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Interpretation of results of modeling of rainfall contamination due to Los Alamos National Laboratory's proposal to vent tritium waste containers

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February 2025

Main findings

These findings are based on a report on potential rainwater contamination in adverse weather conditions due to a Los Alamos National Laboratory proposal to vent tritium from four waste containers in Area G at Technical Area 54 of the laboratory, commissioned by the Communities for Clean Water Coalition (Rau and Winkler 2025).[2] The weather conditions used in the modeling are rare events based on Area G weather data chosen to indicate rainfall concentration of tritium at White Rock, which is the estimated location of the most exposed person.[3] Rau and Winkler (2025) modeled venting from the container most loaded with tritium.

The U.S. Environmental Protection Agency (EPA) drinking water standard is a common reference value for understanding water contamination. For tritium, it is 20,000 picocuries per liter (pCi/L). In New Mexico, there is also the reporting guideline for surface water in the Rio Grande downstream of Los Alamos; it is 4,000 pCi/L.[4] This short report interprets the Rau and Winkler (2025) modeling results in terms of these reference values.

1. **Rainwater contamination on the venting day**: The venting of the Flanged Tritium Waste Container (FTWCs) most loaded with tritium over one-day (24 hours) would, under specified adverse weather conditions, result in rainwater contamination at White Rock between 750 and

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[2] Matthias Rau, Ingenieurbüro Rau, In collaboration with: Dr. Winkler, Ingenieurbüro Winkler. 2025. Dispersion Concentration of Tritium in Rainwater and from W et Deposition, released during the Venting of Tritium Waste Containers with Flange at TA-54 of LANL. February 9. Report prepared for Communities for Clean Water, New Mexico. Hereafter Rau and Winkler 2025.

[3] Modeling by Los Alamos National Laboratory and Bernd Franke indicates a location at White Rock, about 2.2 kilometers east-south-east (ESE) of the Area G venting point as the position of the maximally exposed receptor. See Bernd Franke. 2024. Review of LANL radiation dose assessment for the Venting of Flanged Tritium Waste Containers (FTWCs) at TA-54 of Los Alamos National Laboratory, 14 September. https://ieer.org/wp/wp-content/uploads/2024/11/ifeu_Review-of-LANL-radiation-dose-assessment-for-the-Venting-of-Flanged-Tritium-Waste-Containers-FTWCs-at-TA-54-2024-09-14-Final-report-1.pdf. Hereafter Franke 2024.

[4] Standards for Interstate and Intrastate Surface Water, 20.6.4.114 NMAC. https://www.env.nm.gov/surface-water-quality/wp-content/uploads/sites/18/2022/11/2022-09-24-SRCA-NMAC_Integrated_Rule.pdf

3,500 times the drinking water standard and between 3,750 and 17,500 times the New Mexico guideline. Venting of all four FTWCs under similar conditions would create proportionately similar contamination of rainwater to hundreds to thousands of times the two reference levels.

2. **Annual average contamination**: The drinking water standard and New Mexico guidelines would also be greatly exceeded even if the rainfall contamination were averaged over an entire year, assuming zero tritium releases on all days except those during which the ventings would be done.
3. **Rio Grande contamination**: Tens to hundreds of curies may be deposited in the Rio Grande River as a result of the ventings. A heuristic calculation of cumulative impact indicates that the Rio Grande may be seriously burdened with tritium as a result of the ventings.
4. **Groundwater contamination**: Tritium in rainwater would also contaminate groundwater as well as streams other than the Rio Grande in the area.
5. **Los Alamos failure to evaluate groundwater impact**: Los Alamos National Laboratory is required to assess groundwater impact under DOE Order 458.1. It has not done so.

Details

This memorandum interprets the results of the modeling of rainfall contamination in the report titled *Dispersion Concentration of Tritium in Rainwater and from Wet Deposition, Released during the Venting of Tritium Waste Containers with Flange at TA-54 of LANL*, prepared by Matthias Rau, Ingenieurbüro, Heilbronn, Germany, in collaboration with Ingenieurbüro Winkler and commissioned by Communities for Clean Water (Radu and Winkler 2025). This report analyzed concentrations of tritium in rainfall as tritiated water under rare, adverse weather conditions that would impact locations East-Southeast of Area G for three different rates of rainfall: 1 millimeter per hour (1 mm/h), 5 mm/h, and 10 mm/h. The lowest value, 1 mm/h, is equal to about 0.04 inches per hour. Rainfall at the higher rates for extended periods of time – eight hours or more – is very rare. Rau and Winkler have discussed their reasons for these choices, which are based on analysis of local weather data (Rau and Winkler 2025, Section 3.4).

Assuming adverse weather conditions is usual practice in attempting to estimate the potential worst case consequences of an event. Though the model used for rainwater contamination is different, the procedure used for setting the calculation parameters is similar in principle to that for estimating doses to the maximally exposed to person, as for instance was done in Franke 2024.

The Rau report modeled the venting of a single Flanged Tritium Waste Container (FTWC). The FTWC chosen was the one that has the largest tritium loading. This follows the modeling done in Franke 2024, prepared for Tewa Women United. The amount of tritiated water vapor vented over 24 hours is postulated to be 32,000 curies, which was the amount of tritium in the most loaded FTWC decay-corrected to September 1, 2024.

This short report translates the modeling results in the Rau report in terms of two reference values:

- The EPA drinking water standard of 20,000 picocuries per liter (pCi/L); and

- The New Mexico tritium reporting guideline for the Rio Grande downstream of Los Alamos of 4,000 pCi/L.[5]

It is important to remember that the standards and guidelines themselves are expressed as annual averages. However, they are also used as reference values to gauge the contamination levels. For instance, in representing contamination of a mix of radionuclides in water, drinking water limits are used to express the number of times the contaminated water would have to be diluted with uncontaminated water to reach the drinking water limit. This memorandum uses the EPA standard and the New Mexico guideline as reference values in this sense.

Figures 1 and 2 are taken from the Rau report and are the results for two different stability classes that often occur in the weather of the area as measured at the weather station in Los Alamos Area G. Class D is somewhat less stable (i.e., somewhat more turbulent) than Class E. Tritium concentration in rainwater decreases with increasing turbulence because the concentration of tritiated water vapor (which is what comes down as rain when aggregated into drops) in air is lower when there is more turbulence. Class F is the most stable (least turbulent) but typically such stability does not last an entire day; it was not modeled. Tritium concentration in rainfall decreases with increasing rate of rainfall because a fixed amount of tritium (the amount vented) is mixed with a larger amount of normal (non-radioactive) rainwater.

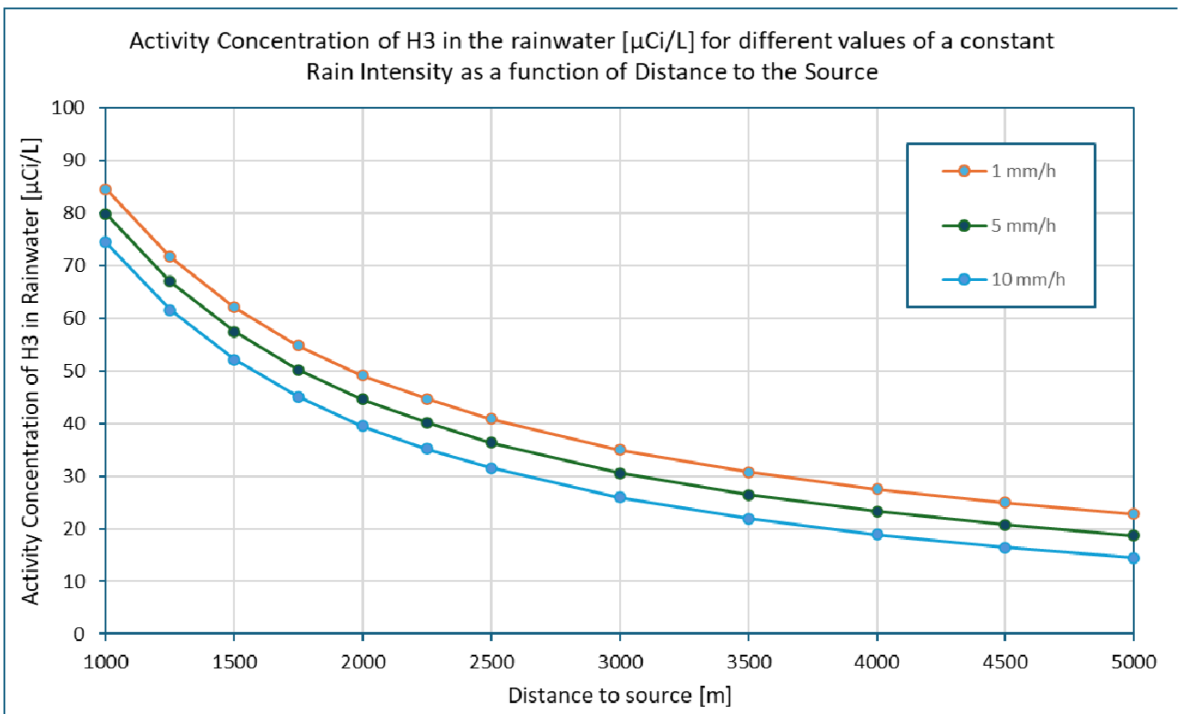

Figure 1: Tritium concentration in rainwater, averaged over 24 hours, Stability Class D.
Source: Figure 8 in Rau and Winkler 2025

[5] Rau and Winker 2025 results are in microcuries per liter (µCi/L). I have converted the results to picocuries per liter (pCi/L), since that is the unit used in the standards and guidelines in the United States. Conversion is: 1 microcurie = 1 million picocuries.

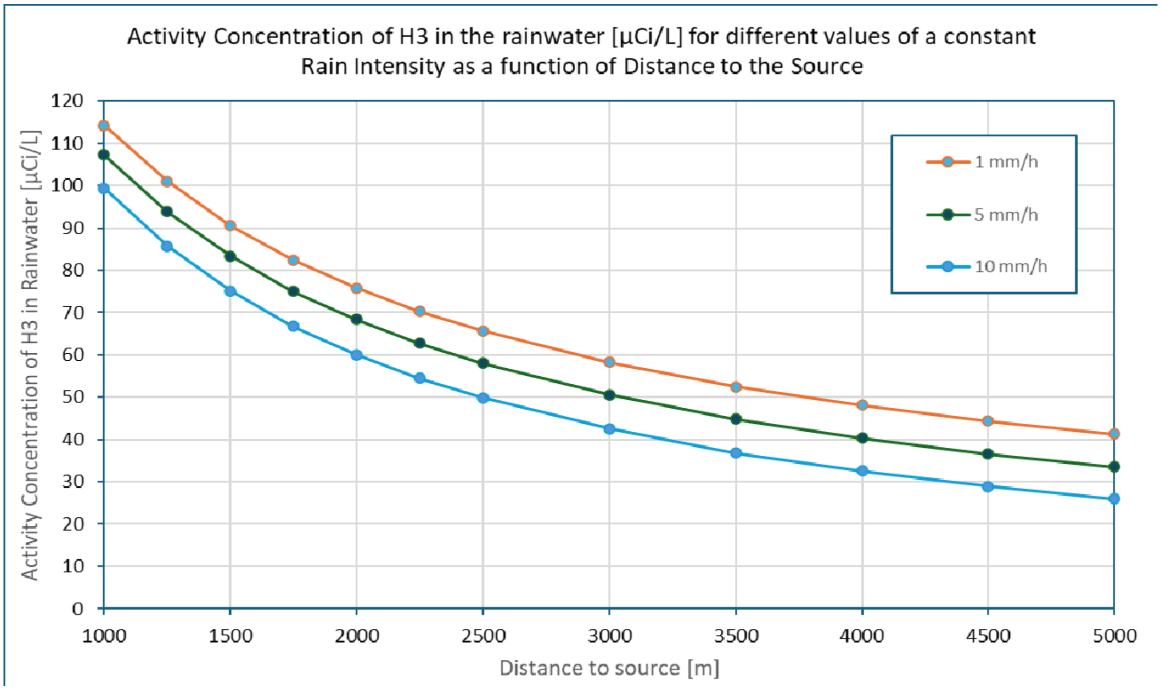

Figure 2: Tritium concentration in rainwater, averaged over 24 hours, Stability Class E.
Source: Figure 9 in Rau and Winkler 2025

The maximally exposed receptor in the modeling by LANL and Franke (2024) is at White Rock, 2,250 meters (about 1.4 miles East-south east of the venting point. It is about 5,000 meters (3.1 miles) to the closest point on the Rio Grande from the venting location. Figure 3 shows the concentrations of tritium at White Rock and the closest location on the Rio Grande for the two stability classes and three rainfall rates.

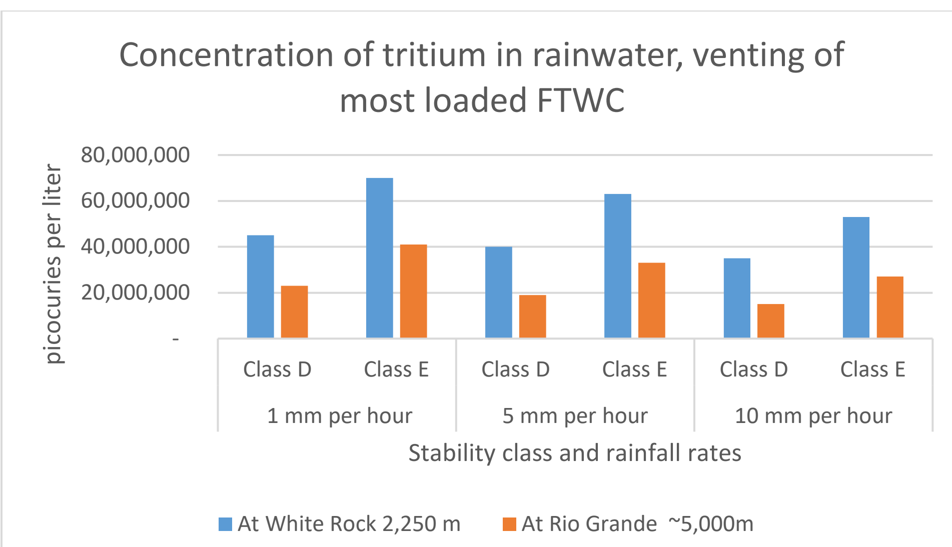

Figure 3: Concentration of tritium in rainfall at White Rock and at the Rio Grande, 2,250 m and 5,000 m respectively, from the release point in Area G. The drinking water limit is 20,000 pCi/L.
Source: Calculated from Figures 8 and 9 Rau and Winkler 2025, reproduced above as Figures 1 and 2.

Figure 4 shows the tritium concentrations expressed as multiples of the EPA drinking water standard (20,000 pCi/L) and the New Mexico reporting guideline (4,000 pCi/L).

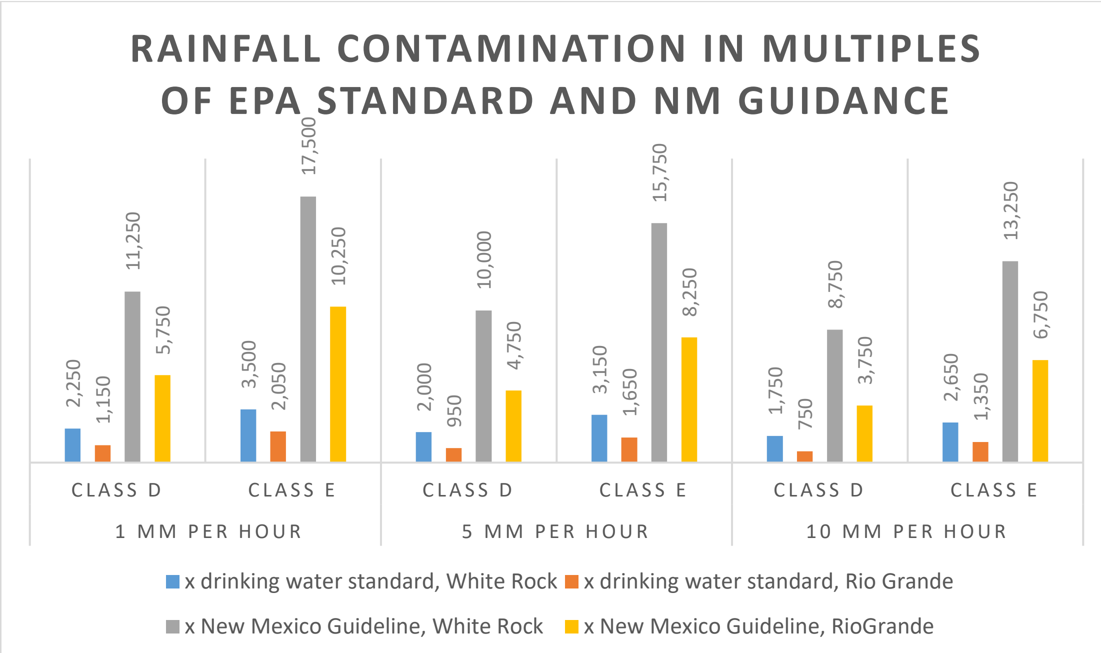

Figure 4: Concentration of tritium in rainfall expressed as multiples of the EPA drinking water standard and the New Mexico reporting guideline, at White Rock and the Rio Grande, 2,250 m and 5,000 m respectively, from the release point in Area G.
Source: Calculated from Figures 8 and 9 Rau and Winkler 2025, reproduced above as Figures 1 and 2.

The various weather and rainfall scenarios give a range of rainwater contamination between 1,750 and 3,500 times the drinking water standard and between 8,750 and 17,500 times the New Mexico reporting guideline, at the maximum receptor location at White Rock at about 2,250 m. The exceedance would also be in the hundreds of times to thousands of times at the Rio Grande location closest to the Area G venting point at about 5,000 m.

Total contamination would be greater since Los Alamos proposes to vent four FTWCs in all. Their contents, decay-corrected to September 1, 2024, are shown in Table 1, rounded to the nearest 1,000 curies. Under similar weather conditions, the releases from the other FTWCs would produce proportionately lower tritium concentrations in rainfall. Even for the least loaded FTWC, the rainwater would be contaminated to between about 500 times and 1,000 times the EPA drinking water standard and between 2,500 times and 5,000 times the New Mexico guideline at the White Rock receptor location.

FTWC #	Curie content
225	31,000
226	32,000
227	9,000
228	13,000

Table 1: Tritium content of four FTWCs, decay-corrected to September 1, 2024.
Note: Rounded to the nearest 1,000 curies

The above calculations represent contamination levels on the day of the venting under various adverse weather scenarios. The drinking water standard is calculated on the basis of an annual average contamination. That would also be greatly exceeded.

Assuming that there is zero tritium contamination on all days except the four days of releases, rainfall would be contaminated to considerably above the drinking water standard *even on an annual average basis*. **It would be exceeded at White Rock on an annual average basis by about 13 to 25 times (rounded) on an annual average basis corresponding to the scenarios in Figure 4 above.** The New Mexico guideline is five times more stringent; the exceedance at White Rock relative to that guideline would be 64 to 127 times on an annual average basis.

Cumulative Impact: The above analysis relates to concentrations of tritium in rainwater. There is also a cumulative impact. A significant amount of total tritium would rain out in the watershed. Some would evaporate on contact; some would be taken up by vegetation; some would percolate down and contaminate groundwater, the streams in the area, and the Rio Grande.

DOE Order 458.1: LANL is required by DOE Order 458.1 to minimize impact of its actions on people and the environment under a principle known as keeping exposures "as low as reasonably achievable" (known by the acronym as the "ALARA" principle). This obligation of LANL in relation to the proposed venting was discussed in Makhijani 2024.[6] To all public evidence, LANL has not made an assessment of the impact of its venting proposal on groundwater.

The total amount of tritium is very large in terms of radioactivity. *A thought experiment can illustrate this: the total amount of tritium in the four FTWCs is large enough to contaminate the entire annual flow of the Rio Grande well beyond the drinking water limit.*

As a practical matter, the venting of such a large amount of tritiated water vapor could severely contaminate groundwater, local streams, and for a time, the Rio Grande. Rau and Winkler (2025) calculated the total impact per square meter of land at various distances from the release point. At its closest, the Rio Grande River is about 5,000 meters (3.1 miles) from the release point. The rate of water

[6] Makhijani, Arjun. 2024. Out of Order: An evaluation of the regulatory aspects of Los Alamos National Laboratory's proposal to vent tritium from waste containers, Institute for Energy and Environmental Research, November. https://ieer.org/wp/wp-content/uploads/2024/11/Out-of-Order-Report-on-LANL-tritum-venting-proposal-Arjun-Makhijani-2024-11-01-1.pdf

flow in the Rio Grande at the Otowi Bridge in Pueblo de San Ildefonso over a five-year period is shown in Figure 5.

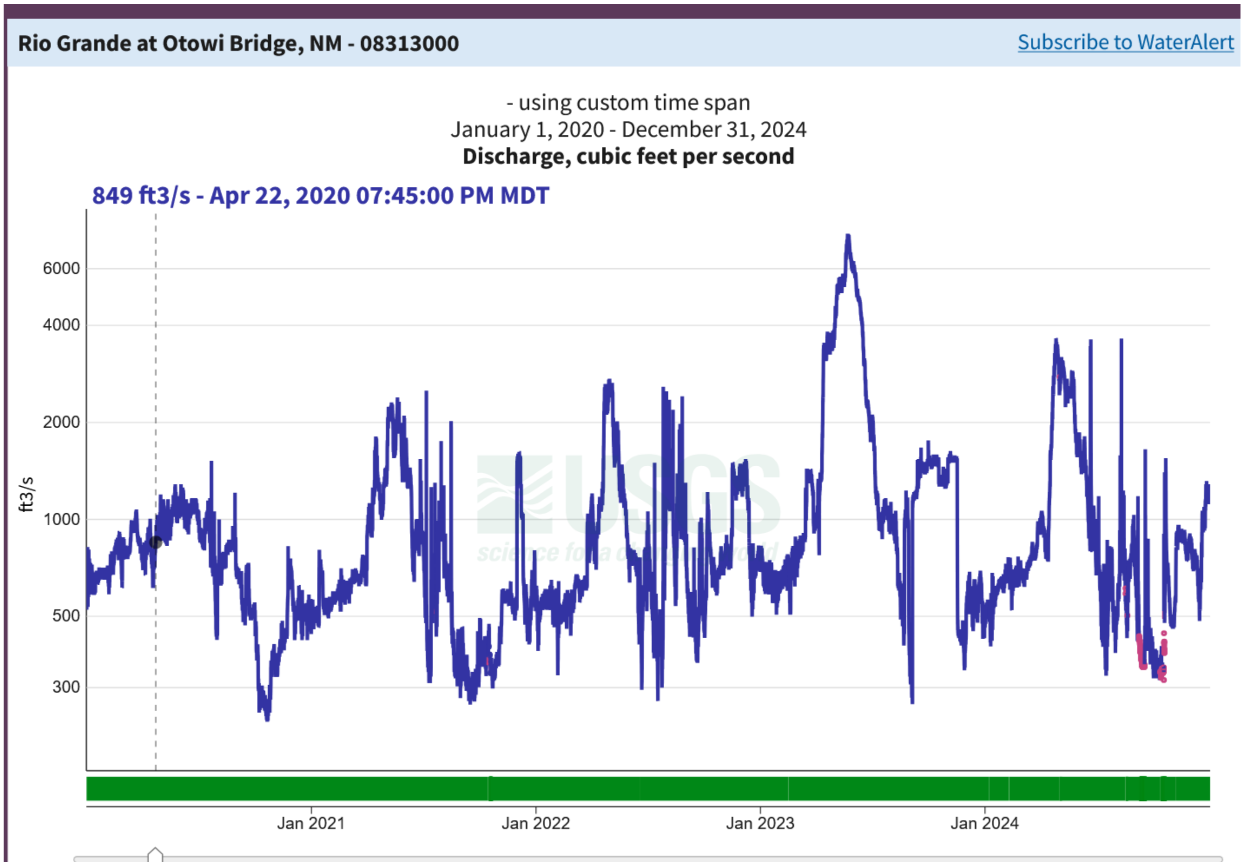

Figure 5: Flow of the Rio Grande River at Otowi Bridge, San Ildefonso Pueblo, New Mexico. Source: Screenshot, USGS at https://waterdata.usgs.gov/monitoring-location/08313000/#dataTypeId=continuous-00060-0&showMedian=false&startDT=2020-01-01&endDT=2024-12-31

A detailed analysis, well beyond the scope of this short report, would be necessary to give realistic estimates of the water contamination that the Los Alamos venting could cause.

1. Some contamination would seep into the soil and from there into the groundwater.
2. Some would evaporate upon hitting the ground.
3. Some would be taken up by vegetation.
4. Some would flow down LANL canyons into the Rio Grande.
5. Some would fall into the watershed of streams that flow into the Rio Grande.

While a precise assessment is beyond the scope here, it is possible to do a heuristic calculation to illustrate the potential seriousness of the problem. For simplicity, we assume that the rainfall in a 300 meter-wide band on each side of the Rio Grande in the ESE 22.5-degree arc would flow into the Rio Grande. This gives an area of about 1.2 million square meters on which the rainfall would flow into the

Rio Grande. Absorption and evaporation are not taken into account. By the same token, flows of tritium from other streams, from groundwater seeps, and from inflows from land farther away are also ignored.

The range of cumulative impacts at 5,000 meters from the source – that is the approximate distance of the Rio Grande from the tritium source – is estimated to be 22.8 to 167.6 microcuries per square meter (22,800,000 to 167,600,00 picocuries per square meter), depending on the weather and the rainfall rate (Rau and Winkler 2025, Tables 3 and 4). The lowest value is for 1 mm/hour rainfall and Class D stability; the highest value is for 5mm/hour rainfall with Class E stability. We have ignored the 10 mm/hour rainfall case for cumulative impact, since it is extremely unlikely, and hence unsuitable for a heuristic calculation. The total amount of tritium in the river in this heuristic scenario would be 30 to 200 curies from the venting of the most loaded cylinder (rounded). That extrapolates to between 70 and 500 curies due to the venting of all four cylinders (rounded), assuming venting in similar weather conditions. Drinking water and New Mexico guidelines would be significantly exceeded on the days of the ventings and for some days afterwards. The New Mexico guideline would be exceeded when averaged over several months.

It is important to remember that these are heuristic calculations. They are not a substitute for careful modeling of the impact of contaminated rainfall on the groundwater and the streams in the area and on the Rio Grande. Los Alamos is required by Department of Energy Order 458.1 to conduct an impact of the venting on groundwater (Makhijani 2025) and should make the necessary precise assessment.