Final Jefferson Parkway soil sampling results

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On December 23, 2019 Lindsay Masters of CDPHE communicated the final results of the Jefferson Parkway Public Highway Authority soil testing for 467 soil samples. The graphics below report on the 453 JPPHA samples I could detect in a large spreadsheet from the CDPHE.

- Of 453 soil tests for a variety of radionuclides, the only anomalous result was from a single sample with a very high soil radioactivity (264 pCi/g) traced to a large (8.8 μ) 'hot particle', almost definitely PuO_2. The particle alone[1] would exhibit an activity of about 225 pCi; more if larger. This is an indication of how extremely rare a large hot particle is in Rocky Flats soil. The inhalation of 400 such large hot particles could raise your lifetime cancer risk by as much as 1% (see the 'Hot particles' document here).
- A table of results for the most significant radioisotopes is shown in the margin. Figures below show histograms of sample numbers by their soil radioactivity and the 'cumulative distribution function' for the nuclides. These are described below.
- 50 additional 'step out' samples (25 measured by the 'carbonate fusion' method and 25 by the 'acid digestion' method) on a 5×5 uniform grid centered on the approximate location of the prior 'hot sample' were reported by Lindsay Masters to David Abelson on October 1, 2019. I regard these as substituting for the single 'hot sample'.
- Surface plots based on the 'step out' measurements for each method for $^{239+240}$Pu are shown in the lower two panels. Note that no measurement exceeded 3 pCi/g.

Explanation:

1. The histograms (in red) show the number of samples which lie in each range of radionuclide soil concentration. It is likely that 'bumps' in the histograms reflect particular sampling regions with higher concentrations.
2. To interpret the cumulative distribution curves (in blue), select a radioactivity level of interest, say 1 pCi/g for $^{239+240}$Pu. Find the 'y value' corresponding to this 'x value', in this case approximately 85.3%. This means that 85.3% of all samples had a soil radioactivity level of 1 pCi/g or *below*. 99.8% of all samples had levels below 5 pCi/g.
3. For the gray scale surface plots, sampling locations were at the vertices of the polygons (where lines on the surface come together) for the two measurement methods. The height of the surface (and the lightness of the gray scale shading) indicates the soil concentration.

Thanks to Laura Dixon of the CDPHE for clarifying the breakdown of the total of 520 samples. As of January 14, 2020 the locations of these samples are shown on the CDPHE website. The 5×5 grid used for the 'step out' samples discussed below is clearly evident.

There are 467 JPPHA samples drawn from about 200 locations at several soil depths using two different analytical methods (see the 'step out' samples below). 48 samples were taken at the behest of the Fish&Wildlife Service as part of the Rocky Mountain Greenway project: 20 on the northern boundary, 13 extending southwest from the eastern refuge boundary through the Woman Creek basin, and 15 near the western entrance along Woman Creek. 5 samples were reported by Dr. Michael Ketterer.

[1] Based on elementary calculations in the 'Hot particles' document here.

radionuclide	mean	std dev	max	median
$^{239+240}$Pu	0.54	0.79	11.3	0.32
^{241}Am	0.16	1.41	32.2	0.064

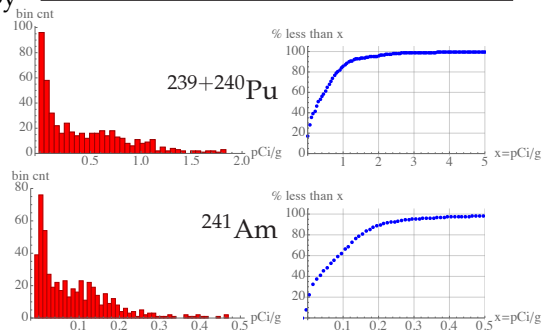

Figure 1: Results for 453 soil samples (CDPHE, 23 December 2019) for the two most significant artificial radioisotopes.

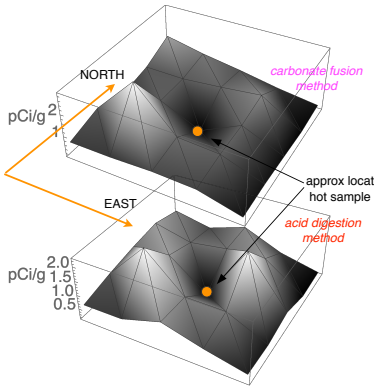

Figure 2: Measured soil concentrations of ^{239}Pu for 'step out' sampling around hot sample. There is reasonable agreement between the two methods. It is apparent that soil radioactivity ranges (depending on the method) from about 0.11 pCi/g to about 2.9 pCi/g, depending on location.