SAND2016-3896C

Aliso Canyon Leak Summary
&
Intro to Well Integrity Workshop

presentation to

Solution Mining Research Institute
April 26, 2016

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LLNL-PRES-689919

Sandia National Laboratories

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Lawrence Livermore National Laboratory

BERKELEY LAB

Background

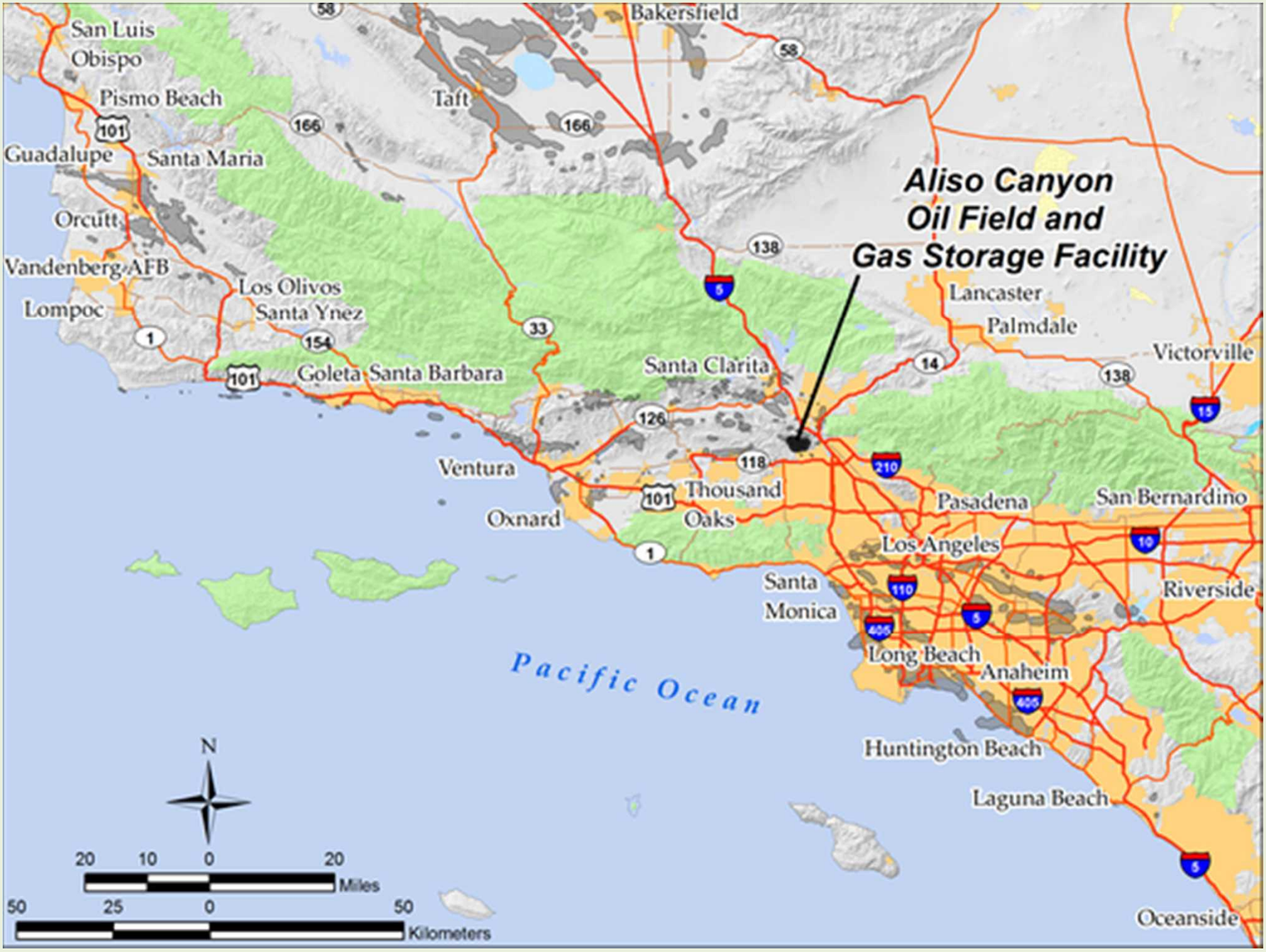
- In October 2015, a leak developed at the Aliso Canyon Natural Gas Storage Facility that released large amounts of methane, impacted thousands of local residents, and took more than four months to seal.
- On February 18, 2016, state officials announced that the leak was permanently plugged. An estimated 97,100 tonnes (95,600 long tons; 107,000 short tons) of methane and 7,300 tonnes (7,200 long tons; 8,000 short tons) of ethane was released into the atmosphere, making it the worst natural gas leak in U.S. history in terms of its environmental impact.
- An interagency task force on Natural Gas Storage Safety coordinated by the DOE is being assembled to review the circumstances surrounding the incident. The overarching objective of the review is to gather, analyze, catalogue, and disseminate information and findings that can lead to improved natural gas storage safety and security and thus reduce the risk of future events.

National Lab Activities

- **Nov 19, Initial discussion with state of CA regarding setting up technical advisory group**
- **Dec 10, Establishment of technical support group consisting of LLNL, SNL and LBNL. Start of contracting effort**
- **Dec 16, Initial site visit of Lab Team to Aliso Canyon**
- **Jan 15, Site visit with Boots and Coots, SoCalGas to discuss well kill model**
- **Feb 16, DOE/PHMSA visit to site with Lab Team and Roundtable discussion**
- **Mar 11, Initiation of discussions for Well Integrity Workshop**

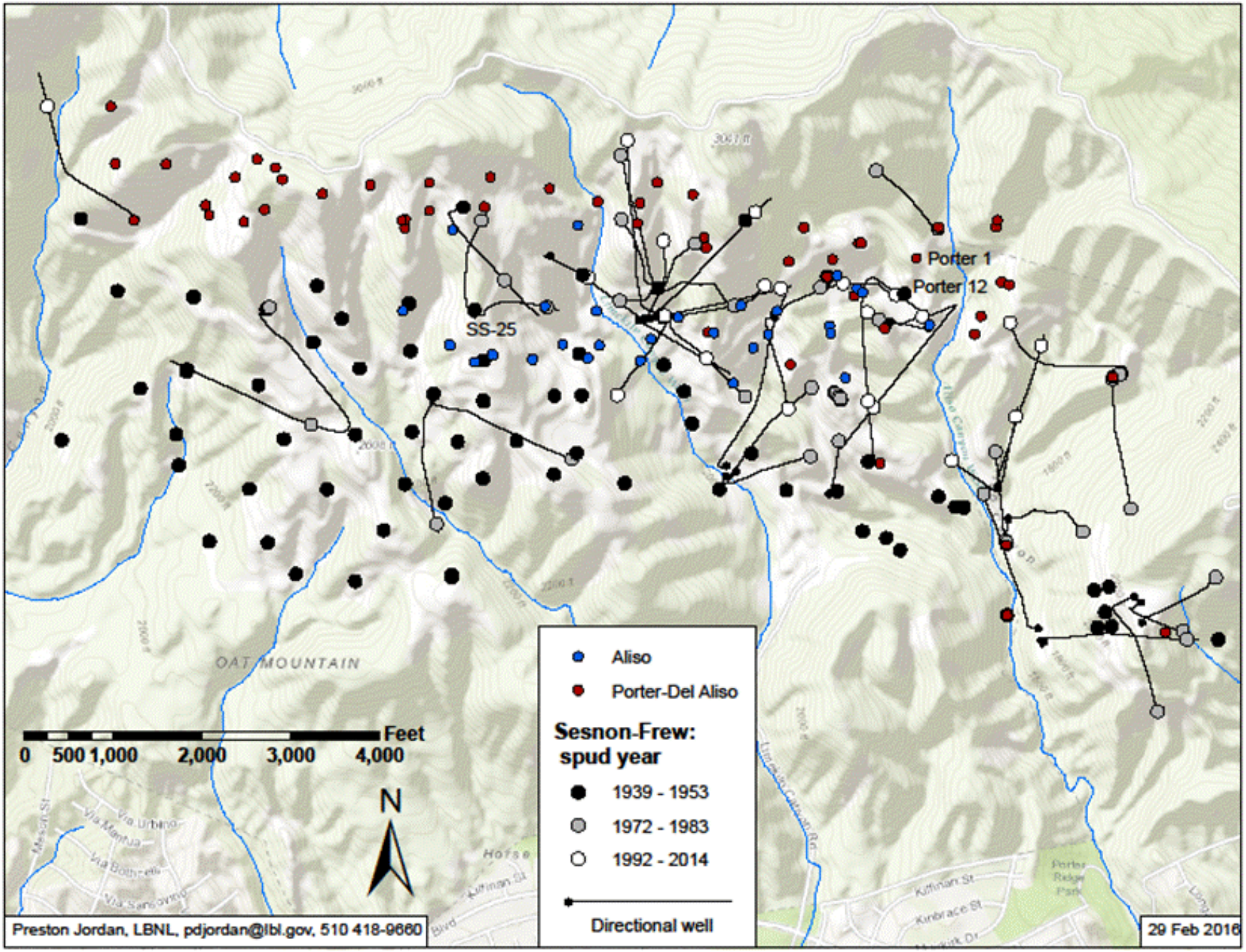
Other Lab Team Activities

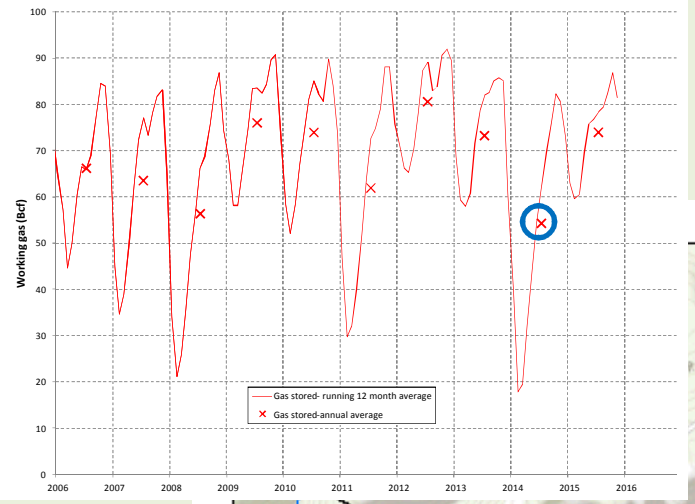
- Review of history and operations at Aliso Canyon to understand the design and operations impacting Sesnon-25
- Informal review of other state well integrity regulations and regulations directly applied to natural gas storage
- Modeling of top kill and relief well operations
- Periodic informal updates submitted to DOE/HQ as requested to inform WH and interagency task force
- DOE/FE initiated a multi-lab research team (SNL, LBNL, LLNL, and NETL) with the charter to provide a report back in 6 months on natural gas well integrity and best practices
- Participation in Workshop with regulators, operators and technical experts on Well Integrity

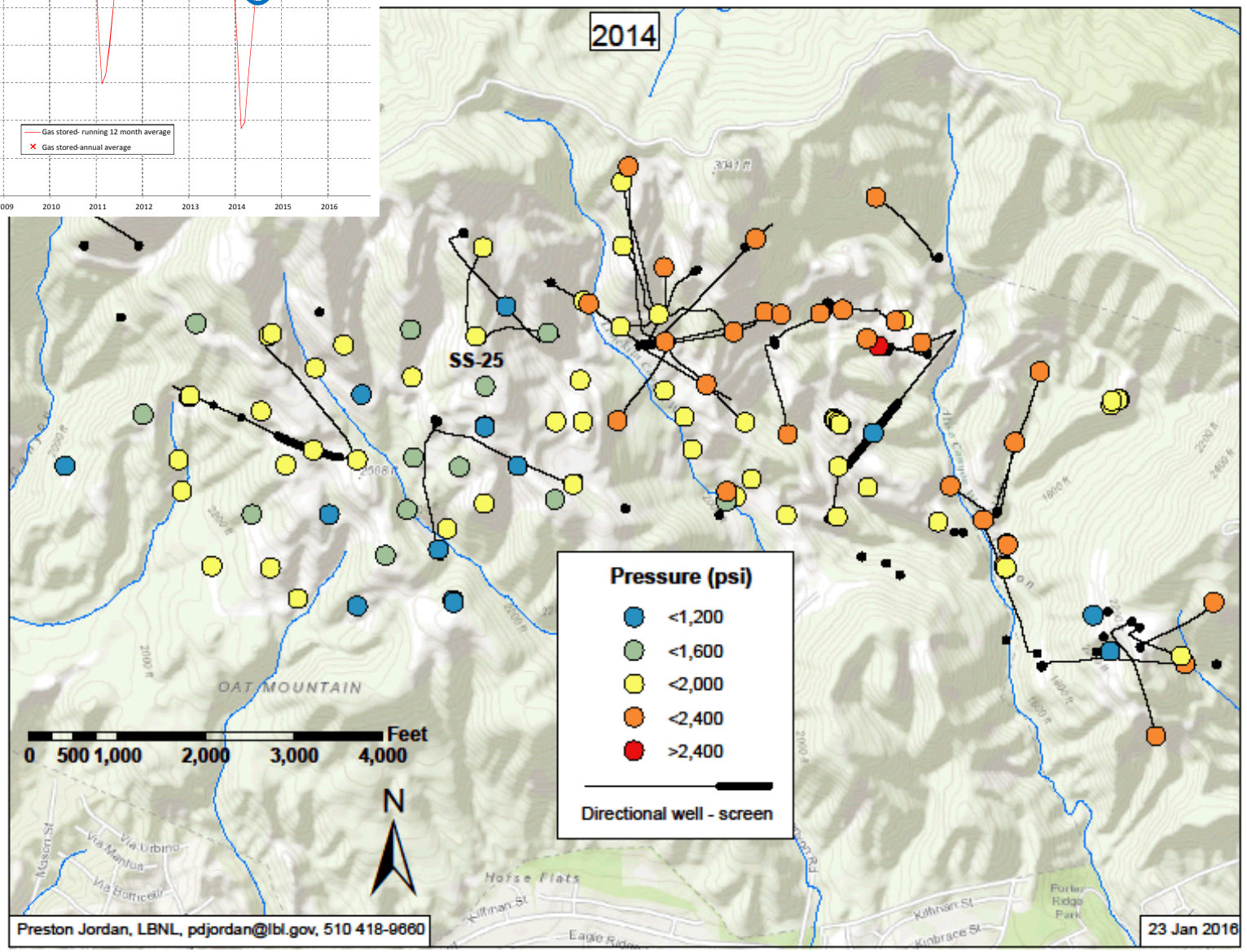

Aliso Canyon
Oil Field and
Gas Storage Facility
San Luis
Obispo
Pismo Beach
Guadalupe
Santa Maria
Orcutt
Vandenberg AFB
Lompoc
Los Olivos
Santa Ynez
Goleta
Santa Barbara
Ventura
Oxnard
Thousand
Oaks
Santa Clarita
Bakersfield
Taft
Lancaster
Palmdale
Victorville
Pasadena
San Bernardino
Los Angeles
Riverside
Santa
Monica
Long Beach
Anaheim
Huntington Beach
Laguna Beach
Oceanside
Pacific Ocean
N
20 10 0 20
Miles
50 25 0 50
Kilometers

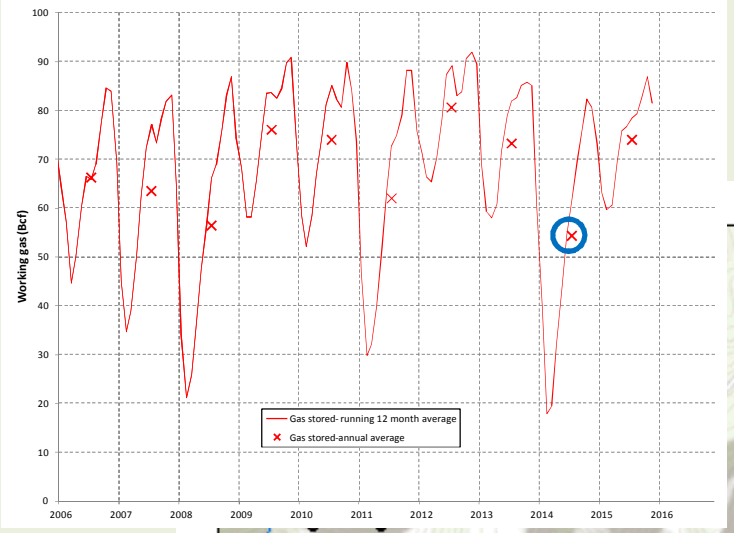
http://www.ibtimes.com/california-methane-leak-heres-where-over-400-us-natural-gas-storage-facilities-are-2265607?rel=rel1

Stephen Conley/University of California, Davis


Porter 1
Porter 12
SS-25
OAT MOUNTAIN
Aliso
Porter-Del Aliso
Sesnon-Frew:
spud year
1939 - 1953
1972 - 1983
1992 - 2014
Directional well
0 500 1,000 2,000 3,000 4,000
Feet
N
Preston Jordan, LBNL, pdjordan@lbl.gov, 510 418-9660
29 Feb 2016


Working gas (Bcf)
100
90
80
70
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
Gas stored- running 12 month average
Gas stored-annual average


2014
SS-25
OAT MOUNTAIN
Pressure (psi)
<1,200
<1,600
<2,000
<2,400
>2,400
Directional well - screen
0 500 1,000 2,000 3,000 4,000
Feet
N
Horse Flats
Preston Jordan, LBNL, pdjordan@lbl.gov, 510 418-9660
23 Jan 2016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100
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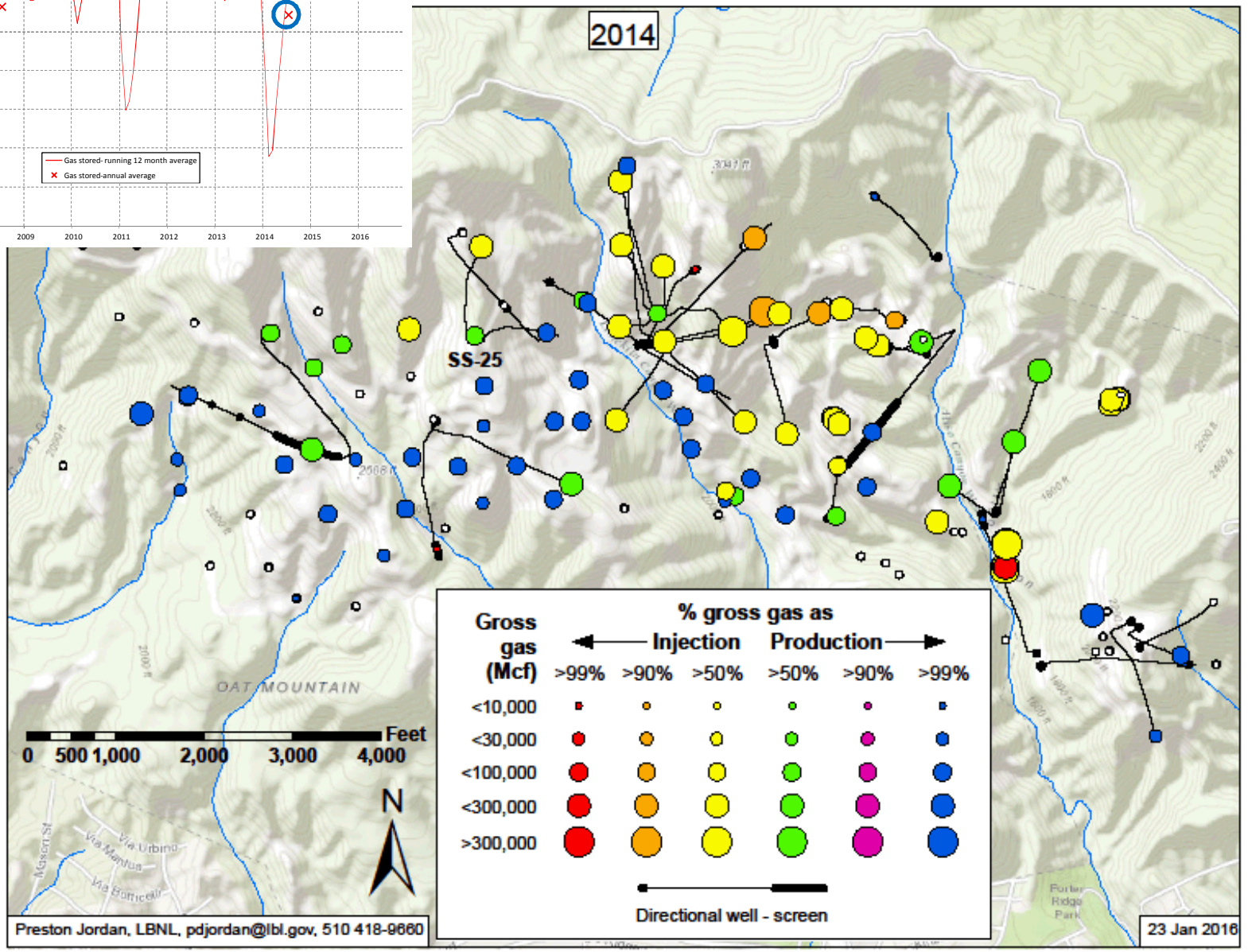
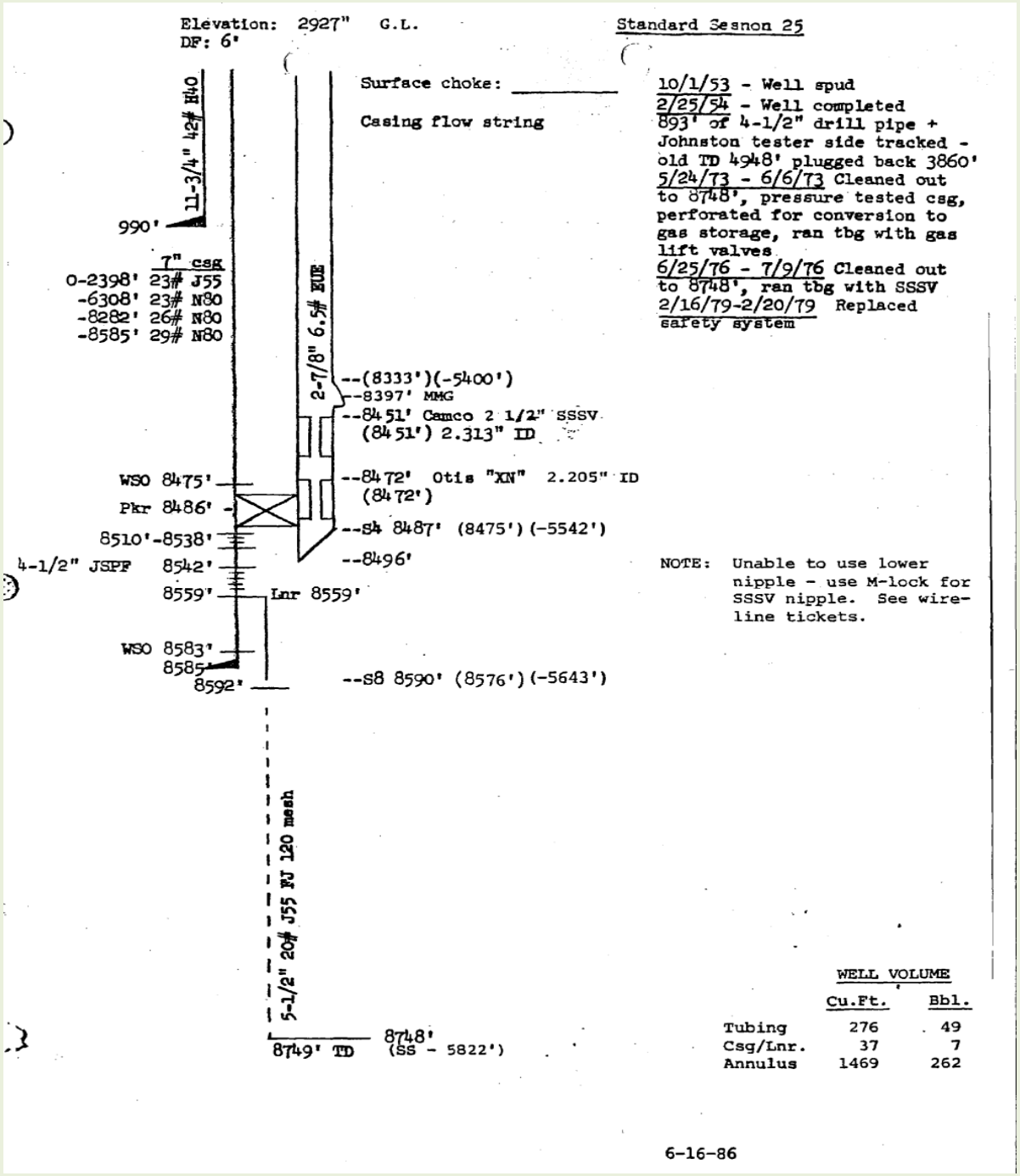
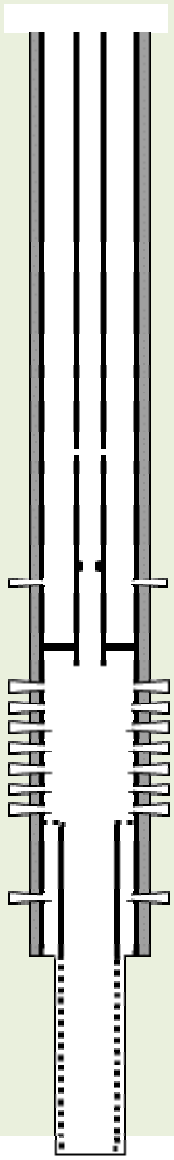

2014
SS-25
OAT MOUNTAIN
Feet
0 500 1,000 2,000 3,000 4,000
N
Gross gas (Mcf)
% gross gas as
Injection
Production
>99%
>90%
>50%
>50%
>90%
>99%
<10,000
<30,000
<100,000
<300,000
>300,000
Directional well - screen
Preston Jordan, LBNL, pdjordan@lbl.gov, 510 418-9660
23 Jan 2016

Standard Sesnon 25 Well History



Source:
DOC/DOGGR website

Traceable configuration of the base of the well prior to blowout



Tubing 2-7/8" OD, 6.5# (2.441" ID)

4 ½" holes shot at 8,475'

Packer at 8,486'

Hanger at 8,559'

Drilled with 10-5/8" bit, cased with 7" OD, 29#, N-80 (6.184" ID) to 8,585', then cemented

24, 2" tall by 0.120" wide slots per foot with 6° undercut from 8,592' to 8,748'

Drilled with 6" bit to 8,749'

8,397' Camco MMG: 5 slots 3/4" tall by 3/8" wide

8,451' Camco 2-1/2" SSSV: 2.313" ID, 6 slots 3" tall by 3/8" wide slots

8,472' Otis "XN": 2.205" ID

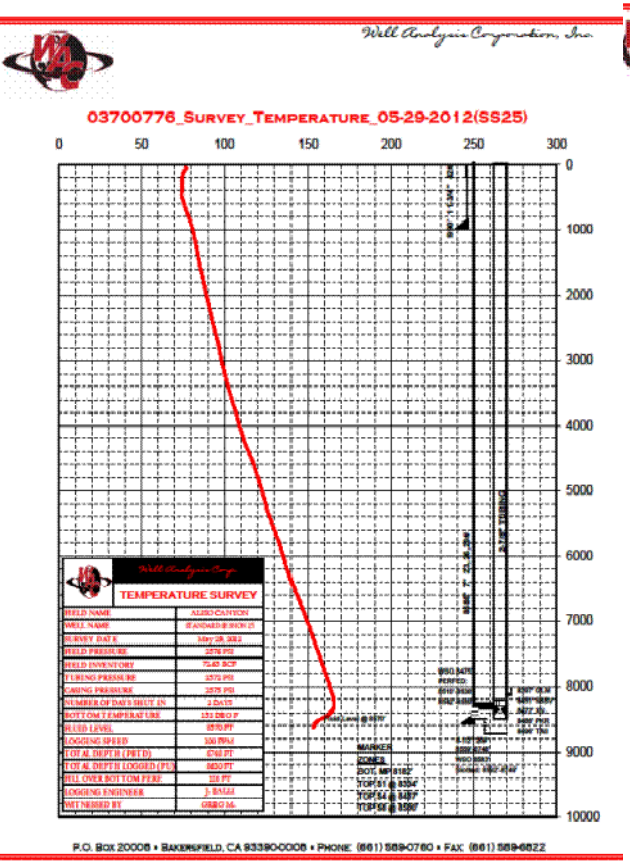
8,510 to 8,538" 4 ½" holes per foot shot
8,538 to 8,542" 4 ½" holes shot
8,542 to 8,559" 4 ½" holes per foot shot

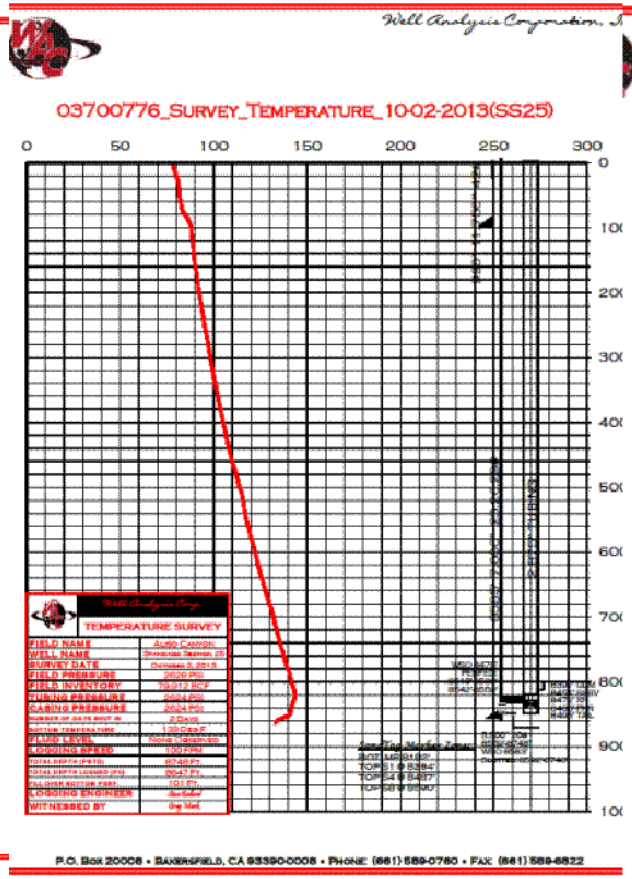
8,583' 4 ½" holes shot

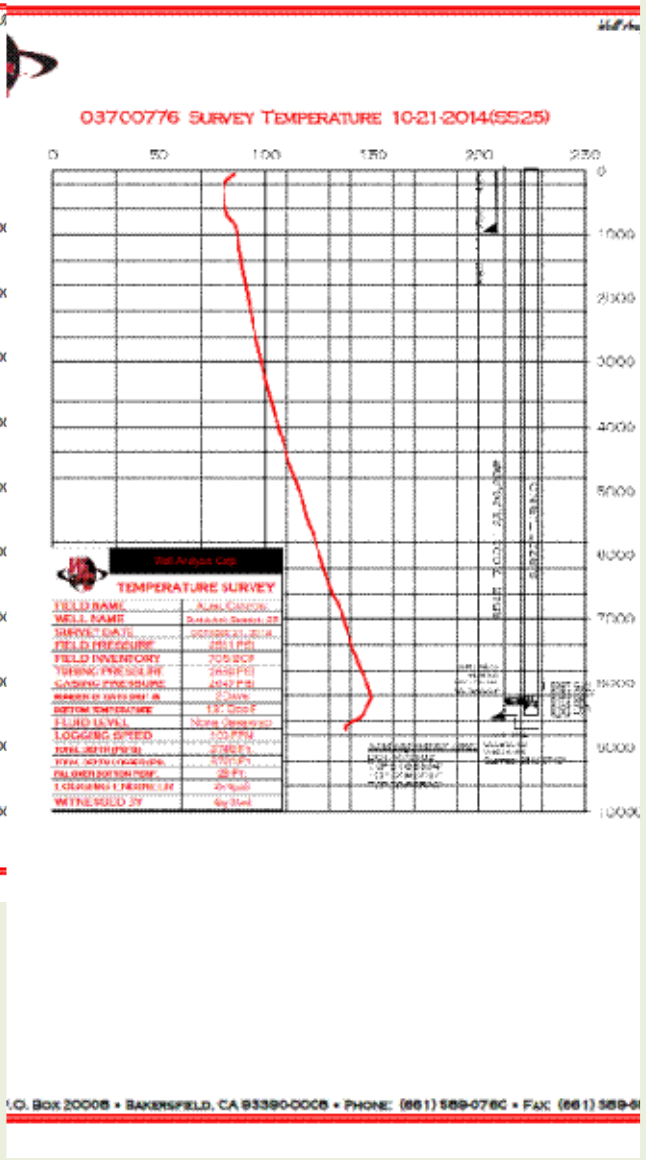
8,559' to 8,748' lined with 5-1/2" OD, 20#, J-55 (4.778" ID)

MMG and SC-1 slots from slide 3 of "SOCALLCM Diaseal M 12.16.2015.pptx" except SSSV slot width shown as 3/3" instead of ¾" based on corrected information from the well operator
Casing ID from http://www.oilzonetools.com/casing_sizes.htm
Tubing ID from http://www.oilzonetools.com/casing_sizes.htm

Temperature logs, past 3 years

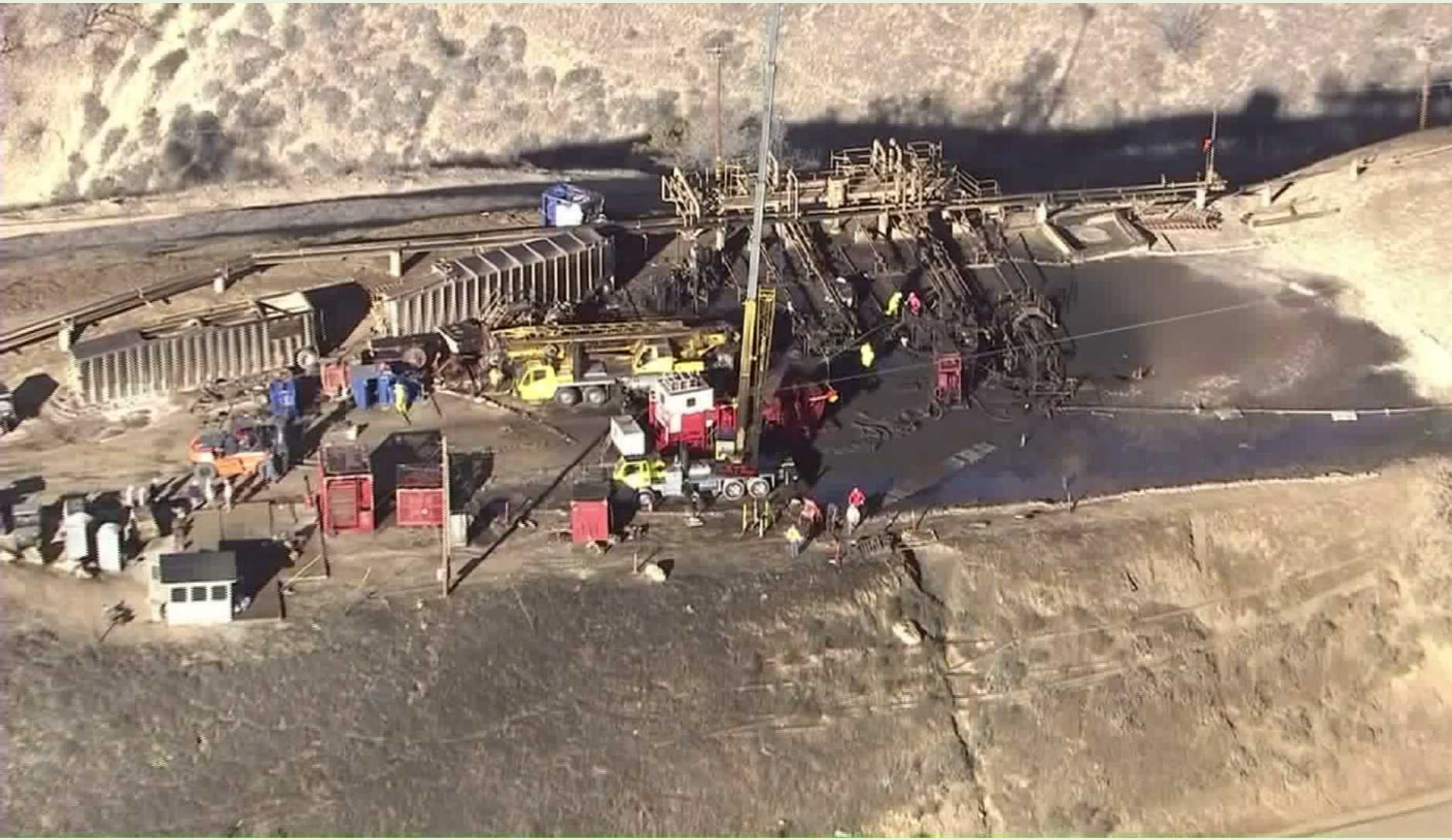






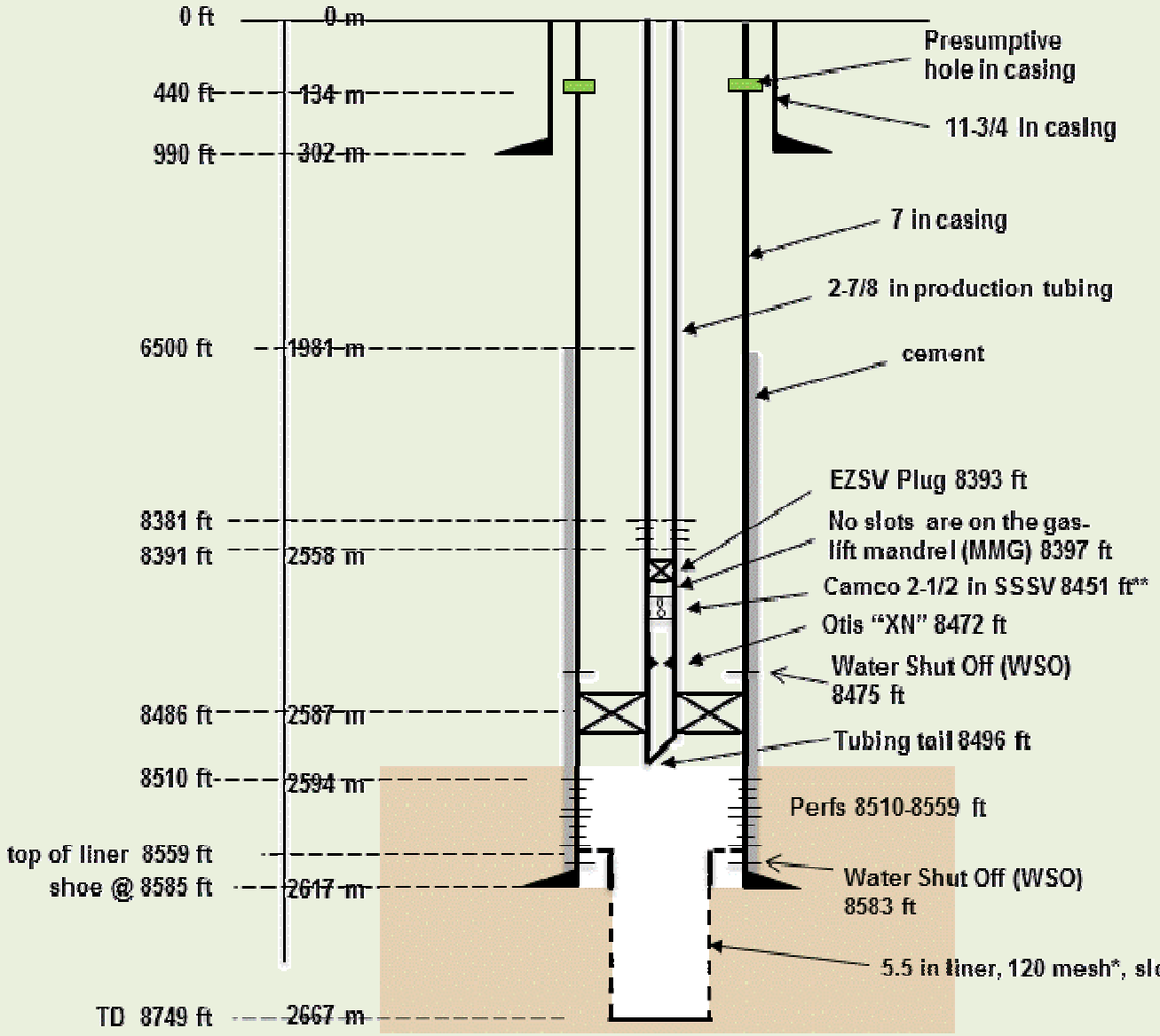
Source DOC/DOGGR website
ftp://ftp.consrv.ca.gov/pub/oil/Standard_Sesnon_25_API_037-00776_Well_File

http://ktla.com/2016/02/18/socal-gas-porter-ranch-leaking-well-announcement/ Earthworks



http://ktla.com/2016/02/18/socal-gas-porter-ranch-leaking-well-announcement/

Components in the SS-25 well create a complex flow path for gas and kill fluid



Well Volume

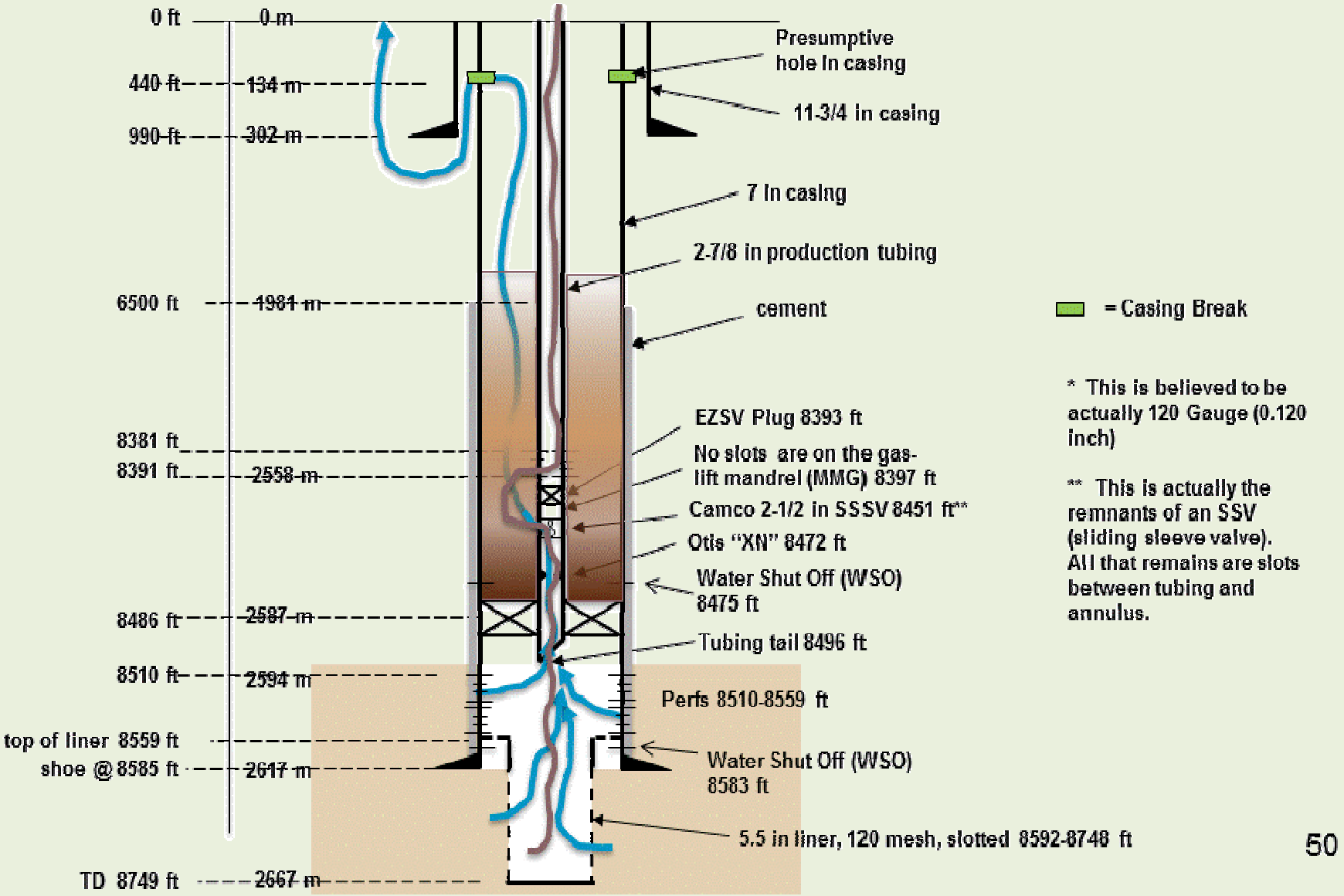
	Cu.Ft.	Bbl
Tubing	276	49
Csg/Lnr	37	7
Annulus	1469	262
Total	1782	318

= Casing Break

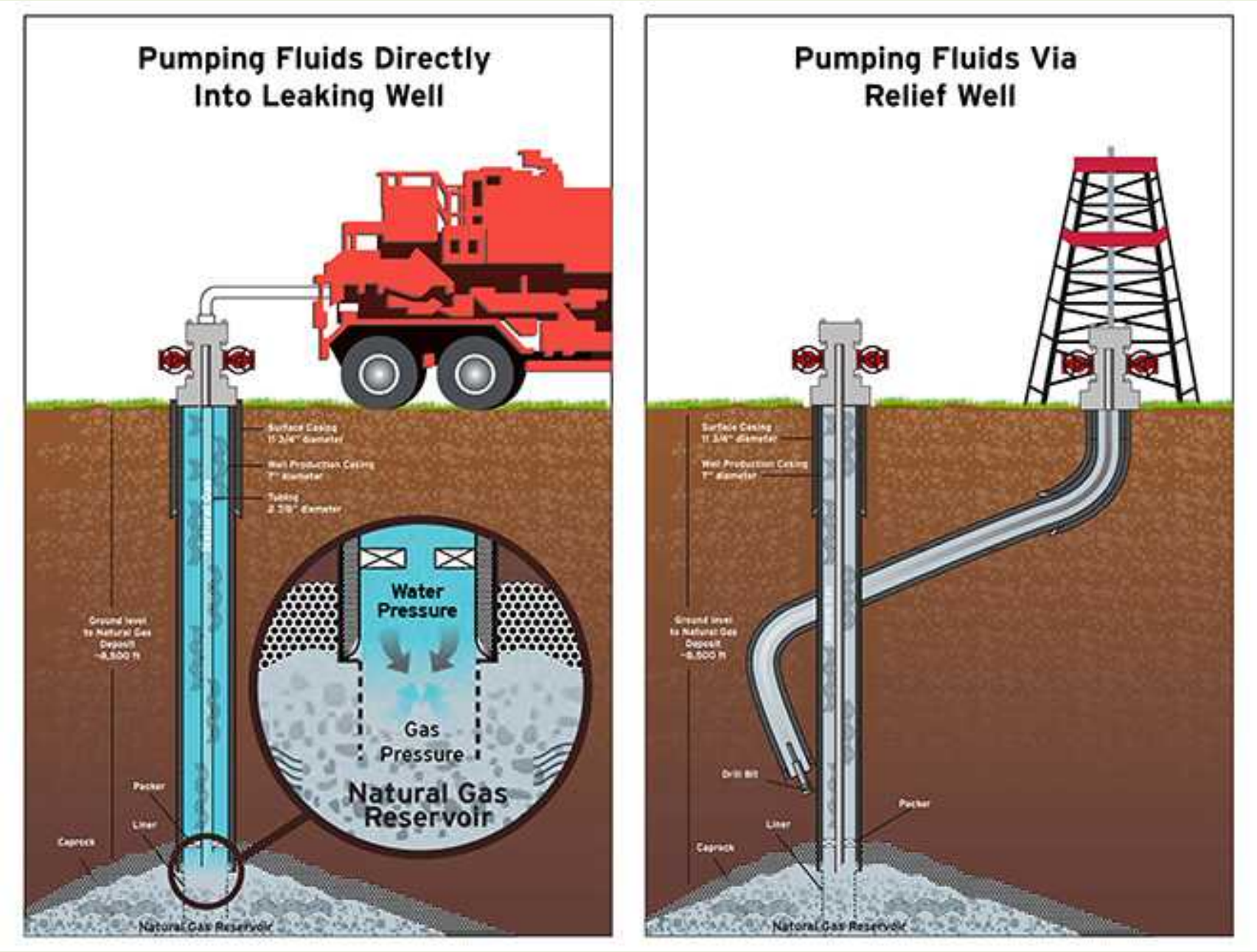
* This is believed to be actually 120 Gauge (0.120 inch)

** This is actually the remnants of an SSV (sliding sleeve valve). All that remains are slots between tubing and annulus.

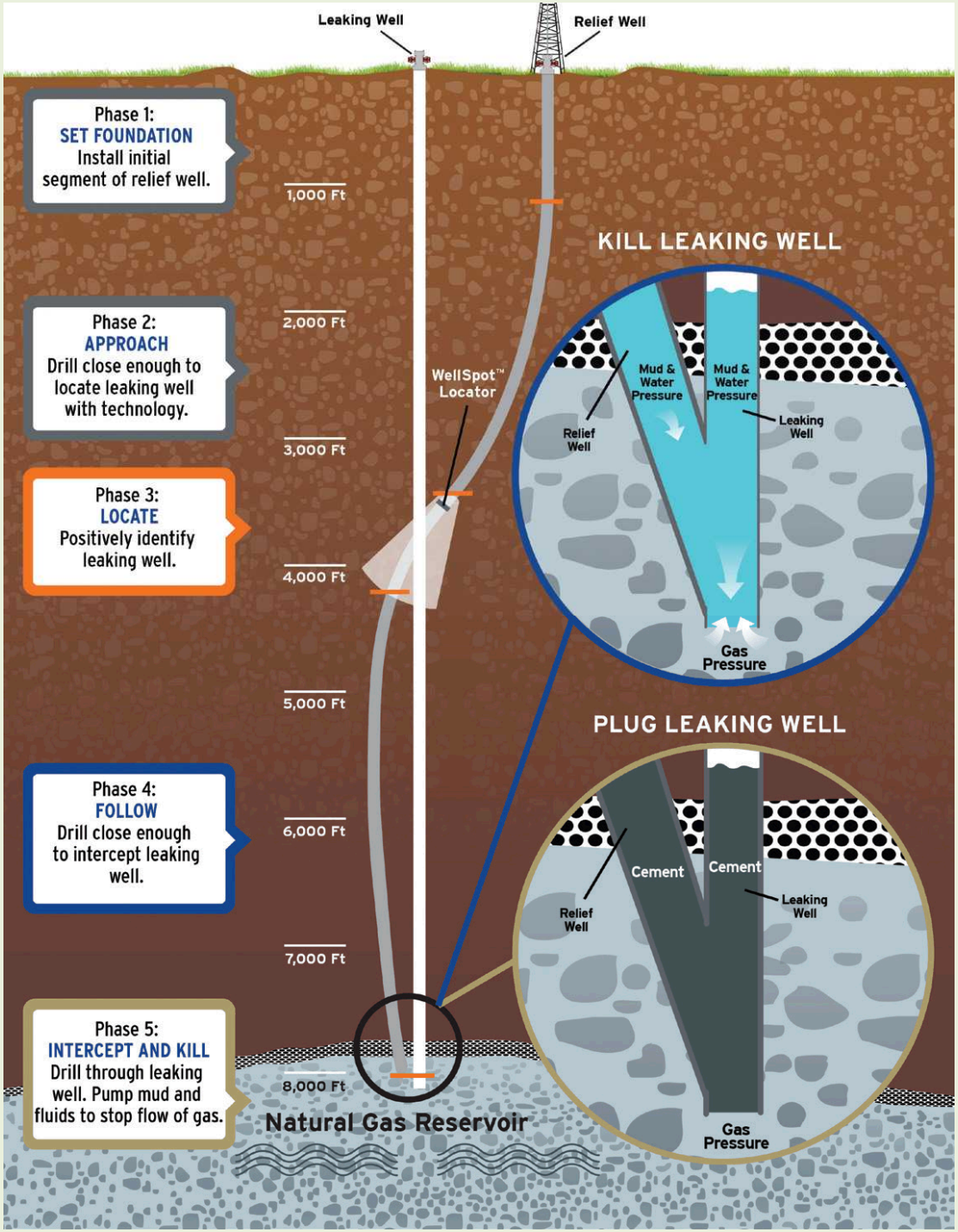
For SS-25 top-kill, kill fluid (brown) has to build up in the casing and overcome gas (blue) flowing out of the SSV slots



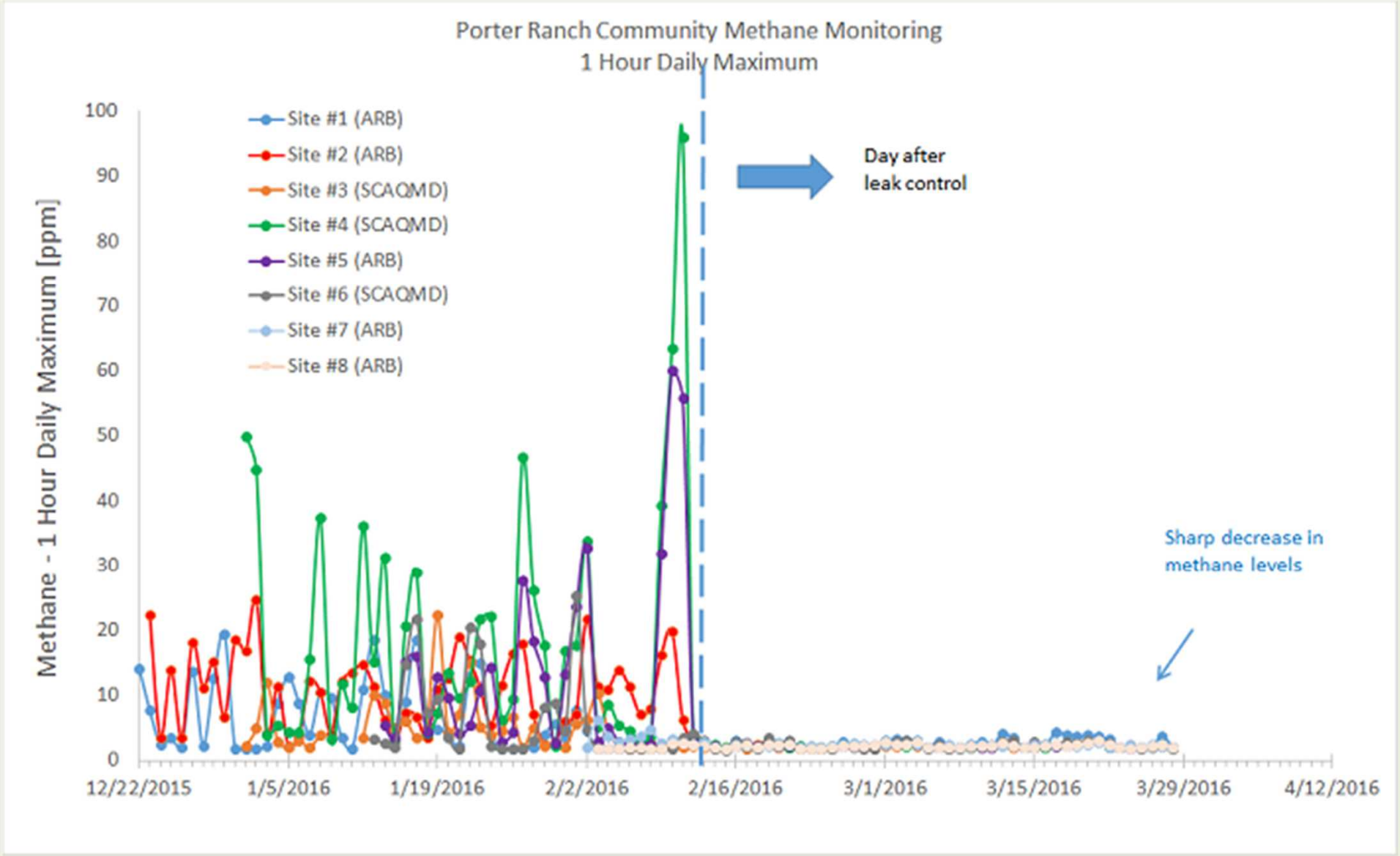
LBNL 2016



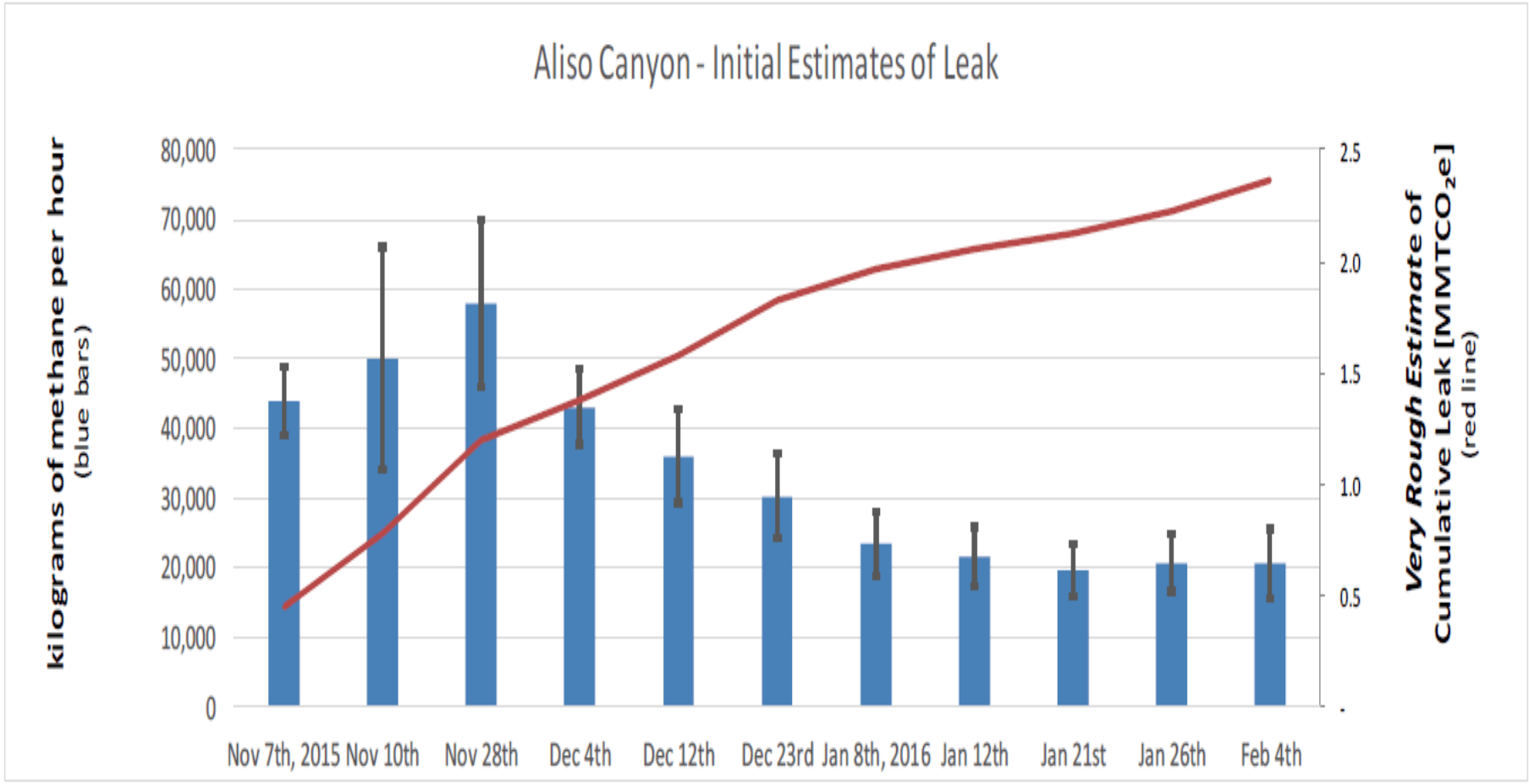
SoCal Gas, November 19, 2015



socalgas.com



http://www.arb.ca.gov/research/aliso_canyon/aliso_canyon_natural_gas_leak_updates-sa_flights_thru_April_5_2016.pdf



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Workshop on Well Integrity for Natural Gas Storage in Depleted Reservoirs and Aquifers

July 12-13, 2016

Denver, CO

Renaissance Boulder Flatiron Hotel, Broomfield, CO 80021

esd.lbl.gov/wellintegrity/

Organizing committee:

Barry Freifeld and Curt Oldenburg, LBNL

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DOE, ***Interagency Task Force on Natural Gas Storage Safety***

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Agenda

Speakers are invited to present on these topic areas:

- Risk and subsurface integrity management of gas storage fields
- Case studies relating to construction/design and operation/maintenance of gas storage wells
- Regulatory requirements and regulatory oversight activities
- Best practices
- Advanced Technologies for assessing well integrity
- Modeling and simulation of accident management processes
- Other topic areas directly related to managing risks associated with subsurface reservoir gas storage

Panel discussions will be led by experts in the following areas:

- Best practices for managing risks associated with well integrity
- Regulations for ensuring safe gas storage operations – do we have necessary and sufficient rules in place?

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