Early Warning:

A Radioactive Rio Grande

By: Norm Buske
The RadioActivist Campaign

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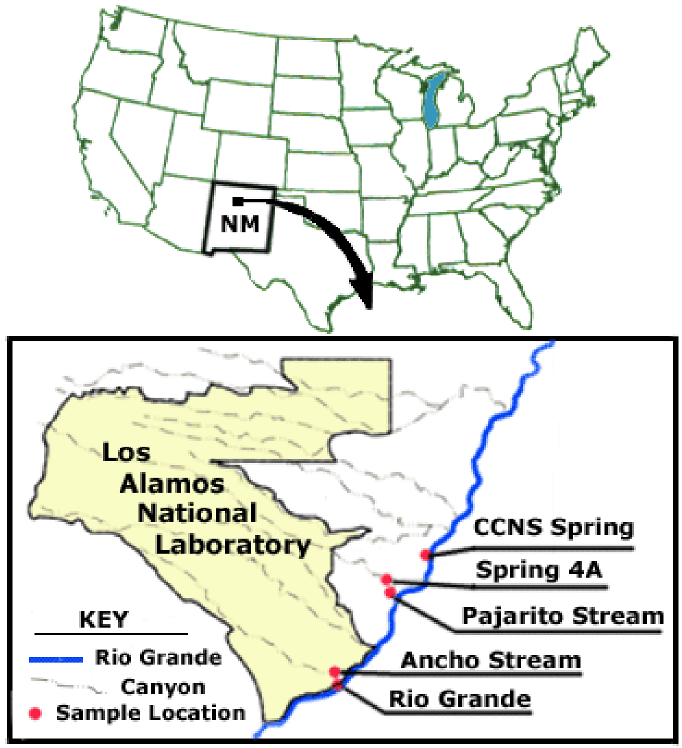


Fig. 1. LANL and Sample Locations

Summary

The Los Alamos National Laboratory (LANL) Risk Reduction and Environmental Stewardship Program monitors contaminants migrating off the 40 square mile, Department of Energy (DOE) site. While LANL has reported contaminated storm water running off the site after the wildfires of 2000, LANL has not reported any nuclear waste *leaking* into the Rio Grande.

In Fall 2002 and Spring 2003, The RadioActivist Campaign (TRAC) joined a research team, collaborating with Concerned Citizens for Nuclear Safety (CCNS), to study the LANL bank of the Rio Grande. TRAC checked whether any radioactivity from LANL is already leaking into the Rio Grande at detectable levels.

TRAC focused on sampling Spring 4A, which flows into Pajarito Stream and then into the Rio Grande. Spring 4A is relatively close to LANL facilities and has an unusually large flow. Low activities of a natural, short-lived radioactive tracer, beryllium-7, showed that the waters in Spring 4A and Pajarito Stream are almost undiluted groundwater.

Samples from both Spring 4A and Pajarito Stream contained consistently low levels of cesium-137 of LANL origin. This is the first confirmed detection of LANL radioactivity entering the Rio Grande from a groundwater pathway.

This is an early warning for the public to take an active role in LANL oversight to protect and restore the Rio Grande.

Background

In March 1943, the Los Alamos National Laboratory (LANL) opened on the Pajarito Plateau as the Manhattan Project's central laboratory for measurements and the design and construction of the world's first atomic bombs.


J. R. Oppenheimer
[DOE Photo]

One month later, LANL's new director, J. Robert Oppenheimer outlined the three technically feasible paths to producing the necessary fissile material for the world's first *super bomb.* The easiest way would be to produce uranium-233 by wrapping thorium blankets around the B-Reactor at Hanford, Washington: but the yield would be low. The second option was to use the gaseous diffusion plant at Oak Ridge, Tennessee to extract uranium-235 from natural uranium. The most challenging path would be to use Hanford's B-Reactor to produce plutonium-239 (Pu-239), which would co-produce plutonium-240 that would pose a pre-ignition problem for the super bomb.


"Gadget" at Trinity Site
[DOE Photo]

LANL pursued all three technical paths at the same time, but focused on a Pu-239 bomb. If LANL could overcome the obstacles to a plutonium bomb, the smaller challenges presented by the two different uranium bombs would be solved along the way.

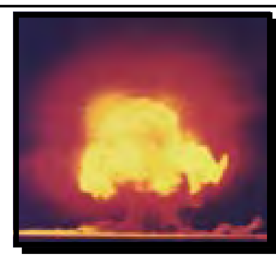
At 5:29 am on July 16, 1945, a combination of fissile materials was *imploded* in the "Gadget," at Trinity Site, Alamogordo, New Mexico. This proof-of-principle test released a force equal to 21,000 tons of TNT. Three weeks later, the Air Force dropped LANL's uranium-235 bomb, "Little Boy," on Hiroshima, Japan. Three days after that, the explosion of LANL's plutonium bomb, "Fat Man," over Nagasaki ended World War II.

At the war's end, the 40 square mile LANL campus - operated by the University of California for the U.S. Department of Energy (DOE) - had become one of the world's greatest research-and-development facilities.

LANL's mission now includes cleanup of wastes from LANL's nuclear weapons work and monitoring and blocking nuclear wastes that are washing from the Pajarito Plateau toward the Rio Grande.

"The whole country was lighted by a searing light with the intensity many times that of the midday sun."

- Gen. Thomas Farrell


Trinity Explosion
[DOE Photo]

Introduction

In 2002 and 2003, The RadioActivist Campaign (TRAC), in collaboration with Concerned Citizens for Nuclear Safety (CCNS), sampled along the Rio Grande shore to see whether any LANL waste is already seeping, through groundwater pathways, into the river.

Fig. 2. Researchers Sampling at CCNS Spring in October 2002

In 2002, the researchers discovered a new spring, "CCNS Spring," that has a distinct chemistry. That chemistry suggests the spring drains Pueblo Canyon, where LANL has disposed of its liquid radioactive waste. Further study of CCNS Spring is needed to determine whether it is a contaminant pathway from LANL into the Rio Grande.

TRAC found low levels of radioactive cesium-137 (Cs-137) both in Spring 4A and Pajarito Stream. Spring 4A feeds Pajarito Stream. Pajarito Stream flows into the Rio Grande. See Fig. 1., on the inside front cover, for sample locations. See the next page for the results of radiological analyses of those samples.

Fig. 3. Washing Aquatic Moss from Spring 4A, Sample #1

Aquatic moss samples from both Spring 4A and Pajarito Stream tested significantly positive for Cs-137 at 2.4 - 5.8 picocuries/kilogram. TRAC's analyses showed that the moss samples had bio-accumulated Cs-137 by 200 - 500 times the levels in the spring and stream water.

Fig. 4. 40-liter Water Sample Collected from Spring 4A, Filtered as Samples #4 and #5

To confirm that the positive Cs-137 results were groundwater seepage from LANL, TRAC analyzed other sample media and used a natural tracer in rainwater, beryllium-7 (Be-7) with a half-life of 53 days, to determine the water source. For details of the analyses reported here, for an explanation of the role of Be-7 as a tracer, and for TRAC's other sample results from this study, see TRAC's LANL reports "Preliminary Radiological Results of Samples from Potential Pathways..." at www.radioactivist.org/reports.html.

Aquatic moss from Ancho Stream also tested positive for Cs-137 at 10 picocuries/kilogram. That finding might indicate a second groundwater pathway for radioactivity from LANL to reach the Rio Grande. Further study is needed to test this possibility.

Study Results

Location / Sample No. sample medium	Wet/Dry	Sample Identifier[r]	Be-7 picocuries/kilogram(wet)	Cs-137 picocuries/kilogram(wet)
Spring 4A (Pajarito Canyon) : [North Lat. 35° 48.243' • West Long. 106° 11.829']				
1. *aquatic moss, washed* :	6.9	350109	**216.** ±25.	**2.4** ±1.2
2. *solids from moss wash, above* :	8.5	350111	**157.** ±31.	**3.5** ±1.9
3. *fine sediment, not washed* : [s]	1.0	350110	**2003.** ±286.	**–1.3** ±8.0
4. *water, dissolved* (d) :	--	350108d	**0.08** ±.16	**0.005** ±0.008
5. *water, particulates* (p) :	--	350108p	**0.02** ±.16	**0.004** ±0.008
water, total (d+p) :	--	350108	**0.10** ±.23	**0.009** ±0.011
Pajarito Stream (below Spring 4A) : [North Lat. 35° 48.143' • West Long. 106° 11.725']				
6. *aquatic moss, washed* :	6.7	2x1015	**200.** ±[t]	**5.8** ±2.5
7. *fine sediment, **washed*** :	1.0	2x1016	**160.** ±[t]	**50.** ±[t]
8. *water, dissolved* (d) :	--	2x1017d	**0.48** ±[t]	**0.015** ±0.009
9. *water, particulates* (p) : [u]	--	2x1017p	**0.56** ±[t]	**–0.004** ±0.006
water, total (d+p) :	--	2x1017	**1.04** ±[t]	**0.011** ±0.011
Ancho (Canyon) Stream : [North Lat. 35° 46.287' • West Long. 106° 13.212']				
10. *aquatic moss, washed* :	7.4	350113	**431.** ±33.	**10.3** ±1.8
Rio Grande (below Ancho Stream) : [North Lat. 35° 46.207' • West Long. 106° 13.142']				
11. *aquatic moss, washed* :	10.4	2x1112	**20.** ±[t]	**–2.0** ±2.2[v]

Footnotes

r Sample Identifier is 6 digit sample collection time: YearMonthDayDayHourHour = YMDDHH. “350109” is 2003, May 01, 09:00 hours. “2x1112” is 2002, October 11, 12:00 noon.

s Results are for an extended recount to reduce Cs-137 counting uncertainty for data quality control. Original results were: Be-7 = 1557 ±475; Cs-137 = –3.7 ±14.9 pCi/kg.

t Analysis was for purpose of Quantified-Detect vs. No-Detect. No uncertainty report was provided by TRAC’s laboratory.

u Cs-137 results are for an extended recount to reduce counting uncertainty for data quality control. Original result was: Cs-137 = –0.003 ±0.011 pCi/kg. Recounted Be-7 = 2.7 ±2.2 pCi/kg is not listed in the table because of its high uncertainty due to decay before the time of recounting.

v Original TRAC lab report was No Detect for Cs-137. Sample was recounted to quantify Cs-137 result.

See Page 6 for a discussion of the study results. See the back cover for information about TRAC.

This Study at a Glance

Fig. 5. LANL Atop Pajarito Plateau

One of the world's greatest research and development facilities, the Los Alamos National Laboratory (LANL) stands atop the scenic Pajarito Plateau, overlooking the Rio Grande. See Fig. 5. In a little more than two years, LANL took the world from theoretical calculations and a few measurements showing the potential release of energy from nuclear fission to three explosions that ended World War II: Trinity ("Gadget"), Hiroshima ("Little Boy"), and Nagasaki ("Fat Man").

Over the next 50+ years, the wastes from nuclear weapons development atop the plateau began to migrate down the complicated mesa-and-canyon geography, toward the river below. See Fig. 6. LANL has identified and blocked some of those radioactive and toxic waste migration pathways. But the wildfires of 2000 revealed how dramatically changing conditions can suddenly flush contaminants from LANL toward the river. See Fig. 12.

In 2002 and 2003, a collaborative research team, including The RadioActivist Campaign (TRAC) and the public-interest group Concerned Citizens for Nuclear Safety (CCNS), collected samples from along the Rio Grande to see whether radioactive waste has already migrated, from LANL via ***groundwater pathways***, to springs seeping into the river. LANL has not yet reported any release of radioactive waste into the river along potentially unblockable groundwater pathways.

TRAC collected five different sample media from Spring 4A and four different sample media from Pajarito Stream, downstream of Spring 4A for radiological analysis.

TRAC focused on sampling aquatic mosses because they bio-accumulate *radionuclides* such as the fission product cesium-137 (Cs-137). See Fig. 7. TRAC found Cs-137 in the range of 0.01 to 6 picocuries/kilogram in groundwater and aquatic mosses, respectively.

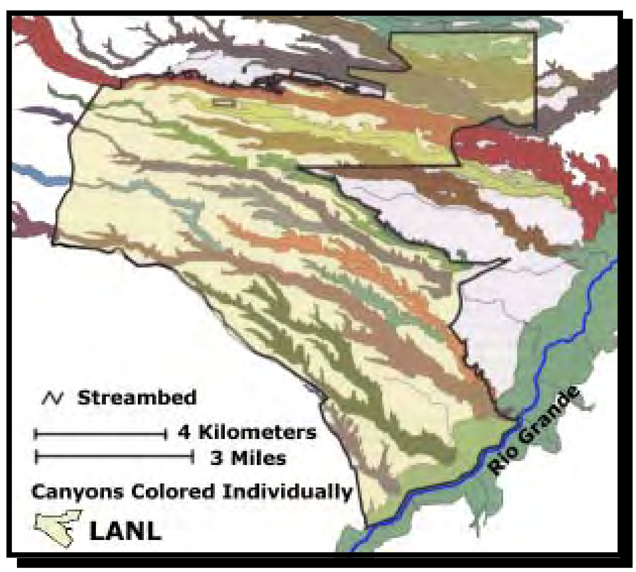


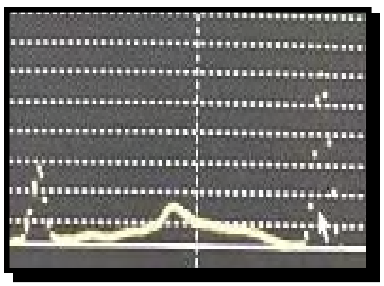
Fig. 6. Complicated Mesa and Canyon Geography Drains LANL into the Rio Grande
[From LA-13861-ENV Fig. 1-3]

TRAC analyzed other sample media to confirm the origin and pathway of the detected radioactivity. See Results on Page 3.

A single sample of aquatic moss from Ancho Stream also tested positive for Cs-137. See Fig. 8. That Cs-137 in Ancho Stream might result either from groundwater seepage from LANL or from runoff of surface water, after the wildfires of 2000. See Fig. 12.

When a Cs-137 atom decays it emits a high-speed electron (beta particle) and photons having distinct energies.

Fig. 7. Washed Aquatic Moss from Spring 4A, Sample #1



32 ➔ [Energy (KeV)] ➔ 662
Cs-137 Photon Energy Spectrum

Cesium-137 is a radioactive, cancer-causing material that is most hazardous when ingested or inhaled. The U.S. Environmental Protection Agency (EPA) has set a goal of *zero* public exposure to ionizing radiations like Cs-137. EPA has set the maximum allowable limit of Cs-137 in drinking water at 200 picocuries/kilogram.

Cesium-137 leaking from LANL groundwater is still at levels far too low to be considered a public health concern.

Present and future contaminant pathways from LANL into the Rio Grande and onto public lands are still little studied and poorly understood. LANL's annual monitoring reports and the present study show that radioactive and toxic wastes of LANL origin have already begun to contaminate the Rio Grande.

The results of this study provide an early warning of the potential contamination that could pollute the river and other public lands. This early warning allows the concerned public and LANL to take the necessary corrective action.

Fig. 8. Washed and Packed Aquatic Moss from Ancho Stream, Sample #10.

Discussion

Fig. 9. Researchers Running Ancho Rapids in the Rio Grande - Just Downstream of Sample #11 Location.

In October 2002 and again in April-May 2003, TRAC, CCNS, and other researchers floated down the Rio Grande. See Fig. 9. The focus of the team's work was to check whether any contaminants from LANL are detectable in the springs seeping into the Rio Grande.

Participating government agencies collected water samples and analyzed their chemistry to identify origins of groundwaters seeping into the river. The RadioActivist Campaign sampled water, aquatic vegetation, and sediments to determine whether water flowing from Spring 4A into Pajarito Stream that flows into the Rio Grande is already contaminated by wastes from LANL. Water samples from Spring 4A and Pajarito Stream tested positive for Cs-137 0. 01 - 0.1 picocurie/kilogram. Radioactivity in washed aquatic moss samples, collected from Spring 4A and Pajarito Stream, was 200-500 times those levels. See Results on Page 3.

TRAC considered four possible explanations of the positive Cs-137 results: **<A>** Groundwater around LANL is generally contaminated from worldwide fallout from atmospheric nuclear weapons testing in the 1950s and 1960s. **<B>** The Cs-137 is in dust in the LANL environs that has blown into Spring 4A and into Pajarito Stream. **<C>** The Cs-137 is in soils around LANL and has been washed by rain into Spring 4A and then into Pajarito Stream. **<D>** The Cs-137 is radioactive waste from LANL that has contaminated the groundwater pathway from LANL to Spring 4A.

Fig. 10. Solids from Moss Wash, Sample #2

Alternative **<A>** was deemed as illogical: If Cs-137 migrates so readily in the groundwater under LANL that the groundwater is contaminated from old fallout, then wastes of LANL origin would be expected to overwhelm the local radiology. Alternative **<B>** was checked by analyzing solids washed off aquatic moss from Spring 4A. See Fig. 10. The solids (Sample #2) washed off the moss (Sample #1) had comparable Be-7 and Cs-137 values, indicating that the solids were actually decaying moss. The fine, unwashed sediment (Sample #3), also from Spring 4A, tested negative for Cs-137, again discounting Alternative **<B>**. (The

Fig. 11. Loading Dried Sample into TRAC's Broad-band, Photon Spectrometer

high activity of Be-7 in Sample #3 has not been explained.) The comparison of Samples #4 and #5 and Samples #8 and #9 discounted both Alternatives **<B>** and **<C>**. Furthermore, the low activity of natural Be-7 in Spring 4A water evidenced little or no rainwater mixed in with the groundwater. Rainwater has a likely Be-7 content of roughly 4 picocuries/kilogram. These considerations discounted Alternative **<C>**. TRAC concludes that the remaining Alternative **<D>** correctly explains the Cs-137 in Spring 4A. The Cs-137 tested positive at 95% confidence level in aquatic moss Samples #1 and #6.

This is the first conclusive evidence of very low-level, radioactive contamination from LANL beginning to seep into the Rio Grande.

Because Cs-137 is detectable in Spring 4A and in Pajarito Stream, the travel time from LANL into the Rio Grande must be less than the 60 years that have passed since LANL opened.

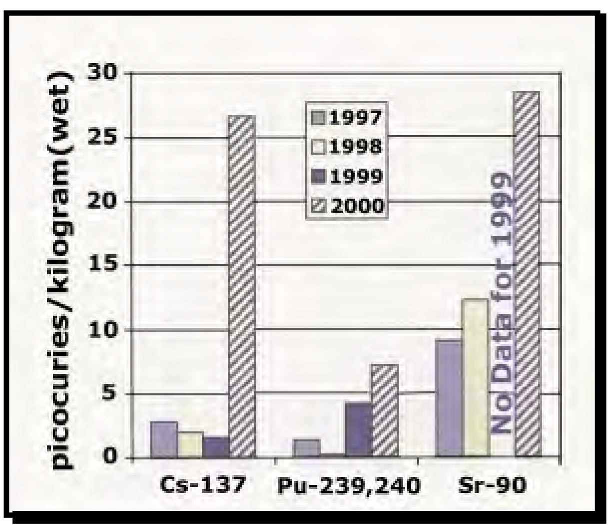


Fig. 12. Average Annual Radionuclide Concentrations in Water Running Off LANL. Note Significant Increases in 2000.
[From LA-13861-ENV Fig. 5-13]

The fires at LANL in 2000 showed how changing conditions can unexpectedly and suddenly stimulate migration of toxic and radioactive materials from LANL into the public domain. See Fig. 12. This reality has already raised a disturbing question about LANL's ability to adequately anticipate future conditions and events in the ever-changing Rio Grande drainage basin.

TRAC's discovery of very low-level Cs-137 leakage is an "early warning." This early warning provides the public and LANL an opportunity to address radioactive migrations into the Rio Grande before the levels pose a human health concern.

Conclusions

Shoreline of the Rio Grande:
a River Worth Saving

1. Low levels of radioactive cesium-137 from LANL have been detected in groundwater seeping from Spring 4A into Pajarito Stream, which flows into the Rio Grande. This is the first report of radioactivity from LANL groundwater entering the river.

2. The detected low level of radioactivity is an "early warning" for the public to take remedial action. The radioactivity does not pose a public health concern at the present time.

3. This early warning provides an opportunity to take preventive and corrective action to halt additional radioactive flows from LANL into the Rio Grande. This is an occasion for the concerned public to become more involved in LANL's decision-making process in order to protect and restore the Rio Grande.

> "This responsibility must in the end be shifted to the people as a whole and that can be done only by making the facts known. This is the only cause for which I feel entitled to do something: the necessity of lifting the secrecy [about LANL and nuclear weapons]...."
>
> - Edward Teller, to Leo Szilard, July 4, 1945

4. This first report of radioactivity entering the Rio Grande shows that waste pathways from LANL into the surrounding environment have not been adequately identified and characterized.

Sediment Collected from
Spring 4A, Sample #3

5. Naturally occurring beryllium-7 provides a useful analytical tool to help sort out the complicated surface and groundwater pathways around LANL, to improve predictions of future impacts, and to allow better site management of radioactive and toxic materials that impact LANL's surroundings.

Questions & Answers

What's the problem?

Recent sampling along the Rio Grande shore revealed low levels of radioactive cesium-137 from LANL seeping into the river. This is an early warning of contamination that is yet to come, which could reach levels dangerous to public health and environmental quality.

Why should I care?

You and 10 million other people depend on the Rio Grande for water.

What should I do?

•1• Get informed! Watch for news items. Use your own contacts or those on the back cover to get more information.

•2• Get involved! Talk to your family, friends, or co-workers - at home, at school, at work, at church, or at the game - about LANL's impact on the Rio Grande.

•3• Speak up! Get the word out. Demand that the Department of Energy become a good neighbor. Participate in public meetings that address LANL and Rio Grande issues.

Glossary

beryllium-7	- (Be-7) radioactive product of cosmic ray spalling of nuclei in the upper atmosphere, falls to earth in rain, mimics magnesium; half-life = 53 days.
cesium-137	- (Cs-137) radioactive product of uranium or plutonium fissioning, produced in nuclear reactors and bombs, resembles potassium; half-life = 30 years.
groundwater	- water contained in and saturating subsoil, beneath the water table.
picocurie/kilogram	- approximately one disintegration of atomic nucleus per minute in a liquid pound, which is one pint.
radioactivity	- emission of particles or radiation from an atomic nucleus that is suddenly changing form (often called "disintegrating" or "decaying").
spectrometer	- device that measures the energy of radioactivity in a sample.
strontium-90	- (Sr-90) radioactive product of uranium or plutonium fissioning, produced in nuclear reactors and bombs, mimics calcium, half-life = 29 years.

Contacts

Concerned Citizens for Nuclear Safety
107 Cienega
Santa Fe, NM 87501
505.986.1973
www.nuclearactive.org

Amigos Bravos
P.O. Box 238
Taos, NM 87571
505.758.3874
www.amigosbravos.org

Rio Grande Restoration
P.O. Box 1612
El Prado, NM 87529
505.751.1269
www.riogranderestoration.org

New Mexico Environment Department
P.O. Box 26110
Santa Fe, NM 87502-0110
505.827.2855 • 800.219.6157
www.nmenv.state.nm.us

LANL Site Owner and Operator
U.S. Department of Energy
505.665.4400 • 888.841.8256
www.lanl.gov

Produced by:

Moon Callison
The RadioActivist Campaign

TRAC Staff: Norm Buske and Moon Callison
[Tom Carpenter Photo]

About the Author

Norm Buske directs The RadioActivist Campaign. He has master's degrees in physics from the University of Connecticut and in oceanography from the Johns Hopkins University. Norm has received a certificate of honor for his scientific and technical investigations of the environmental consequences of nuclear weapons production in the United States and Russia. He has conducted non-governmental, in-field, radiological investigations around nuclear weapons facilities since 1983. He operates TRAC's in-house radiological laboratory.

The RadioActivist Campaign (TRAC) is a scientific project of the Tides Center of San Francisco. TRAC measures radioactivity around nuclear facilities and reports the results and implications to the public. In 2002-03, TRAC measured radioactivity around three DOE sites: Hanford in eastern Washington, LANL in north central New Mexico, and the Savannah River Site, in southern South Carolina.

The RadioActivist Campaign
Norm Buske: search@igc.org ● Moon Callison: mooncal@tscnet.com
7312 N.E. North Shore Rd. ● Belfair, WA 98528 ● 360.275.1351 ● www.radioactivist.org