Aliso Canyon Natural Gas Leak

Preliminary Estimate of Greenhouse Gas Emissions

(As of April 5, 2016)

On October 23, Southern California Gas (SoCalGas) informed the State of a natural gas leak at its Aliso Canyon natural gas storage facility. The Air Resources Board released an initial estimate of the leak rate on November 20 and Scientific Aviation continued to make regular measurements using small planes equipped with monitors to measure methane. This measurement approach is described in more detail in the report from November 20. The periodic measurements provide an emission rate at the time the flights are conducted and may vary considerably. They do however provide a sense of what happened with the leak and can be used to develop a very rough estimate of the total methane leaked. The time series collected suggests the emission rate varied considerably in October and November as various attempt were made to kill the well. Starting in December, after these attempt largely ended the leak rate steadily decreased as the natural gas was withdrawn from the storage facility. This trend continued until the well was controlled on 2/11/2016.

Continuous measurements are also being collected as part of the State's Greenhouse Gas Monitoring network and through other complimentary measurement efforts. A revised estimate of the total leak that include these measurements on the ground will take time to process and will not be available until summer 2016. Once completed, this refined estimate, based on all data available, will be the most robust quantification of the overall leak.

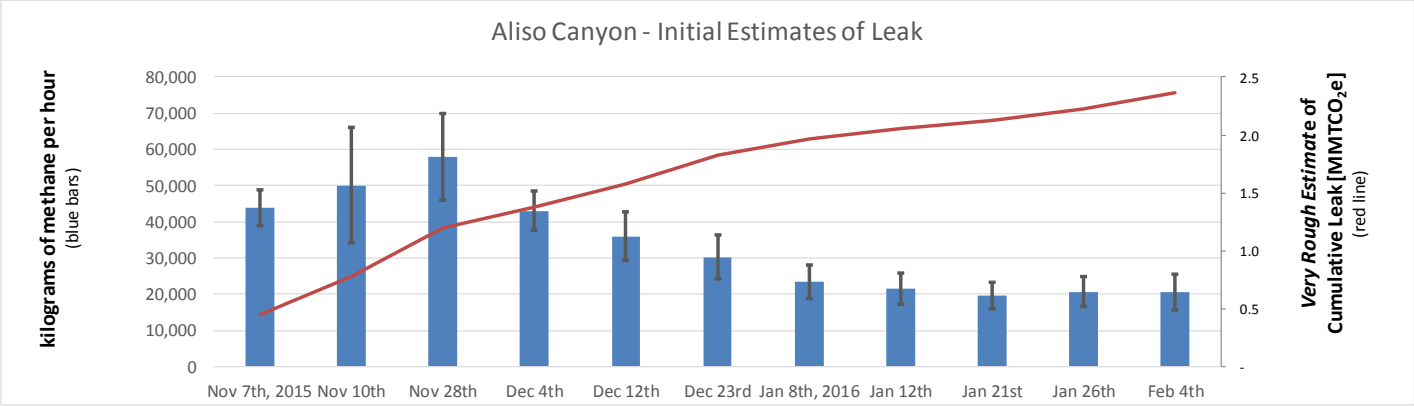
The table below provides the preliminary estimates based on the measurements made from the plane flights up through 2/11/16 when the well was controlled.

Date of Flight	Leak Rate Measured [kilogram methane per hour]	Expected Error in Measurement [kilogram methane per hour]	Assumed number of days at this leak rate	Estimate of leaked methane for this period* [kilogram methane]	*Very Rough Estimate of* Cumulative Leak** [billion cubic feet of natural gas, bcf]	*Very Rough Estimate of* Cumulative Leak*** [$MMTCO_2e$]
Nov 7th, 2015	44,000	±5,000	17	17,952,000	1.0	0.4
Nov 10th	50,000	±16,000	11	13,200,000	1.8	0.8
Nov 28th	58,000	±12,000	12	16,704,000	2.7	1.2
Dec 4th	43,000	±5,400	7	7,224,000	3.2	1.4
Dec 12th	36,000	±6,800	9	7,776,000	3.6	1.6
Dec 23rd	30,300	±6,100	14	10,180,800	4.2	1.8
Jan 8th, 2016	23,400	±4,600	10	5,616,000	4.5	2.0
Jan 12th	21,500	±4,300	7	3,612,000	4.7	2.1
Jan 21st	19,600	±3,700	6	2,822,400	4.9	2.1
Jan 26th	20,700	±4,100	8	3,974,400	5.1	2.2
Feb 4th	20,600	±5,000	11	5,438,400	5.4	2.4
				94,500,000		

* This assumes a constant leak rate since the last measurement.

** Assumes natural gas from the leak is 94% methane, and methane has density of 0.01858 kg/cu-ft

*** Using the 100 year global warming potential for methane of 25. From the date of the leak through the day of the flight. This number will be updated based on continuous measurements once the leak is plugged

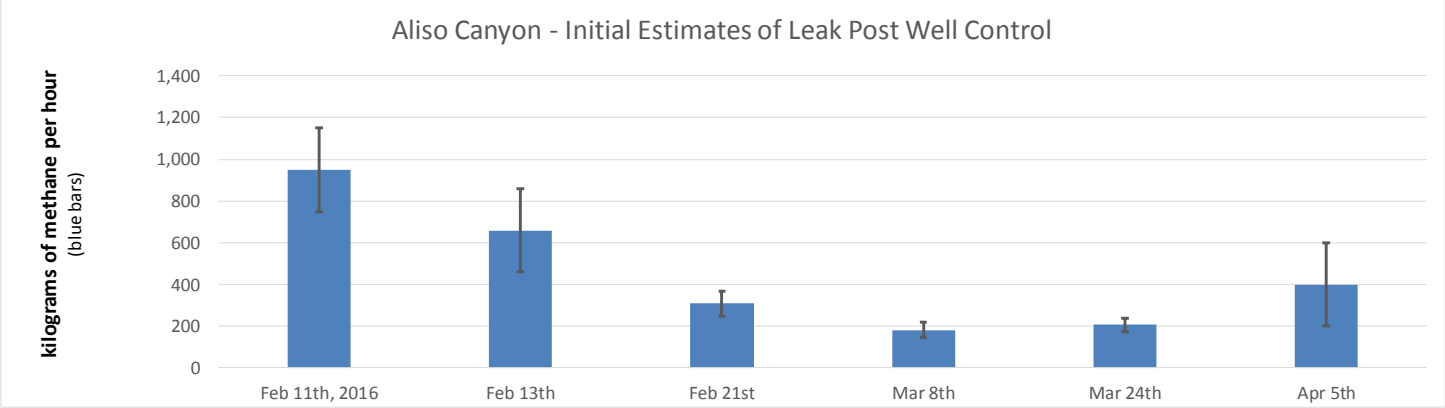


Emissions after Well SS25 was Controlled

On 2/11/2016 SoCalGas halted the leak and gained control of the leaking well, SS25, by injecting mud from a relief well intersecting the bottom of the leaking well. Subsequently, the well was permanently sealed using cement. The Department of Oil, Gas, and Geothermal Resources (DOGGR) confirmed the permanent seal of the well on 2/18/16. The leak in SS25 occurred below the surface, most likely approximately 500 feet below the surface, and natural gas has been leaking into the

ground since the leak started. This residual natural gas will slowly off gas from the ground and in to the atmosphere over the coming weeks and months. To understand this residual off gassing the flights to characterize methane emissions will continue for several weeks. The results for the post well-control flights are listed in the table below. The first flight happened less than three hours after the well was controlled on 2/11/2016, and while the emission rate is more than 95% less than what it was before the well was controlled it was still 950 kg/CH4/hr. In the subsequent month the emission rate dropped by another three quarters, consistent with residual methane continuing to be emitted but at a decreased rate. The most recent flight, on April 5th, measured methane emission of 400 kg/hr, almost double the amount measured two weeks earlier on 3/24. Looking closely at the measurements from the flights, the increase appears to be associated with leaks at the site other than at SS25. A subsequent survey by SoCalGas identified a compressor seal leakage. SoCalGas has indicated that the issue has since been fixed.

Date of Flight	Leak Rate Measured [kilogram methane per hour]	Expected Error in Measurement [kilogram methane per hour]	Assumed number of days at this leak rate	Estimate of leaked methane for this period* [kilogram methane]	*Very Rough Estimate of* Cumulative Leak** [billion cubic feet of natural gas, bcf]	*Very Rough Estimate of* Cumulative Leak*** [$MMTCO_2e$]
Feb 11th, 2016	950	±200	-	-	-	-
Feb 13th	660	±200	-	-	-	-
Feb 21st	310	±60	-	-	-	-
Mar 8th	182	±36	-	-	-	-
Mar 24th	207	±33	-	-	-	-
Apr 5th	400	±200	-	-	-	-



In the absence of leaks, and once the off gassing is no longer affecting the overall emissions of the site, the measured emission rate should flatten out and stay approximately constant.