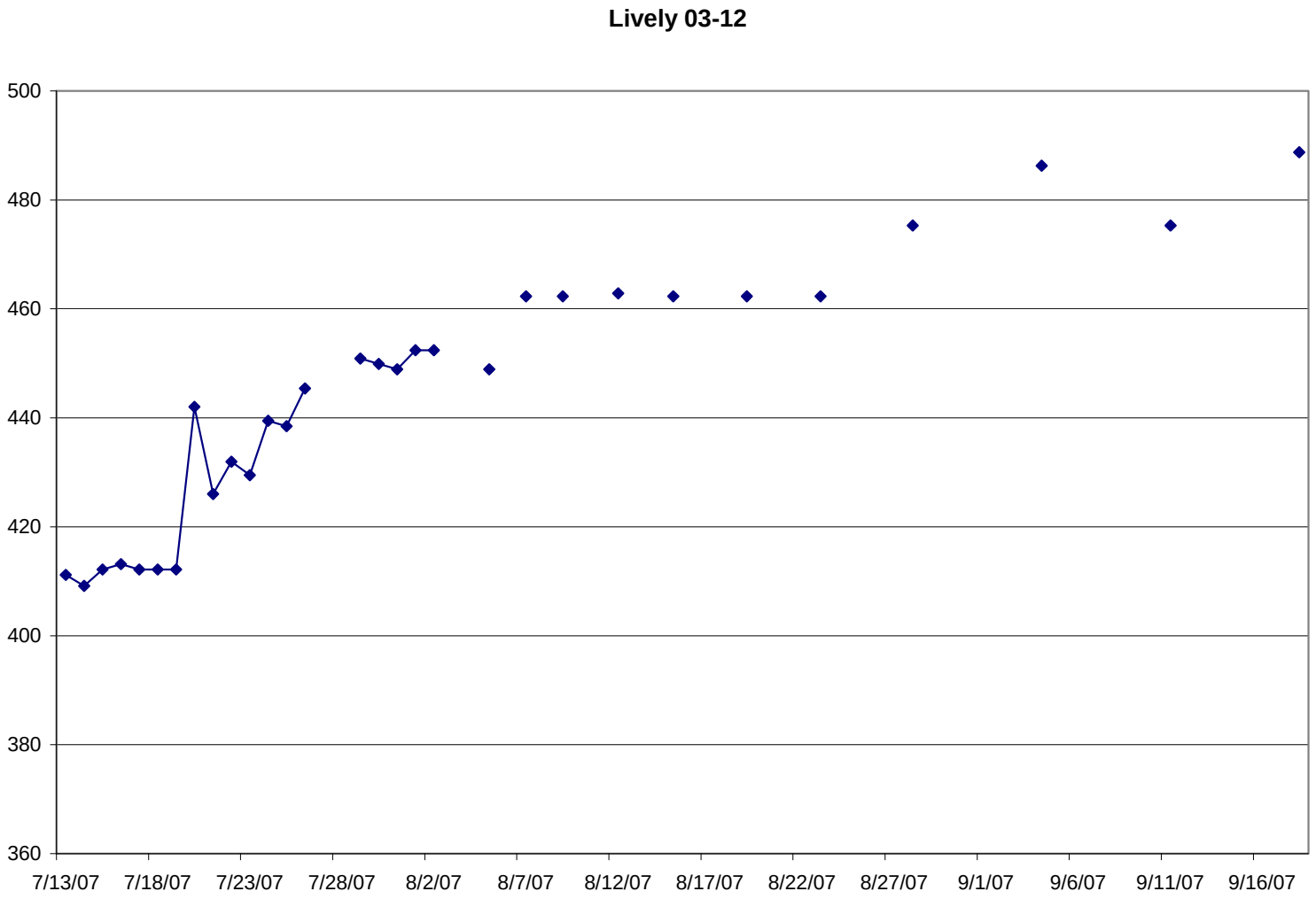


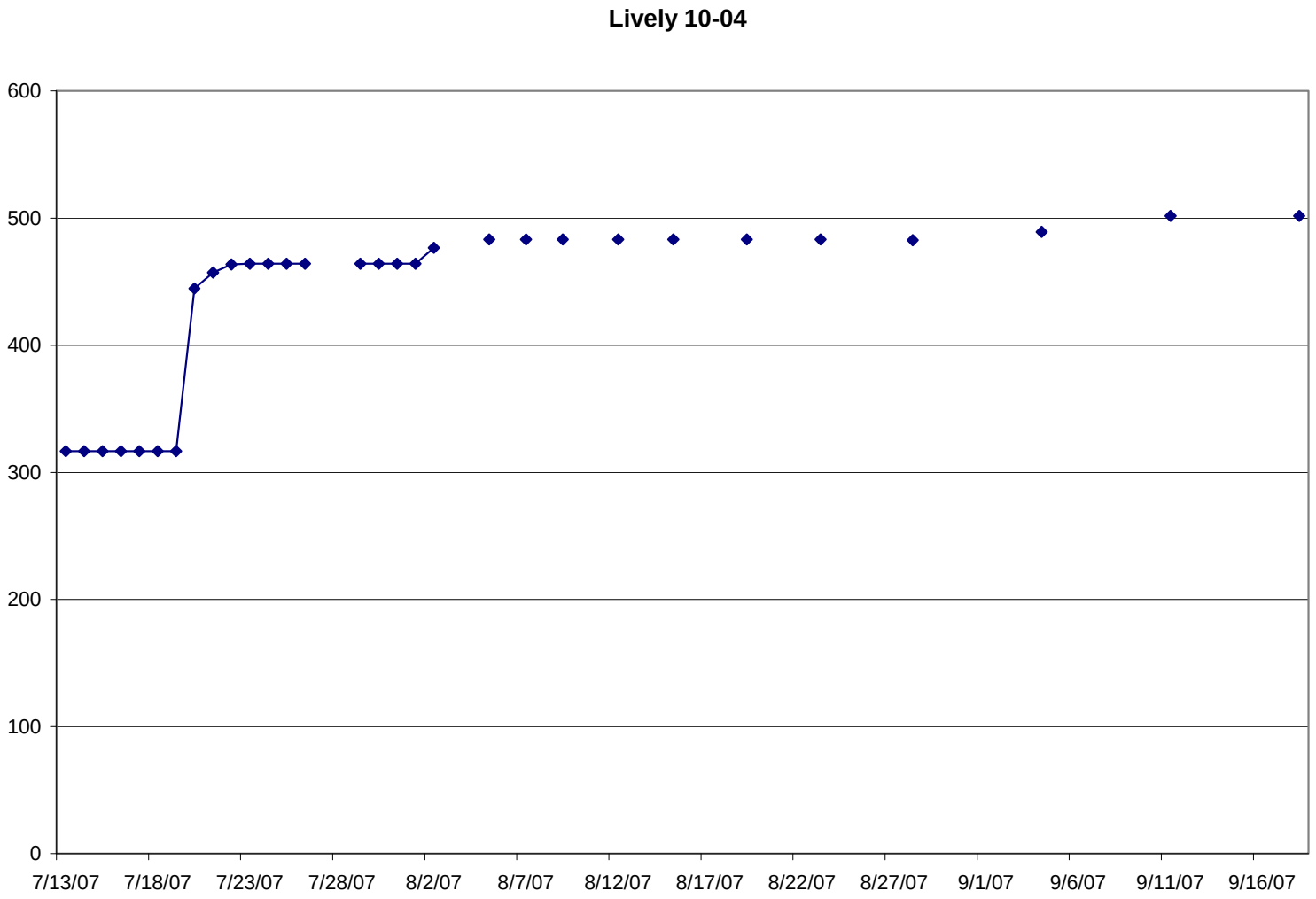

Lively 02-02
400
350
300
250
200
150
100
50
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

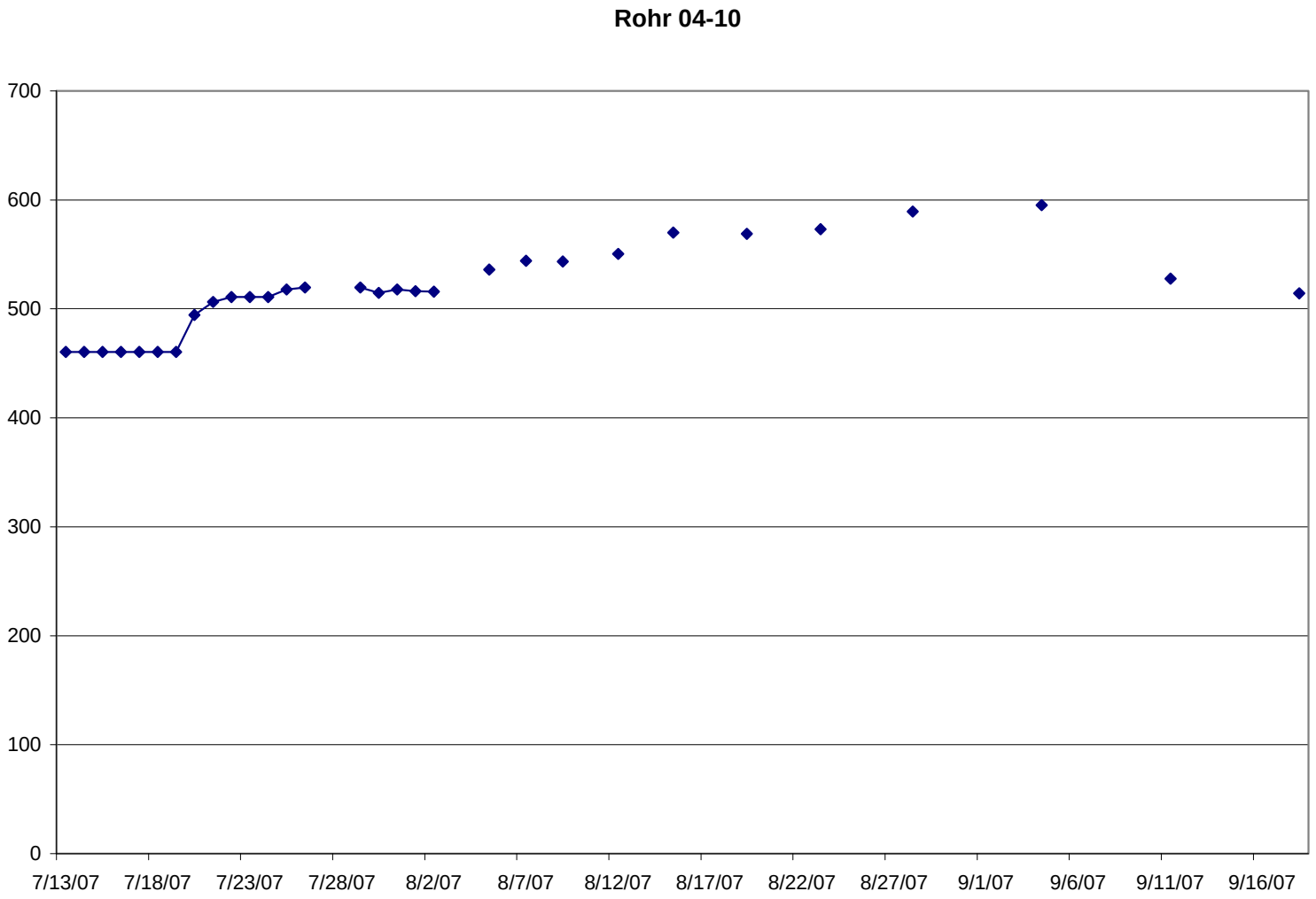

Lively 02-12
450
400
350
300
250
200
150
100
50
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

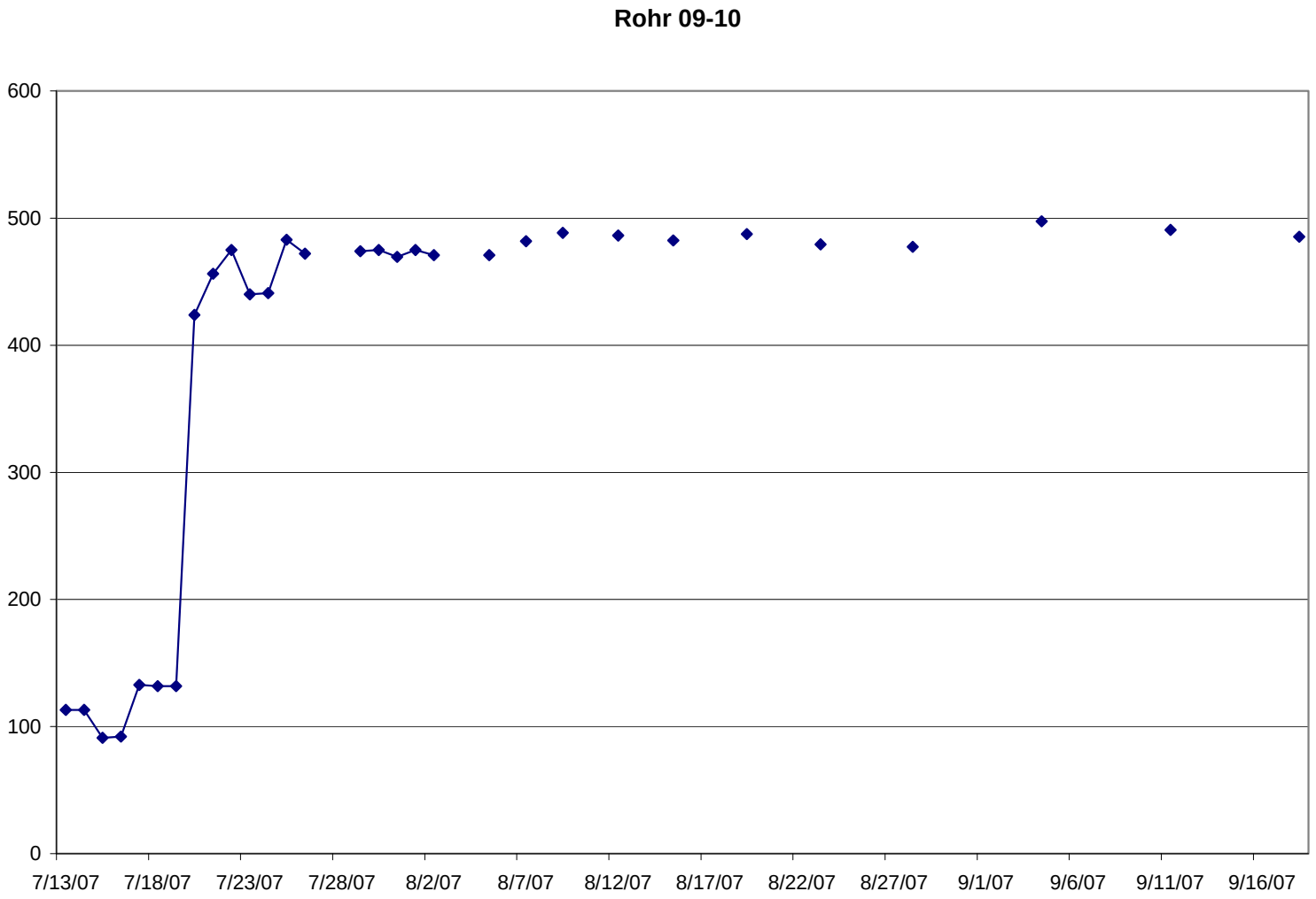

Lively 03-01
440
430
420
410
400
390
380
370
360
350
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

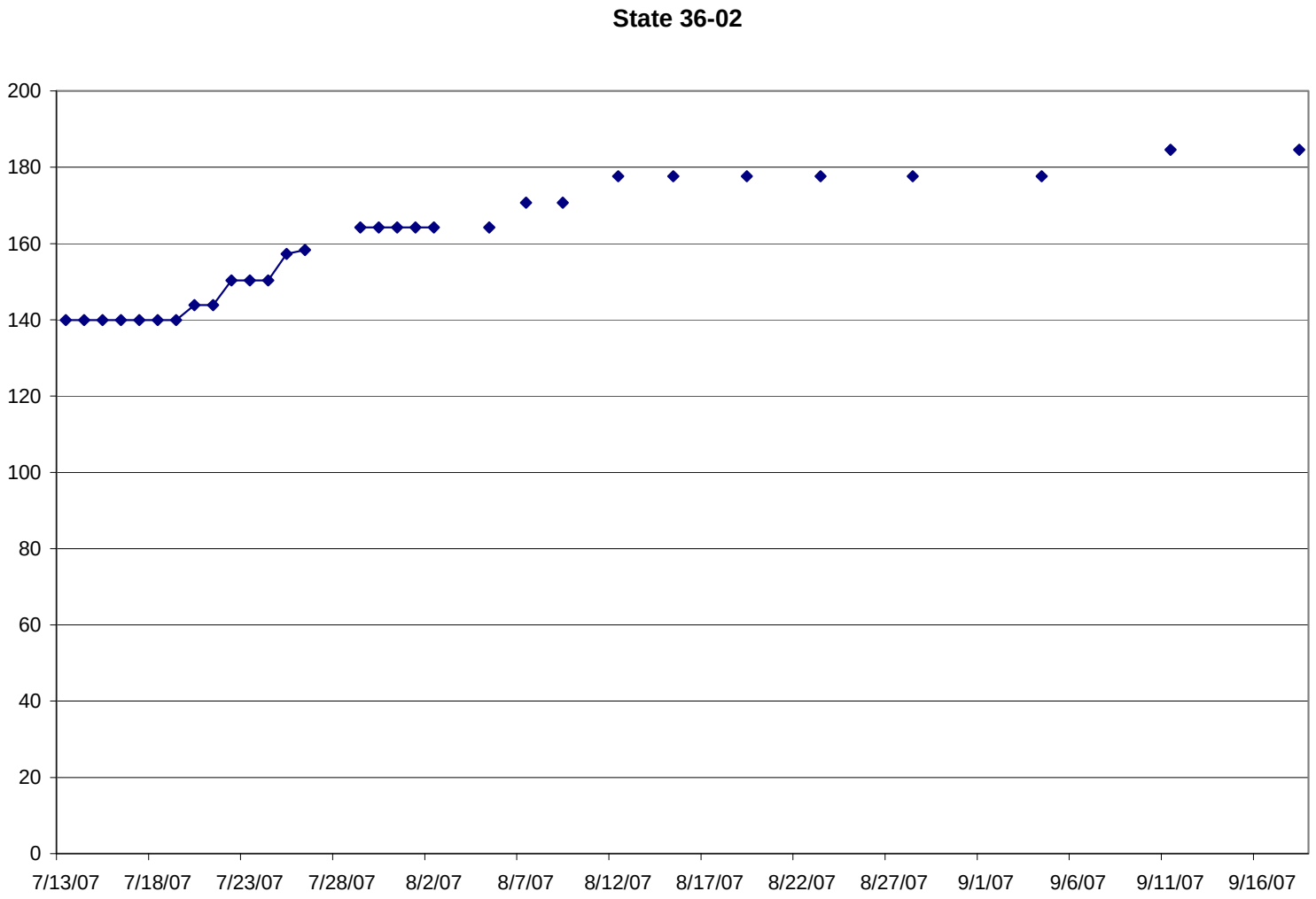

Lively 03-10
500
450
400
350
300
250
200
150
100
50
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

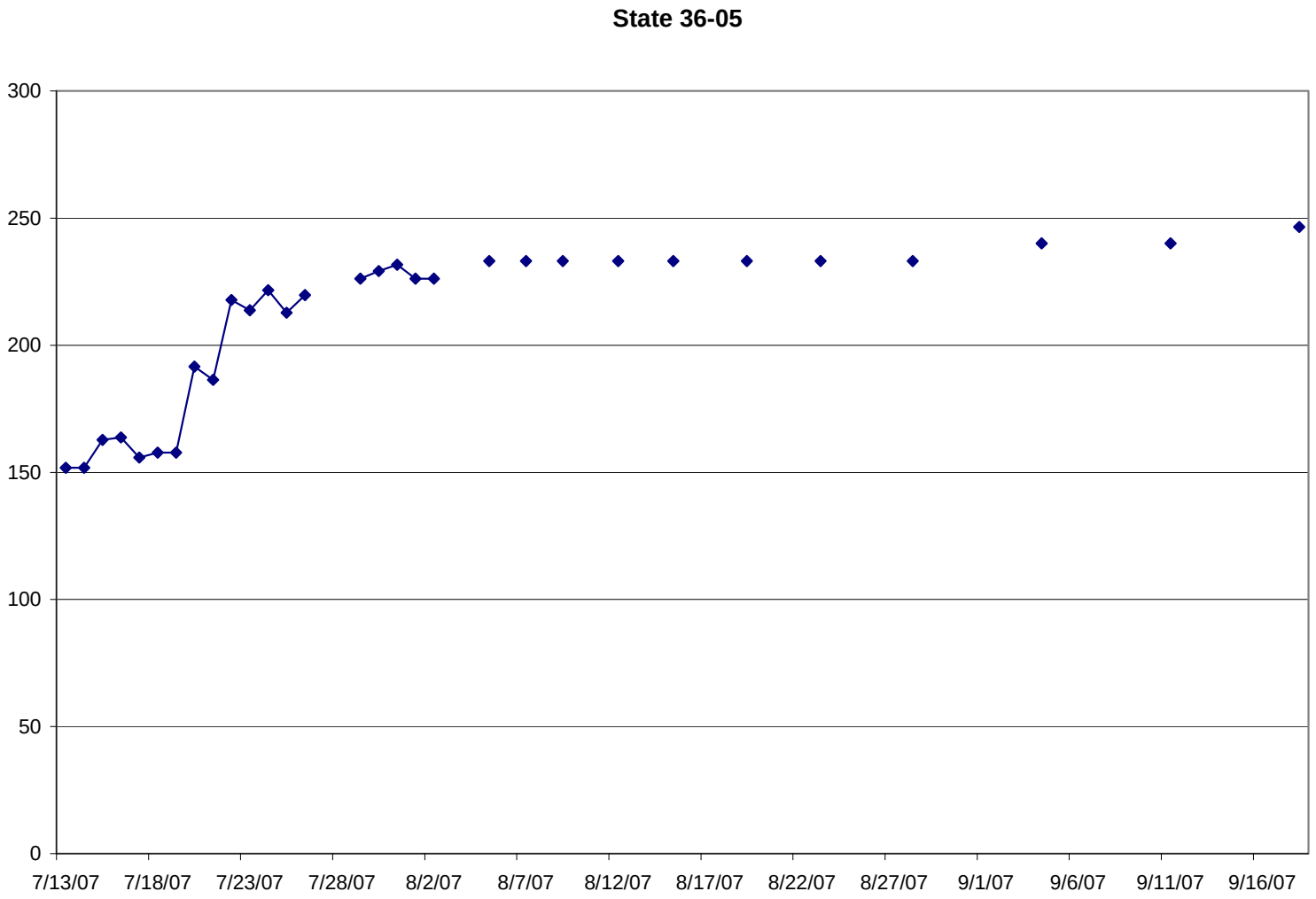

Lively 03-12
500
480
460
440
420
400
380
360
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

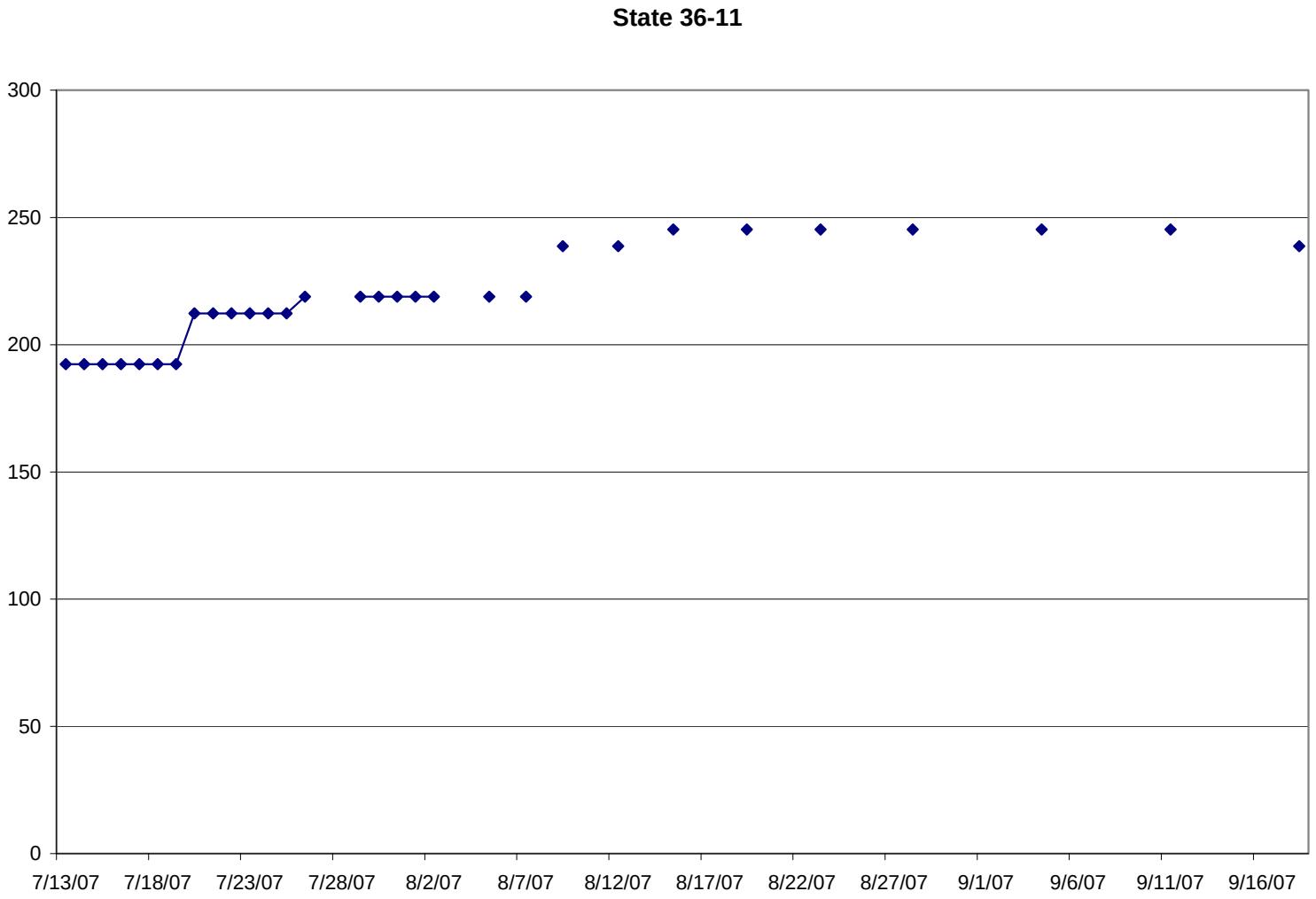

Lively 10-04
600
500
400
300
200
100
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07


Rohr 04-10
700
600
500
400
300
200
100
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

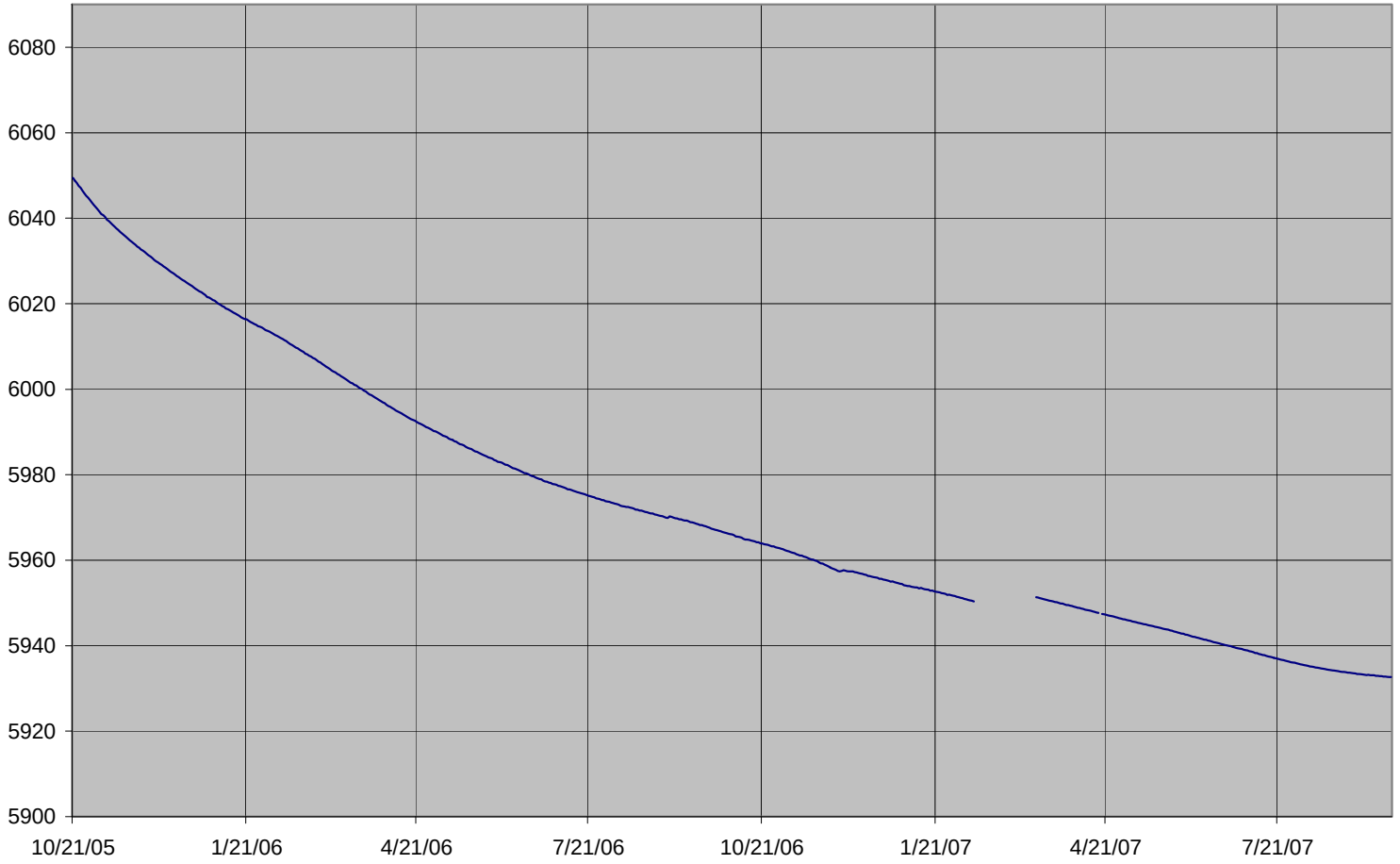

Rohr 09-10
600
500
400
300
200
100
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07


State 36-02
200
180
160
140
120
100
80
60
40
20
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

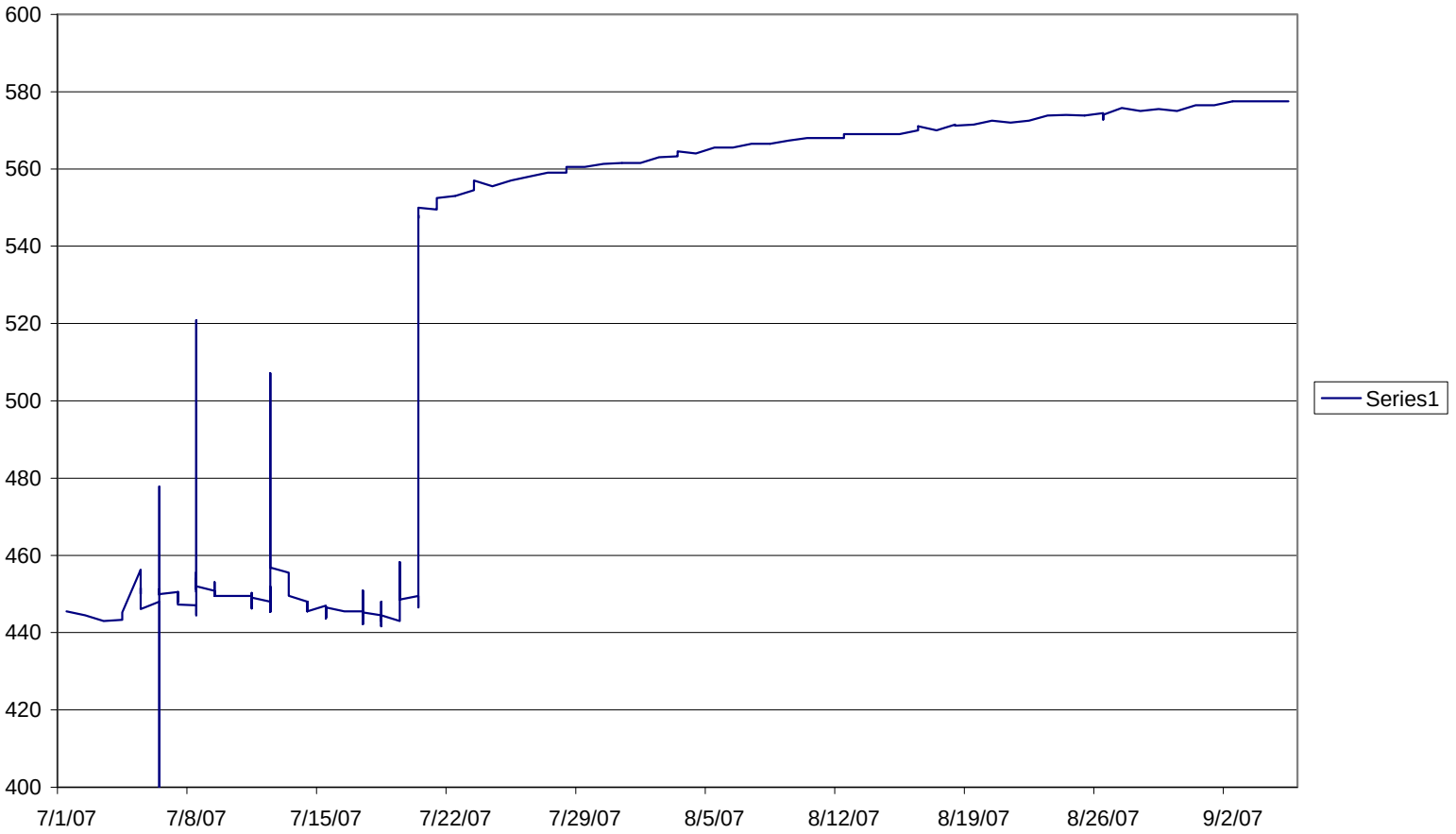

State 36-05
300
250
200
150
100
50
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07


State 36-11
300
250
200
150
100
50
0
7/13/07
7/18/07
7/23/07
7/28/07
8/2/07
8/7/07
8/12/07
8/17/07
8/22/07
8/27/07
9/1/07
9/6/07
9/11/07
9/16/07

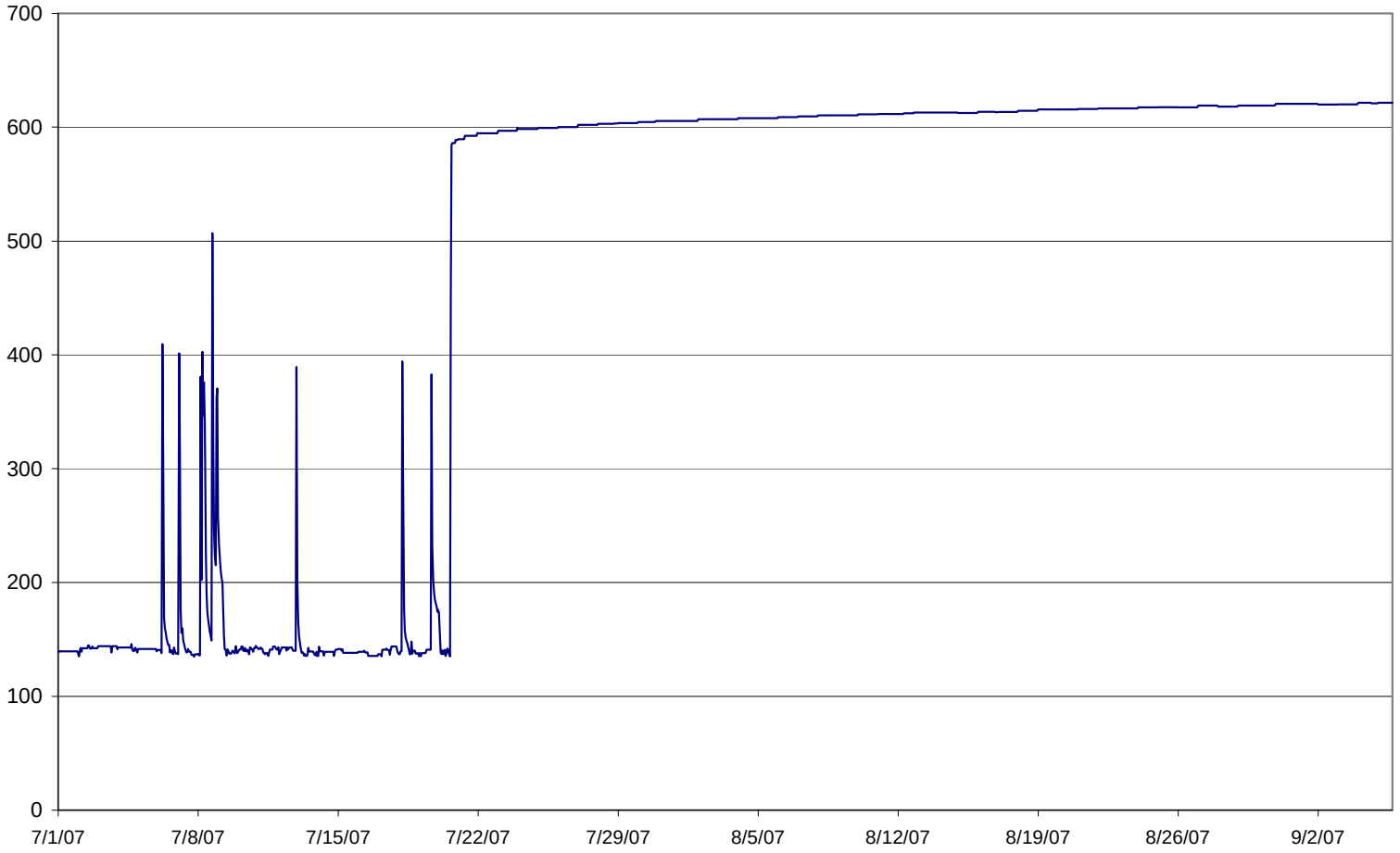
Pearson 19-16 Fl from 10/21/05 to 8/19/07



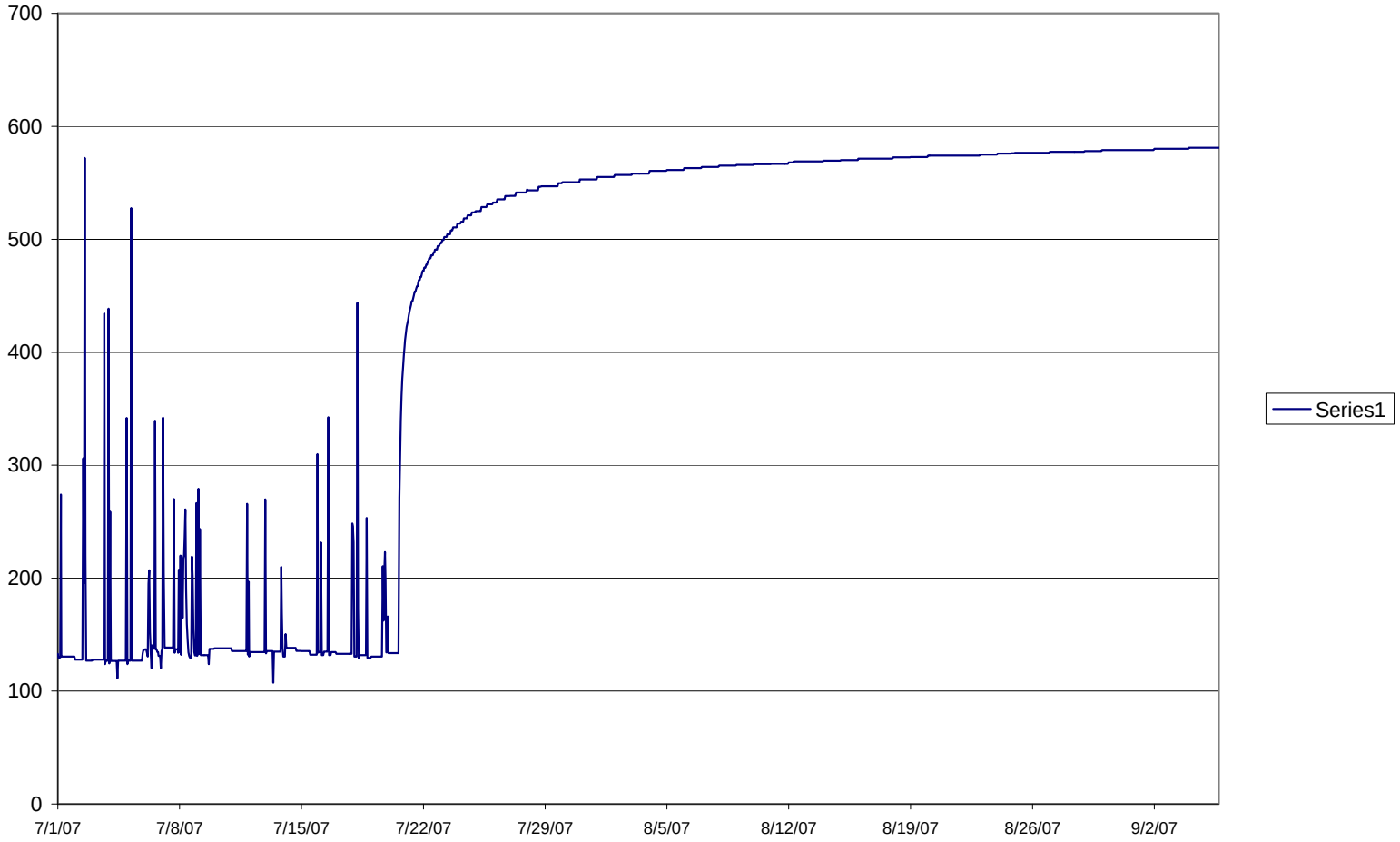
Rohr 04-14 7/1/07 to 9/5/07/07



Rohr 08-01 Bottom Hole pressure (psia) from 7/1/07 to 9/5/07



Rohr 09-04 PBU data (psia) 7/1/07 to 9/5/07



Rohr 09-05 PBU data (psia) 7/1/07 to 9/5/07