

# Mining Oil and Gas Well Integrity Data in Colorado and New Mexico



Greg Lackey

[Gregory.Lackey@Colorado.edu](mailto:Gregory.Lackey@Colorado.edu)

5/18/2018

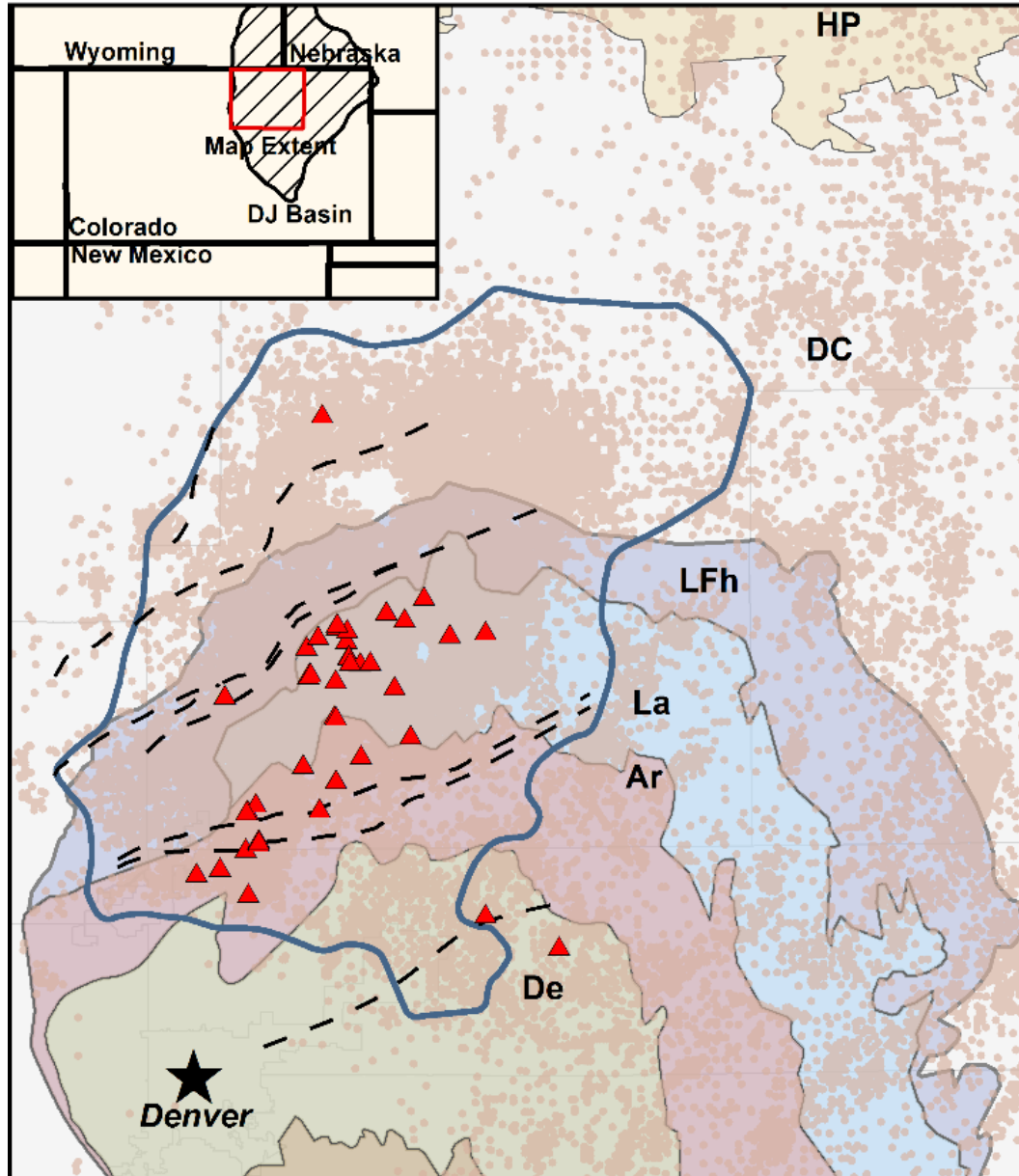


University of Colorado **Boulder**

AirWaterGas



# Wattenberg Field



4<sup>th</sup> largest oil field  
9<sup>th</sup> largest gas field

Stray gas contamination:  
Thermogenic CH<sub>4</sub>  
42 water wells  
32 cases  
11 “culprit” oil and gas wells



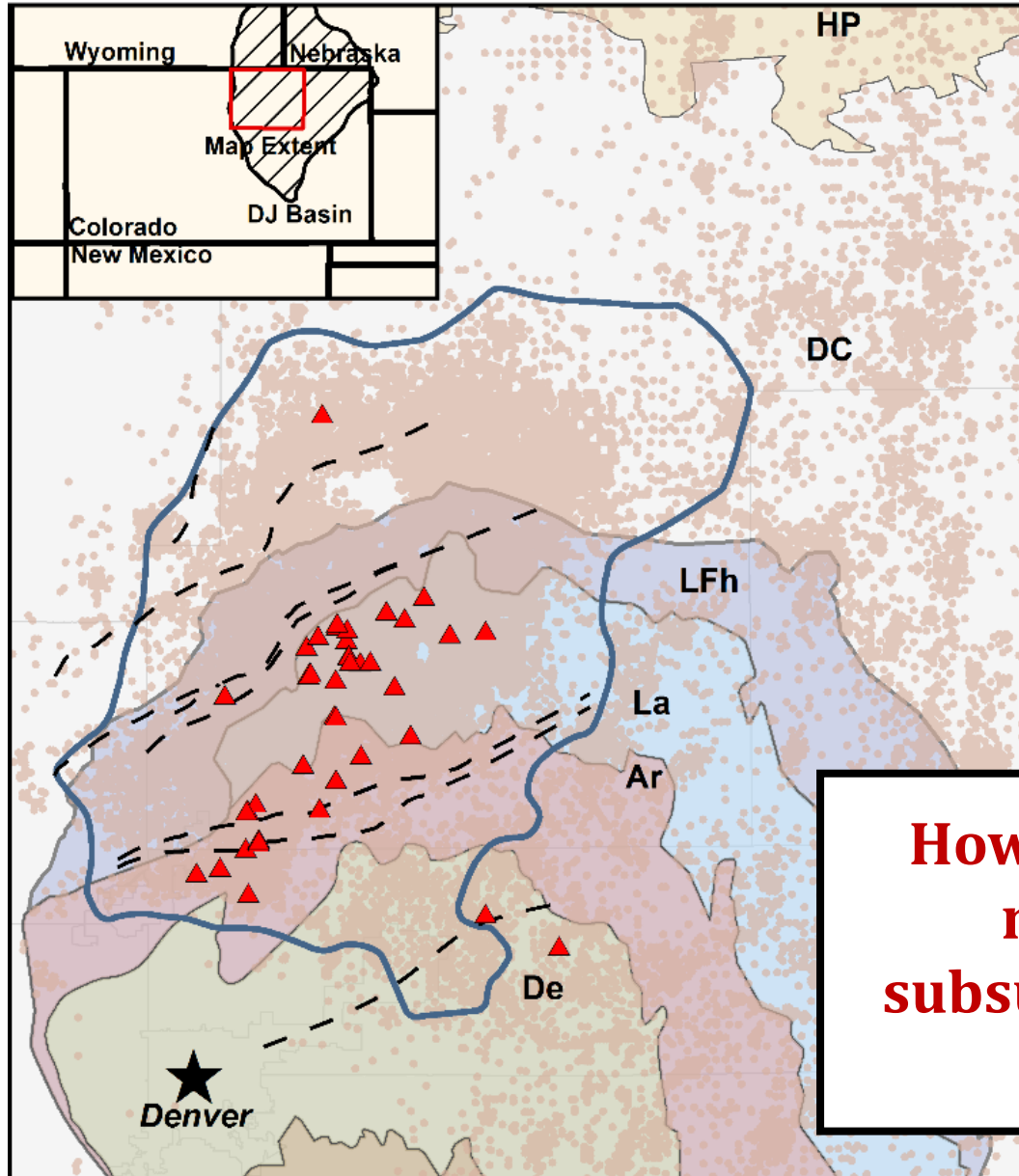
Groundwater methane in relation to oil and gas development and shallow coal seams in the Denver-Julesburg Basin of Colorado

Owen A. Sherwood<sup>a,1</sup>, Jessica D. Rogers<sup>b</sup>, Greg Lackey<sup>b</sup>, Troy L. Burke<sup>b</sup>, Stephen G. Osborn<sup>c</sup>, and Joseph N. Ryan<sup>b</sup>

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Edited by Peter H. Gleick, Pacific Institute for Studies in Development, Environment, and Security, Oakland, CA, and approved June 7, 2016 (received for review November 24, 2015)

# Wattenberg Field



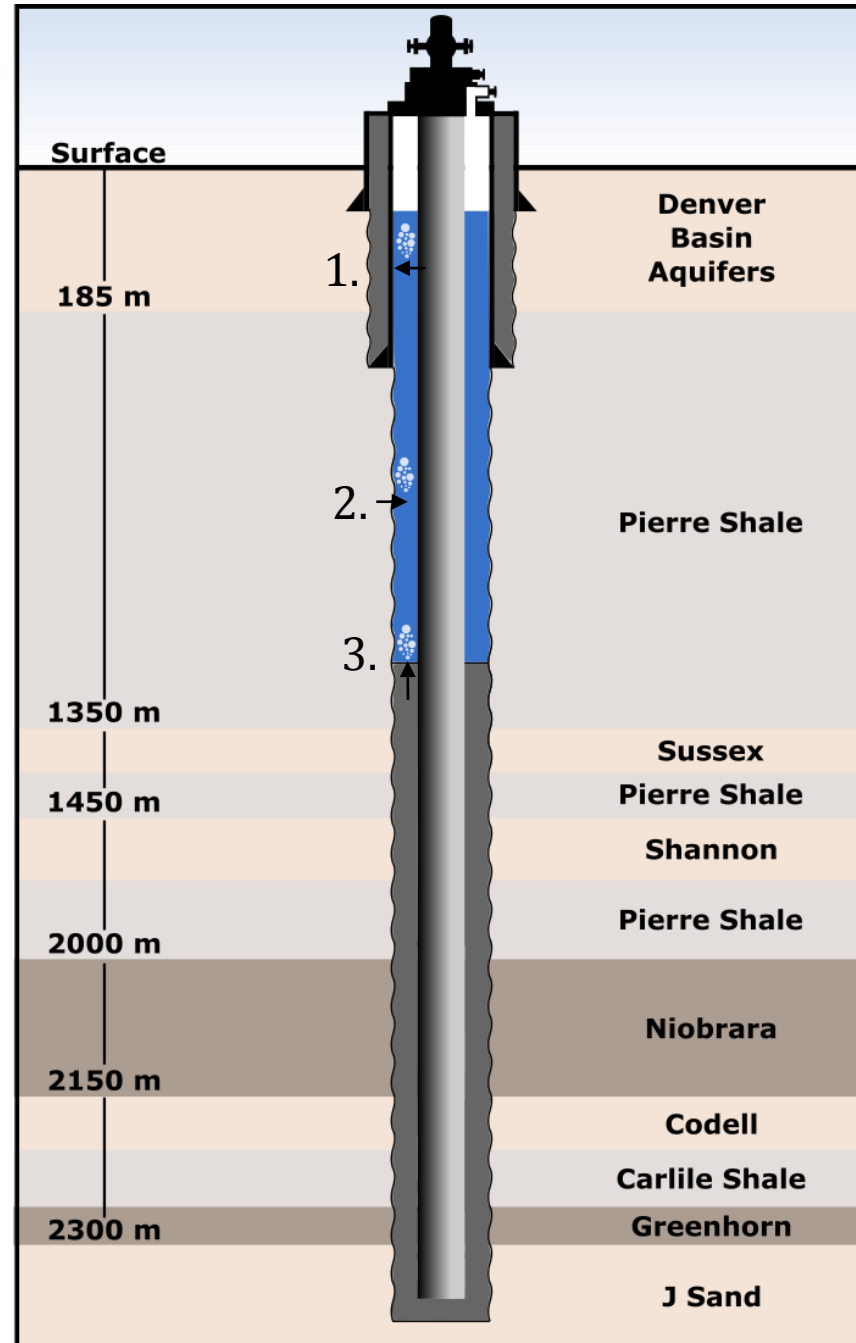
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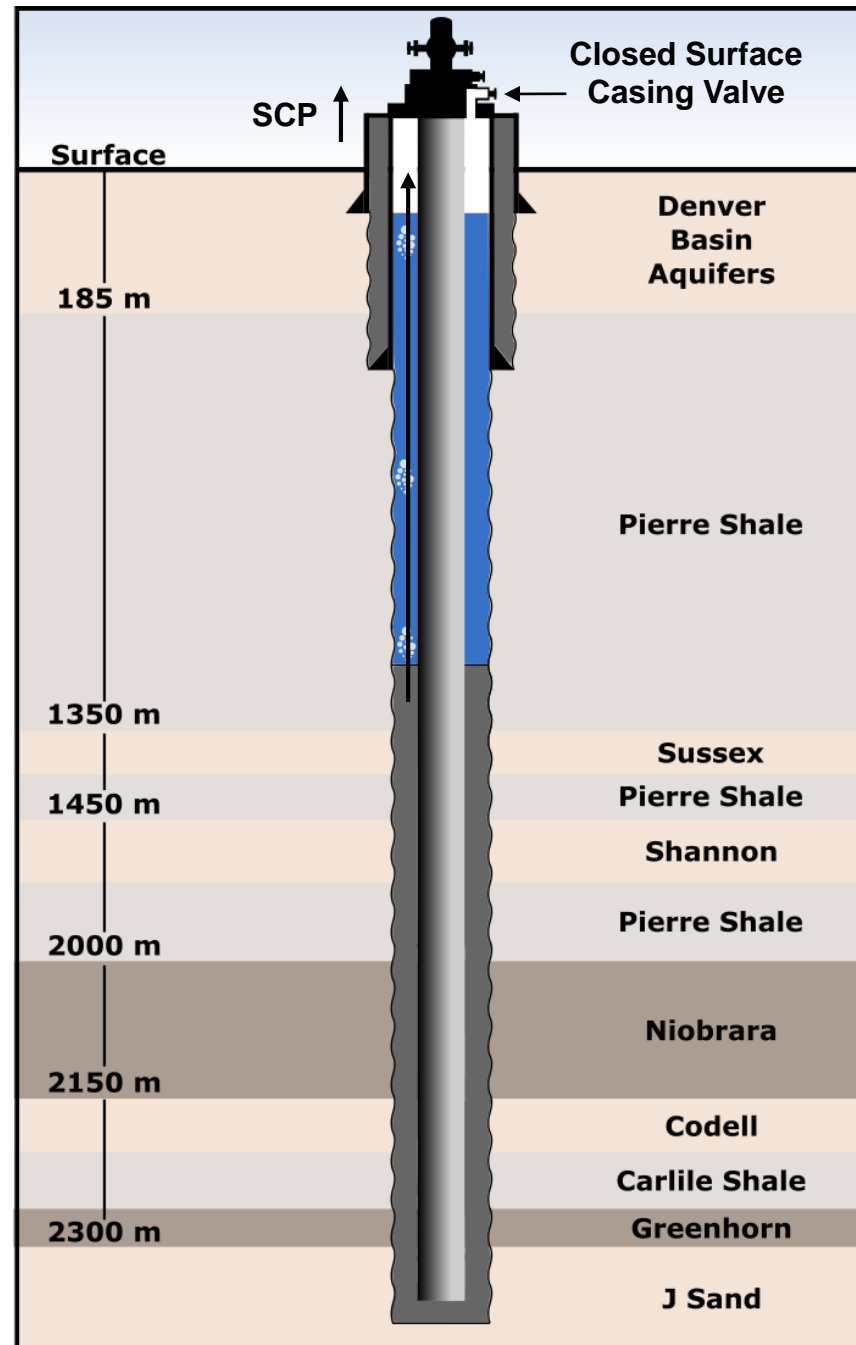
**How did thermogenic stray gas migrate into the shallow subsurface through these culprit wells?**

# Well Leakage

1. Casing leak
2. Unknown intermediate
3. Faulty cement seal or improper cement coverage

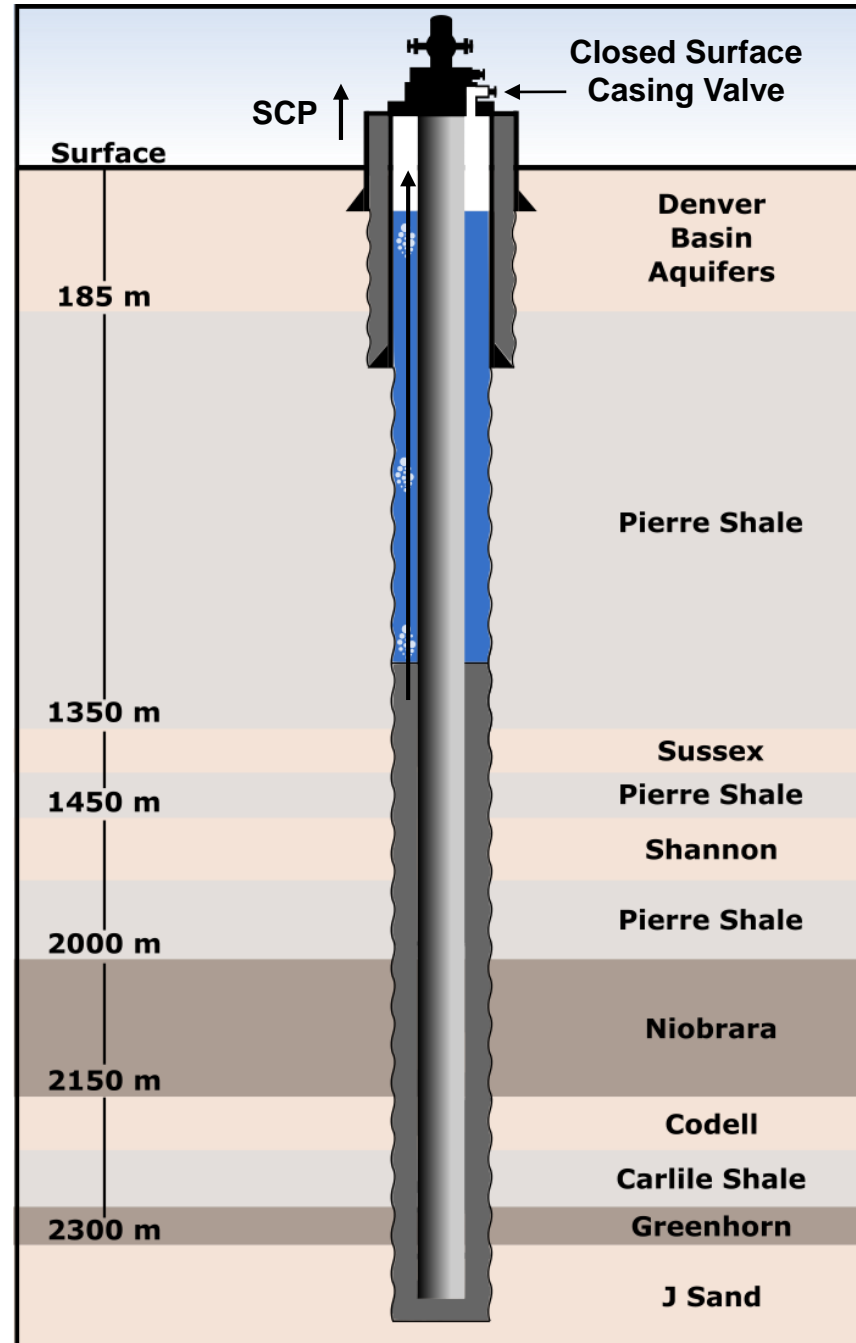


# Sustained Casing Pressure (SCP)



# Sustained Casing Pressure (SCP)

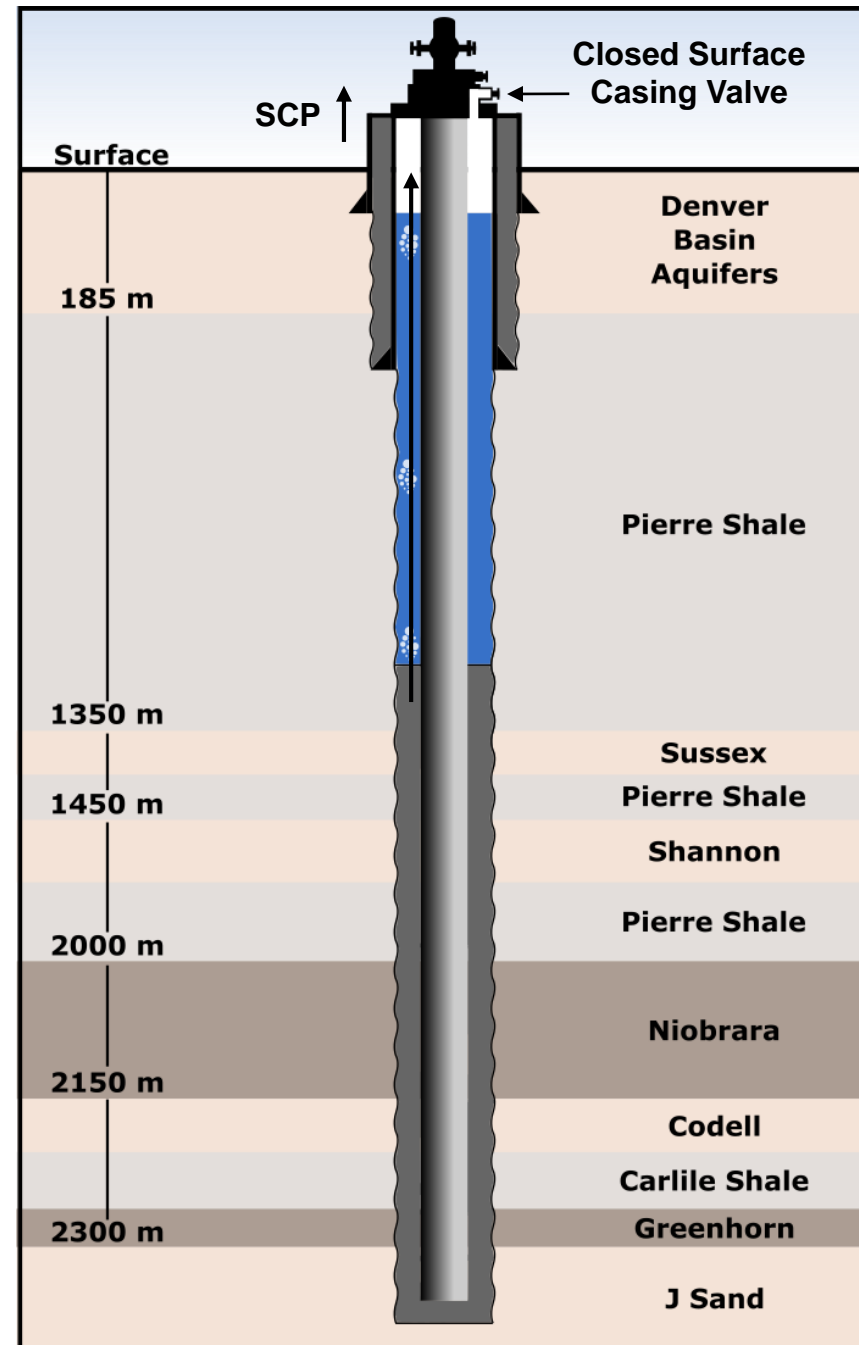
Sustained annular pressure (SAP),  
bradenhead pressure, surface  
casing vent flow (SCVF)



# Sustained Casing Pressure (SCP)

Sustained annular pressure (SAP),  
bradenhead pressure, surface  
casing vent flow (SCVF)

Should be no SCP in a properly  
functioning well

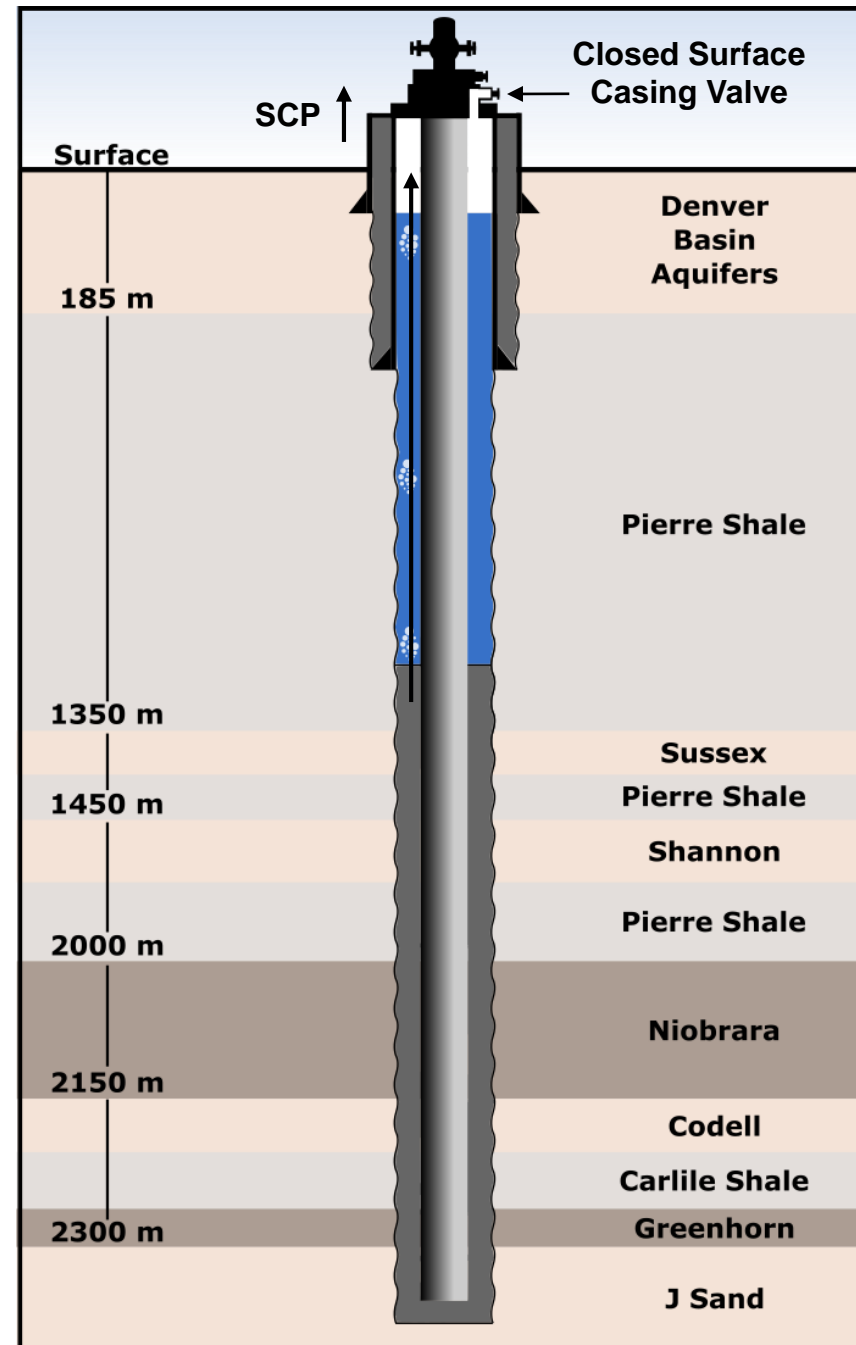


# Sustained Casing Pressure (SCP)

Sustained annular pressure (SAP),  
bradenhead pressure, surface  
casing vent flow (SCVF)

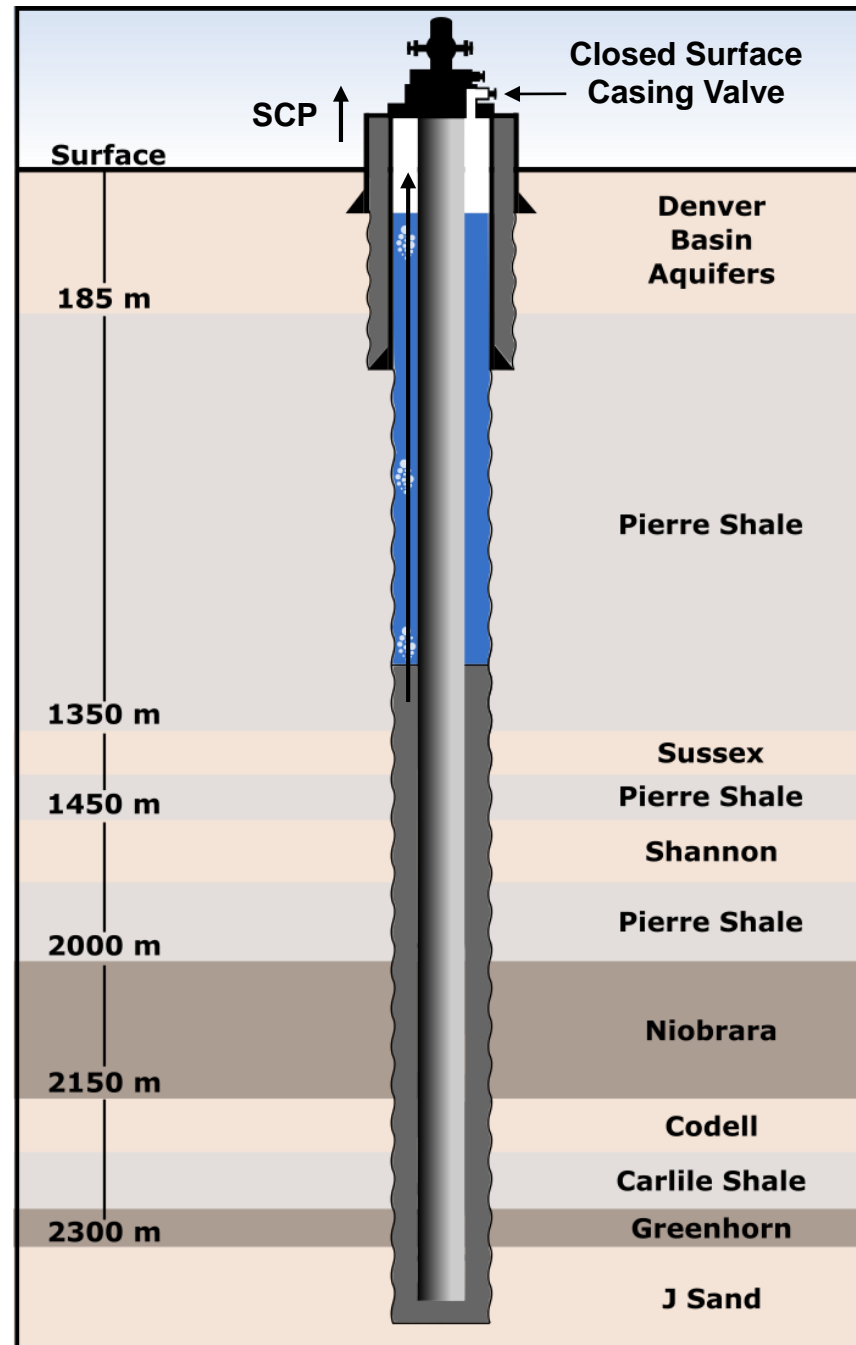
Should be no SCP in a properly  
functioning well

**Sustained casing pressure is an  
easily measured gauge of well  
integrity, but is poorly  
documented**



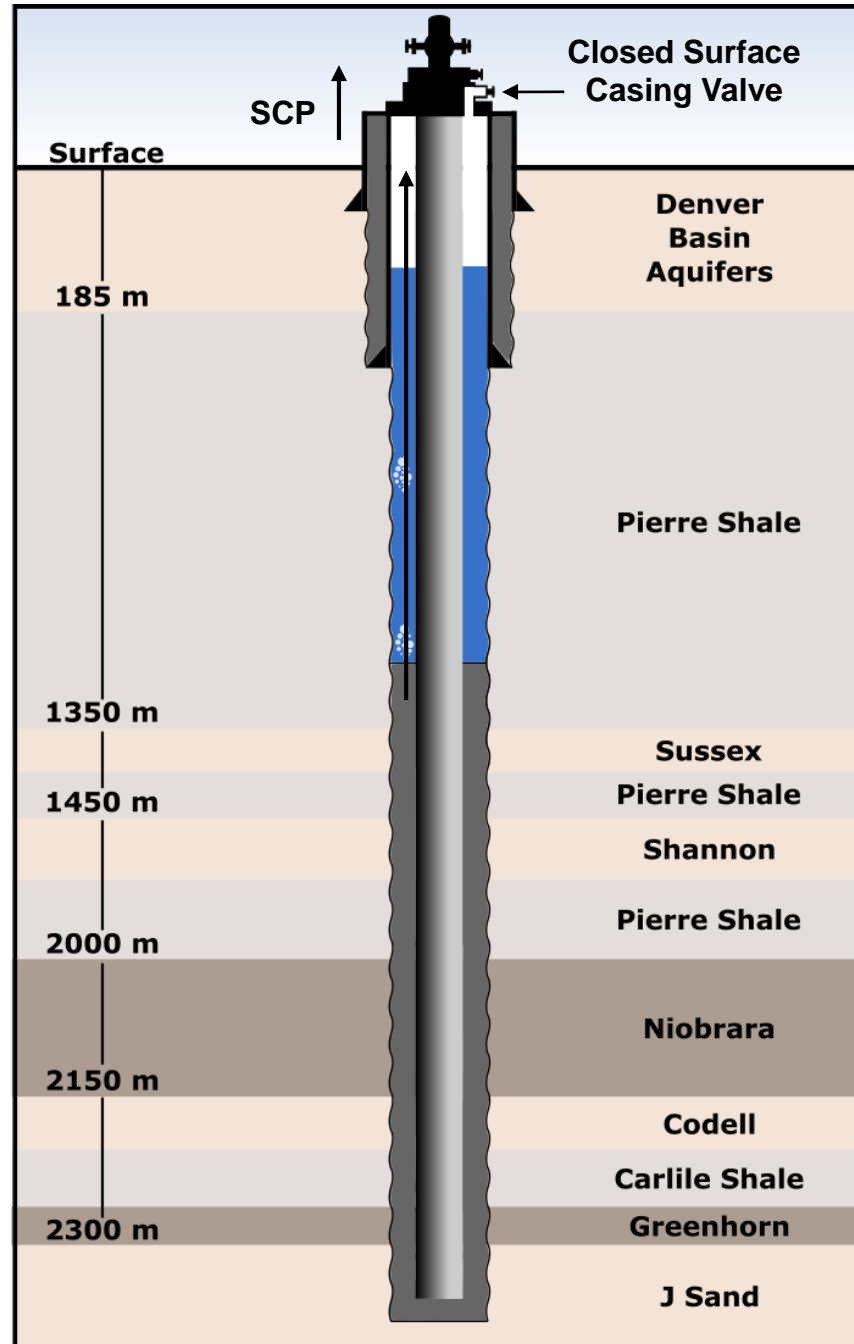


Not all wells that develop SCP  
induce stray gas migration



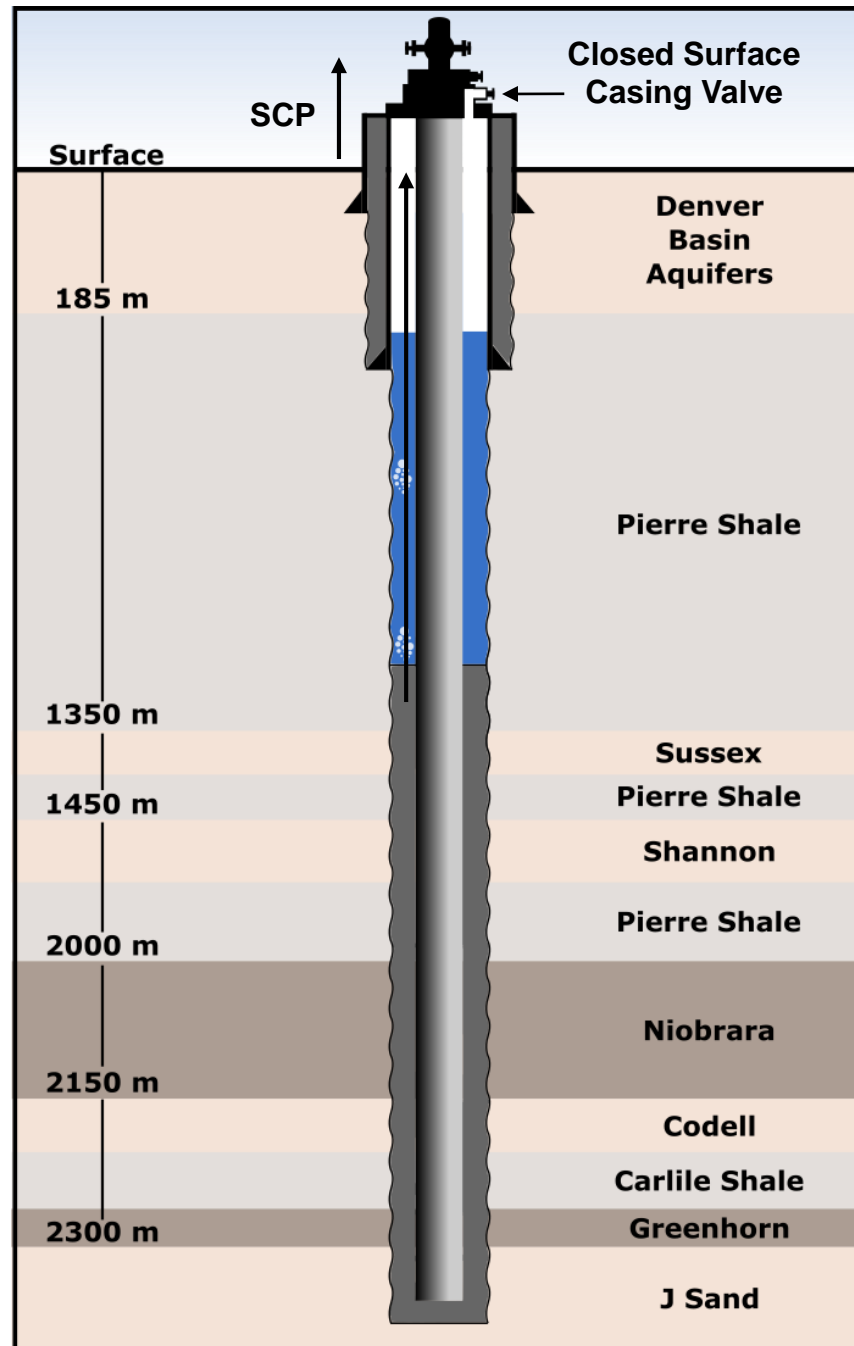
Not all wells that develop SCP  
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As pressure builds annular liquid is  
displaced



Not all wells that develop SCP  
induce stray gas migration

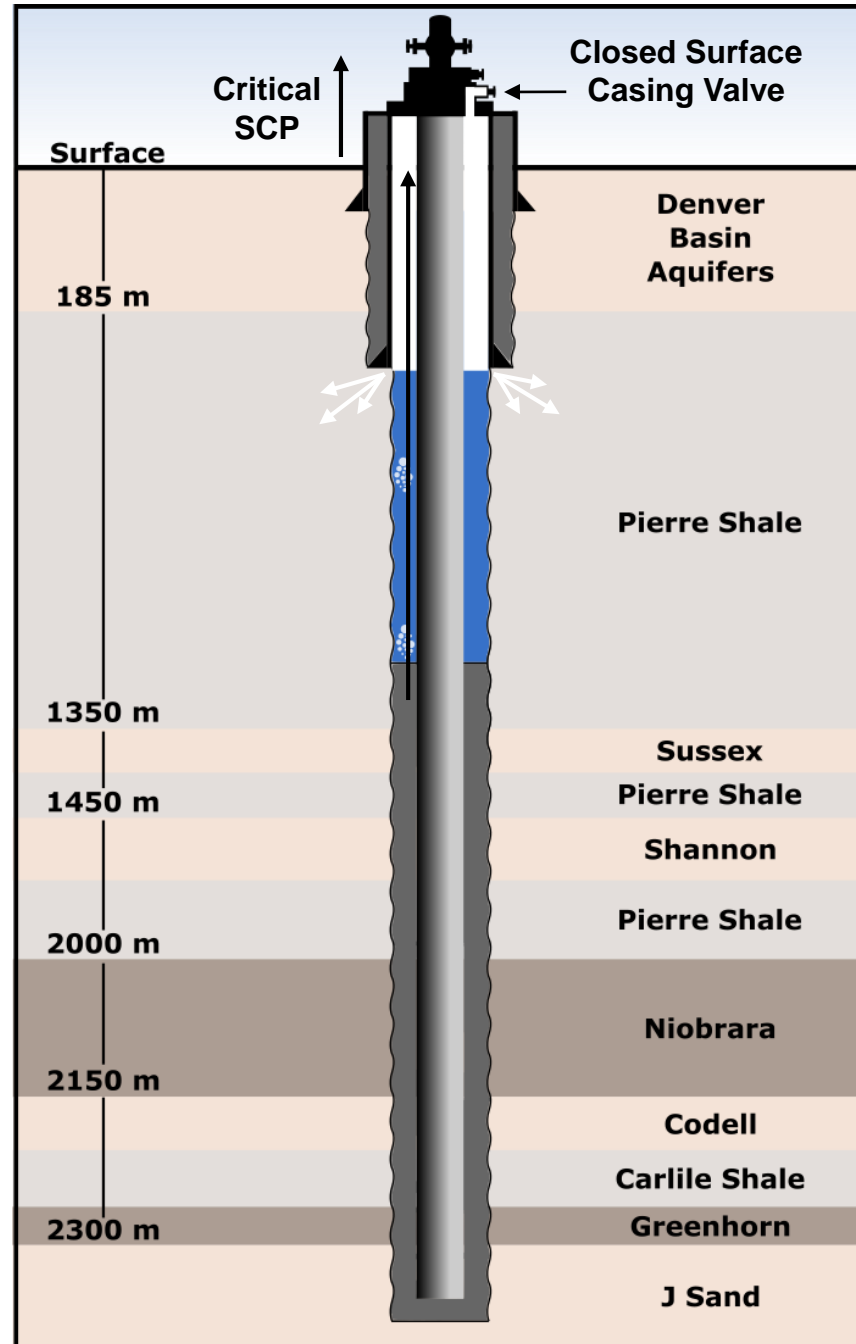
As pressure builds annular liquid is  
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Not all wells that develop SCP  
induce stray gas migration

As pressure builds annular liquid is  
displaced

When SCP = formation fluid  
pressure at bottom of surface  
casing stray gas migration can be  
induced

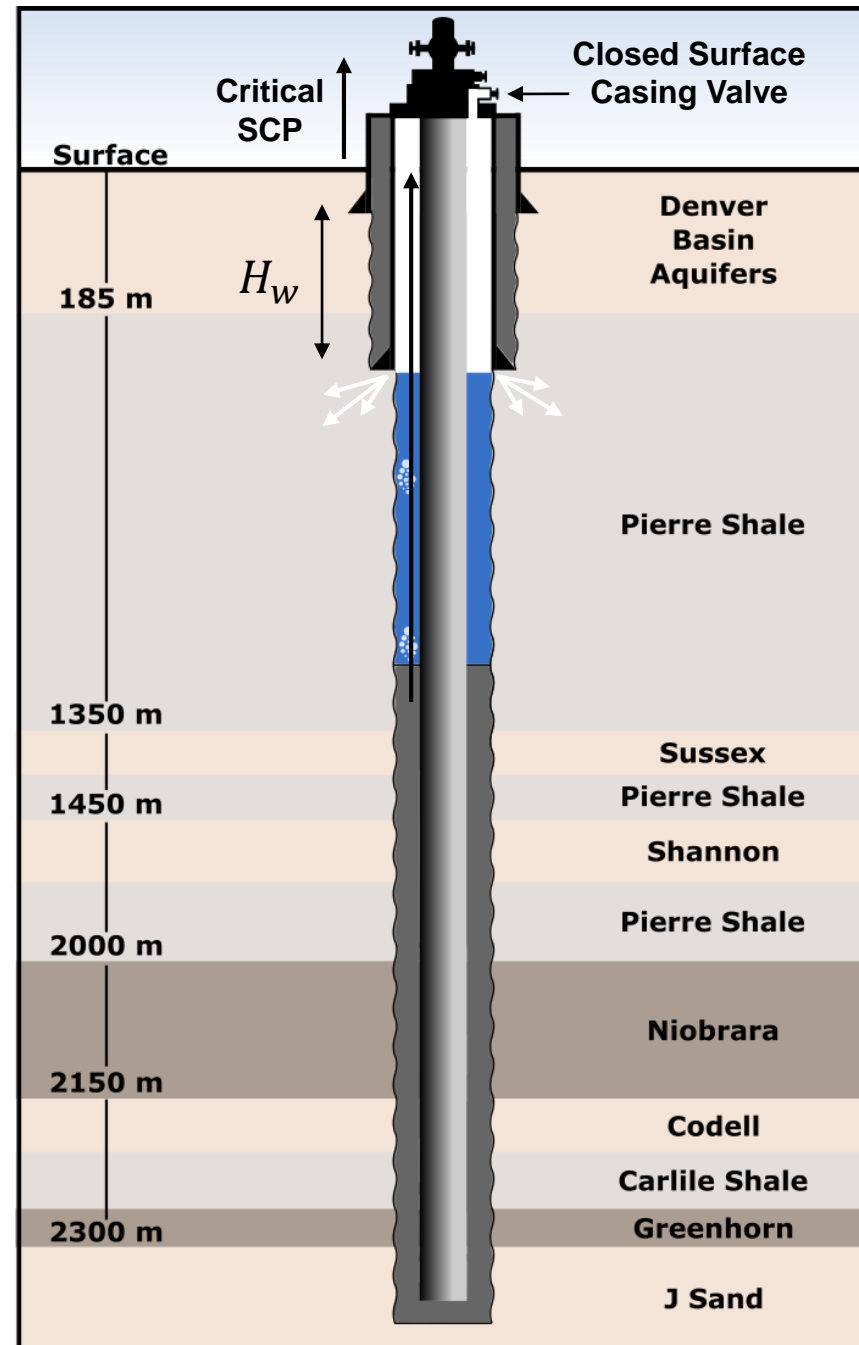


Not all wells that develop SCP  
induce stray gas migration

As pressure builds annular liquid is  
displaced

When SCP = formation fluid  
pressure at bottom of surface  
casing stray gas migration can be  
induced

**Critical sustained casing  
pressure is a well-specific  
physically meaningful  
indicator of stray gas migration**



# Bradenhead Testing

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FORM  
17  
Rev. 8/99

State of Colorado  
Oil and Gas Conservation Commission

1120 Lincoln Street, Suite 801, Denver, Colorado 80203 (303) 894-2100 Fax: (303) 894-2109



FOR OGCC USE ONLY

## BRADENHEAD TEST REPORT

**Step 1.** Record all tubing and casing pressures as found.  
**Step 2.** Sample now, if intermediate or surface casing pressure >25 psi. In sensitive areas, 1 psi.  
**Step 3.** Conduct Bradenhead test.  
**Step 4.** Conduct intermediate casing test.  
**Step 5.** Send report to BLM within 30 days and to OGCC within 10 days. Include wellbore diagram if not previously submitted or if wellbore configuration has changed since prior program. Attach gas and liquid analyses if sampled.

1. OGCC Operator Number: _____	3. BLM Lease No: _____	11. Date of Test: _____
2. Name of Operator: _____	5. Multiple completion? <input type="checkbox"/> Yes <input type="checkbox"/> No	12. Well Status: <input type="checkbox"/> Flowing <input type="checkbox"/> Shut In <input type="checkbox"/> Gas Lift <input type="checkbox"/> Pumping <input type="checkbox"/> Injection <input type="checkbox"/> Clock/Intermitter <input type="checkbox"/> Plunger Lift
4. API Number: _____	6. Well Name: _____ Number: _____	13. Number of Casing Strings: _____ <input type="checkbox"/> Two <input type="checkbox"/> Three <input type="checkbox"/> Liner?
7. Location (Qtr/Qt, Sec, Twp, Rng, Meridian): _____	8. County: _____	
9. Field Name: _____	10. Minerals: <input type="checkbox"/> Fee <input type="checkbox"/> State <input type="checkbox"/> Federal <input type="checkbox"/> Indian	

14. **STEP 1: EXISTING PRESSURES**

Record all pressures as found	Tubing: _____ Fm: _____	Tubing: _____ Fm: _____	Prod. Casing: _____ Fm: _____	Intermediate Csg: _____	Surface Casing: _____	15. <b>STEP 2: See instructions above.</b>
-------------------------------	----------------------------	----------------------------	----------------------------------	-------------------------	-----------------------	--

16. **STEP 3: BRADENHEAD TEST**

Buried valve?  Yes  No Confirmed open?  Yes  No

With gauges monitoring production, intermediate casing and tubing pressures, open surface casing (bradenhead) valve (if no intermediate casing, monitor only the production casing and tubing pressures.) Record pressures at five minute intervals. Define characteristics of flow in "Bradenhead Flow" column using letter designations below:  
 O = No Flow; C = Continuous; D = Down to 0; V = Vapor  
 H = Water H2O; M = Mud; W = Whisper; S = Surge; G = Gas

BRADENHEAD SAMPLE TAKEN?  
 Yes  No  Gas  Liquid

Character of Bradenhead fluid:  Clear  Fresh  
 Sulfur  Salty  Black  
 Other: (describe) \_\_\_\_\_

Sample cylinder number: \_\_\_\_\_

Elapsed Time (Min:Sec)	Fm. _____ Tubing:	Fm. _____ Tubing:	Production Casing PSIG	Intermediate Casing PSIG	Bradenhead Flow:
00:					
05:					
10:					
15:					
20:					
25:					
30:					

Note instantaneous Bradenhead PSIG at end of test. > \_\_\_\_\_

17. **STEP 4: INTERMEDIATE CASING TEST**

Buried valve?  Yes  No Confirmed open?  Yes  No

With gauges monitoring production casing and tubing pressures, open the intermediate casing valve. Record pressures at five minute intervals. Characterize flow in

Elapsed Time (Min:Sec)	Fm. _____ Tubing:	Fm. _____ Tubing:	Production Casing PSIG	Intermediate Casing PSIG	Intermediate Flow
00:					
05:					


# Bradenhead Testing

- Pressure measured as found on surface casing

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**State of Colorado**  
**Oil and Gas Conservation Commission**  
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FOR OGCC USE ONLY

### BRADENHEAD TEST REPORT

**Step 1.** Record all tubing and casing pressures as found.  
**Step 2.** Sample now, if intermediate or surface casing pressure >25 psi. In sensitive areas, 1 psi.  
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**Step 5.** Send report to BLM within 30 days and to OGCC within 10 days. Include wellbore diagram if not previously submitted or if wellbore configuration has changed since prior program. Attach gas and liquid analyses if sampled.

1. OGCC Operator Number: _____			3. BLM Lease No: _____			11. Date of Test: _____	
2. Name of Operator: _____			5. Multiple completion? <input type="checkbox"/> Yes <input type="checkbox"/> No			12. Well Status: <input type="checkbox"/> Flowing <input type="checkbox"/> Shut In	
4. API Number: _____			6. Well Name: _____ Number: _____			<input type="checkbox"/> Gas Lift <input type="checkbox"/> Pumping <input type="checkbox"/> Injection	
7. Location (Qtr/Qt, Sec, Twp, Rng, Meridian): _____			8. County: _____			<input type="checkbox"/> Clock/Intermitter	
9. Field Name: _____			10. Minerals: <input type="checkbox"/> Fee <input type="checkbox"/> State <input type="checkbox"/> Federal <input type="checkbox"/> Indian			<input type="checkbox"/> Plunger Lift	
13. Number of Casing Strings: _____			14. STEP 1: EXISTING PRESSURES			15. STEP 2: See instructions above.	
Record all pressures as found		Tubing: _____ Fm: _____	Tubing: _____ Fm: _____	Prod. Casing: _____ Fm: _____	Intermediate Csg: _____	Surface Casing: _____	

**STEP 3: BRADENHEAD TEST**

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	Tubing	Tubing			
00:					
05:					
10:					
15:					
20:					
25:					
30:					

Note instantaneous Bradenhead PSIG at end of test. > \_\_\_\_\_

**STEP 4: INTERMEDIATE CASING TEST**

Buried valve?  Yes  No Confirmed open?  Yes  No

With gauges monitoring production casing and tubing pressures, open the intermediate casing valve. Record pressures at five minute intervals. Characterize flow in

Elapsed Time (Min:Sec)	Fm: _____		Production Casing PSIG	Intermediate Casing PSIG	Intermediate Flow
	Tubing	Tubing			
00:					
05:					
10:					
15:					
20:					
25:					
30:					

# Bradenhead Testing


- Pressure measured as found on surface casing
- Instantaneous pressure measured at the end of the test

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**Oil and Gas Conservation Commission**

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### BRADENHEAD TEST REPORT

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4. API Number: _____				6. Well Name: _____ Number: _____				13. Number of Casing Strings: <input type="checkbox"/> Two <input type="checkbox"/> Three <input type="checkbox"/> Liner?			
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10. Minerals: <input type="checkbox"/> Fee <input type="checkbox"/> State <input type="checkbox"/> Federal <input type="checkbox"/> Indian				<b>STEP 1: EXISTING PRESSURES</b>							
Record all pressures as found		Tubing: _____ Fm: _____		Tubing: _____ Fm: _____		Prod. Casing: _____ Fm: _____		Intermediate Csg: _____		Surface Casing: _____	
15. <b>STEP 2: See instructions above.</b>											

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00:					
05:					
10:					
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20:					
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	Tubing	Tubing			
00:					
05:					
10:					
15:					
20:					
25:					
30:					



# Bradenhead Testing


- Pressure measured as found on surface casing
- Instantaneous pressure measured at the end of the test
- Filed as text-based PDFs that can be mined using Python

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Oil and Gas Conservation Commission

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Sample cylinder number: \_\_\_\_\_

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	Tubing	Tubing			
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05:					
10:					
15:					
20:					
25:					
30:					

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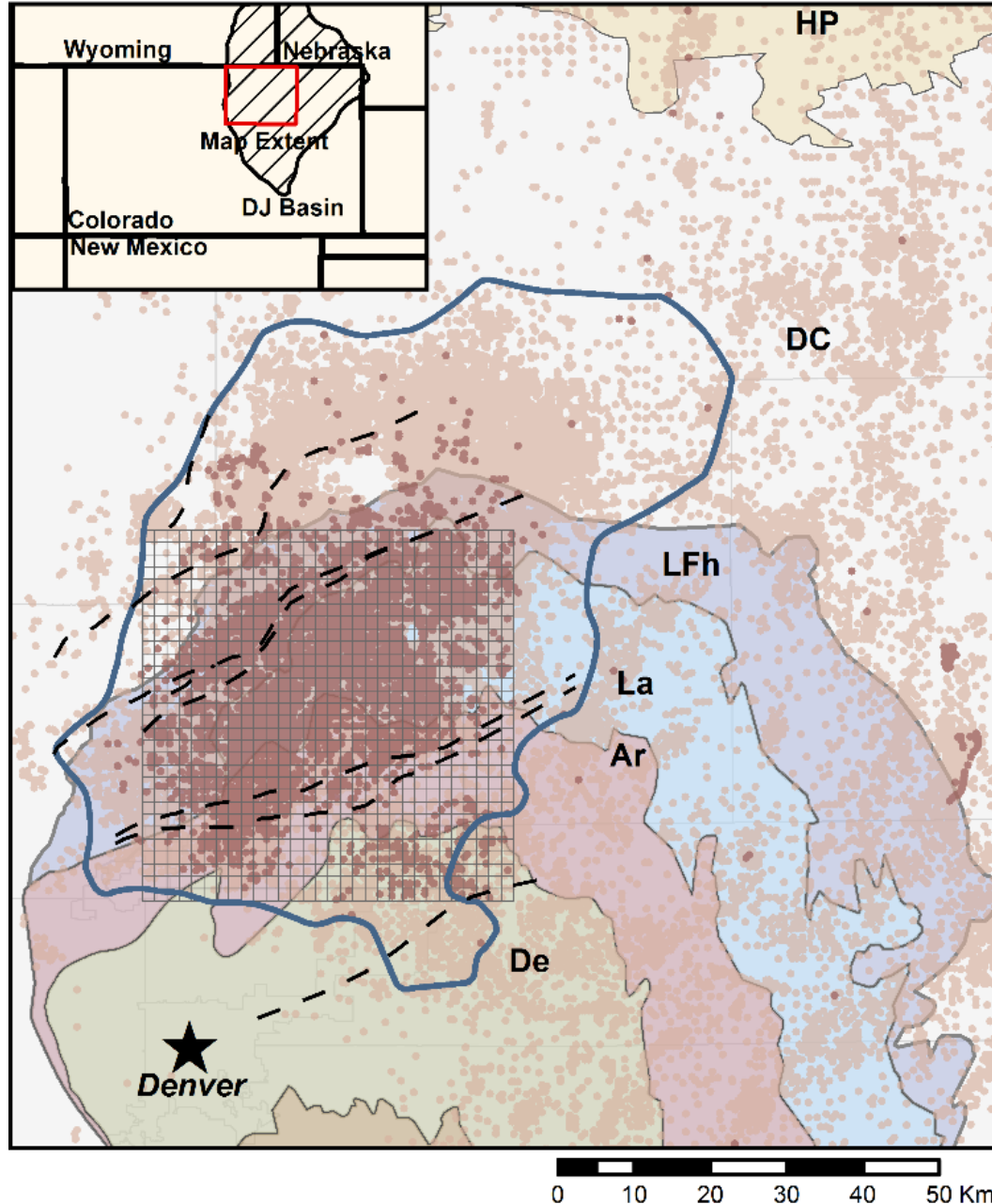
**17. STEP 4: INTERMEDIATE CASING TEST**

Buried valve?  Yes  No Confirmed open?  Yes  No

With gauges monitoring production casing and tubing pressures, open the intermediate casing valve. Record pressures at five minute intervals. Characterize flow in

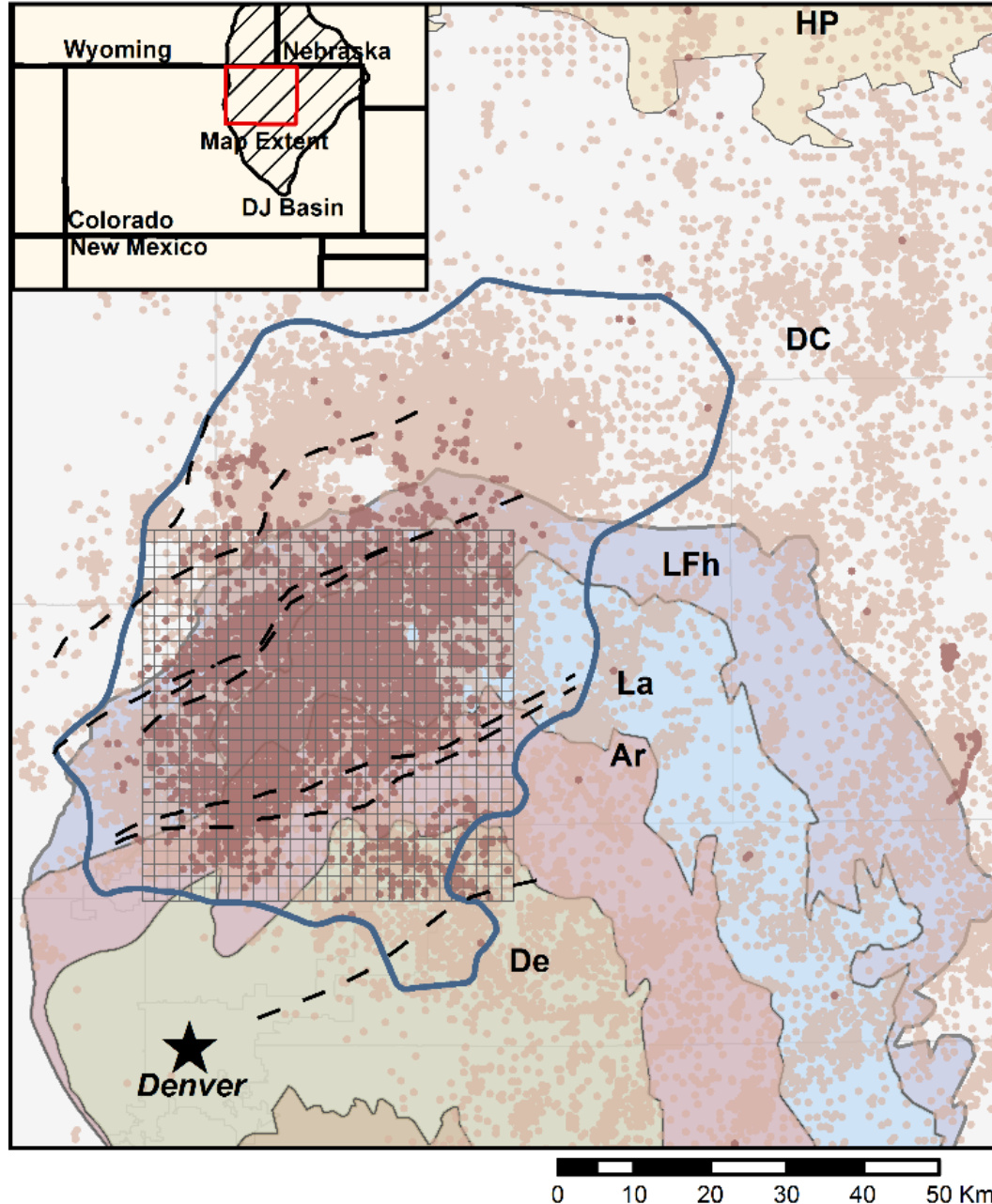
Elapsed Time (Min:Sec)	Fm: _____		Production Casing PSIG	Intermediate Casing PSIG	Intermediate Flow
	Tubing	Tubing			
00:					
05:					

# First Well Integrity Study



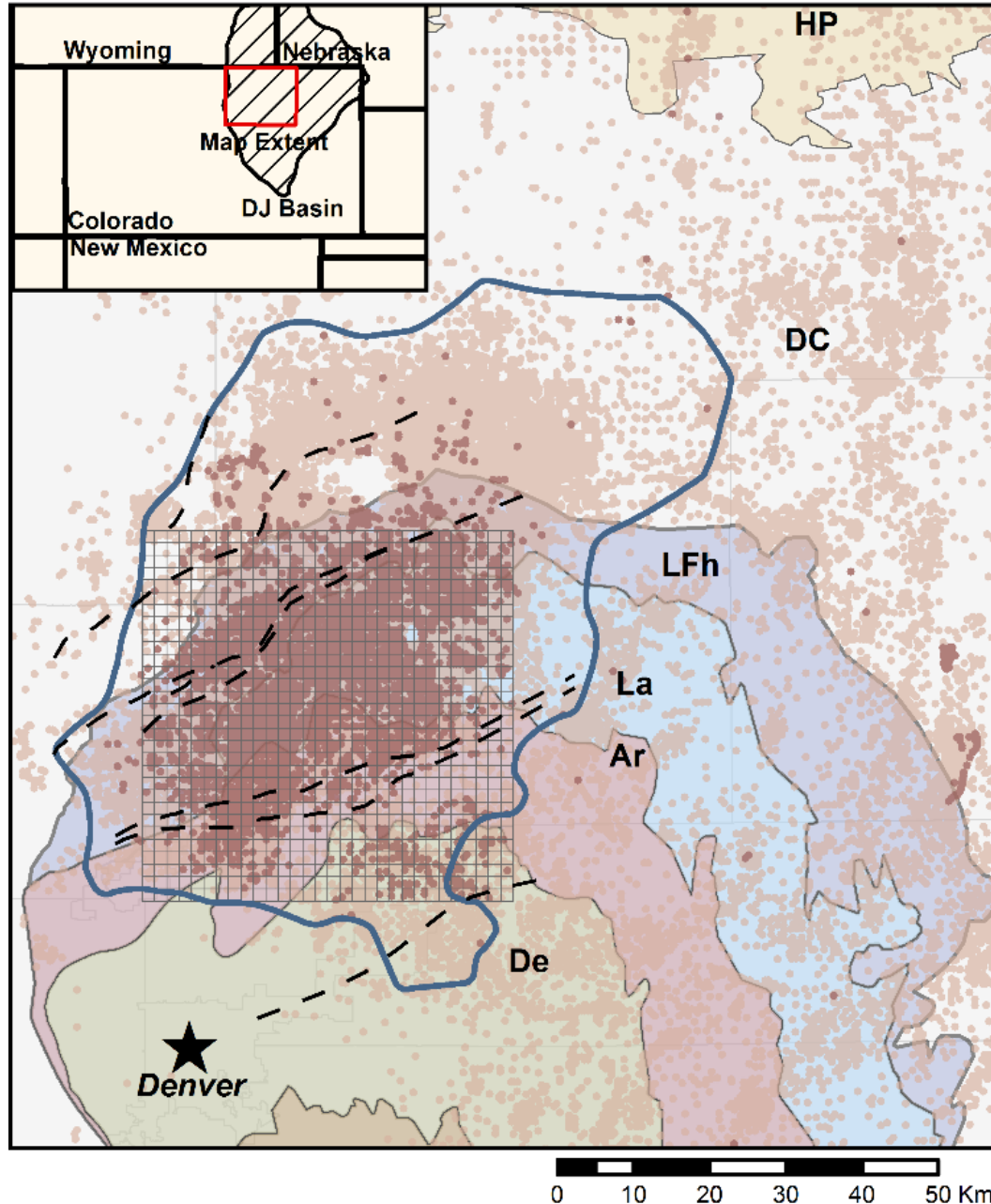
2010 bradenhead testing  
policy establishes  
Wattenberg Test Zone (WTZ)

# First Well Integrity Study



2010 bradenhead testing  
policy establishes  
Wattenberg Test Zone (WTZ)  
3,923 readable bradenhead  
tests (after QA/QC)

# First Well Integrity Study

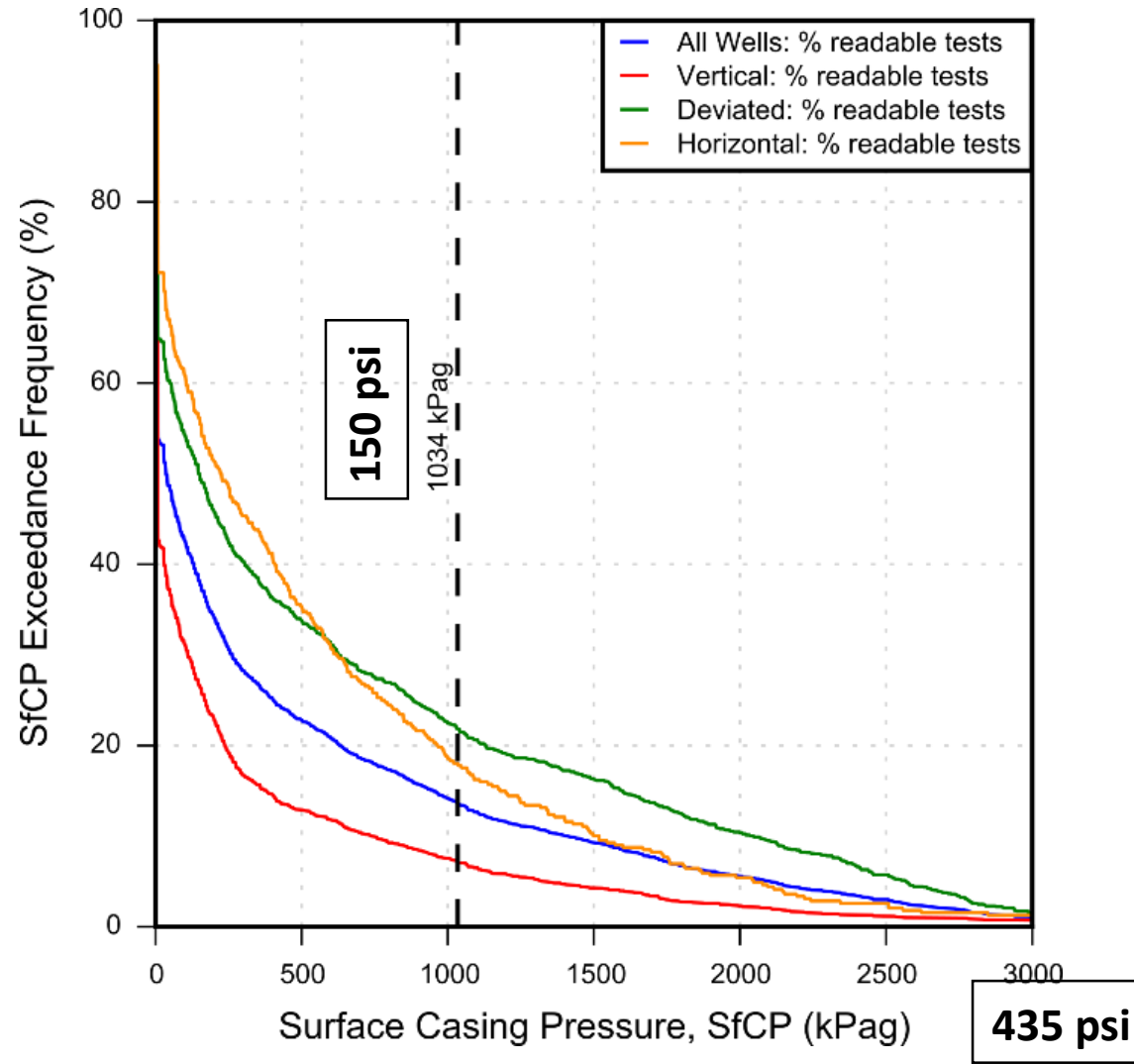


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3,923 readable bradenhead  
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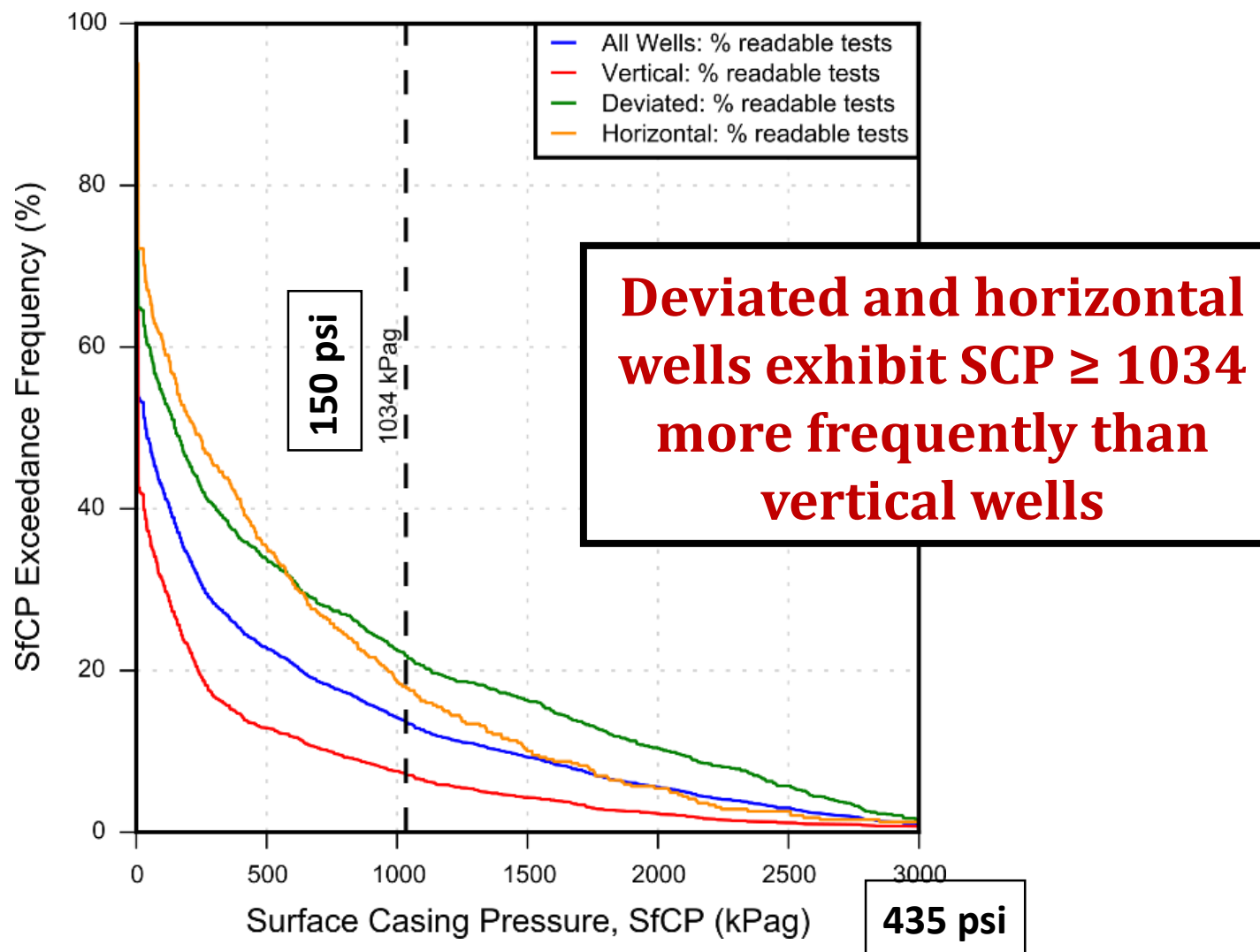
Paired with QA/QC well  
construction data

# How Many Wells Have SCP?

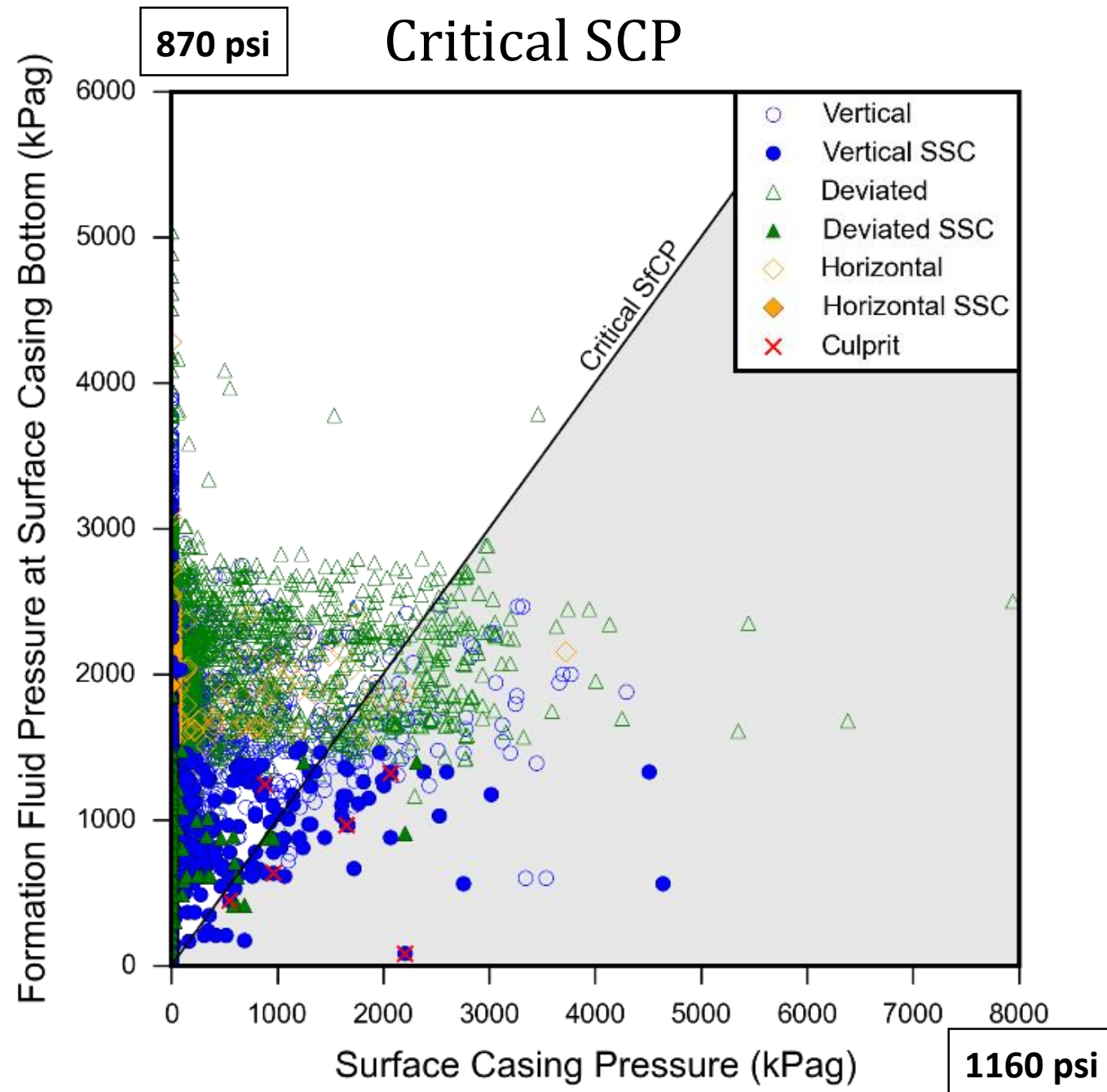


All Wells (13.8%), Vertical Wells (7.4%), Deviated Wells (21.9%), and Horizontal Wells (18%)

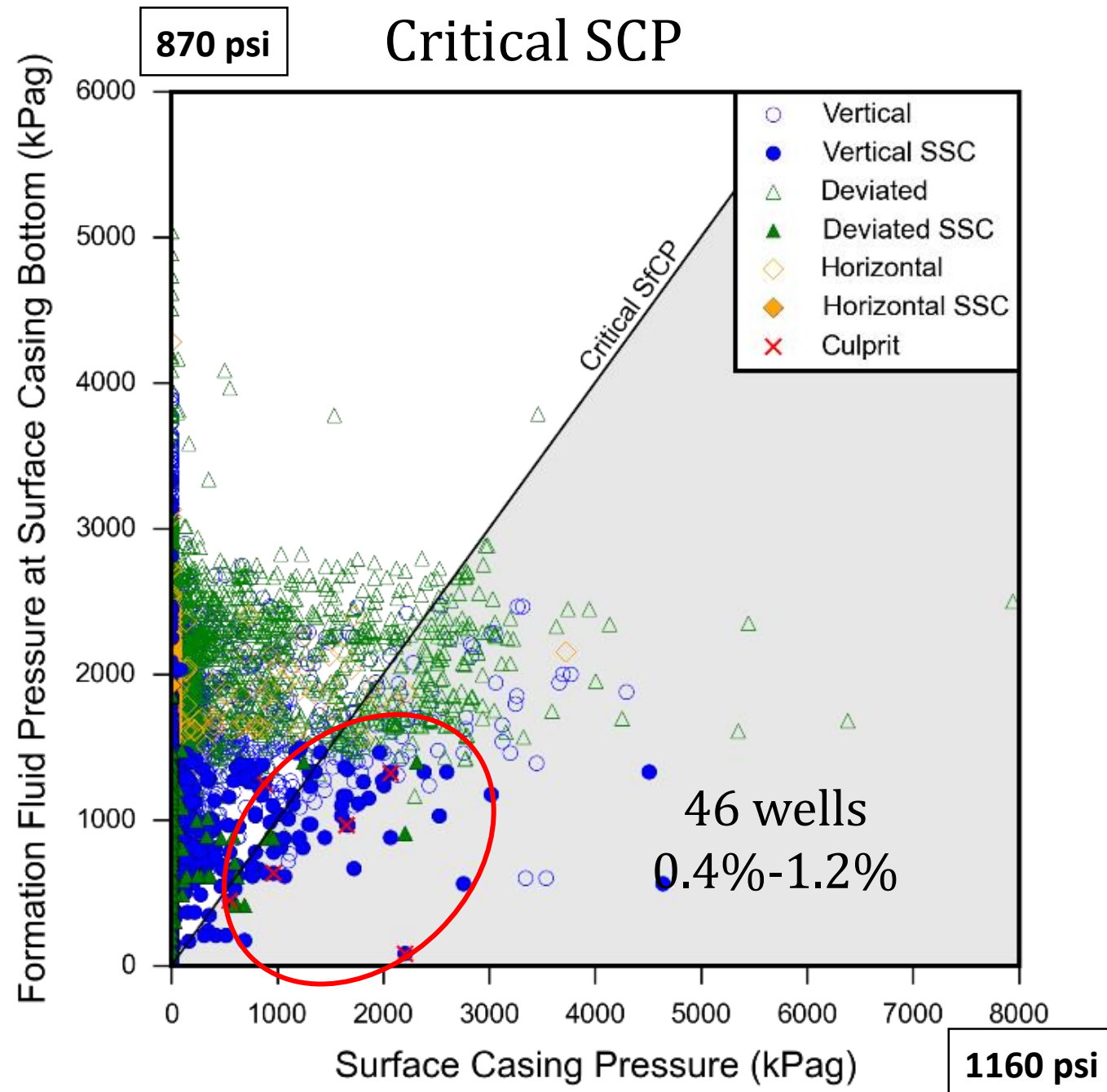
# How Many Wells Have SCP?



All Wells (13.8%), Vertical Wells (7.4%), Deviated Wells (21.9%), and Horizontal Wells (18%)



Critical SCP typically increases with surface casing depth



Critical SCP typically increases with surface casing depth

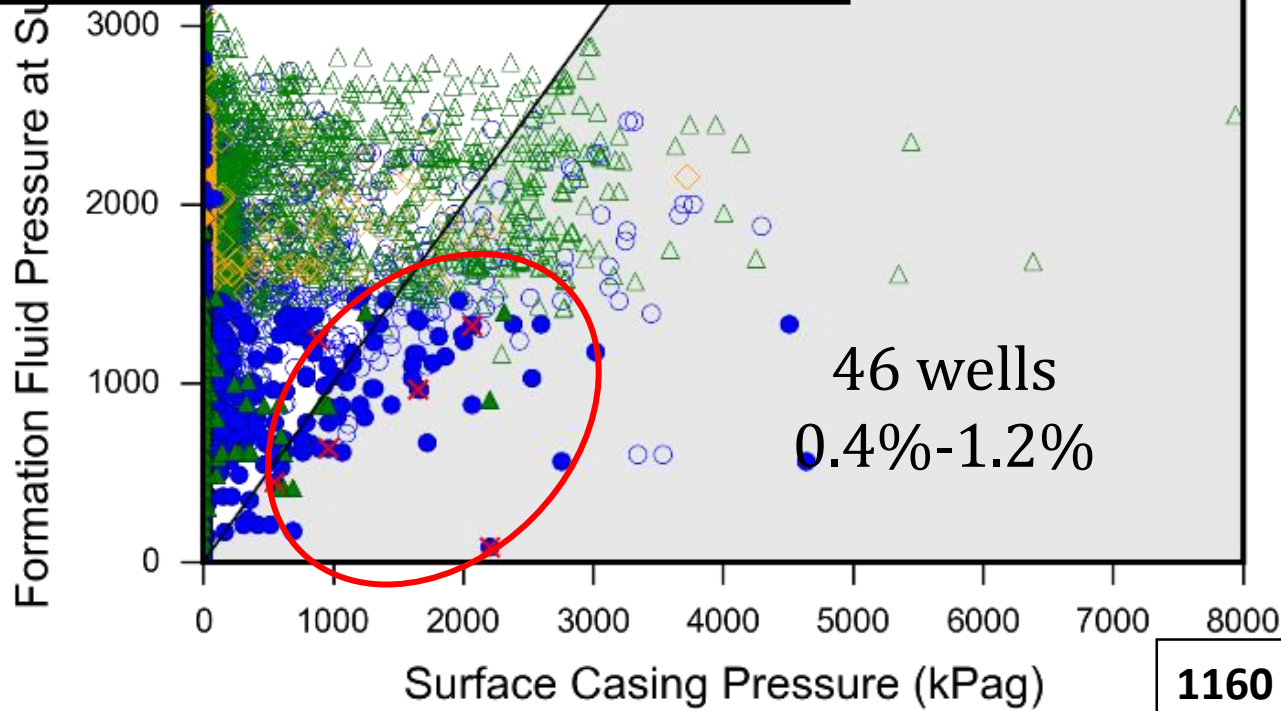


# Critical SCP

870 psi

**Newer horizontal wells, built with deeper surface casings that exceed current regulations, pose a lower risk for inducing stray gas migration than older vertical wells**

- Vertical
- Vertical SSC
- △ Deviated
- ▲ Deviated SSC
- ◇ Horizontal
- ◆ Horizontal SSC
- × Culprit



Critical SCP typically increases with surface casing depth

# New Mexico

The screenshot shows the homepage of the New Mexico Oil Conservation Division. At the top left is the state seal, which features a yellow cross on a red background, with a black oil derrick and a green landscape below it. The text 'STATE OF NEW MEXICO' is at the top and 'OIL CONSERVATION DIVISION' is at the bottom of the seal. To the right of the seal is a navigation menu with links: 'About OCD', 'Contact OCD', 'FAQs', 'Oil Field Education', and 'Brine Well Info'. Below this is a secondary menu with links: 'Home', 'Bureaus', 'Rules', 'Forms', 'OCD Online', 'OCD GIS', 'Hearings', 'Statistics', and 'Publications'. The main content area consists of five vertical panels. The first panel shows an oil pumpjack with a document icon below it and the text 'Announcements Notifications' and 'Click Here to Learn More'. The second panel shows a close-up of a wellhead with an information icon below it and the text 'Outreach and Training' and 'Click Here to Learn More'. The third panel shows a wellhead with a scale icon below it and the text 'Hearings' and 'Click Here to Learn More'. The fourth panel shows a large rusted metal tank with an information icon below it and the text 'Oil and Gas Education' and 'Click Here to Learn More'. The fifth panel shows a pressure gauge.

<http://www.emnrd.state.nm.us/oed/>)

# New Mexico



NEW MEXICO ENERGY, MINERALS  
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION  
2000 UNIVERSITY BLVD., N.E.  
ALBUQUERQUE, NEW MEXICO 87102  
PHONE: 505-341-4171 FAX: 505-341-4170  
http://www.oilconservation.state.nm.us

## BRADENHEAD TEST REPORT

(submit 1 copy to storage address)

Date of Test 10-27-11 Operator Conrad Williams API # 30-045-23745  
 Property Name Slain Comb Well No. 348 Location Unit \_\_\_\_\_ Section 36 Township 32 Range 12  
 Well Status (Shut-In or Producing) 0 Initial PSI: Tubing 145 Intermediate 111 Casing 118 Bradenhead 133

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE				FLOW CHARACTERISTICS	
	Bradenhead		INTERM.		BRADENHEAD	INTERMEDIATE
	BH	Inl	Csg	Inl	Csg	
5 min	0		143			Steady Flow
10 min	0		143			Surge
15 min	0		103			Down to Nothing
20 min						Nothing
25 min						Gas
30 min						Gas & Water
						Water

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR \_\_\_\_\_ OILY \_\_\_\_\_ SALTY \_\_\_\_\_ SULFUR \_\_\_\_\_ BLACK \_\_\_\_\_

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0 INTERMEDIATE 111

REMARKS: SH to vapor in 10 seconds - to nothing in 15

By [Signature]

Witness Monica Kuhlberg

(Position)

E-mail address

RCVD JUN 22 '11  
OIL CONG. DIV.  
DIST. 3

# New Mexico Challenges



NEW MEXICO ENERGY, MINERALS  
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION  
ACTING DISTRICT OFFICE  
3000 I-40 BRIDGE ROAD  
SOUTH PLAINS  
SANTA FE, NM 87505  
(505) 336-6170 FAX: (505) 336-6170  
http://www.oilconservation.state.nm.us

## BRADENHEAD TEST REPORT

(submit 1 copy to above address)

Date of Test 10-27-11 Operator ConocoPhillips API #30-0 45-23745  
Property Name Slack Camp Well No. 548 Location: Unit      Section 36 Township 32 Range 12  
Well Status (Shut-In or Producing) Initial PSI: Tubing 145 Intermediate N/A Casing 148 Bradenhead 135

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	Bradenhead BH	Bradenhead Int	INTERM Csg	BRADENHEAD	INTERMEDIATE
5 min	0	143		Steady Flow	
10 min	0	143		Surges	
15 min	0	143		Down to Nothing	✓
20 min				Nothing	
25 min				Gas	
30 min				Gas & Water	
				Water	

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR  FRESH  SALTY  SULFUR  BLACK

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0 INTERMEDIATE N/A

REMARKS: Bl to vapors in 40 seconds. - to nothing in 15

By [Signature] Witness Monica Kuhlberg MOVED JUN 22 '11  
OIL CONSERV. DIV. DIST. 3  
E-mail address: \_\_\_\_\_



NEW MEXICO ENERGY, MINERALS  
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION  
ACTING DISTRICT OFFICE  
3000 I-40 BRIDGE ROAD  
SOUTH PLAINS  
SANTA FE, NM 87505  
(505) 336-6170 FAX: (505) 336-6170  
http://www.oilconservation.state.nm.us

OIL CONSERV. DIV. DIST. 3

OCT 08 2015

## BRADENHEAD TEST REPORT

(submit 1 copy to above address)

Date of Test 10-8-15 Operator BP America API #30-0 45-20006  
Property Name Guo disposal Well No. 259 Location: Unit P Section 14 Township 28 Range 12  
Well Status (Shut-In or Producing) Initial PSI: Tubing 160 Intermediate N/A Casing 0 Bradenhead 0

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	Bradenhead BH	Bradenhead Int	INTERM Csg	BRADENHEAD	INTERMEDIATE
5 min	0	0		Steady Flow	
10 min	0	0		Surges	
15 min	0	0		Down to Nothing	
20 min				Nothing	✓
25 min				Gas	
30 min				Gas & Water	
				Water	

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR  FRESH  SALTY  SULFUR  BLACK

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0 INTERMEDIATE N/A

REMARKS: Nothing when opened.  
(Nothing when opened after 5 min shut in

By Debra Dyer / ISP Witness Monica Kuhlberg

(Position)

E-mail address \_\_\_\_\_

2.25 million documents labeled only by API# and all are scanned images (~600,000 of interest)

# New Mexico Challenges



NEW MEXICO ENERGY, MINERALS  
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION  
ACTING DISTRICT OFFICE  
3000 P.O. BOX 2000  
SOUTH PLAZA  
SANTA FE, NM 87501  
(505) 336-6170 FAX: (505) 336-6170  
http://www.oilconservation.com

## BRADENHEAD TEST REPORT

(submit 1 copy to above address)

Date of Test 10-27-11 Operator ConocoPhillips API #30-0 45-23745  
Property Name Slack Camp Well No. 548 Location: Unit      Section 36 Township 32 Range 12  
Well Status (Shut-In or Producing) Initial PSI: Tubing 145 Intermediate N/A Casing 148 Bradenhead 135

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	Bradenhead	INTERM	INTERM		
	BH	Int	Csg	BRADENHEAD	INTERMEDIATE
5 min	0		143		Steady Flow
10 min	0		143		Surge
15 min	0		143		Down to No
20 min					Nothing
25 min					Gas
30 min					Gas & Water
					Water

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR  FRESH  SALTY  SOILY

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0

REMARKS: BH to vapors in 40 seconds - no nothing in IS

By          Witness Monica Kurling MOVED JUN 22 '11  
(Position) OIL CONG. DIV. DIST. 3  
E-mail address:         



NEW MEXICO ENERGY, MINERALS  
& NATURAL RESOURCES DEPARTMENT

OIL CONSERVATION DIVISION  
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3000 P.O. BOX 2000  
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SANTA FE, NM 87501  
(505) 336-6170 FAX: (505) 336-6170  
http://www.oilconservation.com

OIL CONSERV. DIV. DIST. 3

OCT 08 2015

## BRADENHEAD TEST REPORT

(submit 1 copy to above address)

Date of Test 10-8-15 Operator BP America API #30-0 45-20006  
Property Name Gov disposal Well No. 259 Location: Unit P Section 14 Township 28 Range 12  
Well Status (Shut-In or Producing) Initial PSI: Tubing 160 Intermediate N/A Casing 0 Bradenhead 0

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	Bradenhead	INTERM	INTERM	BRADENHEAD	INTERMEDIATE
	BH	Int	Csg	Int	Csg
5 min	0		0		

Steady Flow           
Nothing           
Water           
below:           
BLACK           
INTERMEDIATE N/A

**How do you sort through hundreds of thousands of image based documents in a reasonable manner?**

Nothing when opened.  
Nothing when opened after 5 min shut in  
By Daniel Dyer / ISP Witness Monica Kurling  
(Position)  
E-mail address:         

2.25 million documents labeled only by API# and all are scanned images (~600,000 of interest)

# TensorFlow



Open source machine learning framework developed by Google

# TensorFlow



Open source machine learning framework developed by Google

Can be used for broad range of machine learning tasks but was developed for deep neural network modeling

# TensorFlow



Open source machine learning framework developed by Google

Can be used for broad range of machine learning tasks but was developed for deep neural network modeling

Commonly used for categorization tasks



# Roughly How it Works

“MobileNet” convolutional neural network

<https://arxiv.org/pdf/1704.04861.pdf>

Already trained using ImageNet (>14 million images)

# Roughly How it Works

“MobileNet” convolutional neural network

<https://arxiv.org/pdf/1704.04861.pdf>

Already trained using ImageNet (>14 million images)

~18,500  
BHTs

45,000  
Other Docs



Retraining

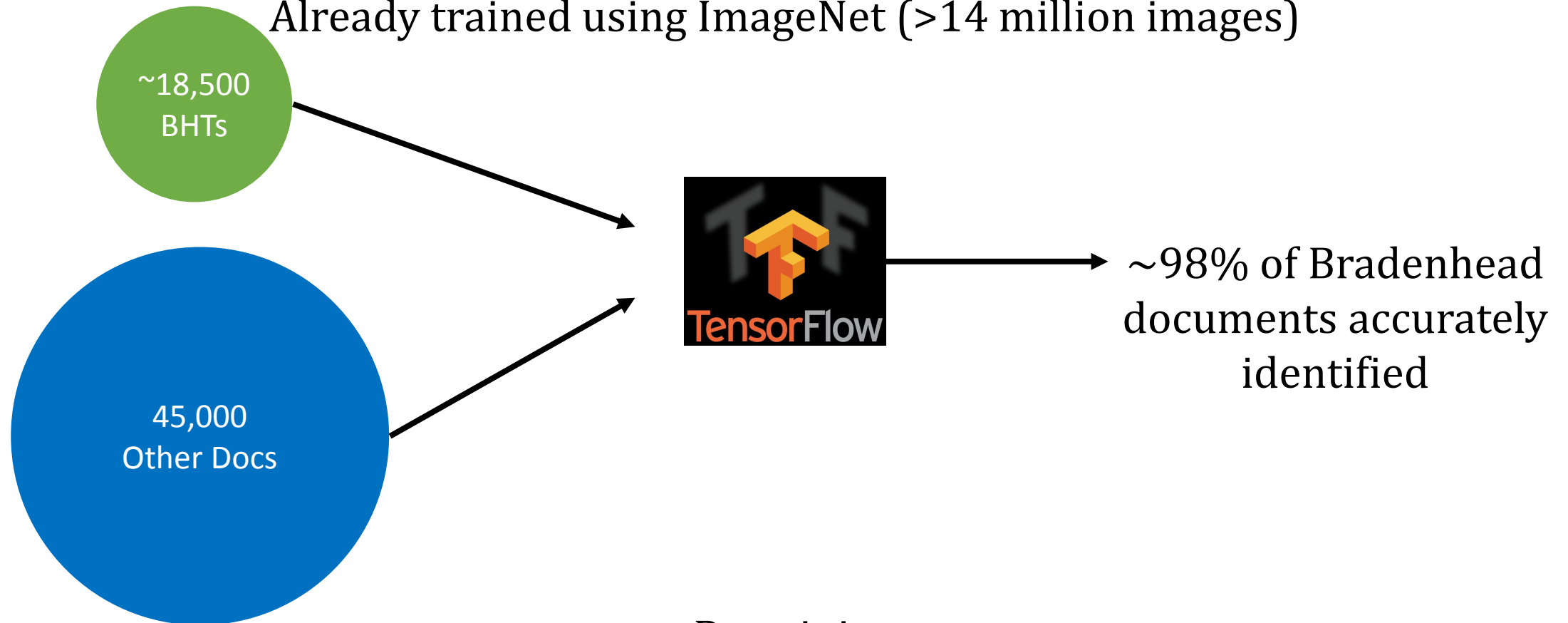
(<https://codelabs.developers.google.com/codelabs/tensorflow-for-poets/#>)

# Roughly How it Works

“MobileNet” convolutional neural network

<https://arxiv.org/pdf/1704.04861.pdf>

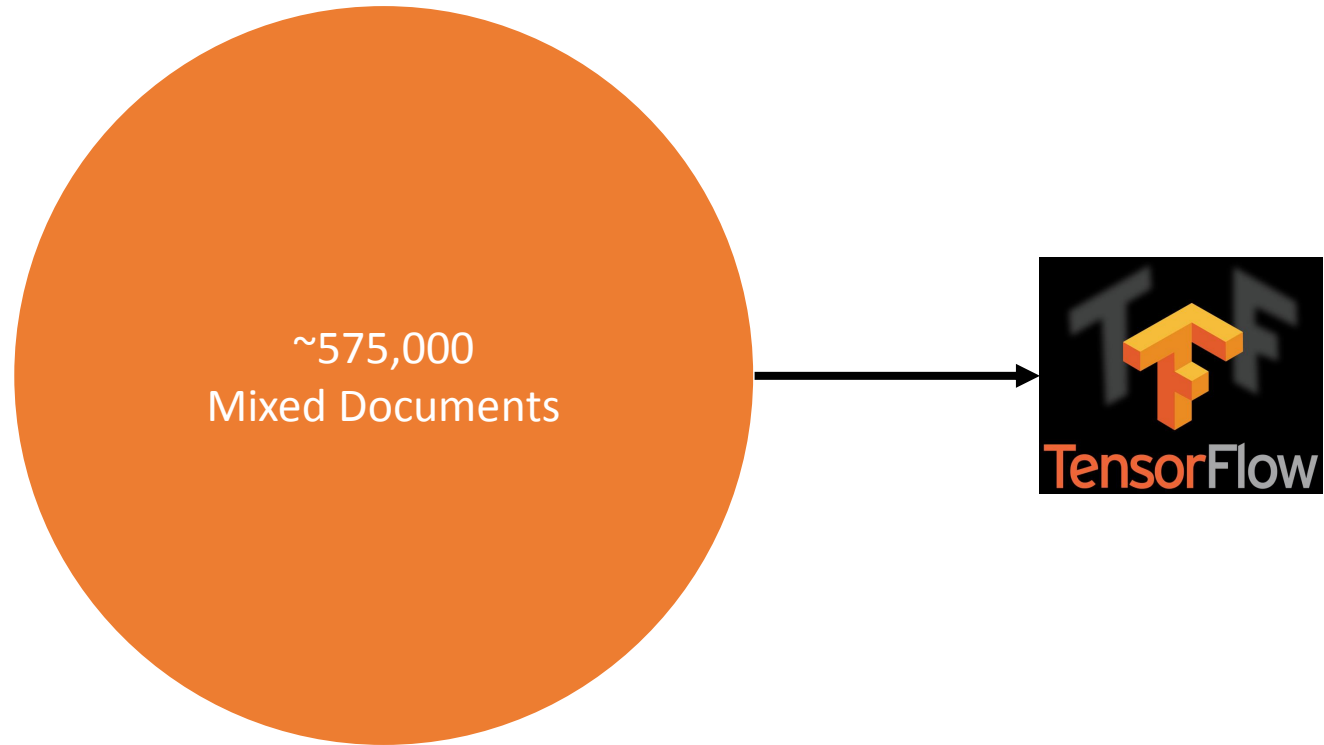
Already trained using ImageNet (>14 million images)



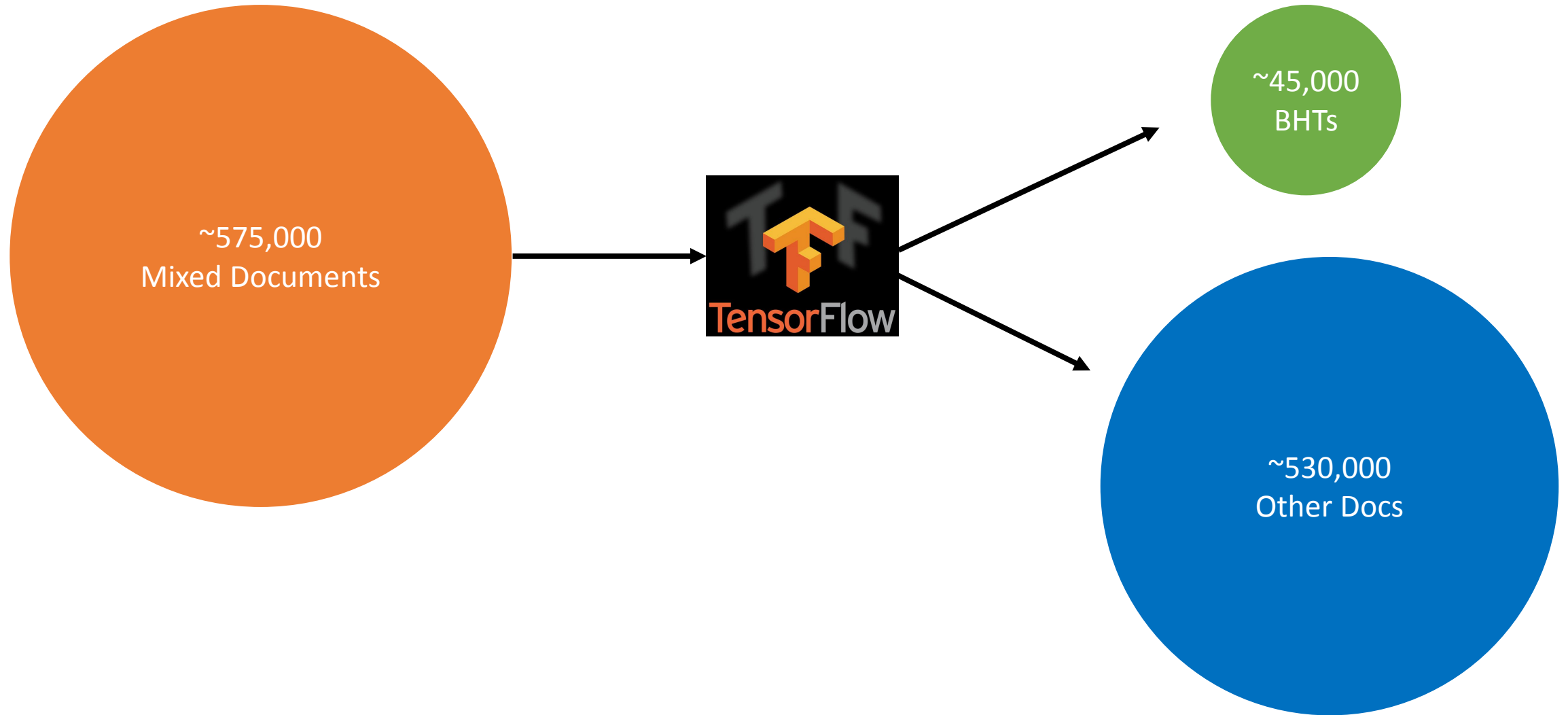
Retraining

(<https://codelabs.developers.google.com/codelabs/tensorflow-for-poets/#>)

# Document Sorting



# Document Sorting



# New Mexico Challenges



NEW MEXICO ENERGY, MINERALS  
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SUTTER, NM 87410  
(505) 336-6170 FAX: (505) 336-6170  
http://www.oilconservation.com

## BRADENHEAD TEST REPORT

(submit 1 copy to above address)

Date of Test 10-27-11 Operator ConocoPhillips API #30-0 45-23745  
Property Name Slack Camp Well No. 548 Location: Unit      Section 36 Township 32 Range 12  
Well Status (Shut-In or Producing) Initial PSI: Tubing 145 Intermediate N/A Casing 148 Bradenhead 135

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	BH	Bradenhead Int	INTERM Csg	BRADENHEAD	INTERMEDIATE
5 min	0		143		
10 min	0		143		
15 min	0		143		
30 min					

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR  FRESH  SALTY  SOILY

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0

REMARKS: Oil to vapors in 40 seconds. - no nothing in 15

By [Signature] Witness Monica Kuhlberg ROAD JUN 22 '11  
OIL CONG. DIV. DIST. 3  
E-mail address: \_\_\_\_\_



NEW MEXICO ENERGY, MINERALS  
& NATURAL RESOURCES DEPARTMENT

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OIL CONSERVATION DIV. DIST. 3

OCT 08 2015

## BRADENHEAD TEST REPORT

(submit 1 copy to above address)

Date of Test 10-8-15 Operator BP America API #30-0 45-20006  
Property Name Gov disposal Well No. 259 Location: Unit P Section 14 Township 28 Range 12  
Well Status (Shut-In or Producing) Initial PSI: Tubing 160 Intermediate N/A Casing 0 Bradenhead 0

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	BH	Bradenhead Int	INTERM Csg	BRADENHEAD	INTERMEDIATE
5 min	0		0		

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	BH	Bradenhead Int	INTERM Csg	BRADENHEAD	INTERMEDIATE
5 min	0		0		

**How do you get data from thousands of images that change format and are often scanned poorly?**

REMARKS: Nothing when opened. Nothing when opened after 5 min shut in  
By Debra Dyer / ISP Witness Monica Kuhlberg  
E-mail address: \_\_\_\_\_

2.25 million documents labeled only by API# and all are scanned images (~600,000 of interest)

# Web Application



python



Flask

web development,  
one drop at a time

# Web Application

Visual Scraper

Home

Login

Please log in to access this page.

## Sign In

**Username**

**Password**

Remember Me

Sign In

scraper.airwatergas.org



# Web Application

Hi, greg!

You have scraped 221 documents.

A total of 6191 documents have been scraped thus far.

There are 39210 documents left to be scraped.

Begin Scraping

## Score Board



valerie\_c: 173



steven\_w: 108



marcus\_k: 44



benjamin\_w: 60



devansh: 713

# Web Application

Visual Scraper Home

Profile Logout Scraper

3004534135\_9\_wf.jpg Successfully Submitted!



NEW MEXICO ENERGY, MINERALS & NATURAL RESOURCES DEPARTMENT

OFFICE OF OIL AND GAS REGULATION  
ATTENTION: REGISTRATION  
SPOKEE, NEW MEXICO  
1000 SOUTH 10TH AVENUE, SUITE 100  
SANTA FE, NEW MEXICO 87502

## BRADENHEAD TEST REPORT

(submit 1 copy to storage address)

Date of Test 10-27-11 Operator Couacat Phillips API # 30-045-73745  
Property Name Silver Creek Well No. 3418 Location Unit \_\_\_\_\_ Section 36 Township 33 Range 12  
Well Status (Shut-in or Producing) Initial PSI: Tubing 145 Intermediate 148 Casing 148 Bradenhead 135

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing TIME	PRESSURE			FLOW CHARACTERISTICS	
	BR	Bradenhead Int	Csg	BRADENHEAD Int	INTERMEDIATE Csg
5 min	0	143			
10 min	0	143			
15 min	0	143			
20 min					
25 min					
30 min					

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR \_\_\_\_\_ OILY \_\_\_\_\_ SALTY \_\_\_\_\_ SULFUR \_\_\_\_\_ BLACK \_\_\_\_\_

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0 INTERMEDIATE 148

REMARKS: Shut to vapor in 40 seconds - no nothing in IS

By [Signature]

Witness [Signature]

RCVD JUN 22 '11  
OIL CONC. DIV.  
DIST. 3

E-mail address \_\_\_\_\_

## Entry Data

[Go Back](#)

Test Date (e.g. YYYY-MM-DD)

2011-06-28

Initial Bradenhead Pressure

Initial Intermediate 1 Pressure

Initial Intermediate 2 Pressure

Initial Casing Pressure

Initial Tubing Pressure

Final Bradenhead Pressure

Final Intermediate 1 Pressure

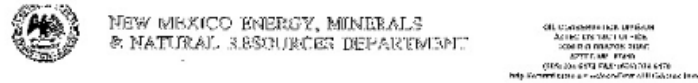
Final Casing Pressure

Bradenhead Buildup Pressure

Intermediate 1 Buildup Pressure

# Web Application

3004534135\_9\_wf.jpg Successfully Submitted!



## BRADENHEAD TEST REPORT

(submit 1 copy to storage address)

Date of Test 10-27-11 Operator Coucou Phillips API # 30-045-73745  
Property Name Salvador Well No. 348 Location Unit 36 Township 33 Range 12  
Well Status (Shut-in or Producing) Initial PSI: Tubing 145 Intermediate 148 Casing 148 Bradenhead 135

OPEN BRADENHEAD AND INTERMEDIATE TO ATMOSPHERE INDIVIDUALLY FOR 15 MINUTES EACH

Testing Time	PRESSURE			FLOW CHARACTERISTICS	
	Bradenhead	INTERMEDIATE		BRADENHEAD	INTERMEDIATE
5 min	0	143		Steady Flow	
10 min	0	143		Stops	
15 min	0	143		Down to Nothing	
20 min				Nothing	
25 min				Gas	
30 min				Gas & Water	
				Water	

If bradenhead flowed water, check all of the descriptions that apply below:

CLEAR  OILY  SALTY  SULFUR  BLACK

5 MINUTE SHUT-IN PRESSURE BRADENHEAD 0 INTERMEDIATE 148

REMARKS: SHUT-IN PRESSURE IN 10 SECONDS - NO NOTHING IN 15

By [Signature] Witness [Signature] RCVD JUN 22 '11  
OIL CONSERV. DIV. DIST. 3  
E-mail address: \_\_\_\_\_

Document Name: 3004523745\_44\_wf.jpg

## Entry Data

[Go Back](#)

Test Date (e.g. YYYY-MM-DD)

2011-06-28

Initial Bradenhead Pressure

Initial Intermediate 1 Pressure

Initial Intermediate 2 Pressure

Initial Casing Pressure

Initial Tubing Pressure

Final Bradenhead Pressure

Final Intermediate 1 Pressure

Final Casing Pressure

Bradenhead Buildup Pressure

Intermediate 1 Buildup Pressure

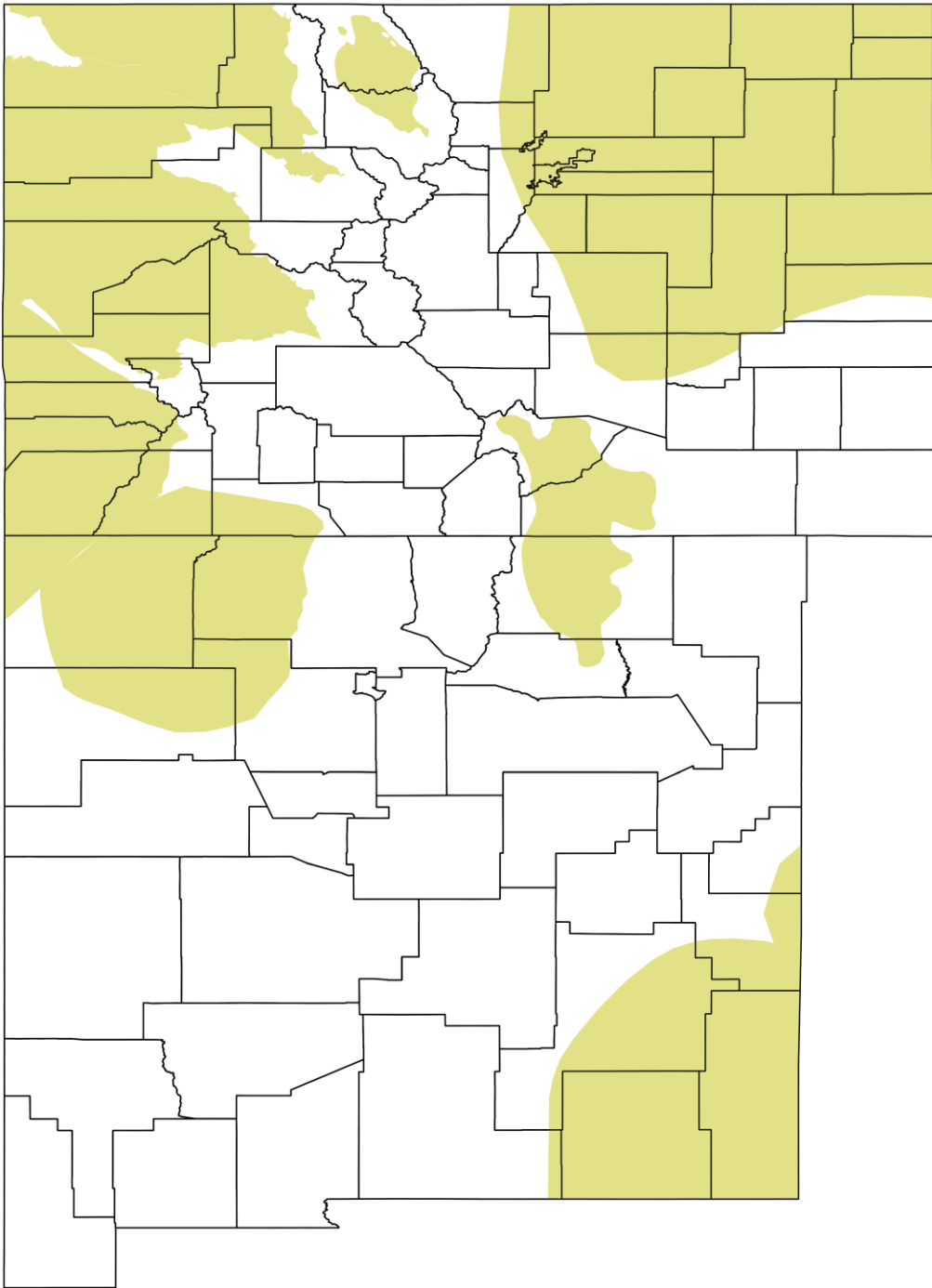
Website accessible from anywhere

Multiple scrapers can work at the same time

~15 seconds a document

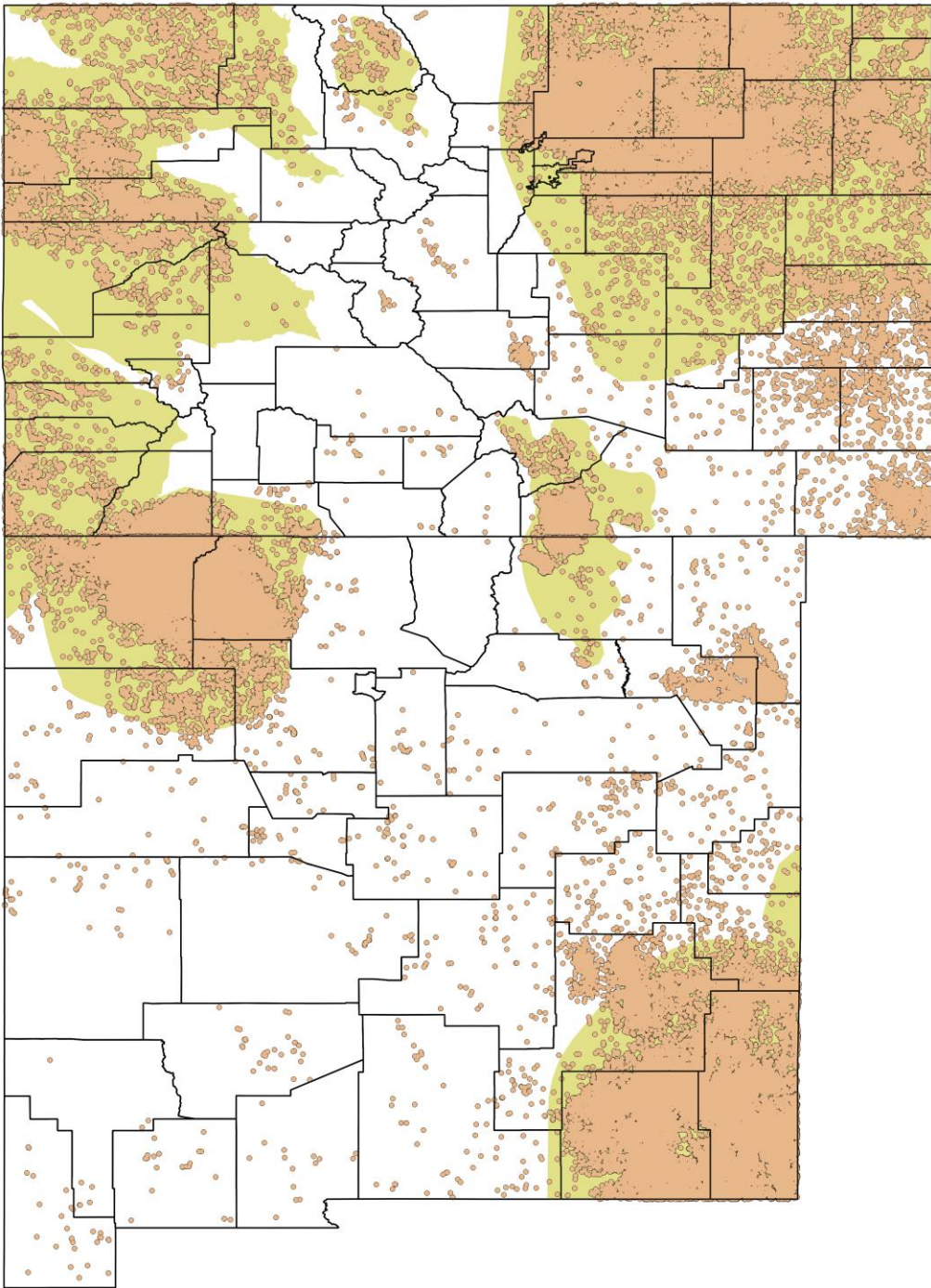
190 hours of work

# Preliminary Data



# Preliminary Data

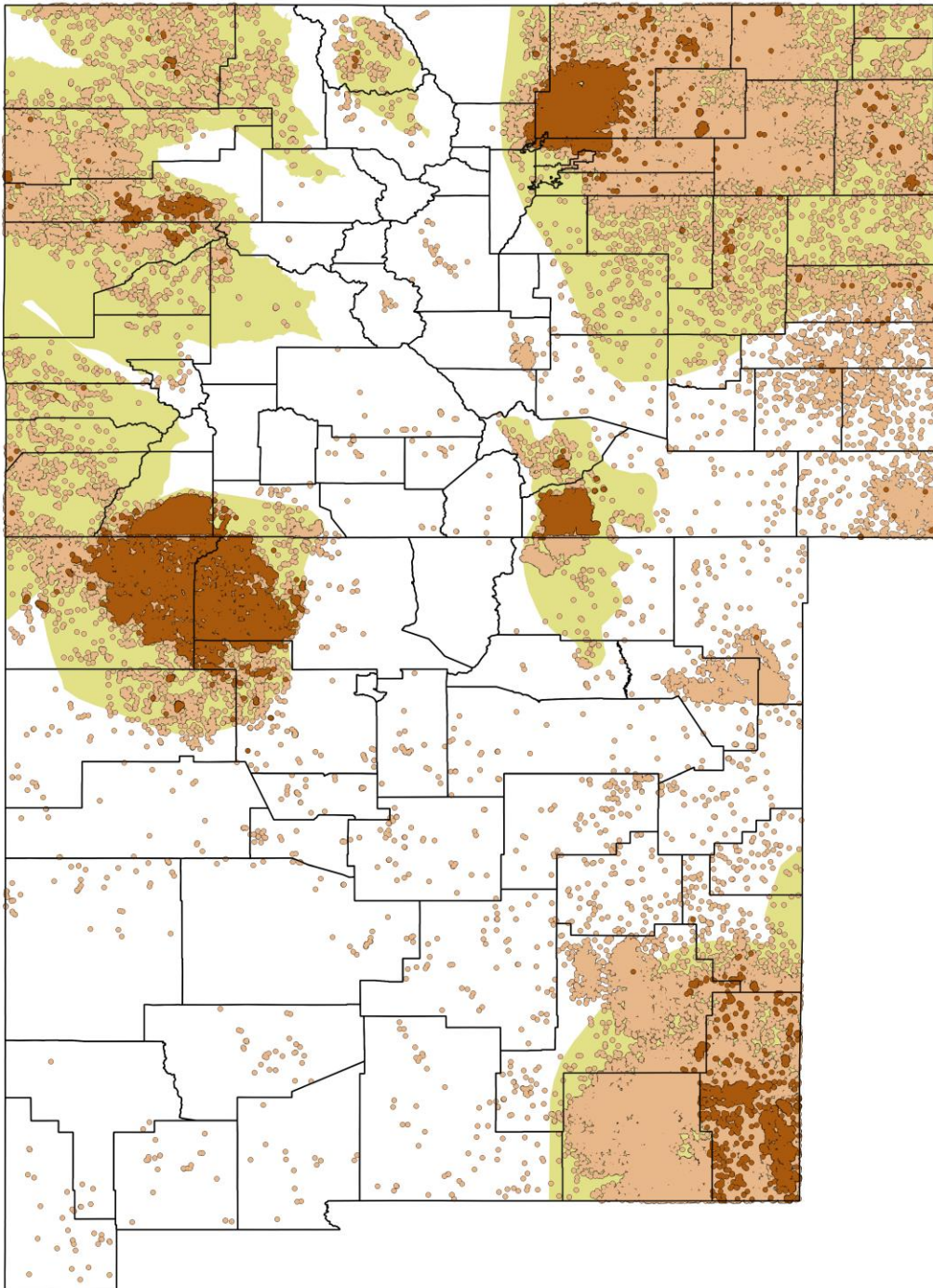
Well construction records for 232,645 wells in Colorado (114,843 ) and New Mexico (117,802).



# Preliminary Data

Well construction records for 232,645 wells in Colorado (114,843 ) and New Mexico (117,802).

Well integrity test records for 34,727 wells. 19,540 in Colorado and 15,187 in New Mexico.

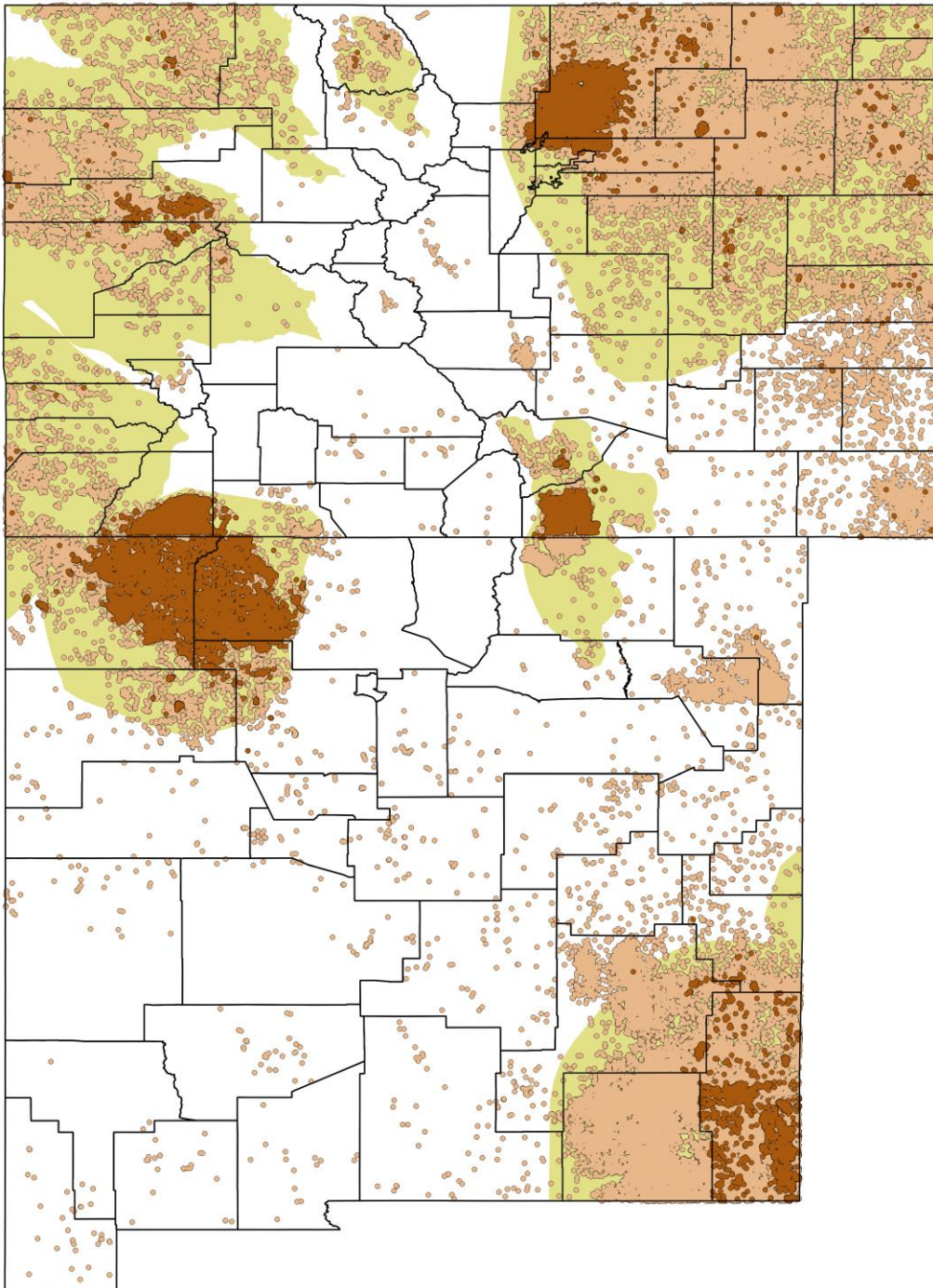


# Preliminary Data

Well construction records for 232,645 wells in Colorado (114,843 ) and New Mexico (117,802).

Well integrity test records for 34,727 wells. 19,540 in Colorado and 15,187 in New Mexico.

After release of PA DEP well integrity data this will be the second largest dataset of well integrity information in the United States.



# Conclusions

- Sustained casing pressure is an easily measure, but poorly documented, gauge of oil and gas well integrity.
- Bradenhead testing in Colorado and New Mexico provides insight into the development of SCP in oil and gas wells and can be used to identify wells that pose a high risk of inducing stray gas migration.
- Image based documents of interest can be identified and sorted from databases that contain seemingly unmanageable numbers of files using TensorFlow.
- Data from these documents can be easily obtained using a simple document scraping web application.



# Acknowledgements

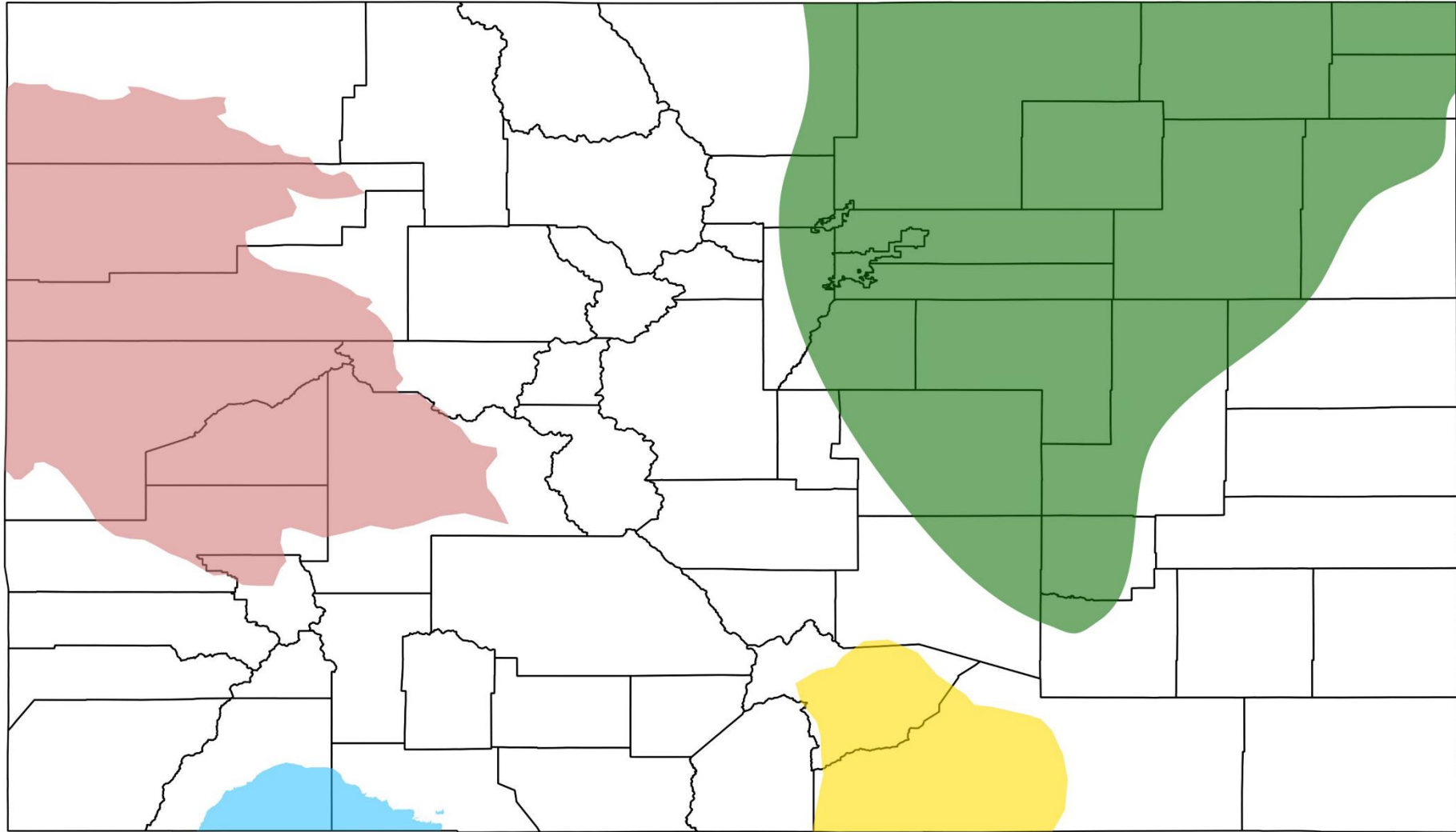
- National Science Foundation Sustainability Research Network Program (Grant CBET-1240584).



- Harihar Rajaram, Owen Sherwood, Joe Ryan, Troy Burke, Devansh Chauhan
- Summer scrapers: Natalie Guinan, Steven Wilder, Lewis Schiebel, Marcus Knipp, Valerie Constien, Benjamin Willows, Ludvig Zwiilmeyer

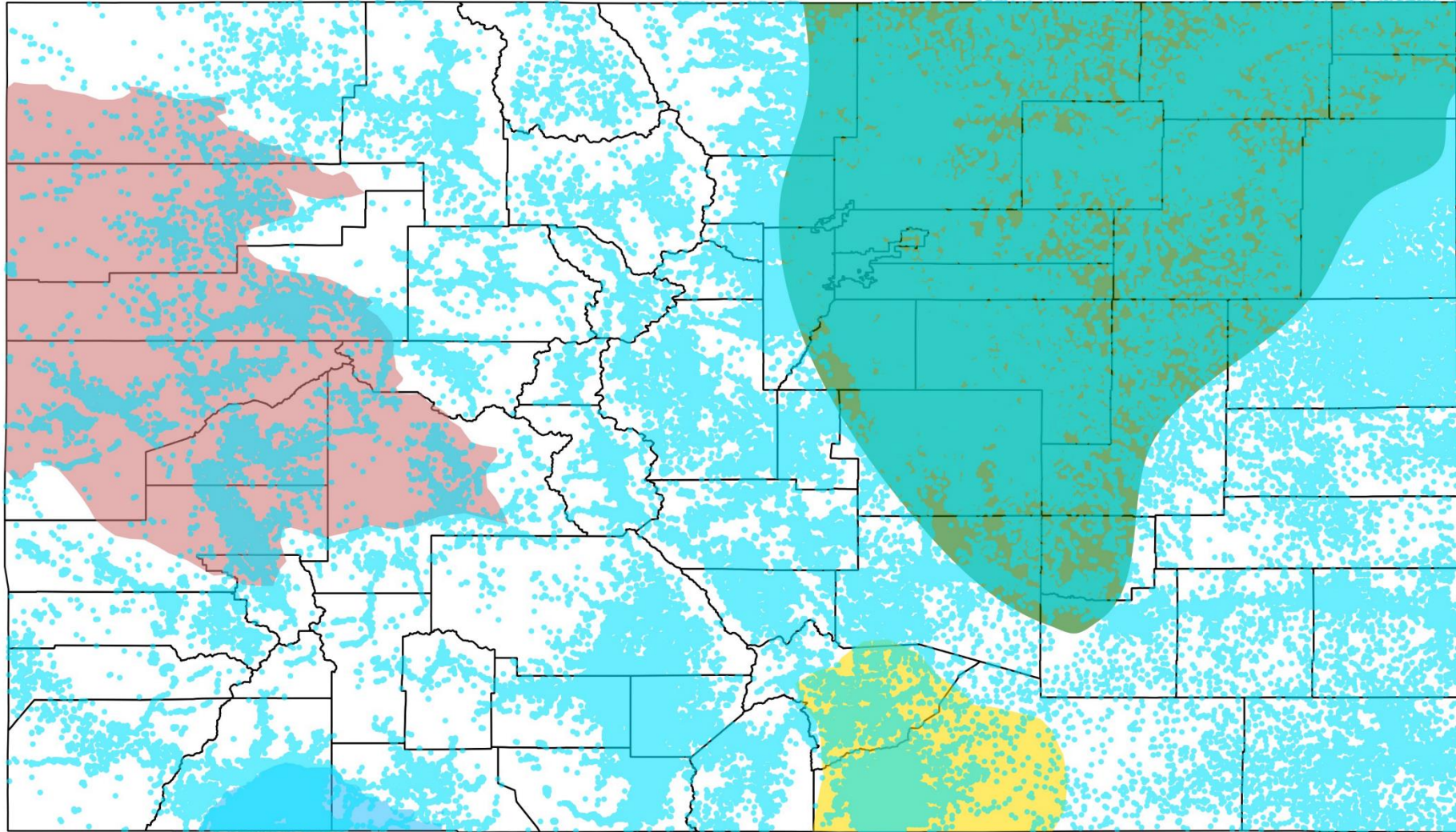
# Extra Slides

# Drilling in Colorado



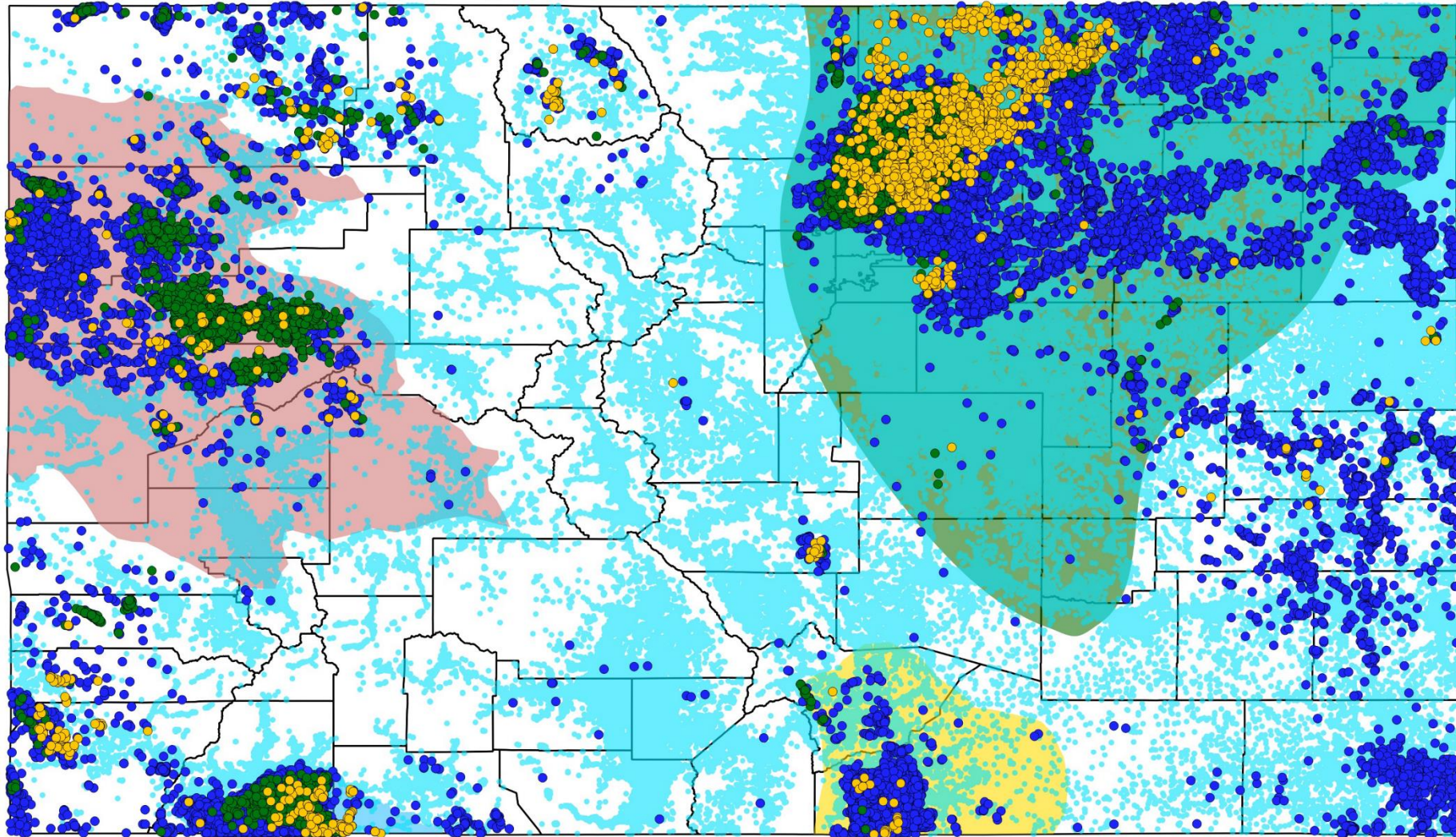
Four major oil and gas basins: DJ, Piceance, San Juan, and Raton

# Drilling in Colorado



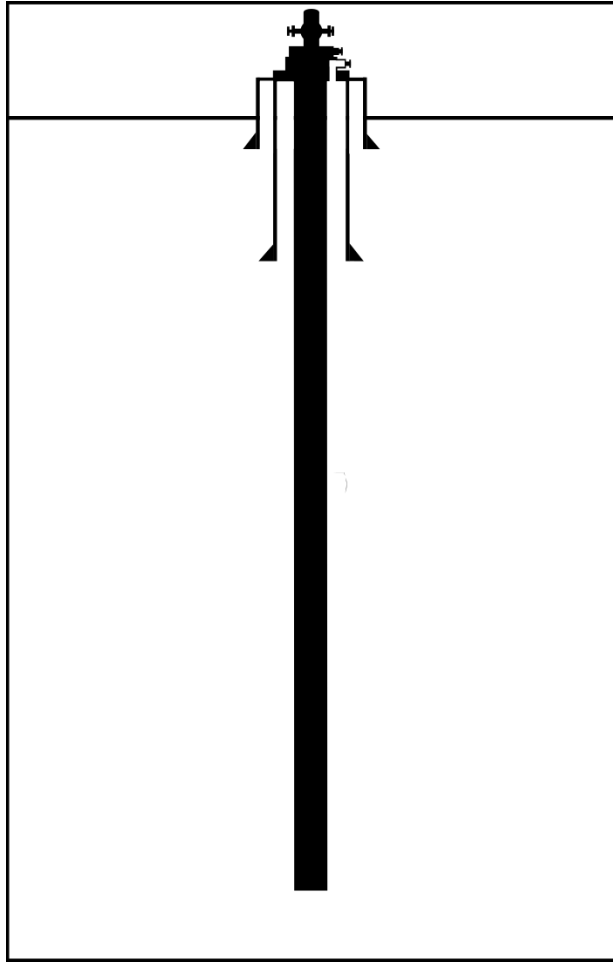
> 300,000 Water wells

# Drilling in Colorado

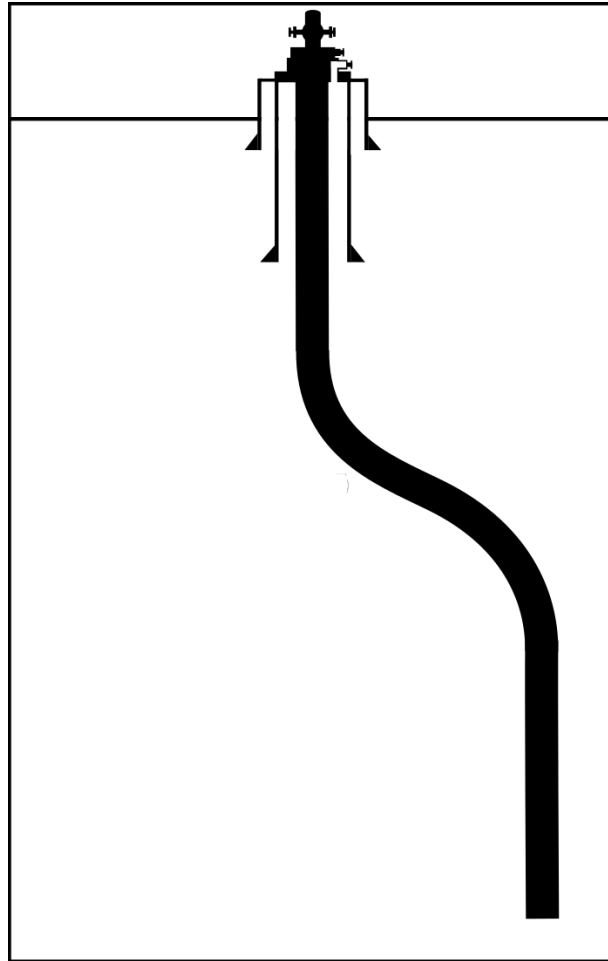


Total: 64,289; Vert: 42,279; Dev: 18,761; Horiz: 3,249

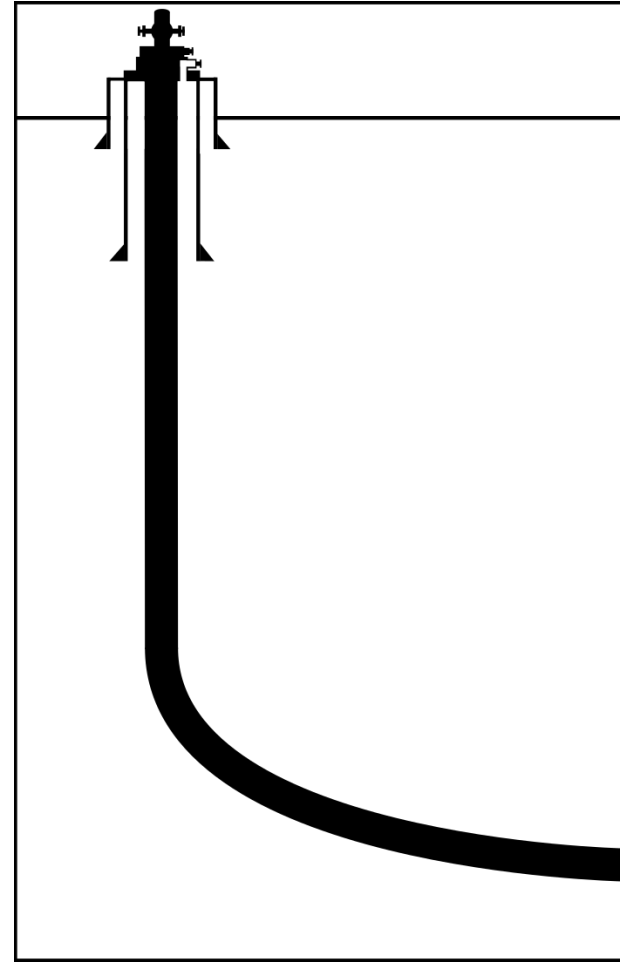
# Well Configurations



Vertical

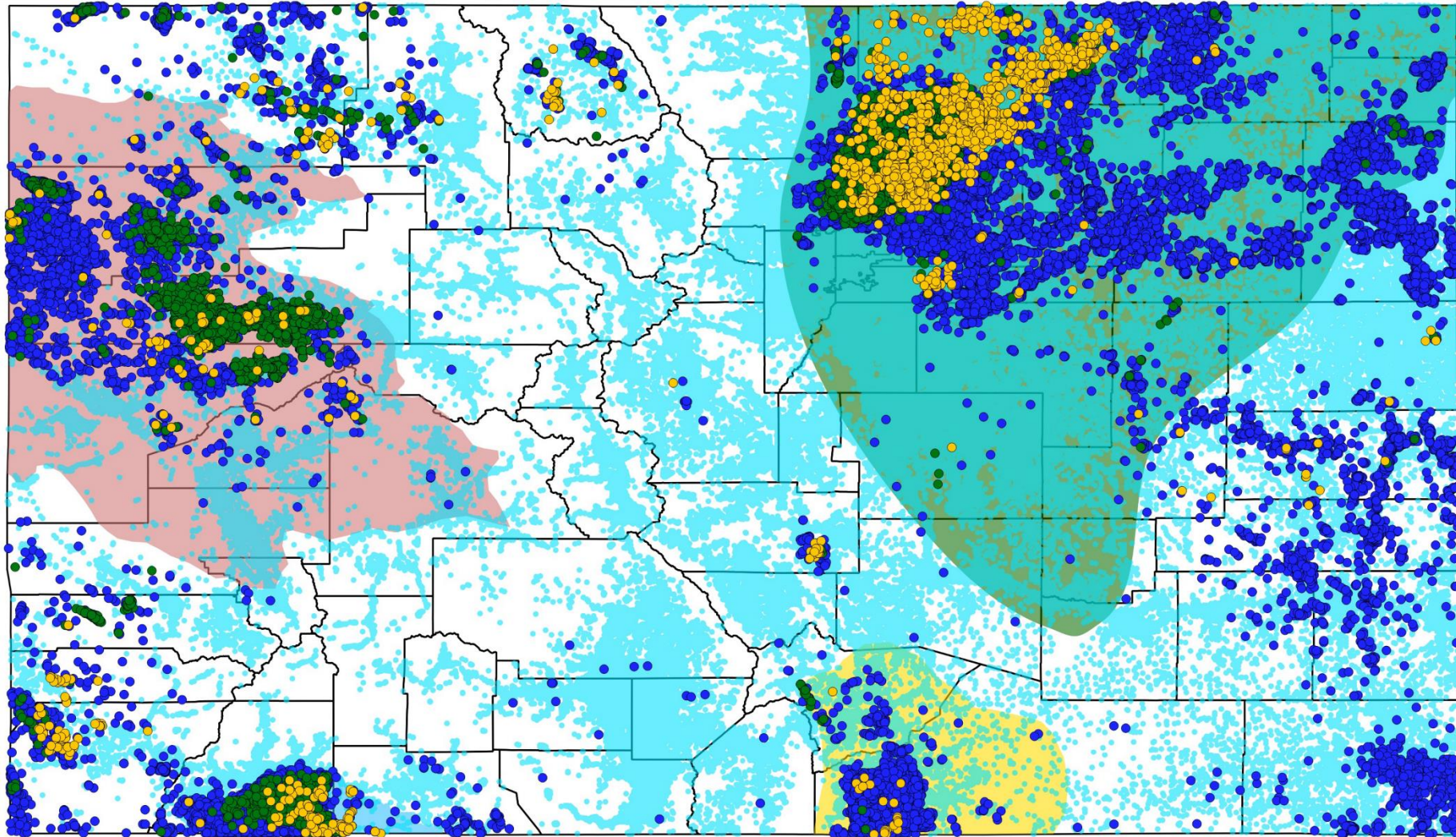


Deviated/Directional



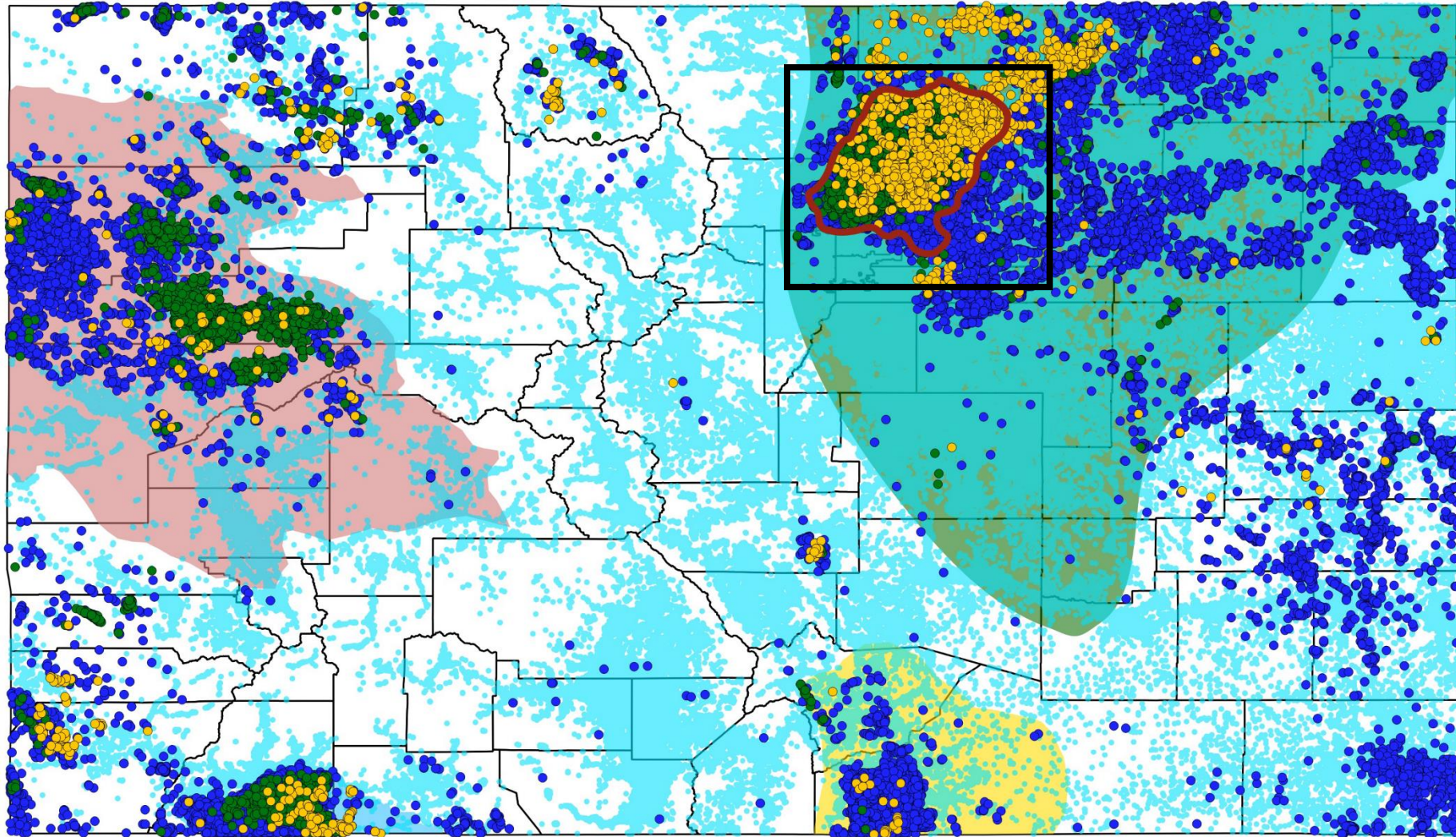
Horizontal

# Drilling in Colorado



Total: 64,289; Vert: 42,279; Dev: 18,761; Horiz: 3,249

# Drilling in Colorado



Total: 64,289; Vert: 42,279; Dev: 18,761; Horiz: 3,249



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cogcc.state.co.us



Python web scraping  
application