

Colorado Oil and Gas Conservation Commission

November 15, 2008

Cause No. 1, Order No. 1-C6

PETROGLYPH ENERGY INC. HUERFANO COUNTY

METHANE INVESTIGATION MITIGATION AND MONITORING PLAN

- **Introduction and Background**
- **Raton Basin Baseline 1 & 2**
- **Problems and Chronology**
- **Monitoring Well – Drilling and Testing**
- **Injection and Removal Wells**
- **Aerial Surveys and Current Monitoring**
- **Summary**
- **Acknowledgements**
- **Questions**

• Introduction and Background

1. COGCC

2. Purpose and Scope of the Meeting

3. Geology of the Area

4. Coals

5. Coal Bed Methane

6. Water wells

7. Methane

"Oil and Gas Conservation Act."

34-60-102. Legislative declaration.



“(1) It is declared to be in the public interest to foster the responsible, balanced development, production, and utilization of the natural resources of oil and gas in the state of Colorado in a manner consistent with protection of public health, safety, and welfare, including protection of the environment and wildlife resources;...”

Information Meeting

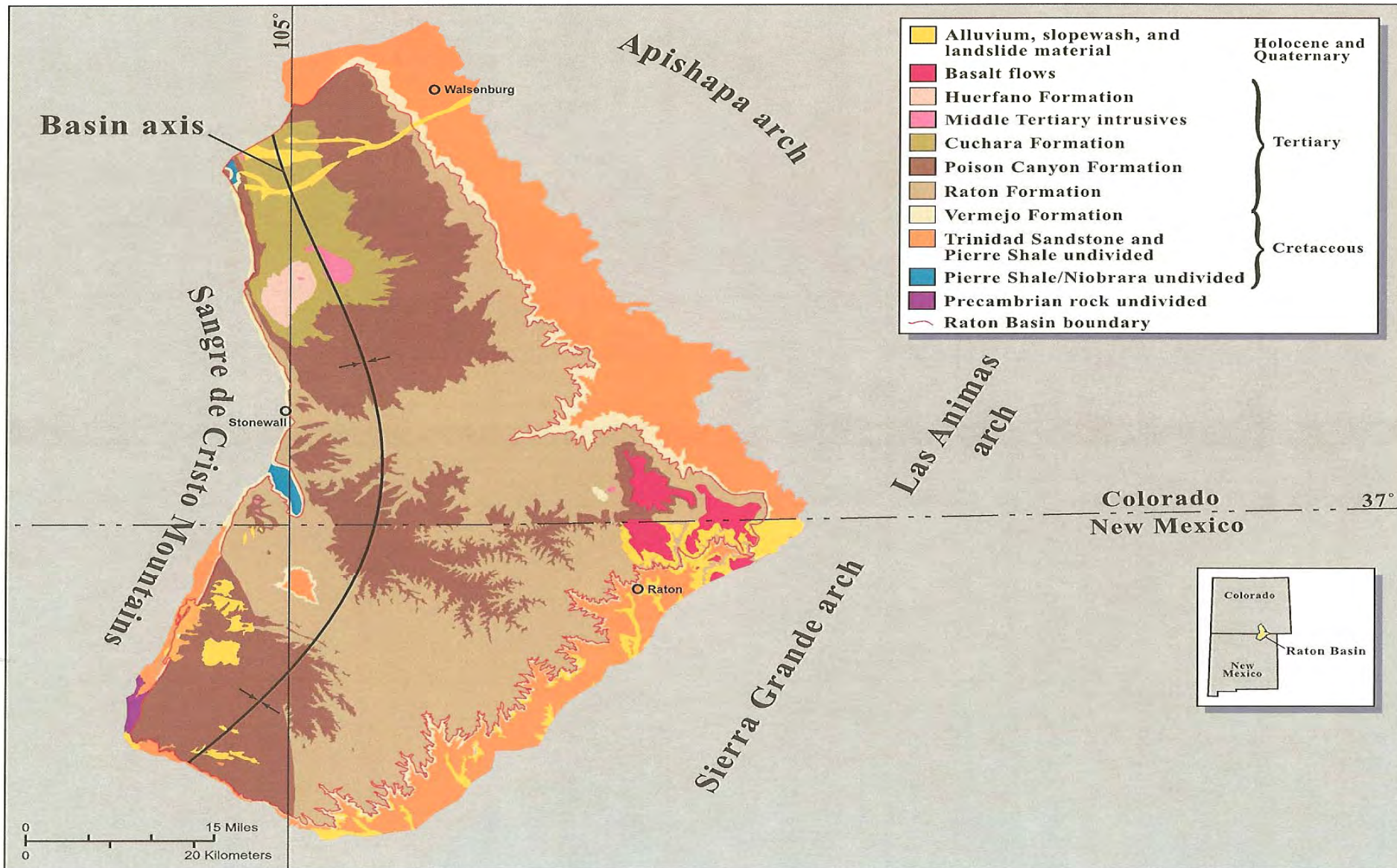
- COGCC Staff Monitoring and Investigation
- Location
- Petroglyph Voluntary Shut-in
- COGCC Cease and Desist Order
- Commission Actions Following Cease and Desist Order
- Petroglyph MIMMP Actions
- Current Status
 - Cause No. 1, Order No. 1-C6

Cause No. 1, Order 1C-6

- **Phase 1**
 - Monitoring well, extraction wells, injection wells
 - Continued monitoring of water wells
 - Outcrop aerial survey
- **Phase 2**
 - Additional water from some CBM wells
- **Phase 3**
 - CBM field in operation

Raton Basin Geology

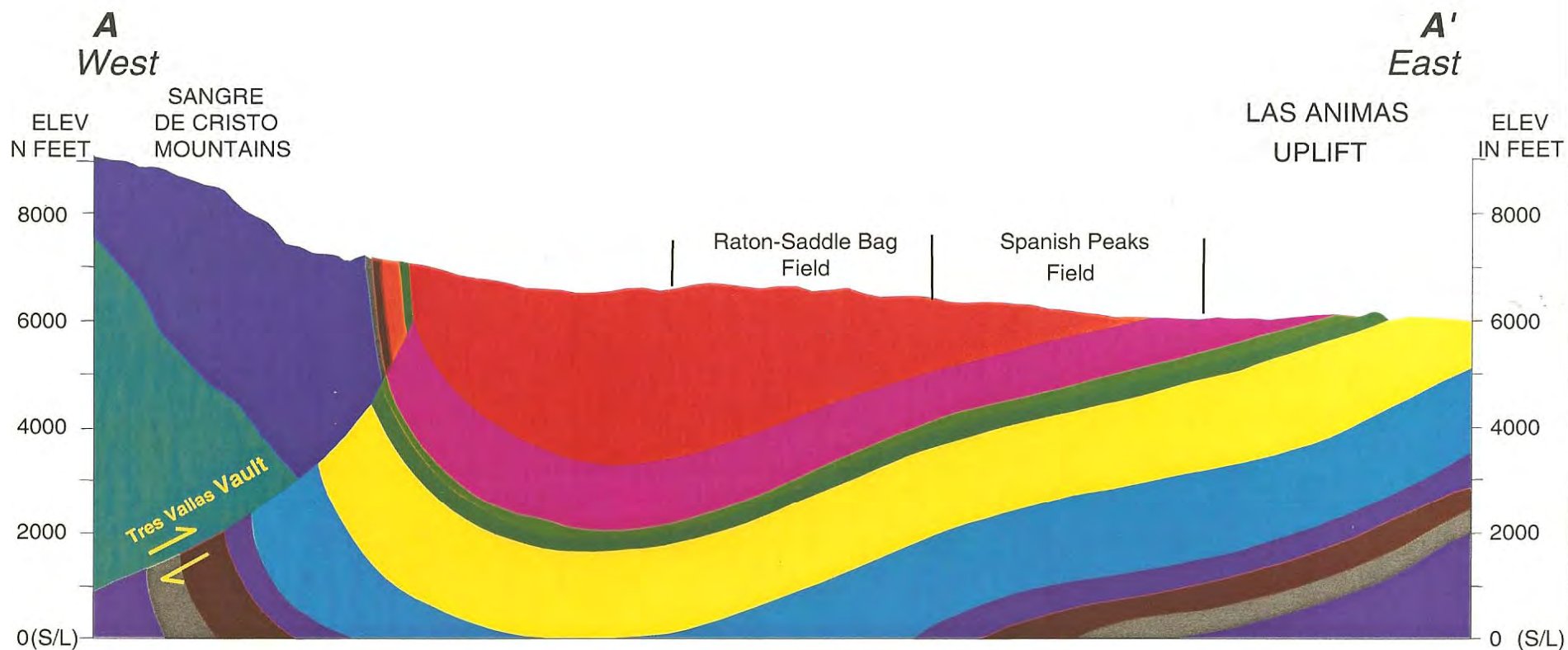
- **Location**
- **Rocks and Structure**
- **Coal**
 - **Formation**
 - **Gas Generation**















Raton Basin Stratigraphy

AGE		FORMATION NAME	GENERAL DESCRIPTION	LITHOLOGY	APPROX. THICKNESS IN FEET	
TERTIARY	PALEOCENE	POISON CANYON FORMATION	SANDSTONE—Coarse to conglomeratic beds 13–50 feet thick. Interbeds of soft, yellow-weathering clayey sandstone. Thickens to the west at expense of underlying Raton Formation		500+	
		RATON FORMATION	Formation intertongues with Poison Canyon Formation to the west UPPER COAL ZONE—Very fine grained sandstone, siltstone, and mudstone with carbonaceous shale and thick coal beds BARREN SERIES—Mostly very fine to fine-grained sandstone with minor mudstone, siltstone, with carbonaceous shale and thin coal beds LOWER COAL ZONE—Same as upper coal zone; coal beds mostly thin and discontinuous. Conglomeratic sandstone at base; locally absent		0(?)–2,100	
MESOZOIC	UPPER CRETACEOUS	VERMEJO FORMATION	SANDSTONE—Fine to medium grained with mudstone, carbonaceous shale, and extensive, thick coal beds. Local sills		← K/T boundary	0–380
		TRINIDAD SANDSTONE	SANDSTONE—Fine to medium grained; contains casts of <i>Ophiomorpha</i>			0–300
		PIERRE SHALE	SHALE—Silty in upper 300 ft. Grades upward to fine-grained sandstone. Contains limestone concretions		1800-1900	

Figure 3. Generalized stratigraphic column for Cretaceous and Tertiary rocks in the Raton Basin. From Flores and Bader (1999), modified from Pillmore (1969), Pillmore and Flores (1987), and Flores (1987).



Vertical exaggeration x 10

- | | | |
|--|--|--|
|  Poison Canyon Formation |  Pierre Shale |  Dakota Sandstone and Purgatoire formations |
|  Raton Formation |  Niobrara Formation |  Morrison Formation, Ralston Creek formation, and Entrada Sandstone |
|  Vermejo Formation |  Carlile Shale, Greenhorn Limestone, and Graneros Shale, undifferentiated |  Paleozoic undivided |
|  Trinidad Sandstone |  Pierre, Niobrara, Carlile, and Greenhorn Formations, undifferentiated |  Proterozoic granite and gneisses |



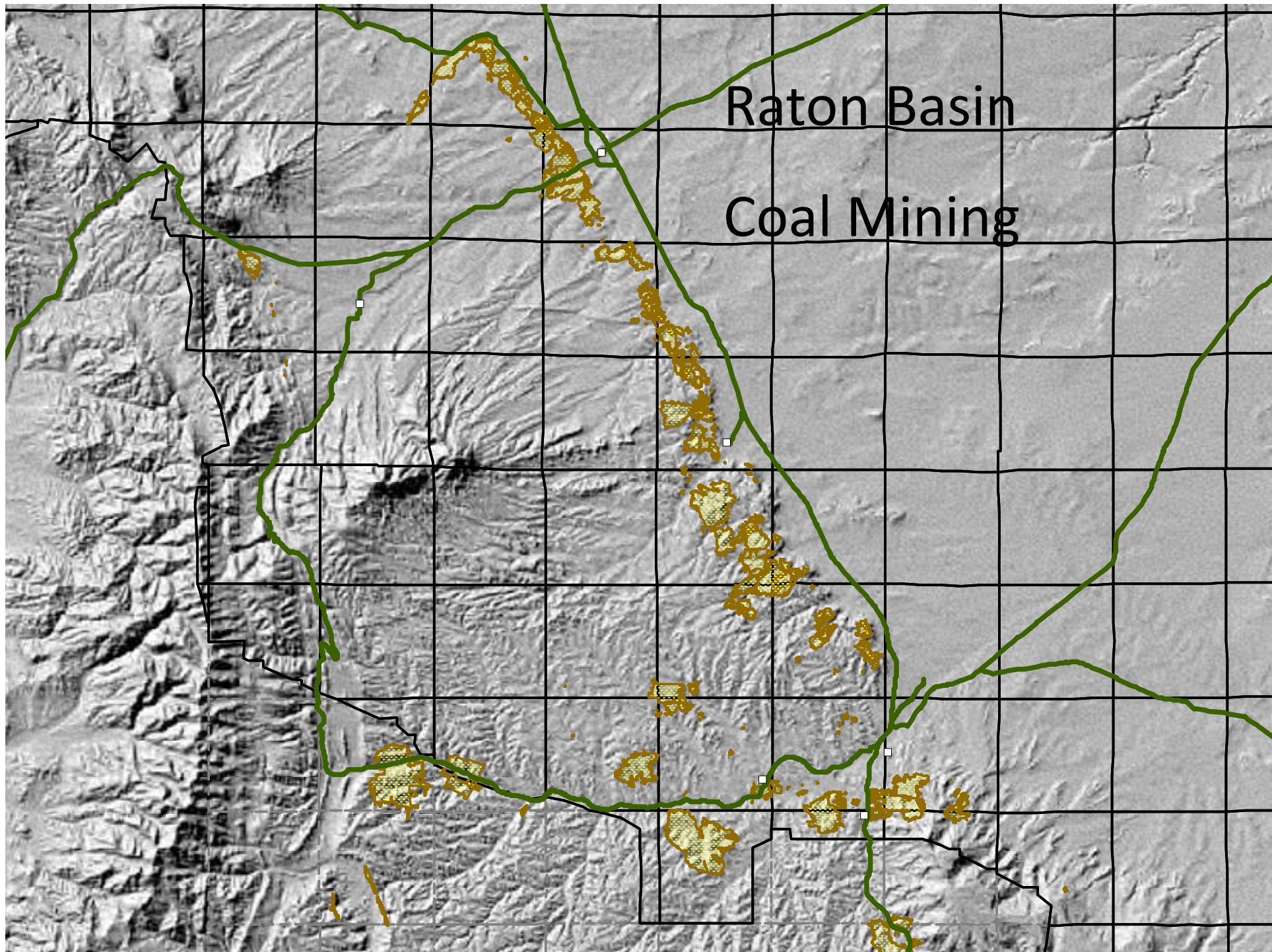
(Modified from Stevens and others, 1992)

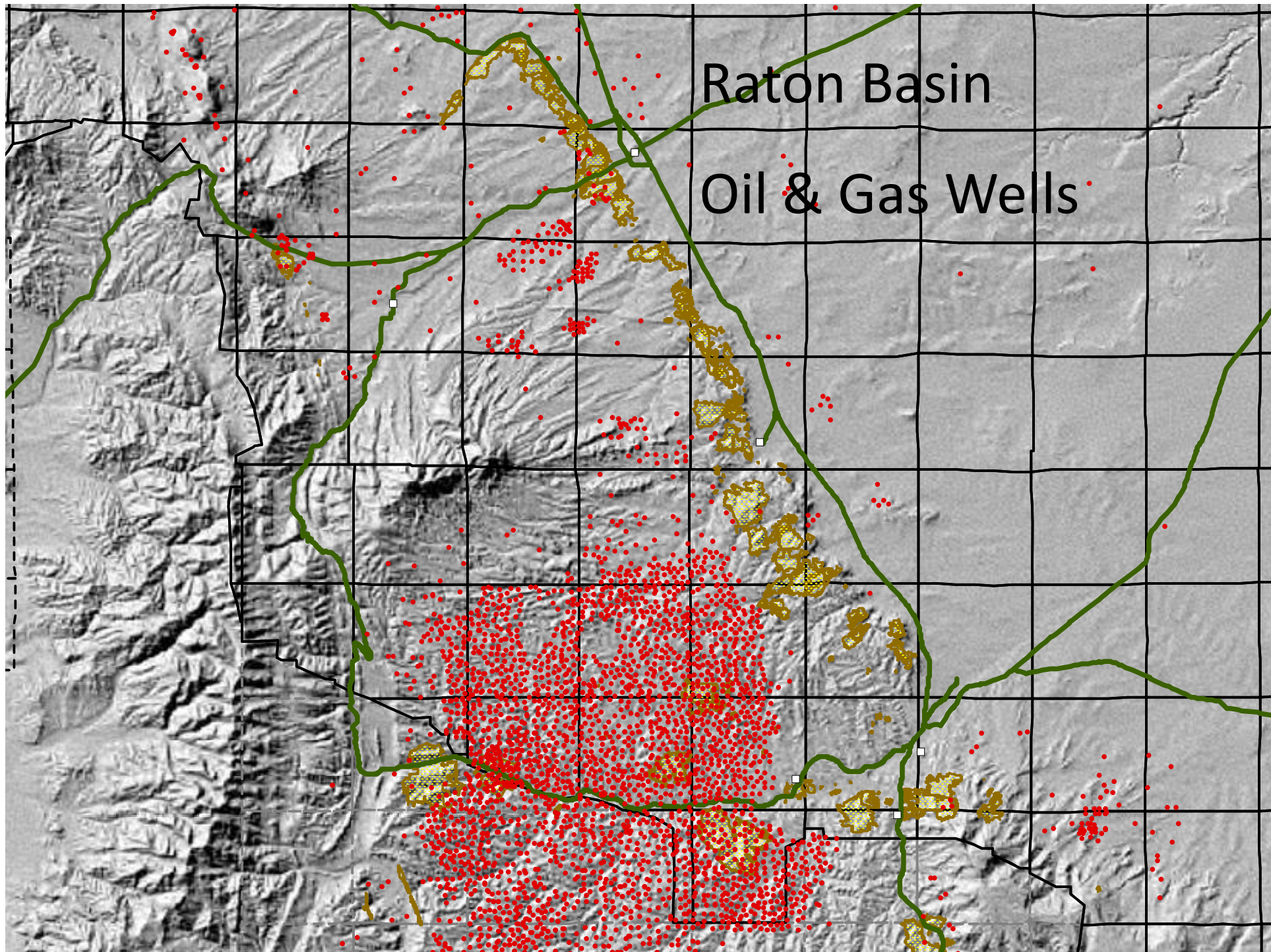
RATON BASIN CROSS-SECTION

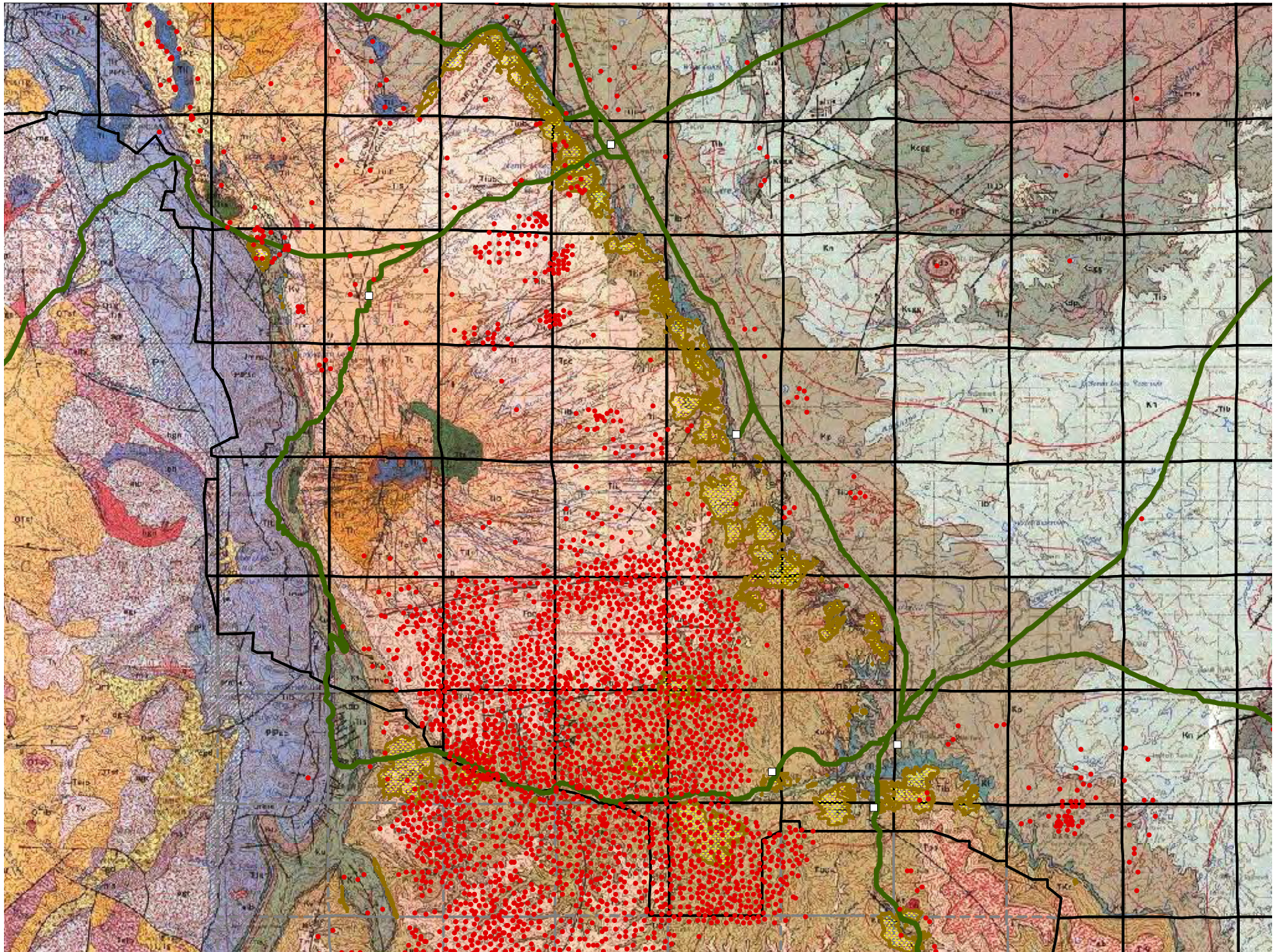


Delta Plain

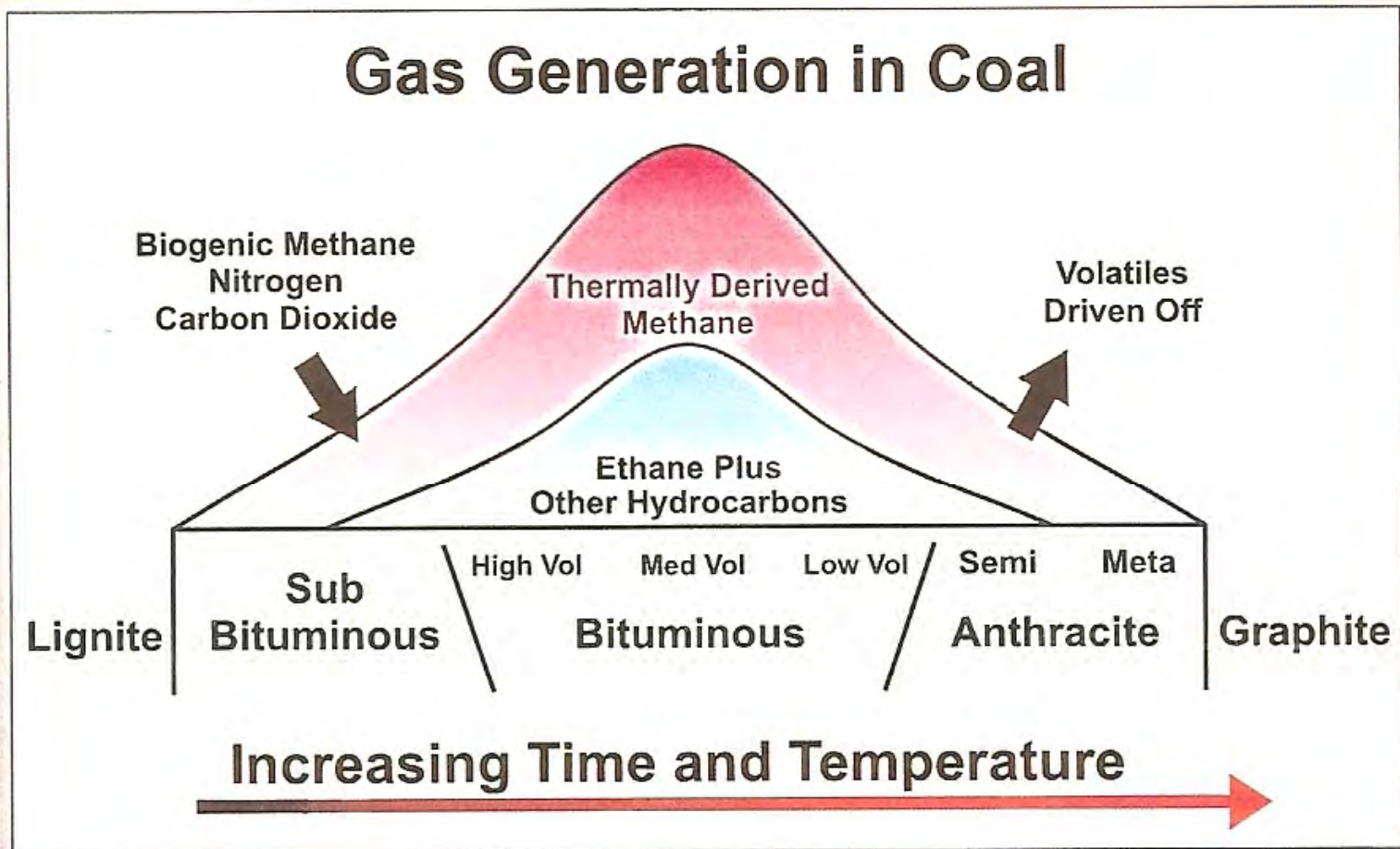








Gas Generation in Coal



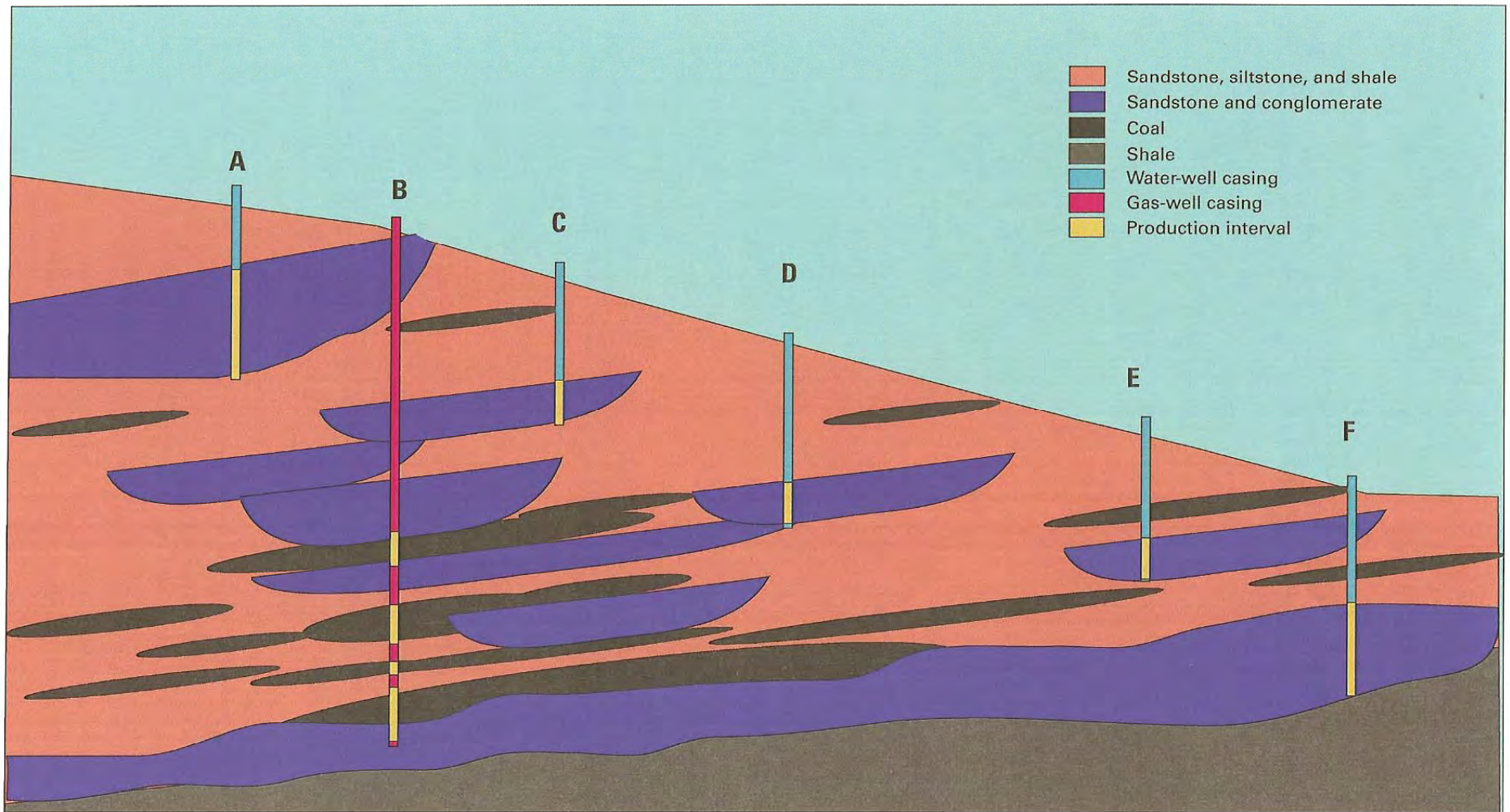
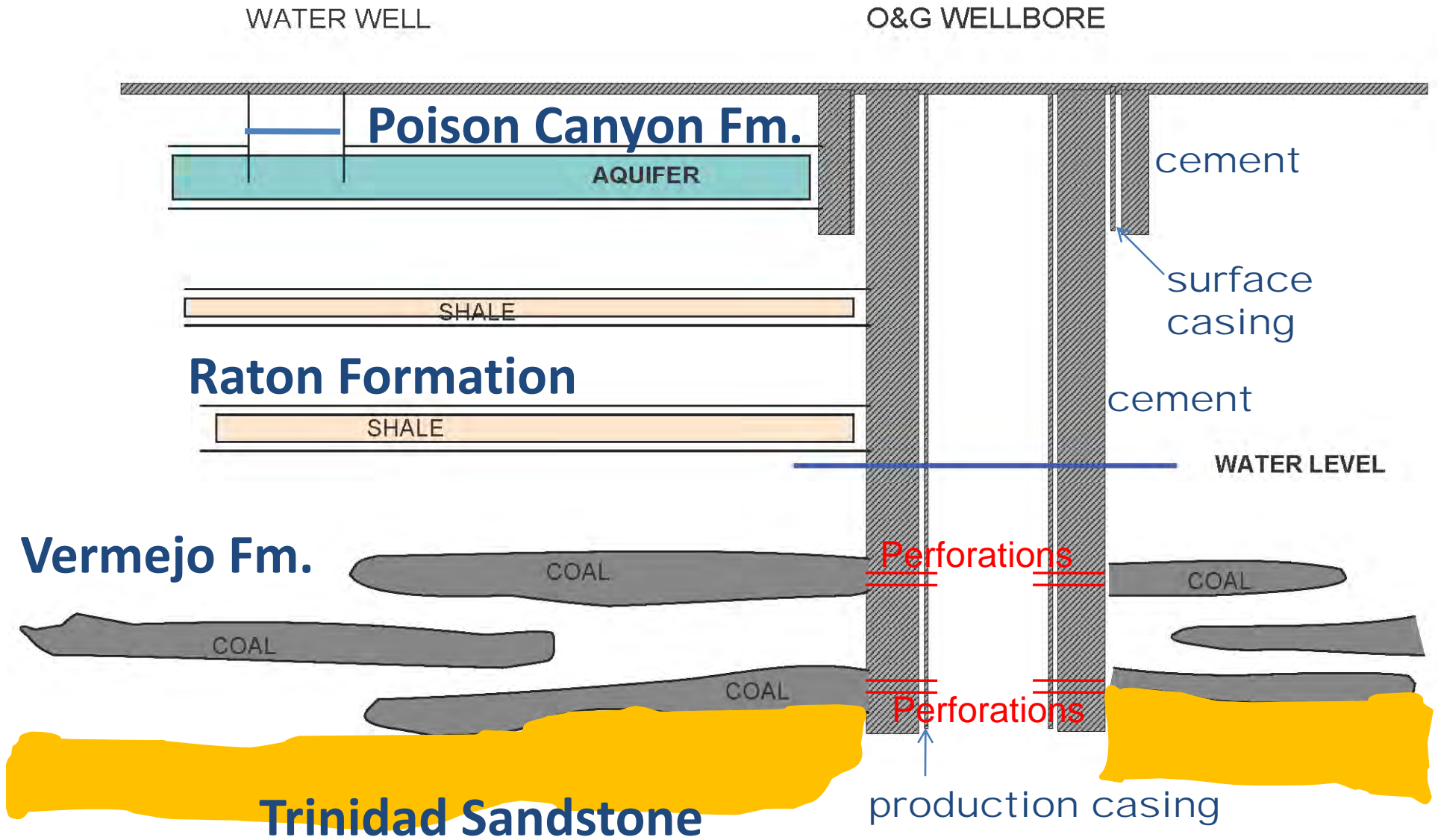
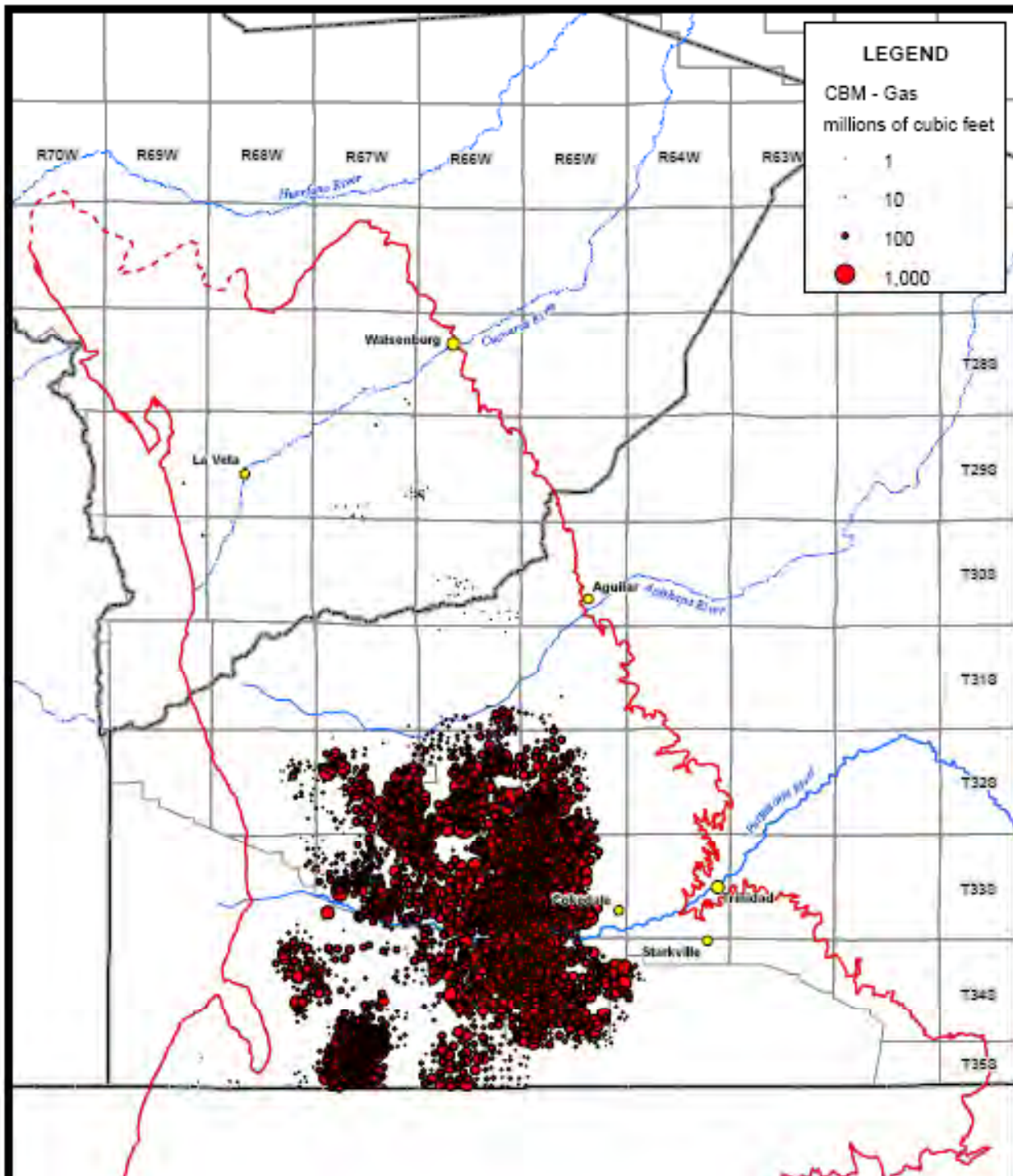


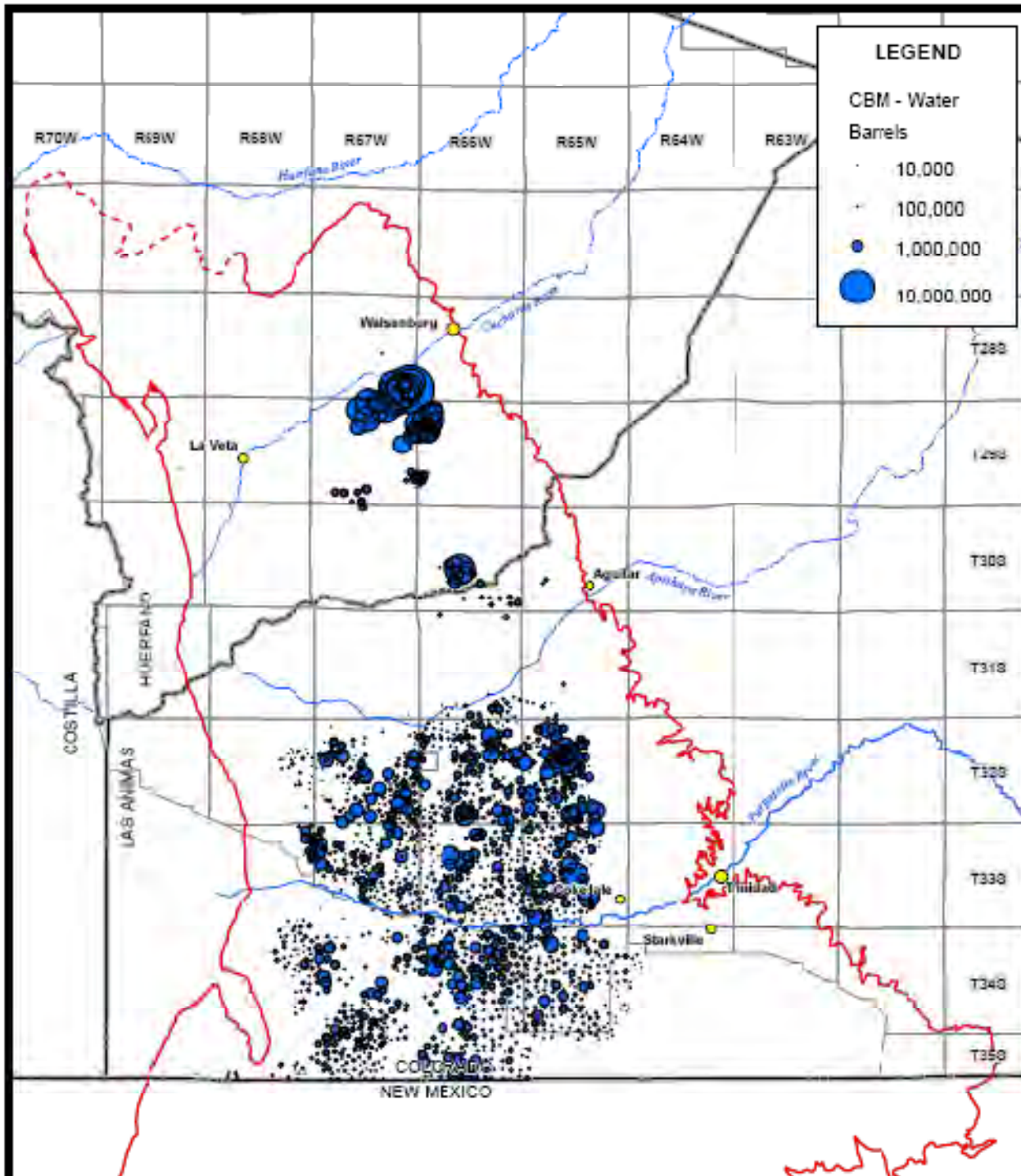
Figure 4. Hypothetical hydraulic connections between production zones of a coalbed-methane well and nearby water-supply wells.

COAL BED METHANE PRODUCTION





Cumulative Gas Production in the Raton Basin



Cumulative Water Production in the Raton Basin

Methane



Colorless and Odorless

Lighter than Air

Simple Asphyxiant

Lower Explosive Limit (LEL) about 5% in air
(50000ppm)

Water Saturated with Methane

($\approx 20\text{-}28\text{mg/l}$) depends on P, T

Lowest Concentration in Water that Could
Theoretically Result in Buildup of Methane in
Confined Space to LEL and Possibly Result in
Explosion 1.1mg/L

- COGCC Raton Basin Baseline



- Phase 1

- 2001-2002

- seep survey

- water well & gas well samples

- Phase 2

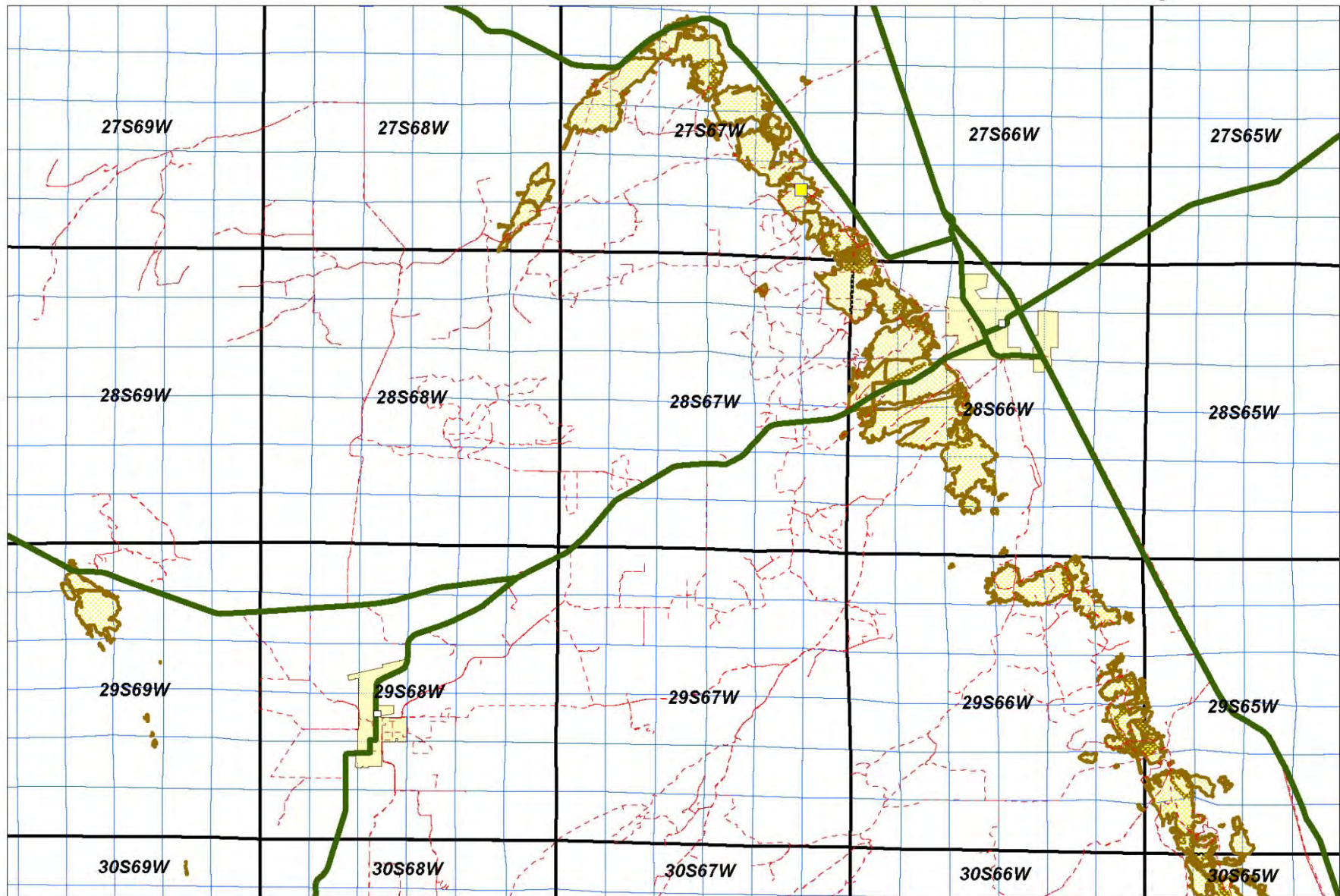
- 2007

- seep survey

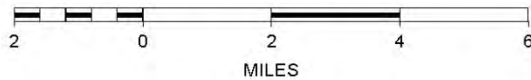
- soil gas & water well samples

- seep mapping & flux

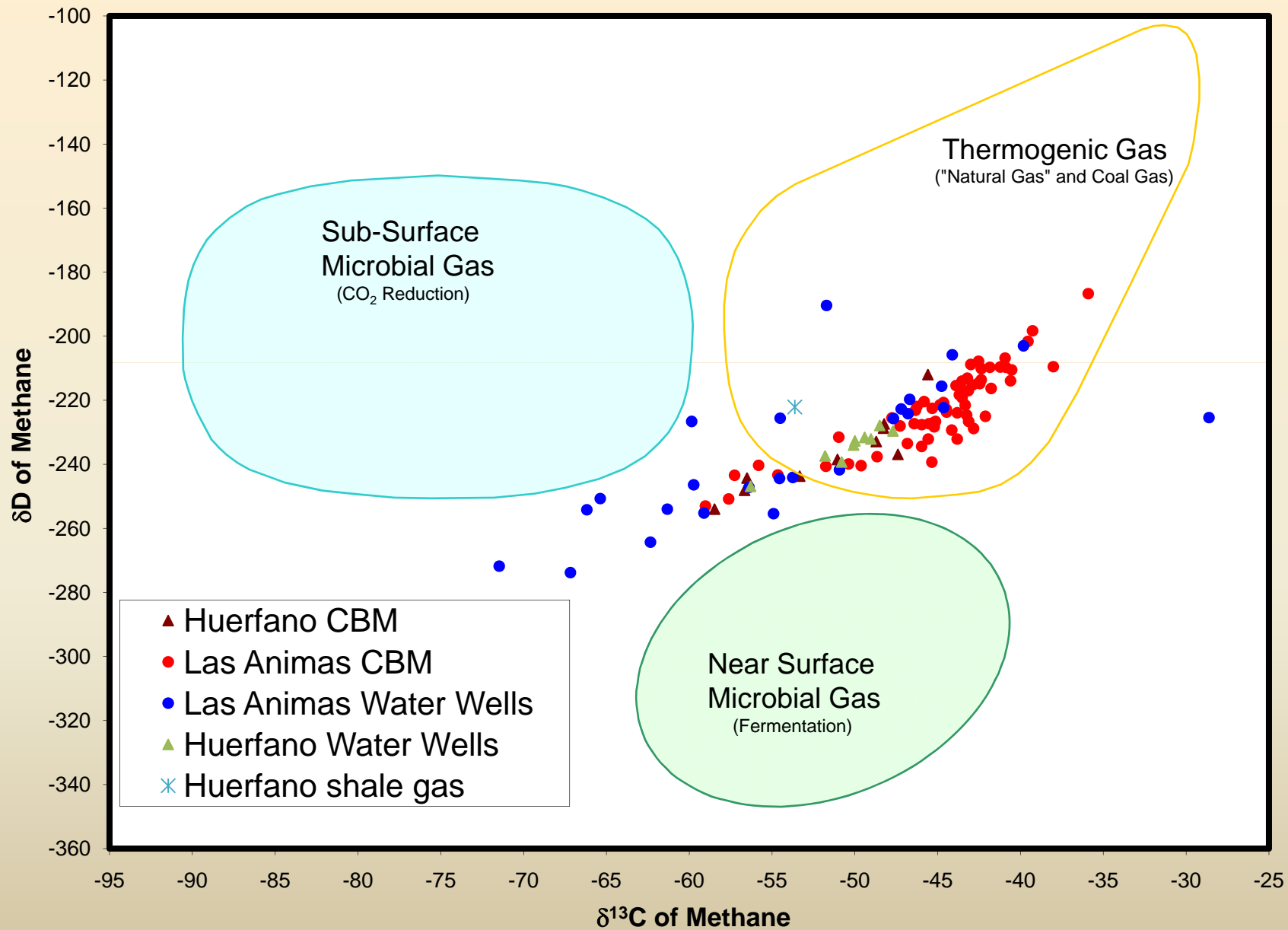
Northern Raton Basin 2001-2 Seep Survey



SCALE 1 : 167,246



Typical Compositional Ranges of Methanes from Different Sources in Huerfano and Las Animas Counties

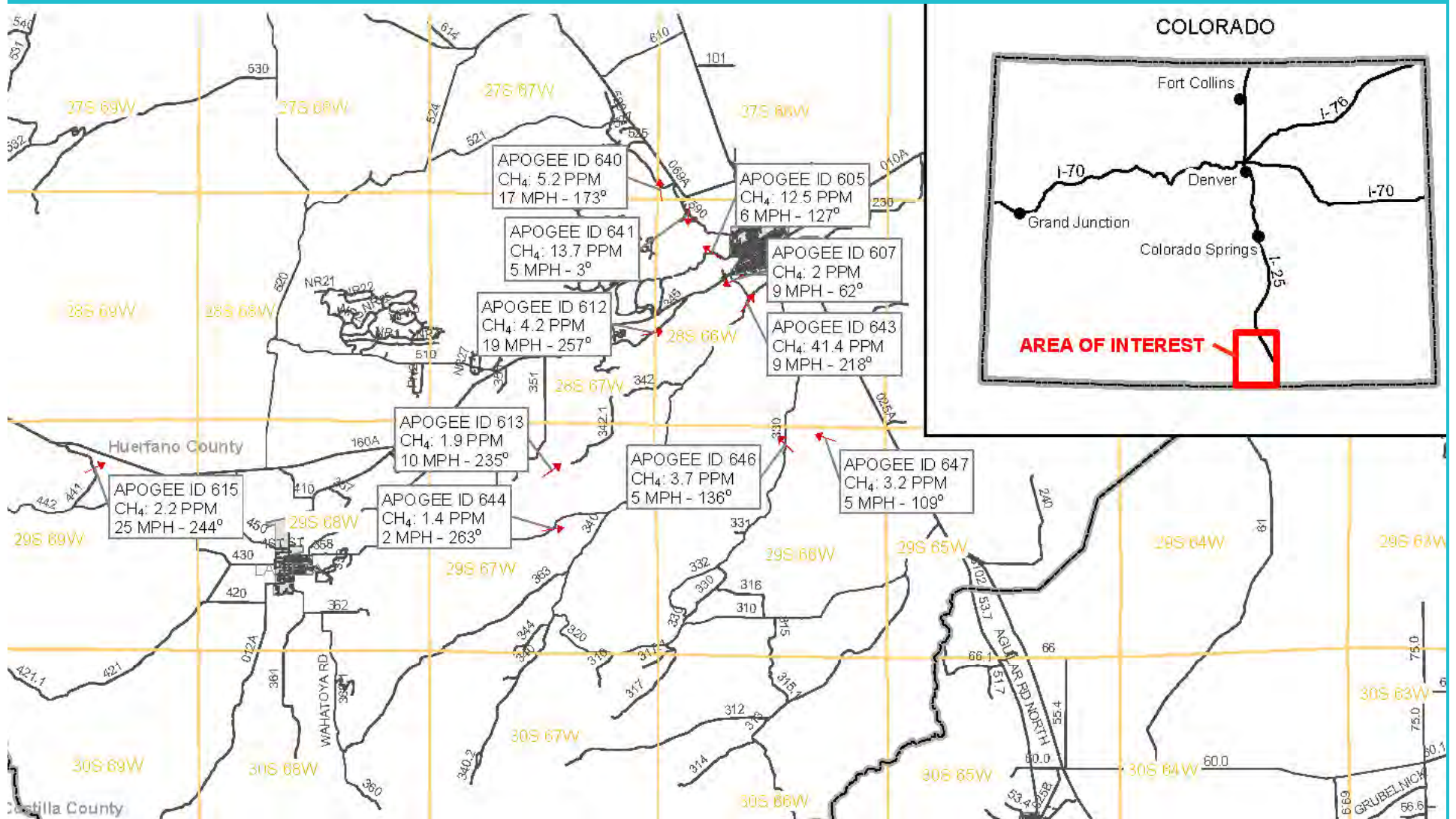


2007 Driving Survey Measured Methane, Carbon Dioxide & Total Hydrocarbons, Wind Speed & Direction, and Location

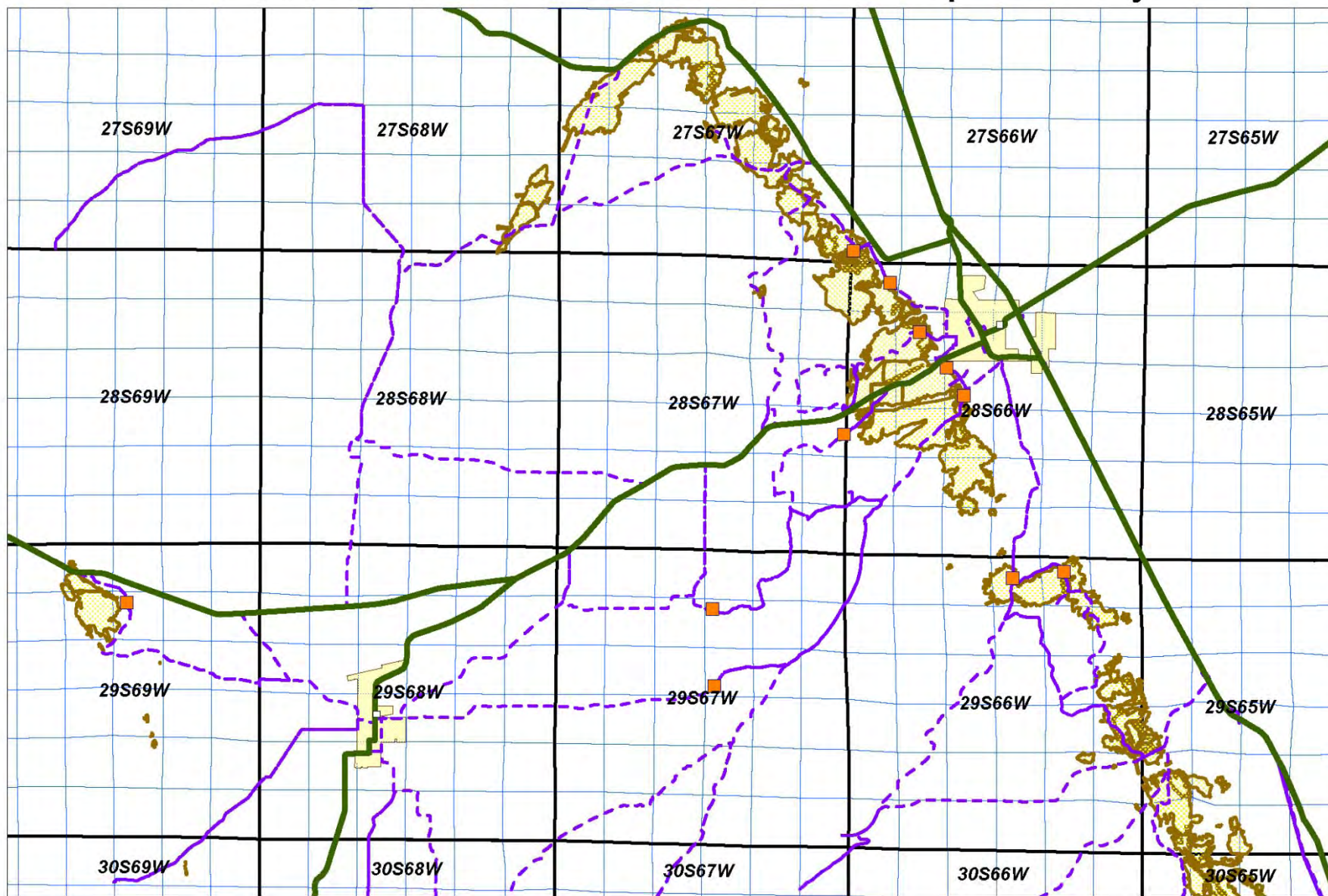


Figure 1: LDS-equipped ground survey vehicles (#1 on left, #2 on right)

2007 Driving Survey Results



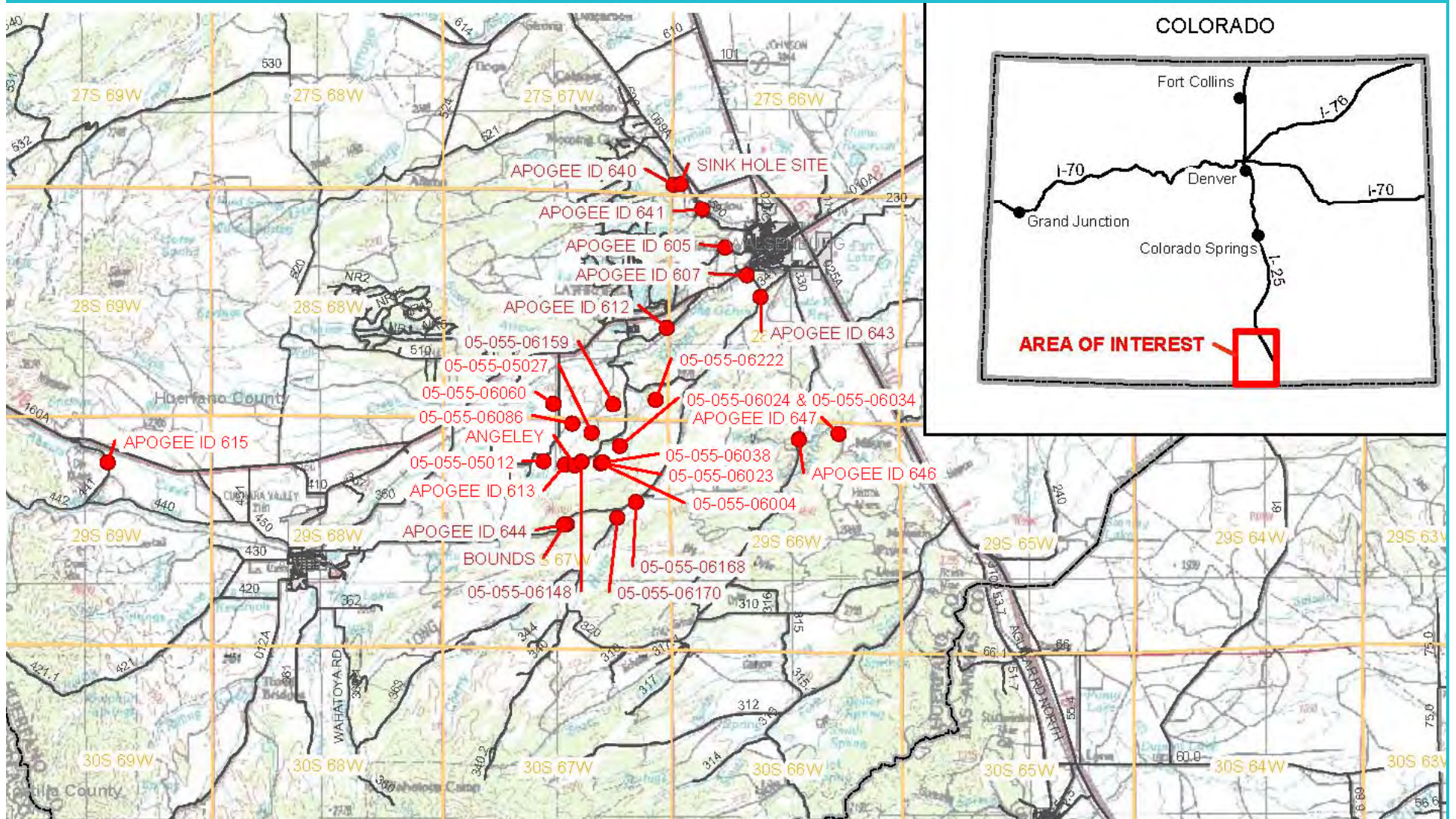
Northern Raton Basin 2007 Seep Survey



SCALE 1 : 167,246



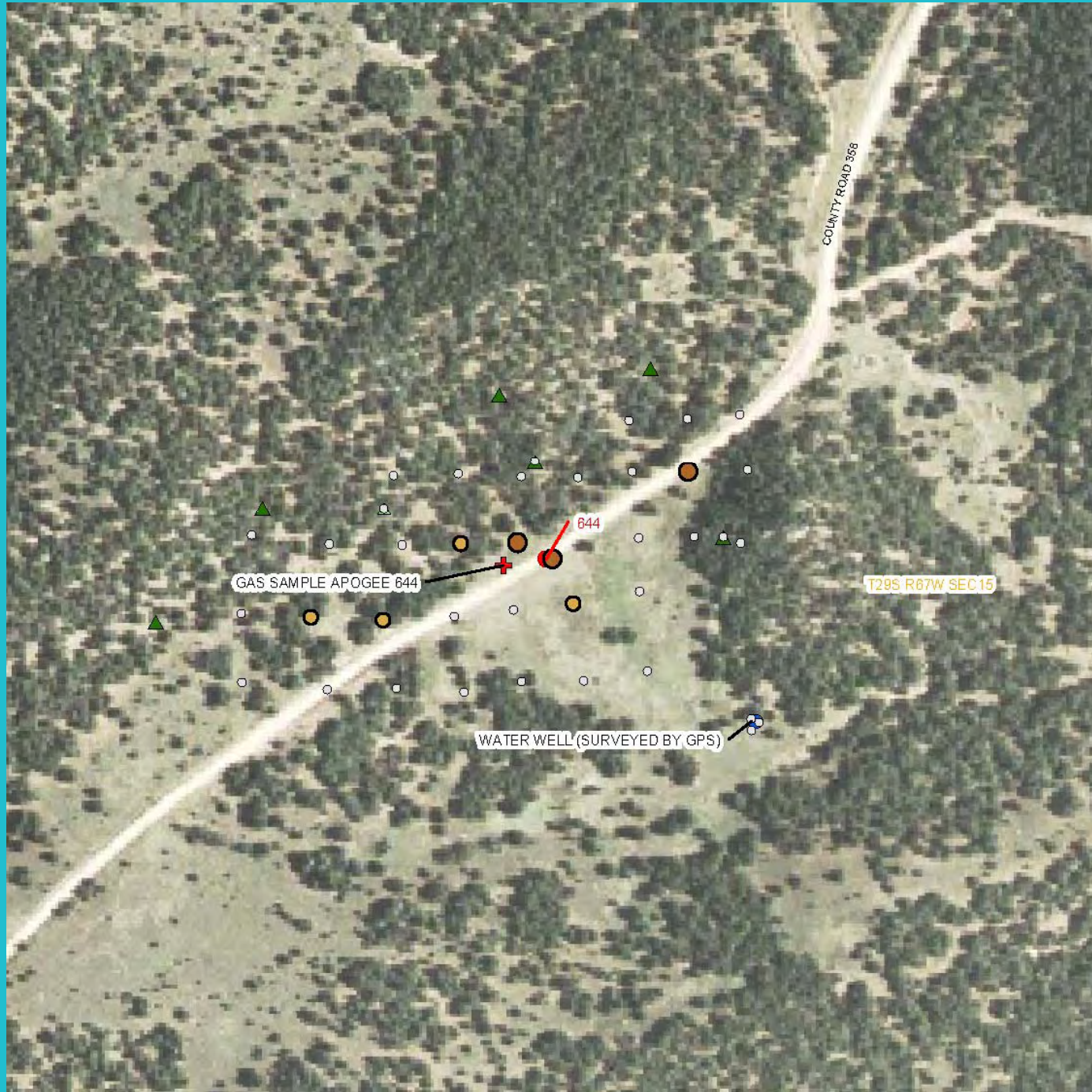
Detailed Seep Mapping - 2007 Following Driving Survey







Sinkhole East of Apogee 640



- **Identification of Problems and Chronology**

- 1. Background**

- 2. June 2007**

- 3. July 2007**

- 4. October 2007**

- 5. January 2008**

Bouvier House, Las Animas County









Trinidad MGP 1 well

27MCF/day

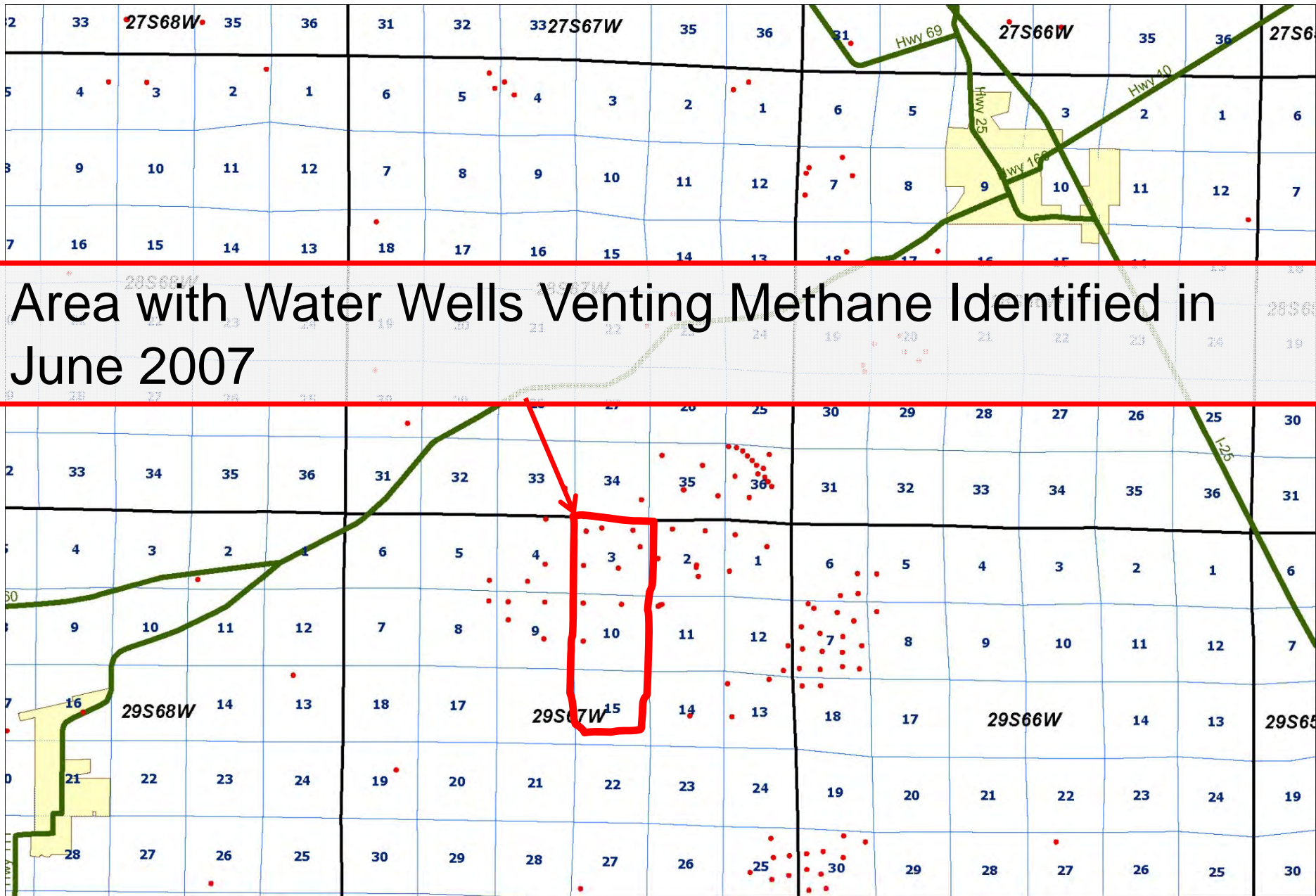
June 2007

2 venting wells identified by landowners

1 venting well identified by Petroglyph

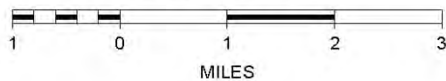
2 venting wells discovered by COGCC staff

Water and gas samples collected by
COGCC and analyzed at commercial
laboratories



Area with Water Wells Venting Methane Identified in June 2007

SCALE 1 : 100,000



July 2007

Colorado Oil and Gas Conservation Commission authorized emergency funding to investigate and monitor water wells in south-central Huerfano County at the recommendation of the staff

COGCC staff concludes that methane venting from several water wells was produced from coals and is similar to gas produced from Petrogyph's operations based on results of isotopic analyses (fingerprinting) of methane in water wells and in gas wells

July 2007 (continued)

COGCC staff investigate records of plugged and abandoned as well as active CBM wells in the area

COGCC contractor discovers 6 more water wells venting methane

COGCC staff meets with Petroglyph
Voluntary shut-in of Petroglyphs CBM wells
as result of meeting (July 20, 2007)

COGCC presentation to affected homeowners (July 21, 2007)

July 2007 (continued)

Petroglyph and contractors start MIMMP activities:

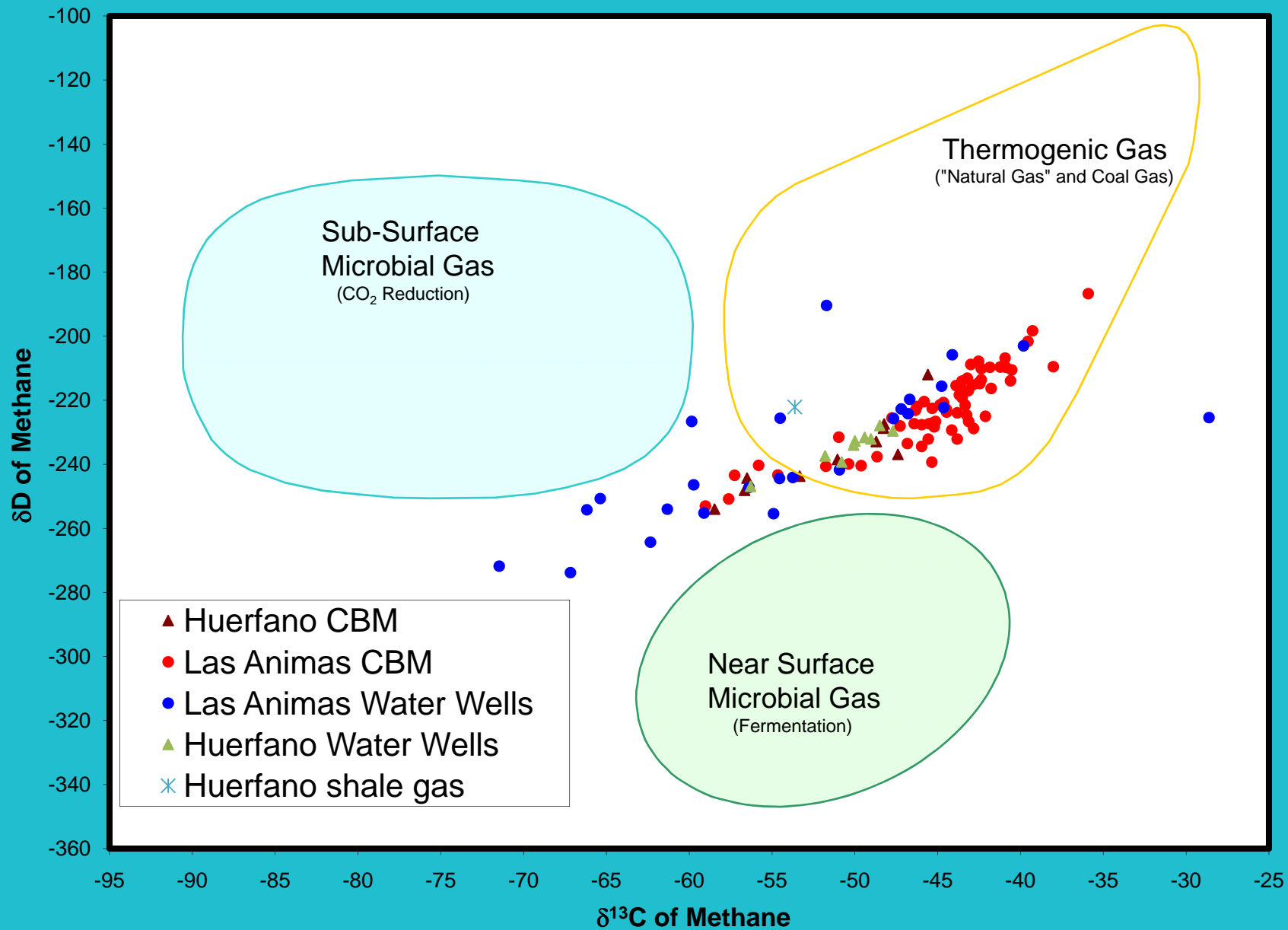
Investigate 2 P&A'ed oil and gas wells

Test oil and gas wells converted to water wells

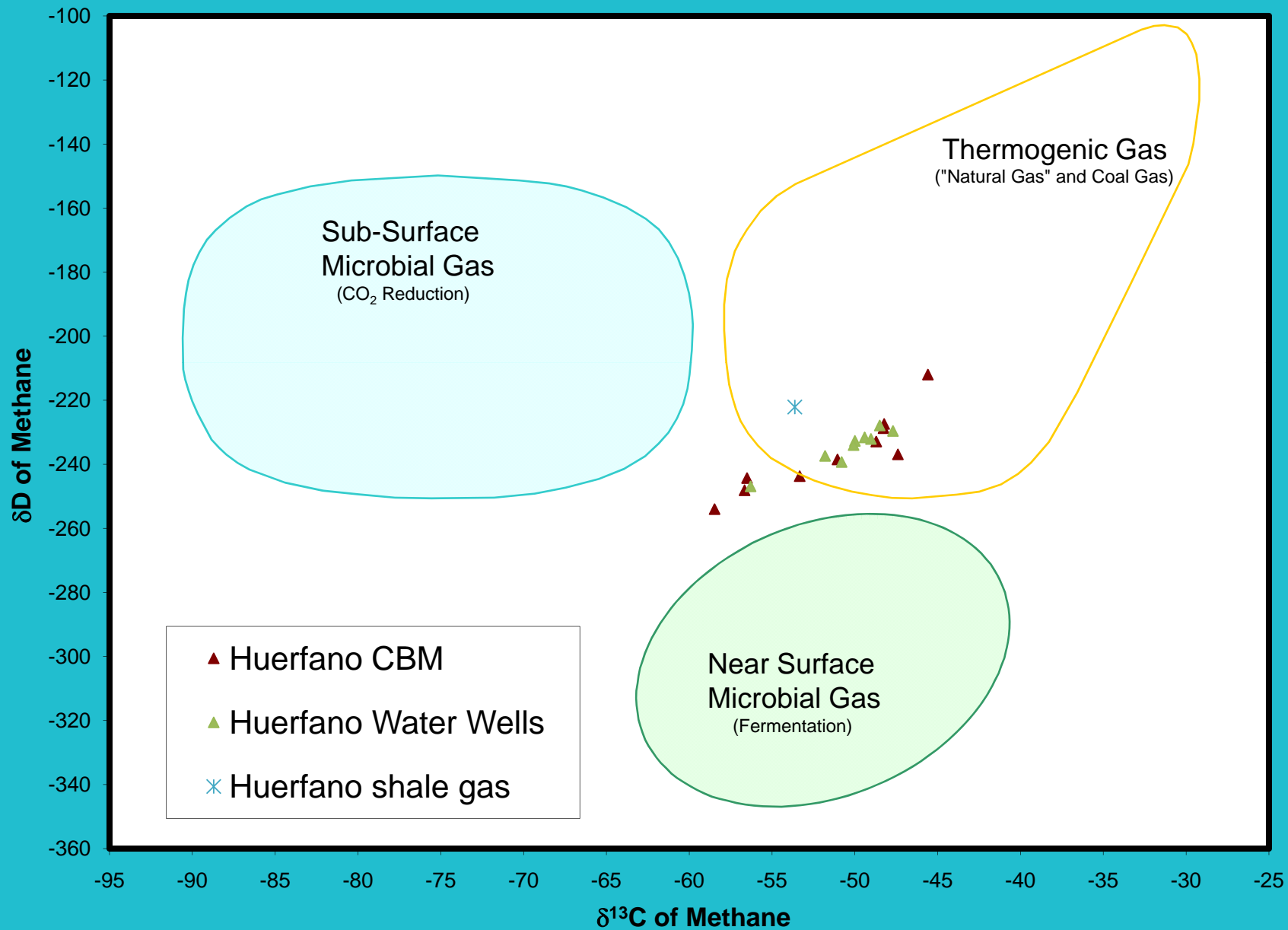
Install gas flow measurement systems on several water wells

Monitor fluid levels in gas wells and water wells

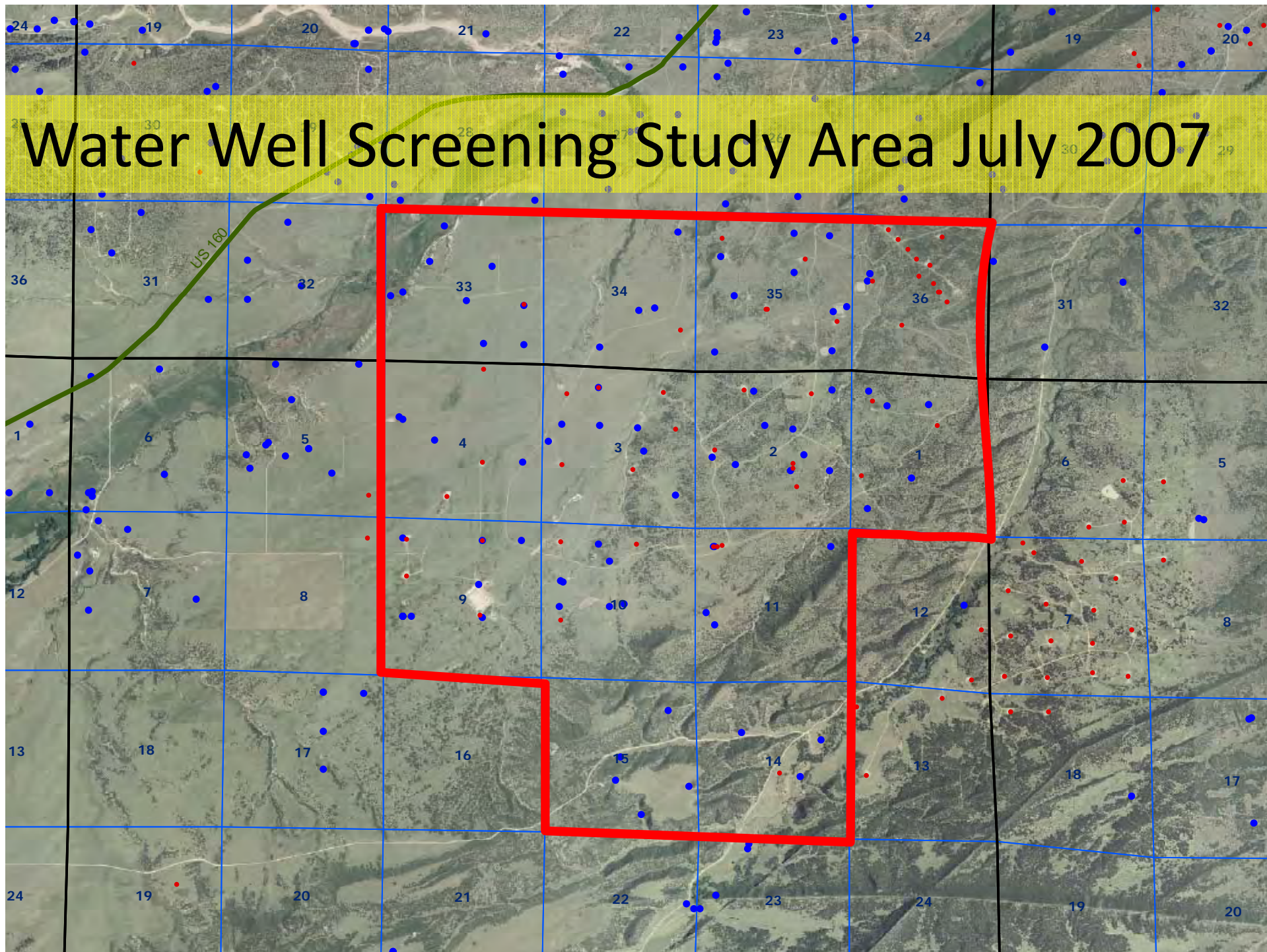
Typical Compositional Ranges of Methanes from Different Sources in Huerfano and Las Animas Counties



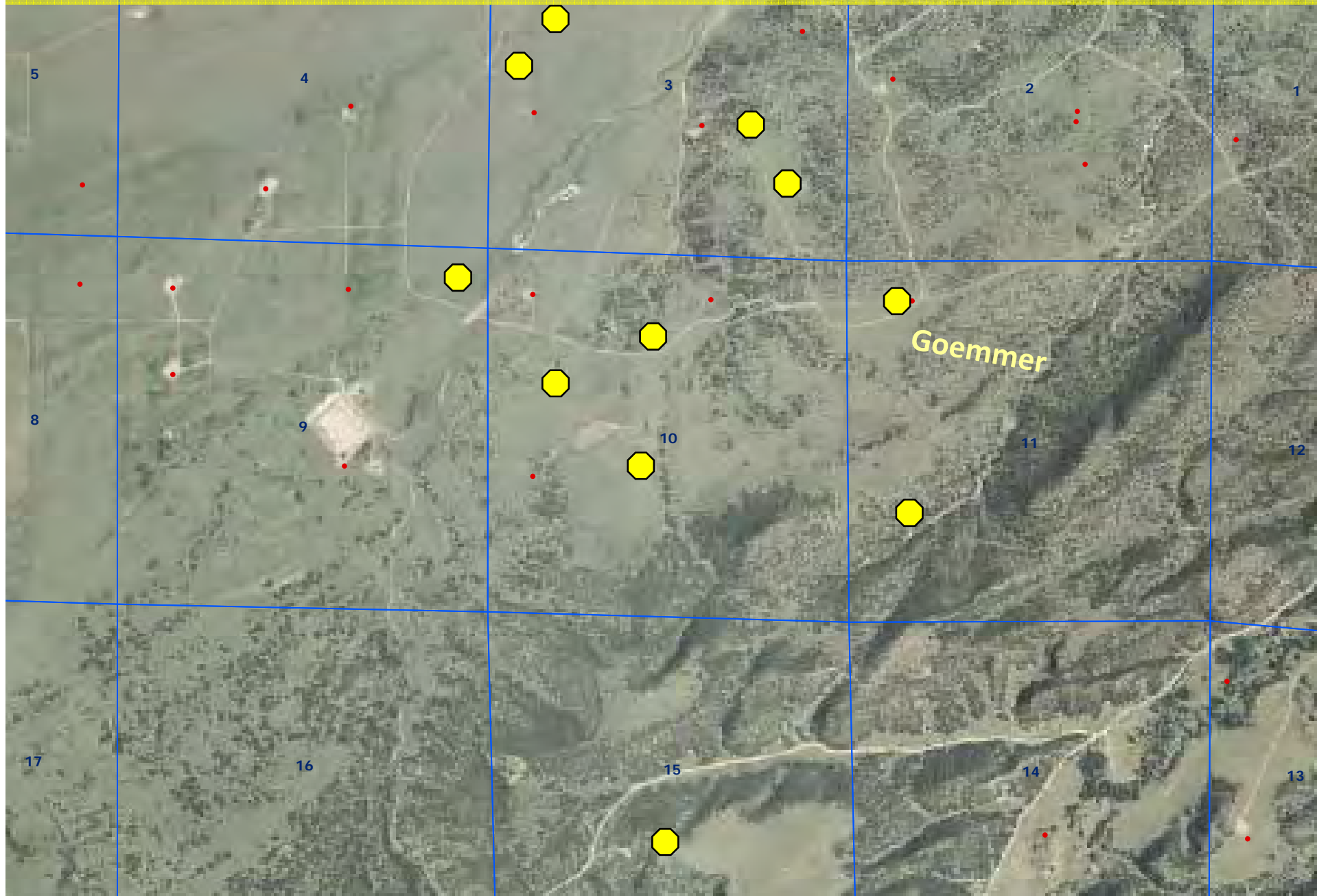
Typical Compositional Ranges of Methanes from Different Sources in Huerfano County



Water Well Screening Study Area July 2007



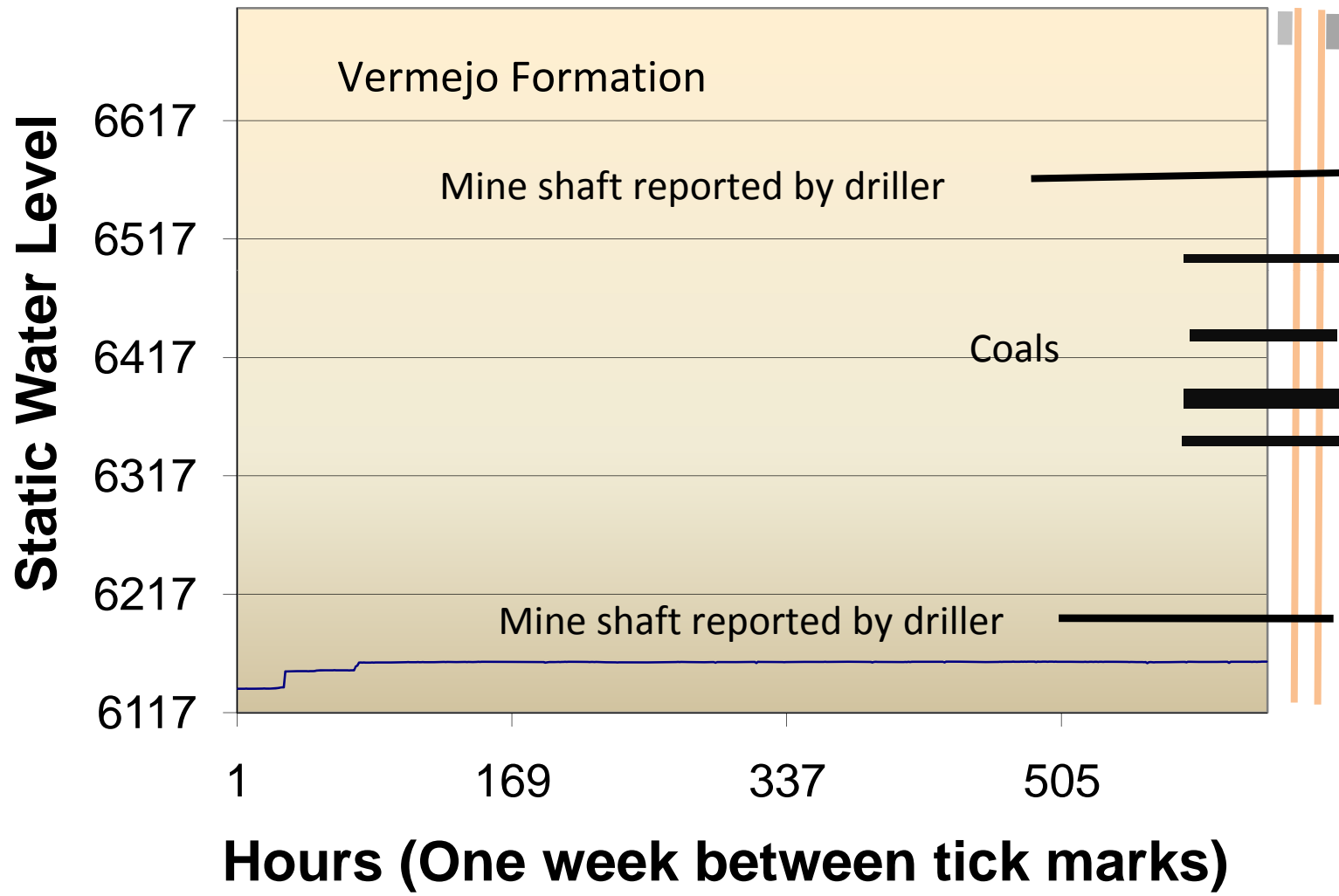
July 2007 Water Wells Venting Methane



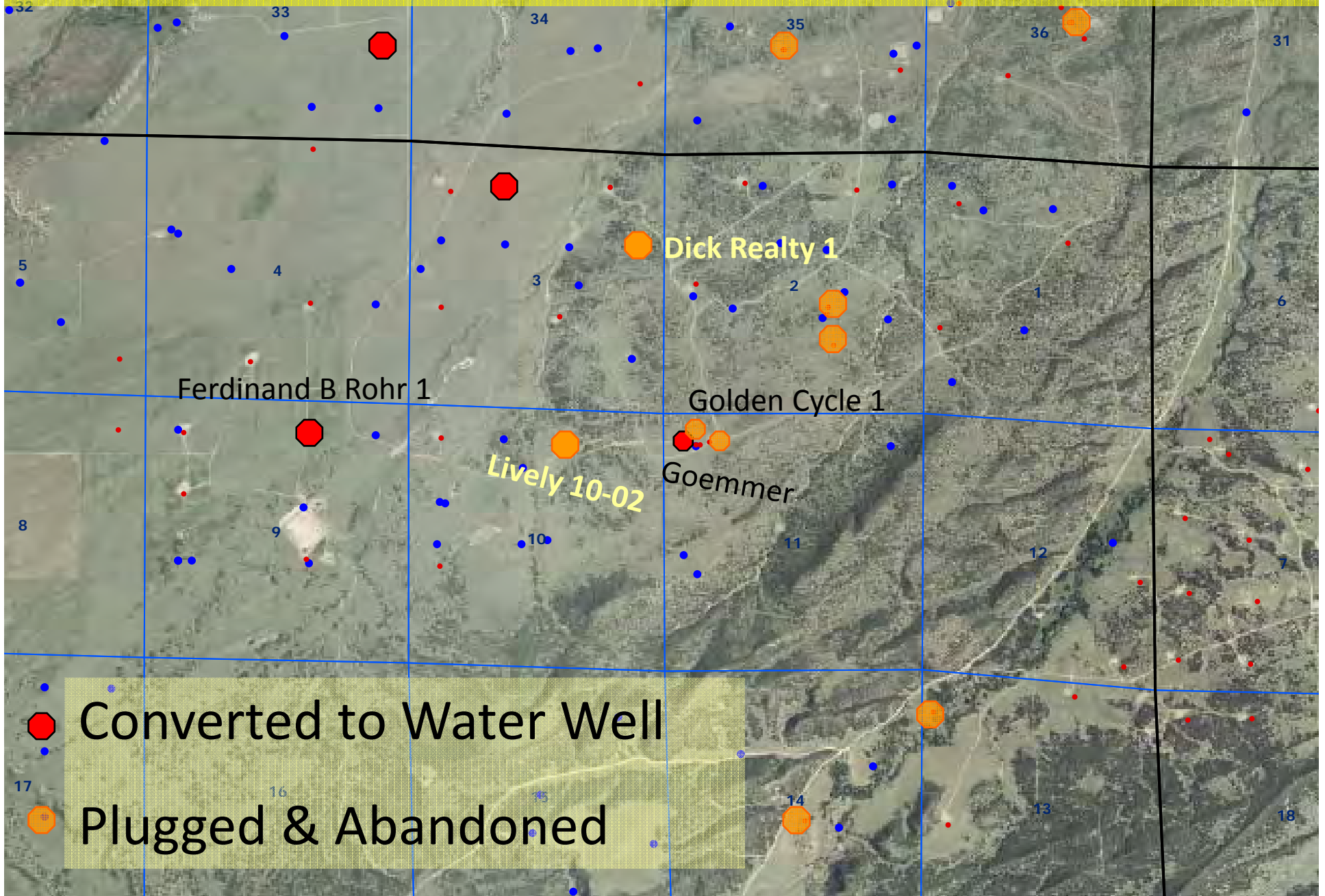
How Can Methane Enter Water Wells

- Water Wells Completed in Coal
- Water Wells Completed in Sandstones or Fractured Zones near Coal
- Migration of Methane into Aquifers
 - Along Fractures
 - Along Dikes
 - From Improperly or Never Plugged Oil & Gas Wells

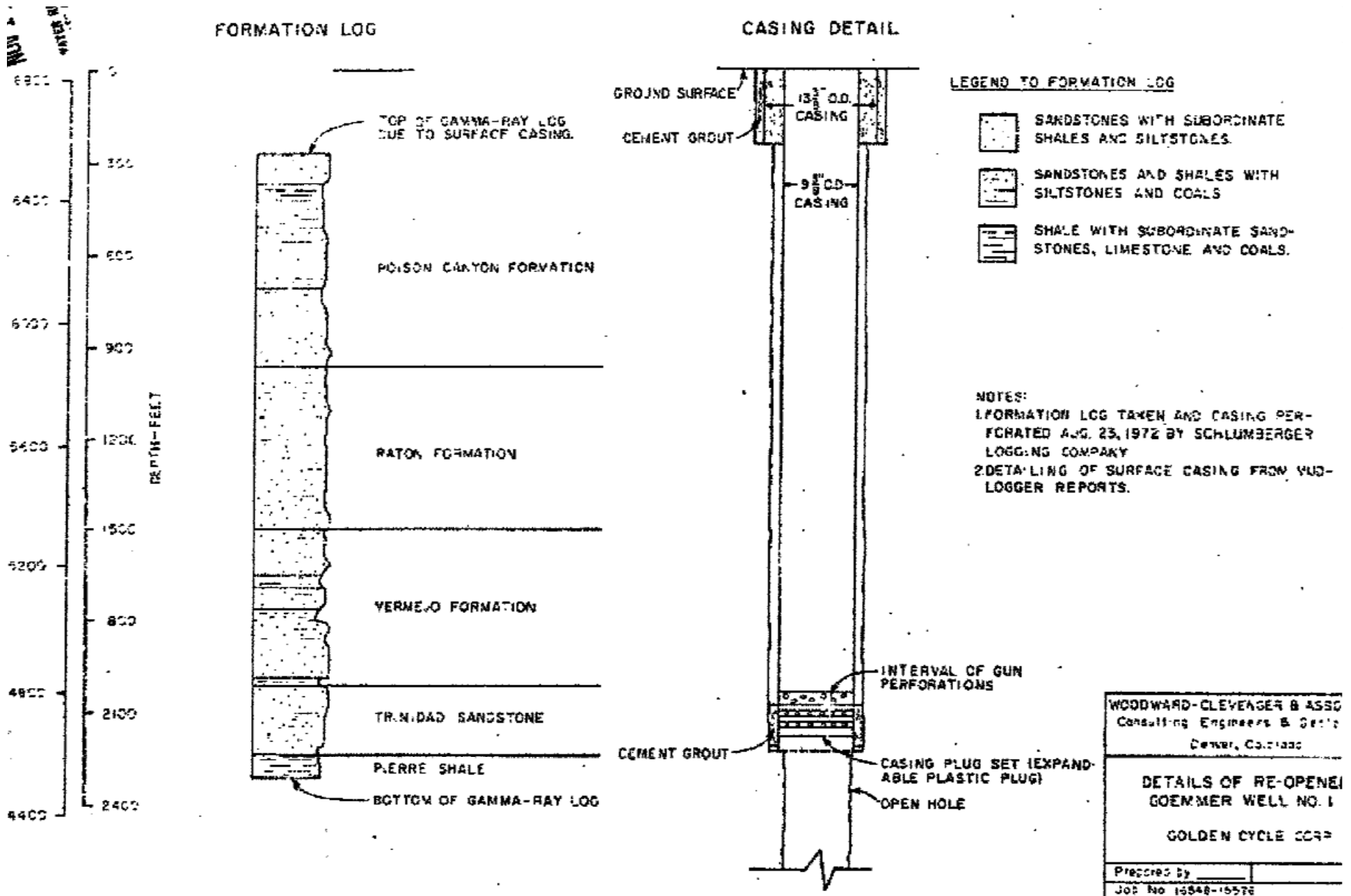
Permit 221465 (10/3/08 to 10/29/08) Lot 117 Silver Spurs Ranch



Oil & Gas Wells Plugged and Abandoned



Goemmer Land CO 1 – Golden Cycle 1 Water well



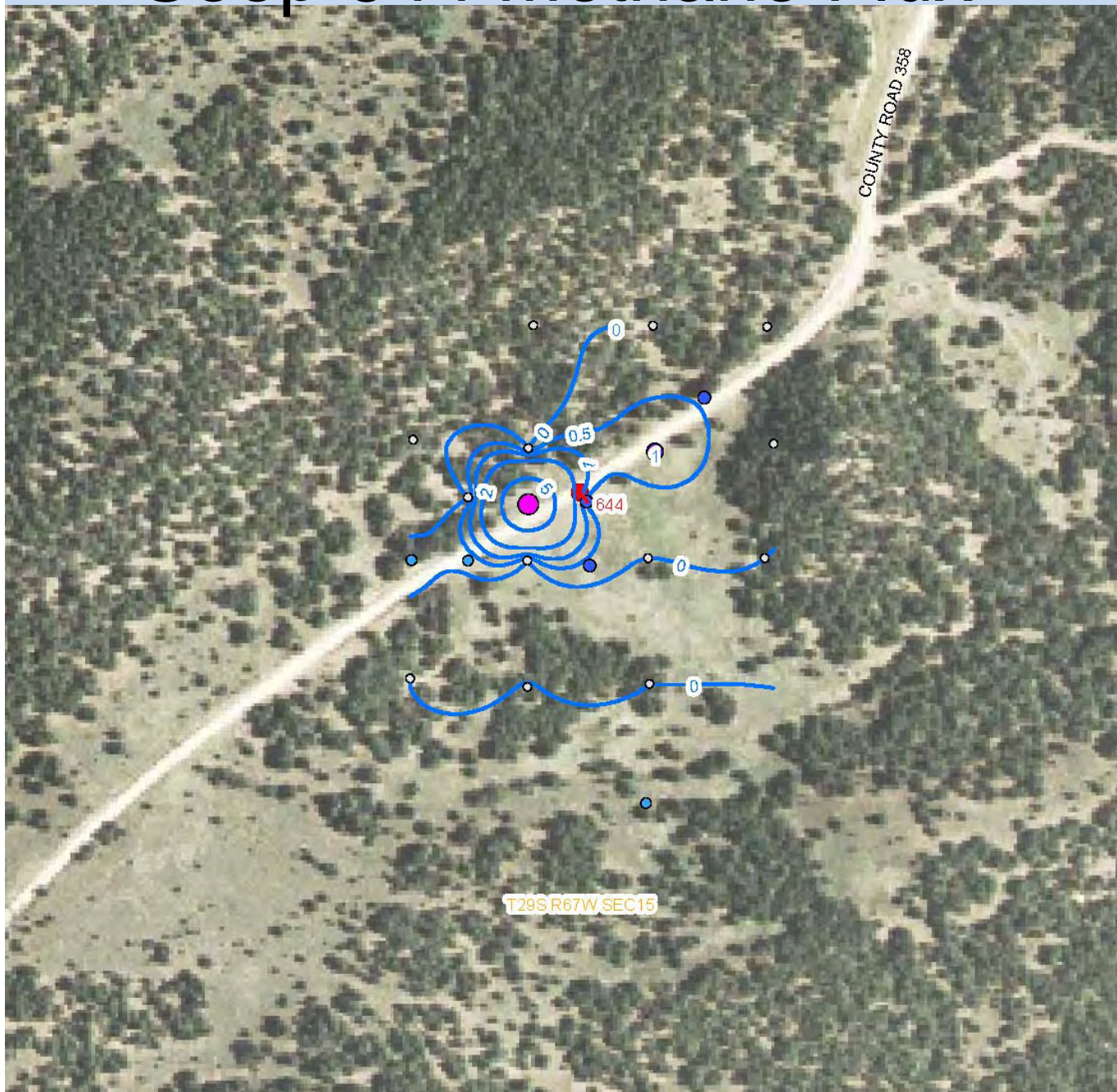
October 2007

COGCC Director issues temporary cease and desist order (1-C4)

November 2007

COGCC Director issues cease and desist order (1-C5)

Seep 644 Methane Flux



25MCF/day

December 2007

Petroglyph requests cease and desist
order be modified with revised MIMMP

Commission defers making a decision to
the January, 2008 hearing

January 2008

Colorado Oil and Gas Conservation
Commission adopts revised order 1-C6
including MIMMP with three phases that
could allow Petroglyph to resume
operations if all conditions are met

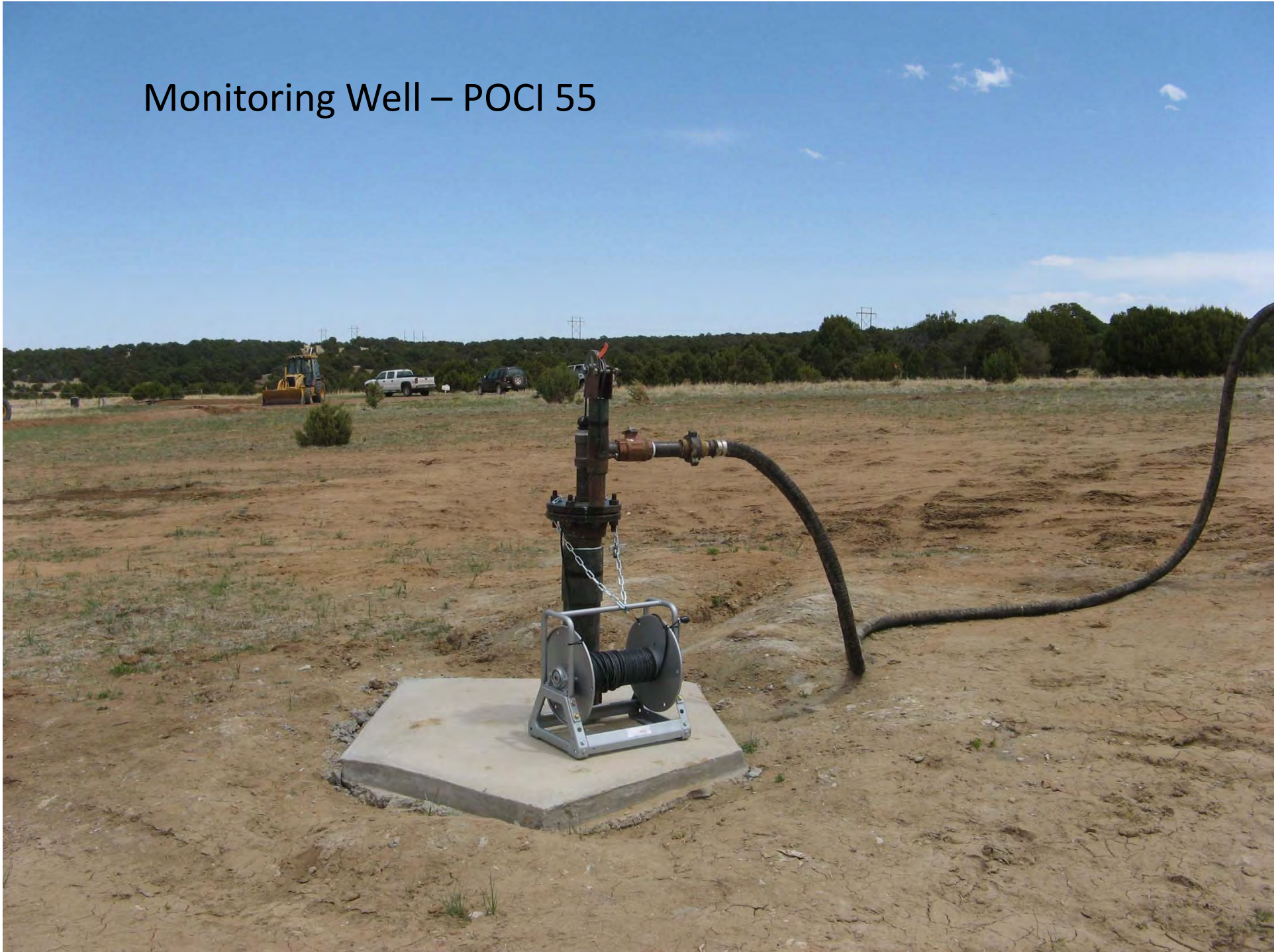
Cause No. 1, Order 1C-6

- **Phase 1**
 - Monitoring well, extraction wells, injection wells
 - Continued monitoring of water wells
 - Outcrop aerial survey
- **Phase 2**
 - Additional water from some CBM wells
- **Phase 3**
 - CBM field in operation



Monitoring well drilled by contractors to
Petroglyph with subsequent testing and
submittal of report in March 2008

Monitoring Well – POCI 55

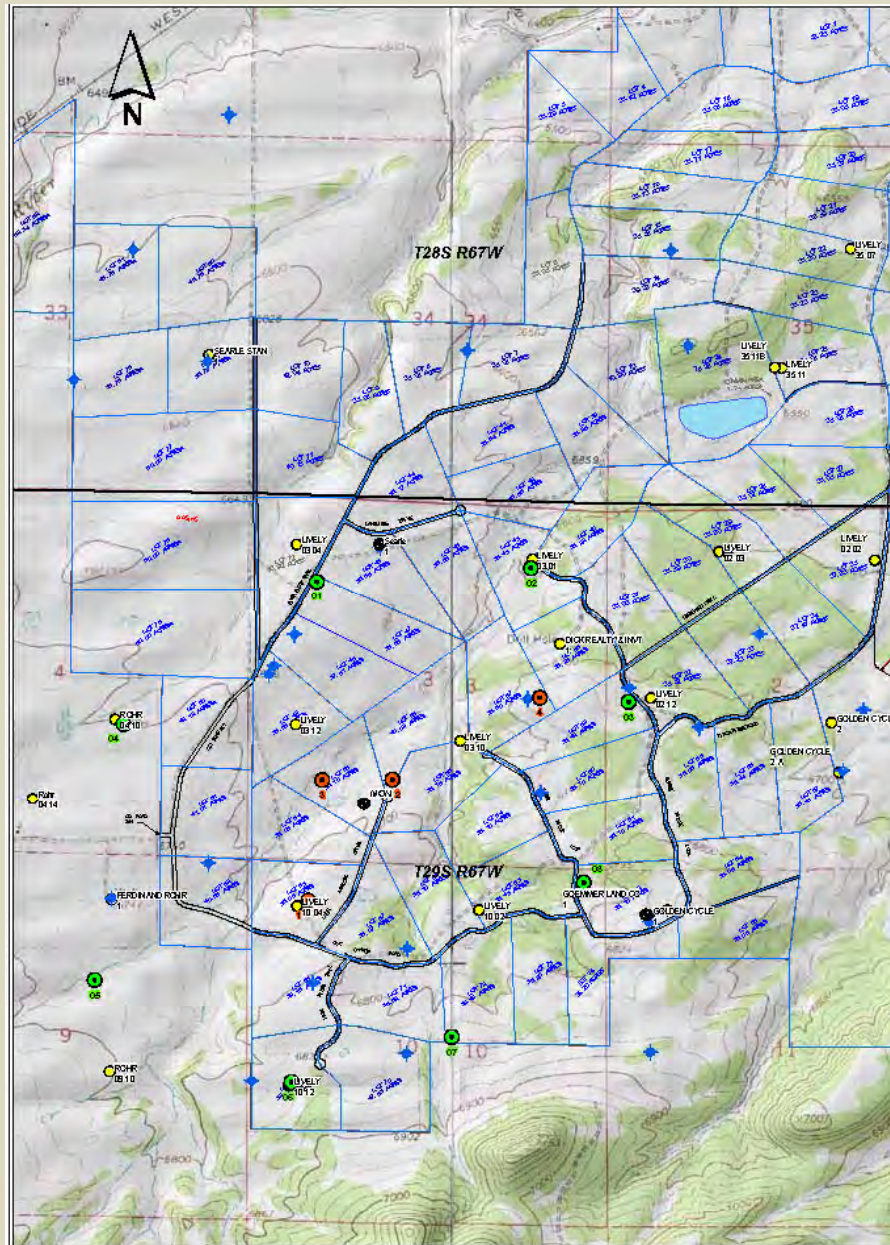


Removal wells and injection wells drilled by contractors for Petroglyph with subsequent testing and submittal of report in September 2008

Pipeline Trench for Water and Gas Transfer



Ferdinand B. Rohr #1



Legend

- | | |
|----------------------|-----------|
| Well Locations | Lot Lines |
| Injection Well | Roads |
| Recovery Well | Lake |
| Monitoring Wells | Townships |
| Water Wells | |
| Petroglyph CBM Wells | |

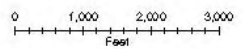


Figure 1 - Petrolgyph Operating Co., Inc. REMEDIATION SYSTEM

Projection: UTM
 Datum: NAD 83
 Zone: 12N
 Units: Feet

Date: 9/10/2010
 Modified: 09/10/2010

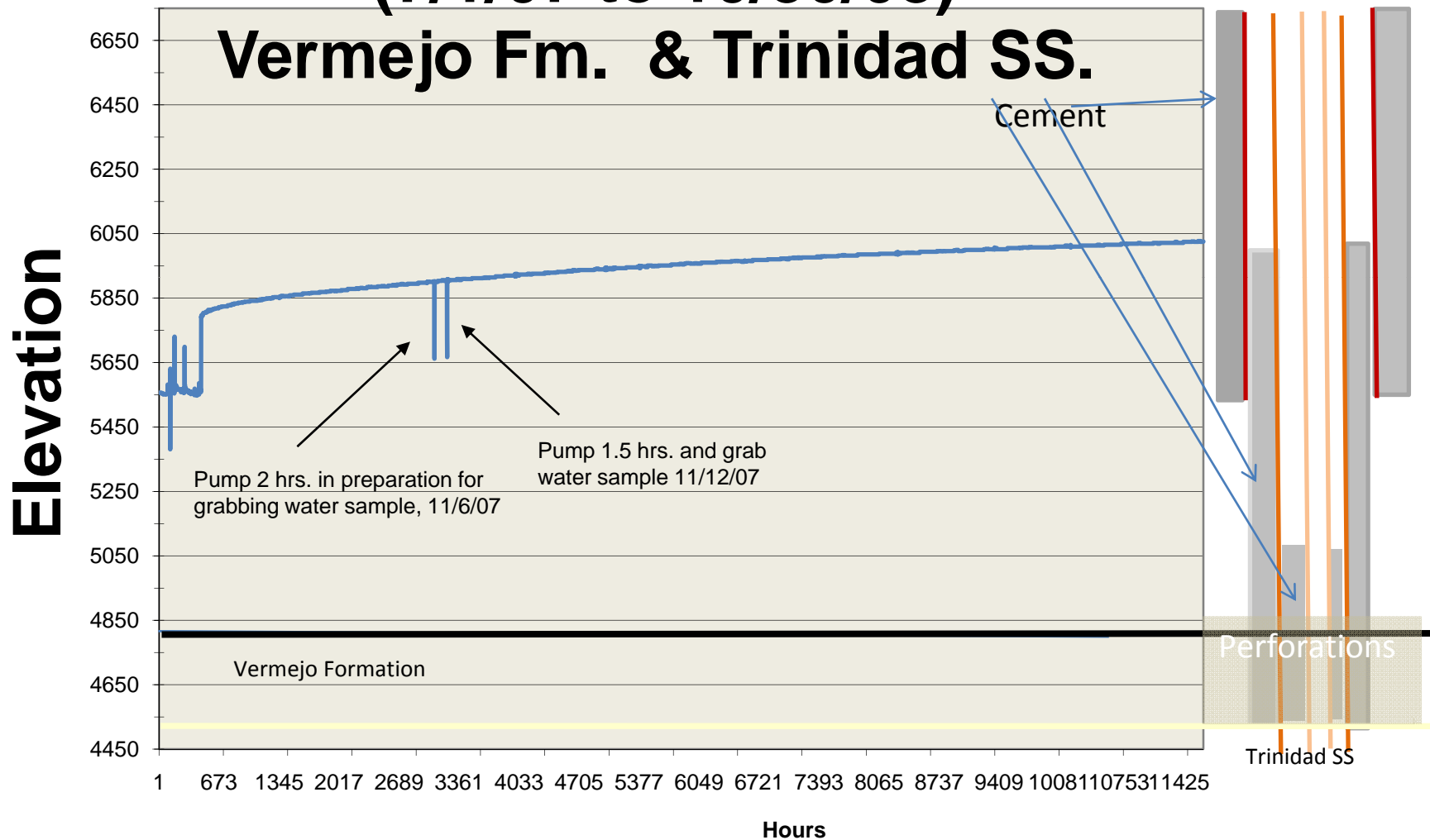
NORWEST
 Applied Hydrology

© 2010 Northwest Applied Hydrology, Inc. All rights reserved.

Continued monitoring of water wells by
Petroglyph or its contractors
July 2007 to present

Rohr 04-14 Water Level (7/1/07 to 10/30/08)

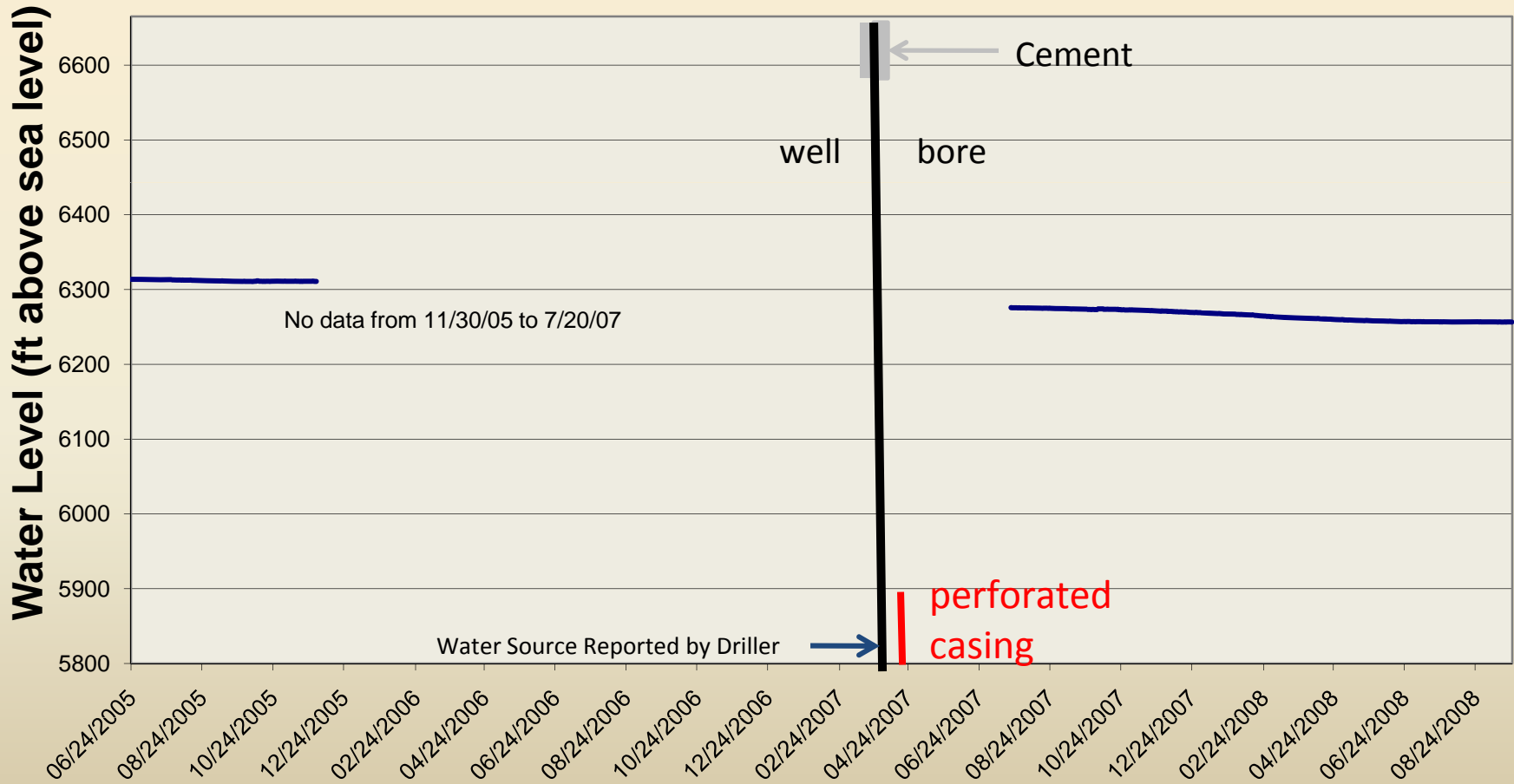
Vermejo Fm. & Trinidad SS.



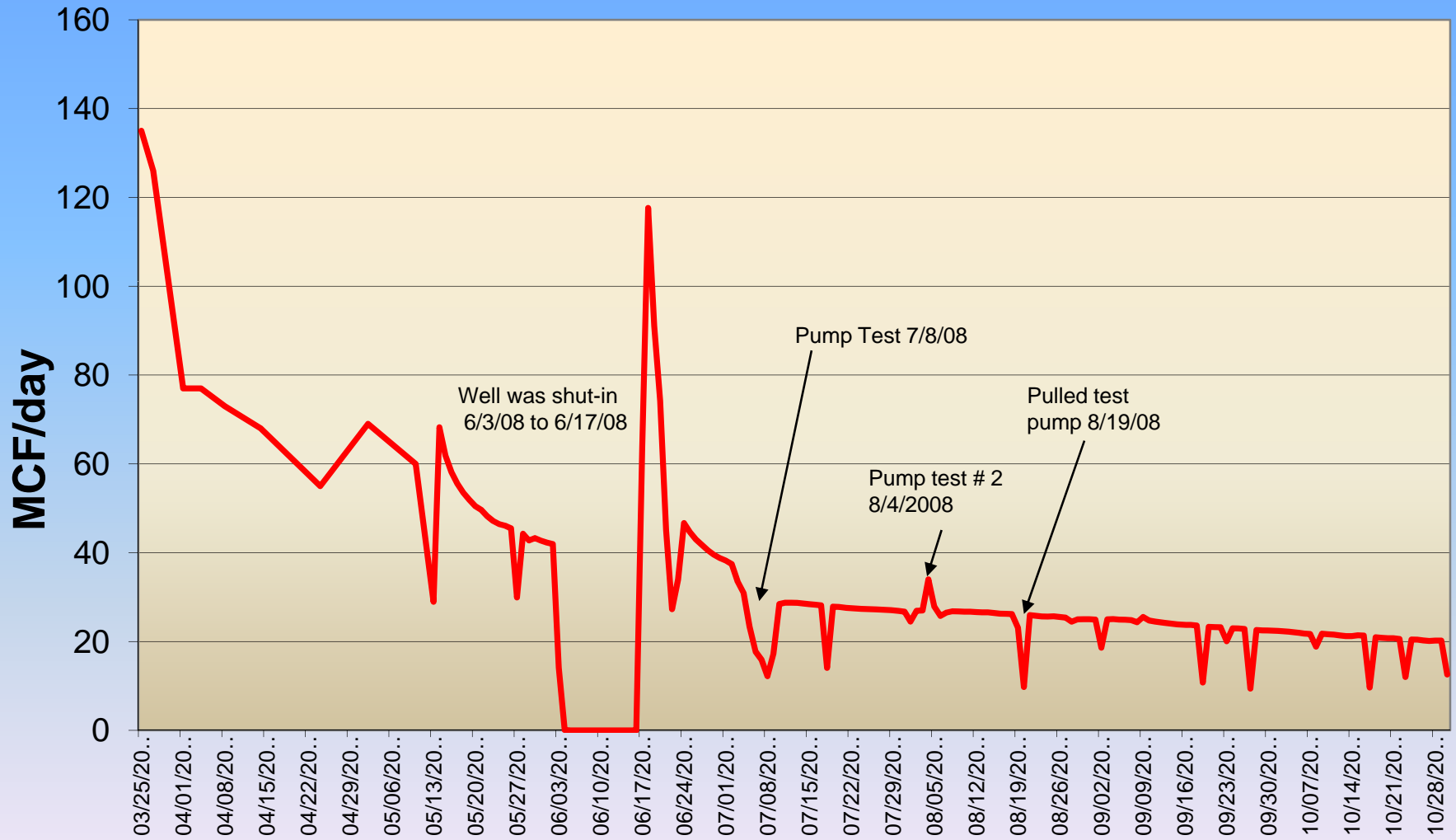
Water Level from 6/24/05 to 9/24/08

Permit # 257994 Lot 57 RRR

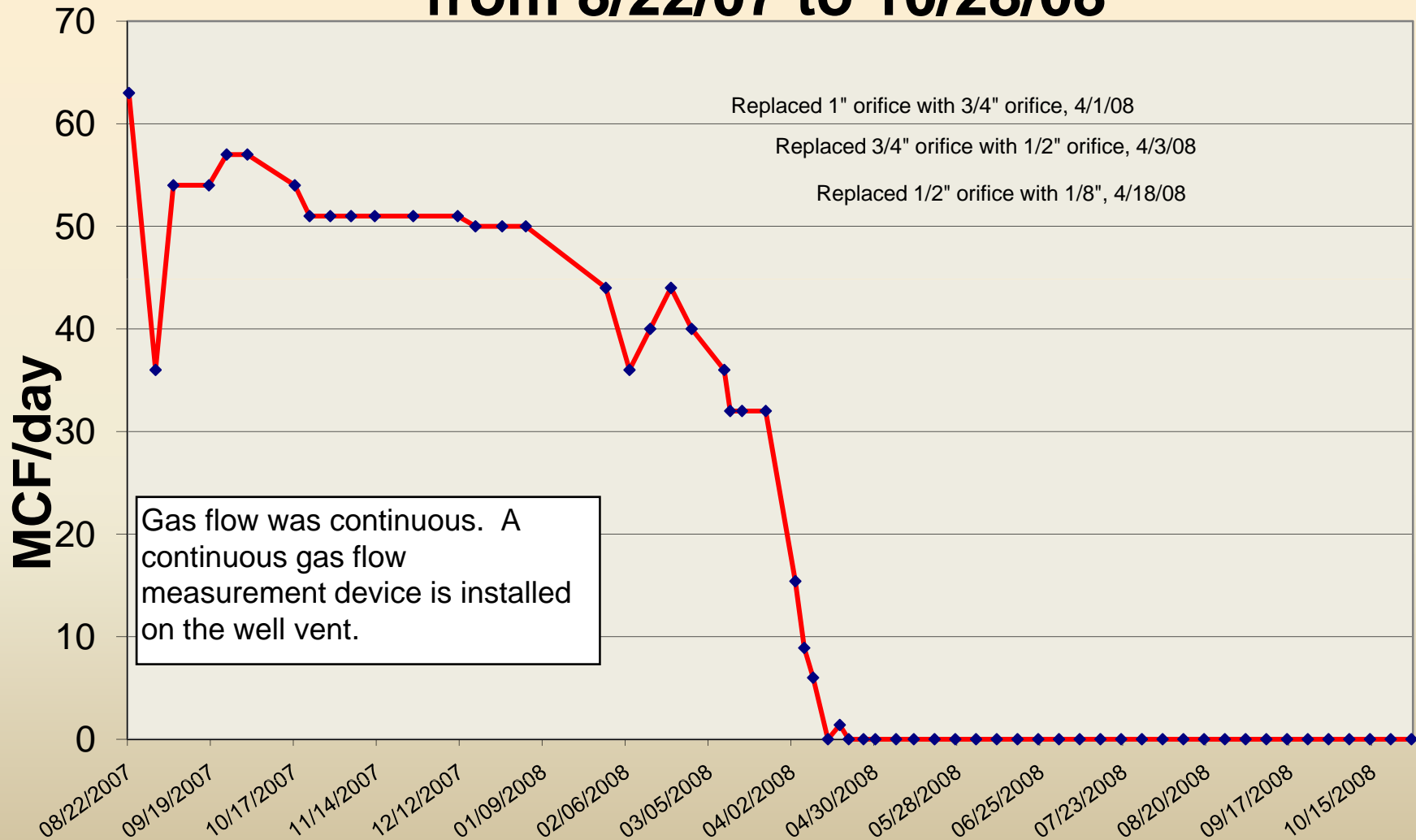
Poison Canyon Formation



Recovery 1 Kittleson Gas Flow from 3/25/08 to 10/30/08



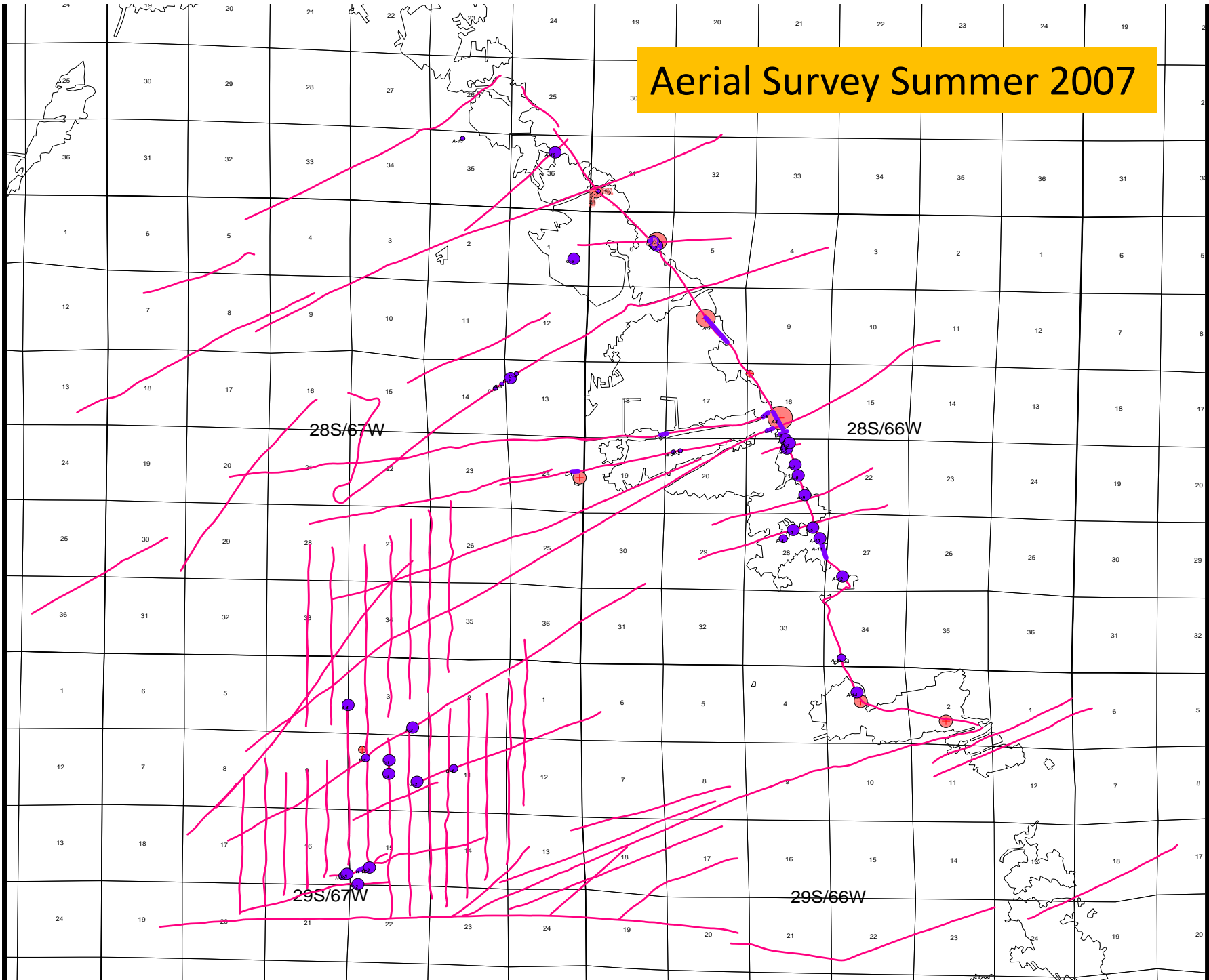
WW # 239657 Measured Gas Flow from 8/22/07 to 10/28/08



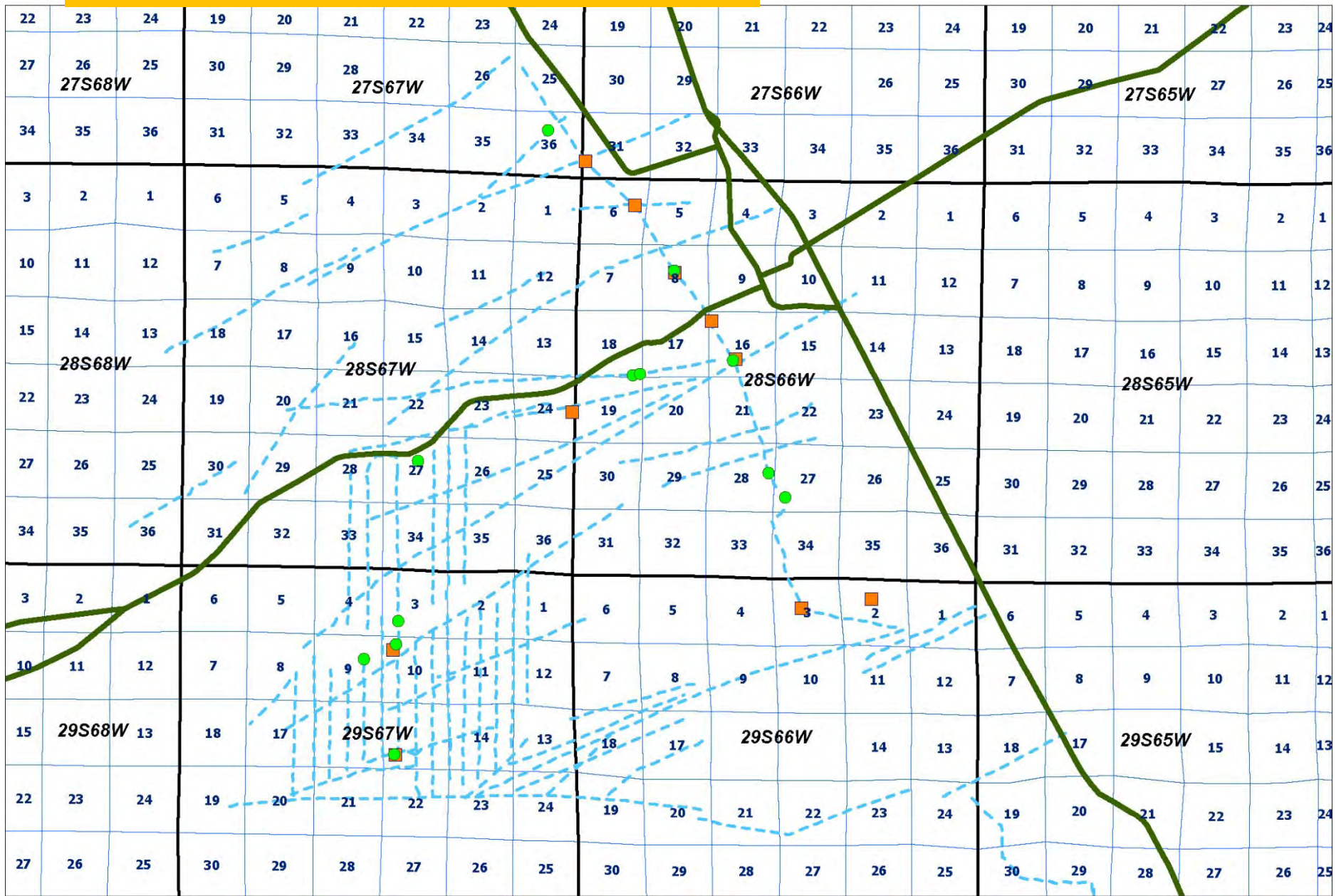
Aerial methane surveys conducted by contractor to Petroglyph in 2007 and again in 2008

Ground methane surveys by Petroglyph staff or contractors near seeps identified in other surveys and in and around homes with venting water wells

Aerial Survey Summer 2007



Aerial Survey Routes Summer 2008



Summary

- Phase 1 investigations still underway
- Reduced number of wells that vent methane in the MIMMP area
- Flow of methane has decreased in MIMMP area wells
- Petroglyph has requested US EPA approval to re-inject Poison Canyon Formation water after methane removed by gas stripper

Summary (cont.)

- Mechanism or pathway that allowed methane migration from Vermejo coals upwards to Poison Canyon Formation has not been determined

Information on COGCC web site

- <http://cogcc.state.co.us/>
- Click on Library link on left side
- Click on Raton Basin link



PRINT PAGE

MISSION

KIDS' PAGE

GENERAL

CONTACTS

LIBRARY

HEARINGS

RULES

POLICIES

ORDERS

FORMS

STAFF RPT

PERMITS

NEWS/MEDIA

DATABASE

LOCAL GOV

IMAGES

MAPS

HELP

November 13, 2008

PUBLIC ANNOUNCEMENTS

[Link to the Rulemaking Activity Pages](#)

The COGCC is involved in rulemaking efforts to implement legislative changes from the 2007 Legislative Session, specifically House Bills 1298 and 1341.

[Statement of Basis and Purpose](#) *New*

The Statement of Basis, Specific Statutory Authority and Purpose can be accessed from the above link.

[Order Regarding Extension of Time for Party Groups](#) *New*

[Final Draft Rules and Reference Chart](#) *New*

The link above provides access to the Final Draft Rules and a Reference Chart to assist readers in reviewing the Rules.

[Order Regarding Party Groups Submittal of Comments](#) *New*

Order Regarding Party Groups Submittal of Comments Setting Out Inconsistencies/Inaccuracies in Final Proposed Rules.

[Upcoming Job Opportunities](#) (11/04/2008)

[Schedule for Final Rulemaking Deliberations](#) (11/04/2008)

Please use the link above to view schedule.

[Effective Dates of COGCC Draft Rules](#) (10/28/2008)

Menu

[MISSION](#)

[KIDS' PAGE](#)

[GENERAL](#)

[CONTACTS](#)

[LIBRARY](#)

[HEARINGS](#)

[RULES](#)

[POLICIES](#)

[ORDERS](#)

[FORMS](#)

[STAFF RPT](#)

[PERMITS](#)

[NEWS/MEDIA](#)

[DATABASE](#)

[LOCAL GOV](#)

[IMAGES](#)

[MAPS](#)

[HELP](#)

LIBRARY

Area Reports/Data

[Parkland Estates](#)

[Piceance Basin](#)

[Raton Basin](#)

[San Juan Basin](#)

[Denver Julesburg Basin](#)

[San Luis Valley](#)

[Sand Wash Basin](#)

RATON BASIN REPORTS/DATA

Raton Basin Phase II Gas Seep Investigation:

[Phase II Seep Investigation Final Report.pdf \(01/09/2008\)](#) 39.66 mb

Raton Basin Coalbed Methane Stream Depletion Assessment:

[Plan of Study \(01/24/2007\)](#) 7.1mb

[Coalbed Methane Stream Depletion Assessment Studies](#)

Huerfano County:

[Petroglyph Methane Mitigation Well Aquifer Testing Report \(09/25/2008\)](#) 42.7 mb

[Review of the Petroglyph Methane Mitigation Well Aquifer Testing Report \(10/28/2008\)](#) 1.49 mb

[Petroglyph September 2008 Monthly Report \(10/07/2008\)](#) 377 kb

[Petroglyph August 2008 Monthly Report \(08/25/2008\)](#) 550 kb

[Petroglyph July 2008 Monthly Report \(07/23/2008\)](#) 586 kb

[Petroglyph June 2008 Monthly Report \(06/18/2008\)](#) 11.4 mb

[Petroglyph Monitor Well POCI 55 Summary Report \(03/28/2008\)](#) 15.7 mb

[Review of the POCI 55 Summary Report \(05/23/2008\)](#) 69 kb

[Response to the POCI 55 Summary Review \(06/12/2008\)](#) 114 kb

[Petroglyph May 2008 Monthly Report \(05/21/2008\)](#) 10.4 mb

[Petroglyph Methane Monitoring and Response Plan \(04/07/2008\)](#) 1657 kb

[Petroglyph March 2008 Monthly Report \(03/17/2008\)](#) 497 kb

[COGCC Staff Presentation at Petroglyph Hearing \(12/12/2007\)](#) 2.4 mb

Methane Investigation, Monitoring, and Mitigation Program (MIMMP)

[Petroglyph & Norwest Questa Engineering MIMMP Presentation \(12/07/2007\)](#) 2.4 mb

[Petroglyph & Norwest Applied Hydrology MIMMP Presentation \(12/07/2007\)](#) 4.0 mb

Thanks

- River Ridge Property Owners
- Huerfano County Commission
- All in Attendance

Questions