Indoor Dust Remedial Investigation Sampling at the Colonie FUSRAP Site – 15578

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ABSTRACT

The Colonie Formerly Utilized Sites Remedial Action Program (FUSRAP) Site is located in the Town of Colonie, Albany County, New York. The U.S. Army Corps of Engineers (USACE) is currently addressing environmental contamination associated with the Site. The area surrounding the Site consists of residential and commercial properties, known as vicinity properties. Cleanup activities have been completed on many of these VPs under the FUSRAP to address depleted uranium contamination.

Soil remediation activities have been substantially completed at the Colonie FUSRAP Site and its VPs under the FUSRAP. Recent studies performed by an independent party and under FUSRAP identified uranium within indoor dust in residencies and businesses in the immediate vicinity of the Site. The studies were limited to non-living areas such as basement window sills, garages, and attics.

This paper discusses the indoor dust Remedial Investigation (RI) for the VPs at the Colonie FUSRAP Site. The indoor dust sample media presented many technical challenges regarding sampling design, data reduction, and data interpretation. In addition, because the RI is focused on numerous resident-owned, rental, and commercial properties, challenges where presented regarding right-of-entry to sample and concerns were raised regarding confidentiality of the results. In response to this, a community outreach communication and education program is being developed to mitigate property-owner concerns. The paper also identifies specific action levels used to determine future actions. Ultimately, property-specific risk assessments, performed at properties exceeding the action levels, will be used to determine whether a response action is appropriate under FUSRAP.

INTRODUCTION

USACE is executing assessment and cleanup of the Colonie FUSRAP Site under the FUSRAP Program. This is accomplished utilizing the administrative, procedural, and regulatory provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). USACE is in the process of implementing an RI and performing sampling and analysis of indoor dust on properties associated with the Colonie FUSRAP Site. These properties are referred to as Vicinity Properties (VPs) and collectively represent an Operable Unit (OU) of the Colonie FUSRAP Site (separate from the Main Site OU). The VPs are located in Albany and Colonie, New York, near or along the border of the two towns. Previous studies performed by USACE and others have identified the presence of uranium in dust within non-living areas of residences (e.g., attics, garages, basements, etc.) (USACE, 2012).

Industrial operations at the Site began in 1923, when a facility was built for manufacturing wood products and toys. In 1937, National Lead (NL) purchased the facility for conducting electroplating operations. In 1958, the nuclear division of NL began producing items manufactured from uranium and thorium under a license issued by the Atomic Energy Commission (AEC) and New York State. The New York State Supreme Court shut down the NL plant in 1984 due to environmental concerns, and ownership of the Site was transferred to the US Department of Energy (DOE). DOE surveyed the VPs surrounding the NL plant for radioactivity in 1980 and determined that uranium released into the air had deposited on residential and commercial properties and structures. DOE's findings also showed that the majority of the deposited uranium was in the direction of the area’s prevailing winds.

The intent of the RI is to collect sampling data of sufficient quality and quantity to characterize the nature and extent of uranium in dust within VP structures and to determine if uranium in dust poses unacceptable risk to building occupants, requiring action under CERCLA[1]. This is being accomplished by:

- Sampling living areas and non-living areas (e.g., attics, garages, crawl spaces) within a representative subset of residential VPs. Sampling is performed in accordance with guidance developed by the U.S. Environmental Protection Agency (USEPA) for sampling of a metal contaminant within household dust, *Guidance for the Sampling and Analysis of Lead in Indoor Residential Dust for Use in the Integrated Exposure Uptake Biokinetic (IEUBK) Model*. (USEPA, 2008).
- Sampling high-use areas (e.g., office areas, retail areas, work areas) and limited-use space (e.g., long term storage areas, attic spaces, lofts) in a smaller subset of commercial properties to verify assumptions regarding exposure potential and to ensure nature and extent of contamination is appropriately characterized.
- Analyzing collected samples for uranium concentration and comparing results to conservative risk-based screening levels to give a preliminary indication of potential for unacceptable risk and to determine if sampling at additional properties is warranted.
- Performing a human health risk assessment for each property with sample results exceeding the screening levels to quantify carcinogenic and non-carcinogenic risk.

Site Conceptual Model for Dust Distribution

The properties that comprise the VP OU were designated by the DOE because they were contaminated with uranium as a result of airborne deposition from stack emissions from the NL plant that formerly operated on the Main Site. The intent of the RI is to determine if uranium in dust poses potential unacceptable risk to occupants of the VPs. It is expected that the highest potential for exposure is to residential building occupants. Thus, this sampling effort focuses on VPs that are residences. Limited sampling will also be performed on commercial properties to verify assumptions regarding exposure potential and to support appropriate characterization of contamination nature and extent. Sampling will be conducted within a subset of the VPs.

The basis of the conceptual site model (CSM) for distribution of uranium in VP indoor dust starts with the initiation of nuclear operations at the NL Plant. Specifically, the potential for uranium dust distribution in and around the NL Plant location starts in 1958, when the nuclear division of NL began producing items manufactured from uranium and thorium under a license issued by the AEC. From 1958 through 1984, NL carried out a number of processes using radioactive materials consisting primarily of depleted uranium. Operations were conducted at the plant to reduce depleted uranium-tetrafluoride to depleted uranium metal, which was then fabricated into shielding components, ballast weights for airplanes, and armor piercing projectiles.

Fabrication processes at the NL Plant produced chemically unstable uranium scrap metal, which when finely divided can spontaneously combust due to uranium metal's pyrophoric characteristics. In order to manage this unstable waste stream, NL converted the uranium to an oxide form in a furnace with a filtered

[1] Where the cumulative carcinogenic site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4} and the non-carcinogenic hazard quotient is less than 1, action generally is not warranted unless there are adverse environmental impacts (USEPA, 1991).

exhaust stack. In 1979 New York State investigated claims that the stack filters were bypassed, and subsequently forced the temporary closure of the plant for excessive emissions of uranium to the atmosphere (Romano, 1982). In 1980, Teledyne Isotopes was contracted by NL to perform a radiological survey of the facility and its vicinity; results indicated measurable deposition of radioactive contaminants on properties primarily to the northwest and southeast of the plant (i.e., in the directions of prevailing winds – see wind rose in Figure 1). The NL Plant later resumed limited operations after the temporary closure. In 1984 all operations at the NL Plant were ceased when the State of New York forced permanent closure of the facility.

The preceding paragraphs establish the timeframe of NL work with radioactive materials as 1958 through 1984 and a mechanism for contamination of the plant environs via stack emissions. These stack emissions resulted in the contamination of surface soils, roofs, and other outdoor surface features in the NL Plant environs. DOE and USACE have completed structure and soil remediation on affected properties and all properties now meet the soil unrestricted use release criteria. Recent dust sampling performed by USACE and others indicate the presence of uranium in excess of background within dusts in non-living, limited-use, portions of some VP residences (USACE, 2012).

The primary method for contamination of dust within VP structures is from the airborne emissions that occurred from 1958 through 1984. Initial deposition of this uranium was impacted by environmental dispersion and wind direction at the time of emission. Current uranium concentrations in dust within VP structures may be reduced from the initial concentration at the time of settling due to: 1) routine and periodic cleaning activities; 2) dilution of contaminated dust by addition of uncontaminated dust that settled after 1984; 3) interior and exterior building construction/renovation activities; and 4) other activities that disturb settled dust.

Based on these facts, the CSM is summarized as follows:

- The period of dust contamination is 26 years, from 1958 through 1984, with no sources of uranium to impact VP structure dust in more than 30 years.

- Initial deposition of uranium in dust was caused by stack emissions and followed predominant wind directions (see wind rose in Figure 1). Initial soil contamination was also caused from stack emissions and is proportional to maximum initial dust concentrations.

- Airborne uranium entered VP structures, especially in areas designed to communicate indoor and outdoor air (e.g., roof vents and eaves) and settled in dust.

- Human activities that occurred since 1984 have the potential to reduce or eliminate deposited uranium from dust within VP structures. Routine cleaning activities in VP living areas and high-use areas have likely reduced and possibly eliminated uranium from VP indoor dust.

- The highest uranium concentrations in dust would be expected in undisturbed portions of VP structures. Uranium dust concentrations in these undisturbed locations would be proportional to initial deposition from the stack (and thus proportional to initial soil contamination).

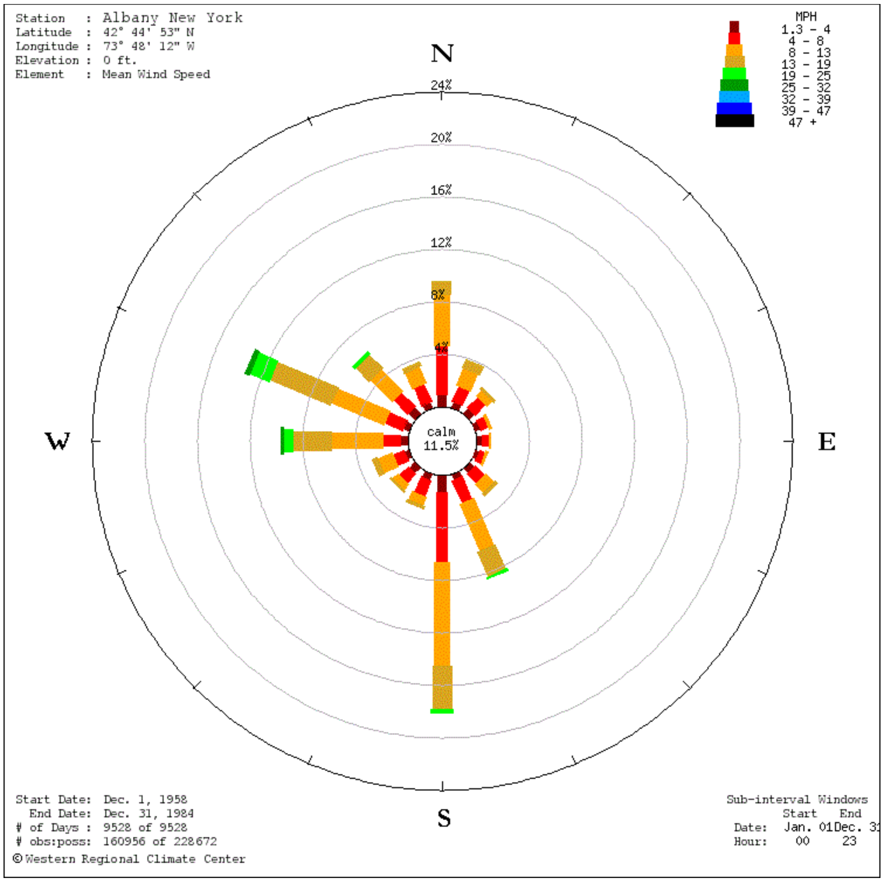

Fig. 1. Albany (Colonie) Area Wind Rose

Selection of Residential VPs to Sample

Of the 56 properties that comprise the VP OU, 30 are confirmed residential, potential residential, or mixed residential and commercial and the balance is commercial, industrial, vacant, and/or lacking permanent structures. These 30 VPs are considered "residential" for the purpose of determining properties to sample. Fourteen (14) VPs designated as residential are planned for sampling during the RI field effort. It is expected that sampling of these properties will provide sufficient information to characterize the nature and extent of uranium in residential household dust and support development of informed risk management decisions. This expectation is based on the fact that the primary mechanism for uranium to become entrained in household dust is via past airborne deposition, which generally followed well characterized prevalent wind directions. Additional VPs will be sampled during follow-on efforts if warranted based on the results of this investigation.

A stratified random sampling plan has been developed, in accordance with USEPA guidance (USEPA, 2008), to increase the likelihood of obtaining a representative sample of the range of dust uranium concentrations across the VPs. Stratification is based on the potential for there to be uranium present in the dust above background and the potential magnitude of uranium concentrations in dust. Because uranium in excess of background was identified in non-living area dust samples from each of the four VPs sampled in the USACE 2011 confirmation sampling, the living areas of each of those properties are targeted for sampling. The remaining properties are divided into two groups based on estimated potential for uranium above background to be present as described below. The non-living and living areas of the selected properties in these two groups will be sampled.

Data directly describing VP living area dust uranium concentrations is not available to support property stratification, as sampling and analysis of this media has not been performed. However, pre-remediation surface soil sample data does exist across all VP areas. It is reasonable to assume that the primary mechanism for surface soil and household dust to become contaminated during operation of the NL plant was through airborne deposition due to stack emissions. An additional mechanism for dust to become contaminated would result from inadvertent tracking of soil indoors. Both mechanisms identify a clear positive relationship between surface soil concentration and potential dust concentration during the NL plant's operating years and prior to VP remediation. Residential VP remediation, which occurred soon after plant shutdown, resulted in elimination of virtually all surface soil contamination. As a result, post-remediation soil concentrations are not considered representative of or related to potential dust concentrations. Based on these conclusions and information, pre remediation surface soil sample results were used to stratify the VPs, assuming a positive relationship between the pre remediation surface soil and current dust concentrations. This method of stratification is recommended in the USEPA guidance.

The 1980 Teledyne Isotopes survey provided detailed surface soil uranium concentration data out to a distance of 600 meters from the NL plant and all VPs lie within the boundaries of the survey (Teledyne Isotopes, 1980). Figure 2 is an overlay of the Teledyne survey results on a map of the VPs. This map was used to divide the VPs into groups based on surface soil uranium concentrations prior to remediation.

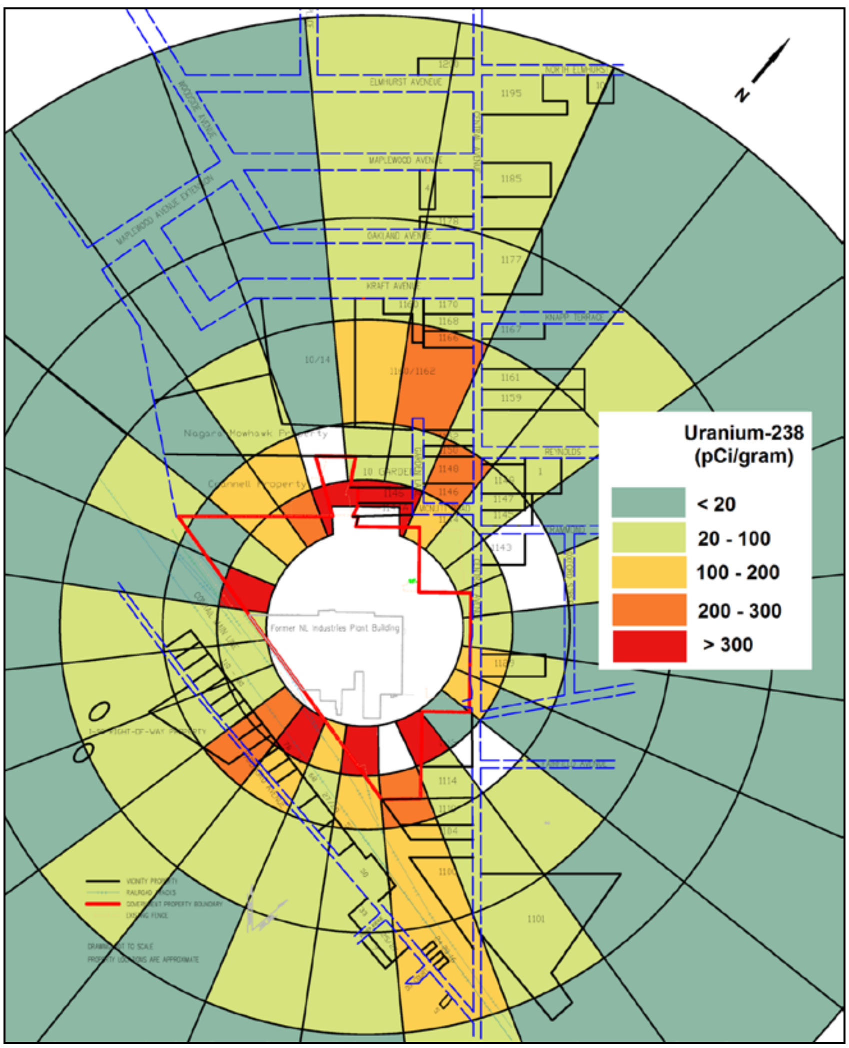

Fig. 2. Pre-Remediation Surface Soil Concentrations (circa 1980)

Three residential stratification groups were ultimately developed, as shown in Table I:

Group R1: Consists of the four VPs sampled during the 2011 USACE effort (uranium above background was confirmed in non-living area dust in these residences). All properties in this group are targeted for living area sampling.

Group R2: Consists of the 13 residential VPs that had pre-remediation soil uranium concentrations in excess of 250 mg/kg (100 pCi/gram). Five properties in this group are targeted for non-living and living area sampling.

Group R3: Consists of the 13 residential VPs that had pre-remediation soil uranium concentrations less than 250 mg/kg (100 pCi/gram) but greater than 50 mg/kg (20 pCi/gram). Five properties in this group are targeted for non-living and living area sampling.

All properties in Group R1 are targeted for sampling. Five properties will be sampled in each of Groups R2 and R3. In accordance with the USEPA guidance, a random process was used to determine the properties for sampling. Microsoft Excel was used to assign a random number to each property in Groups R2 and R3 and the properties were ordered based on the random numbers. In each group, the first five properties are targeted for sampling. It is recognized that some property owners may deny entry and disallow sampling. If that occurs, the next property sequentially on the list will be sampled and the process repeated as necessary.

Selection of Sample Locations in Living Areas of Residences

Four sample locations will be established within the living areas of each residence. Sample collection is biased to assess the variability of dust uranium concentration within the residence while also characterizing the dust uranium concentration in areas of the home where children <7 years (<84 months) of age spend most of their time (if children reside in the residence). Dust sample collection is conducted on hard or carpeted surfaces, depending on the location where children spend their time. All sampling is performed on floors because these areas best represent average long-term dust exposure for children (USEPA, 2008). In the event that more than one residential structure exists on a VP, all living area samples are collected within the same structure.

When children reside in a residence, USACE asks parents/guardians to provide information on what areas of the home the children spend the most time. When information on children's activity patterns is not known (e.g., future exposure scenarios and current exposure scenarios for homes without children), judgment is used to locate samples where children would be likely to spend most of their time.

If children are not present in the home, samples are collected from areas that are most frequently used by the residents. At a minimum, sample locations will include 1) either a bedroom of a child who is <7 years old (<84 months) or any bedroom, if children are not present in the home, 2) the most frequently used living space (preferably by children <7 years old (<84 months), if present), and 3) just inside the most frequently used entrance to the home. USACE documents the rationale for the selected sampling locations within each residence. Each sample location is also photo-documented after sampling.

Selection of Sample Locations in Non-Living Areas of Residences

Four sample locations area established within the non-living areas of each residence, with the exception of Group R1 properties which were already sampled. Non-living areas that may be targeted include unfinished attic areas, crawl spaces, unfinished basement areas, and any other unfinished areas where resident use is limited but possible. Such areas could be used for storage or other non-routine or sporadic building occupant use.

TABLE I. Residential VP Sampling Groups and Random Order

Stratification Group	Random Sort Value	Order Sequence	Property ID	Pre-Remediation Soil > 250 mg/kg (100 pCi/g)?
R1 Confirmed U in Non-living Area Dust	Not Applicable - All Target for Sampling		VP-009	Yes
			VP-010	Yes
			VP-014	Yes
			VP-051	Yes
R2 In Pre-remediation Sector Greater than 250 mg/kg (100 pCi/gram)	0.168	1	VP-016	Yes
	0.203	2	VP-052	Yes
	0.272	3	VP-045	Yes
	0.317	4	VP-046	Yes
	0.619	5	VP-043	Yes
	0.718	6	VP-044	Yes
	0.727	7	VP-017	Yes
	0.742	8	VP-042	Yes
	0.823	9	VP-015	Yes
	0.849	10	VP-048	Yes
	0.896	11	VP-050	Yes
	0.934	12	VP-053	Yes
	0.994	13	VP-007	Yes
R3 In Pre-remediation Sector Less than 250 mg/kg (100 pCi/gram)	0.138	1	VP-021	No
	0.139	2	VP-035	No
	0.145	3	VP-040	No
	0.330	4	VP-019	No
	0.379	5	VP-023	No
	0.574	6	VP-011	No
	0.579	7	VP-046	No
	0.603	8	VP-049	No
	0.735	9	VP-045	No
	0.778	10	VP-032	No
	0.909	11	VP-027	No
	0.923	12	VP-046	No
	0.984	13	VP-013	No

Notes:
- Fourteen (14) properties are targeted for sampling
- All Properties in Stratification Group R1 are targeted for sampling
- The first five properties in each of Stratification Groups R2 and R3 are targeted for sampling. In the event a property owner denies entry, the next sequential property on the list will be targeted. This process will be repeated as necessary.
- Random sort value generated in Microsoft Excel.

Determining sampling locations within each non-living area is performed on a VP-specific basis, as each residence has different conditions and physical constraints. In some cases access is restricted to areas near the entry point of the non-living area (e.g., attics with a trap door entry). Obstacles such as hazardous floor conditions (e.g., lack of decking), insulation, limited crawl space, and the potential to damage the structure or household contents sometimes prevents access to all non-living areas.

If access to the attic is available at a VP, one or more samples are generally collected in the attic. Prior to collection, the attic is inspected for potential health and safety hazards. Samples are not collected where attic floors are not adequately supported, electrical hazards exist, or where damage to the ceiling may result. When possible, samples are located near the attic entry as it is expected that this would represent the dust that is most likely to be tracked into the living space. Samples may also be collected near eave vents and where attic dust disturbance has been unlikely, as these areas may contain higher concentrations and volumes of dust.

Dust Sampling Methodology

The approach for collecting dust at the four VPs is in accordance with the ASTM D5438-05 *Standard Practice for Collection of Floor Dust for Chemical Analysis* (ASTM, 2005). In this procedure, particulate matter is withdrawn from surfaces by means of a vacuum-induced suction device. Particles are drawn through a sampling nozzle at a specific velocity and flow rate, and then separated mechanically by a cyclone. The cyclone is designed to separate and collect particles with an aerodynamic diameter of approximately five micrometers and larger in a catch bottle. A fine-particle filter is added downstream of the cyclone to collect 99.9% of particles between five and 0.2 micrometers aerodynamic diameter. Non-expendable sampling equipment is decontaminated after each sampling event.

Sampling within Residential Living Areas and Commercial High-Use Areas

Sampling is conducted using a modified HVS3 cyclone vacuum sampler, as specified in the ASTM standard, equipped with filters to collect the fine particles. In advance of mobilizing to the site, the filters were pre-weighed and uniquely numbered by the analytical laboratory, who will then weigh the loaded filters once they are returned. Pre- and post-sampling weights will be used to determine the mass of collected dust. The sampling device, shown in Figure 3, is being used in living spaces in the VPs to sample floor areas.

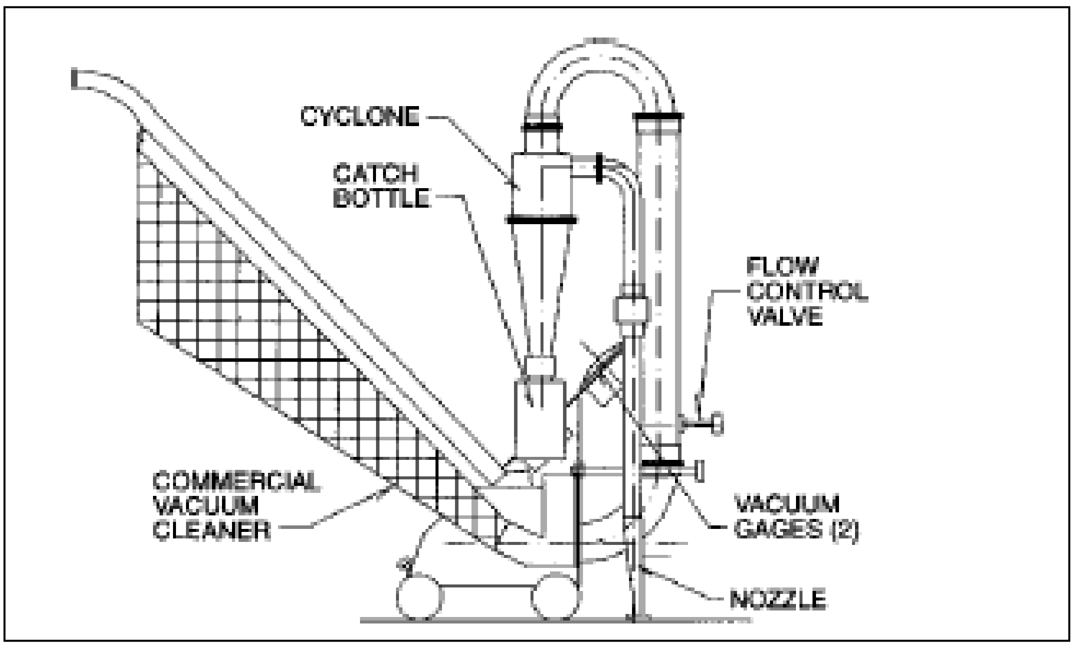

Fig. 3. HVS3 Sampling System Schematic

Dust is collected from four separate floor locations within each VP. At each of these locations, dust is sampled in accordance with Section 11 of the ASTM Standard. All sampling locations are assigned a unique location identifier and photographed. Figure 4 shows the typical sampling procedure. The approximate area sampled is documented for each sample. The particles that collect in the cyclone and the filter are packaged and shipped to the laboratory for analysis.

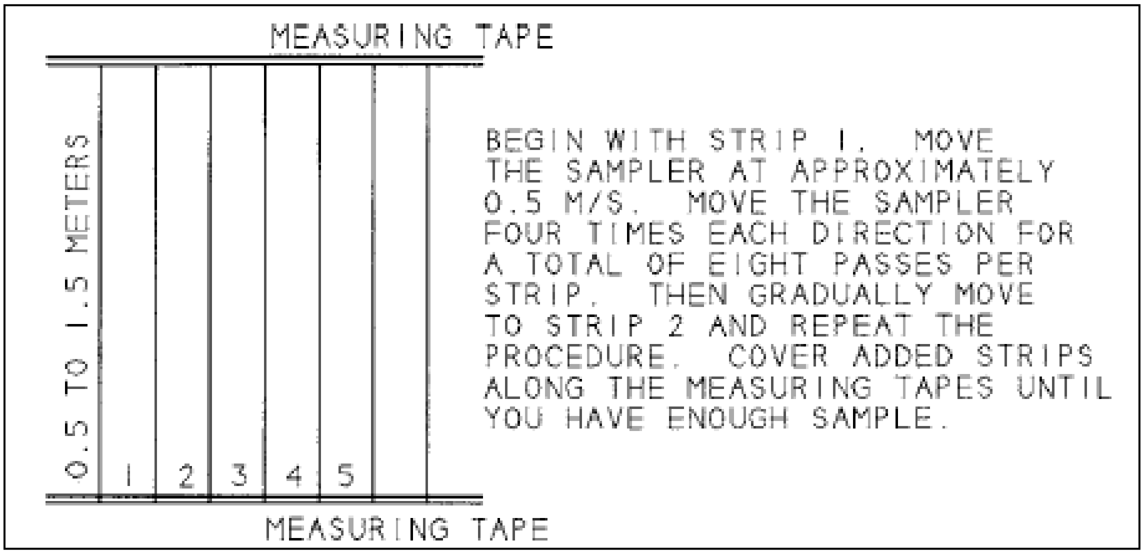

Fig. 4. Typical Sampling Procedure

Sampling Within Residential Non-Living Areas and Commercial Limited-Use Areas

Sampling is conducted using a modified HVFS (or equivalent) cyclone vacuum sampler, as specified in the ASTM standard, equipped with filters to collect the fine particles. In advance of mobilizing to the site, the filters are pre-weighed and uniquely numbered by the analytical laboratory, who will then weigh the loaded filters once they are returned. Pre- and post-sampling weights will be used to determine the mass of collected dust. The HVFS system is used in lieu of the HVS3 to sample the non-living areas because non-living/limited-use area samples are not limited to floor areas and are difficult to access. Practical use of the HVS3 is limited to easily accessible floor areas.

Dust is collected from four separate locations within each. At each of these locations, dust is sampled in accordance with Section 11 of the ASTM Standard. All sampling locations are assigned a unique location identifier and photographed. Samples are collected over an area of approximately 500 square centimeters or greater, as necessary to collect sufficient volume. The approximate area sampled is documented for each sample. The particles that collect in the cyclone and the filter are packaged and shipped to the laboratory for analysis.

Sample Sieving Prior to Analysis

Prior to analysis, samples are sieved by the laboratory in accordance with USEPA guidance (USEPA, 2008). The guidance recommends analyzing only the portion of the dust sample that passes through a No. 60 sieve (250 μm). Researchers who have examined the particle size distribution of dust and soil on children's hands have found that dust particles <200–250 μm are most likely to stick to a child's hands.

Sieving will also remove non-dust material from the sample (e.g., lint, hair). Studies have also shown that there is generally an enrichment of contaminants in the fine fraction of material (USEPA, 2008).

Analytical Methods

The dust and filter samples from the VPs are being analyzed for uranium isotopes via alpha spectrometry analysis (i.e., HASL 300 U-02-RC). Each sample is weighed, with the tare weight of the filter subtracted in order to determine the weight of the collected dust. Samples are then digested and analyzed, with both the sample weight (grams) and the isotopic activity (picocuries) of the sample reported to support determination of the activity concentration of all dust collected (both on in the sample jar and on the filter).

Action Levels

Action levels were developed for living areas (high-use areas) and non-living areas (limited-use areas) to support evaluation of sampling data and are presented in Table II. Separate action levels were derived based on a dose limit of 0.1 mSv/year (10 mrem/year), a non-carcinogenic hazard quotient of one, and an incremental cancer morbidity risk of 10^{-6}. Sample results are compared to these action levels to give a preliminary indication of the potential for unacceptable risk at the property. As part of the RI, property-specific risk assessments will be performed at properties where one or more sample results exceed an action level. The most restrictive action levels will be used for this comparison.

TABLE II. Dust Action Levels

Basis	Depleted Uranium Action Level (mg/kg)	
	Living/High-use Areas	Non-living/Limited-use Areas
Annual dose of 0.1 mSv/yr (10 mrem/yr)	388 (155 pCi/g)	2,750 (1,100 pCi/g)
Lifetime cancer risk (10^{-6})	6 (2.4 pCi/g)	138 (55 pCi/g)
Target Hazard Quotient of 1	348 (139 pCi/g)	348 (139 pCi/g)
Most Restrictive Action level	**6 (2.4 pCi/g)**	**138 (55 pCi/g)**

Rights of Entry and Community Relations

Implementation of the RI field work is underway at the time of this writing. Early in the implementation process, it became apparent that obtaining rights of entry from property owners was going to be a challenge. The vast majority of the residential property owners initially contacted either denied entry or failed to respond to multiple requests for right to enter. Similarly, some commercial property owners were also reluctant to allow entry (but, to a lesser degree than residential property owners). USACE responded to this by developing and refining its community outreach program for the project to better educate and answer any questions or concerns.

As part of the community outreach program, USACE has solicited the assistance of outside, and independent, agencies/groups to assist with helping the public understand the intent of the sampling efforts. Specifically, the New York State Department of Health and a citizen's action group, the Community Concerned about NL Industries (CCNL), are working with the public. While these entities are independent from USACE, all share the common goal of protecting the public and the environment. It is hoped that with the influence of these outside entities and implementation of additional USACE public outreach, rights of entry will be secured with better frequency.

CONCLUSIONS

The USACE is successfully implementing an RI field effort to sample uranium in dust within residential and commercial VP properties at the Colonie FUSRAP Site. The USEPA sampling guidance for lead in homes, *Guidance for the Sampling and Analysis of Lead in Indoor Residential Dust for Use in the Integrated Exposure Uptake Biokinetic (IEUBK) Model*, has proven to be a useful and appropriate sampling framework for the effort. Dust sampling methods identified in *ASTM Method D5438 – 05, Standard Practice for Collection of Floor Dust for Chemical Analysis* (ATSM, 2005) are appropriate for sampling of uranium in dust and are implementable with procurement of off-the-shelf sampling devices. Obtaining rights of entry on properties has proven to be a challenge. This challenge may be mitigated by proactive and quality communication with the public.

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