UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 6
1445 ROSS AVENUE, SUITE 1200
DALLAS, TX 75202-2733

SEP 26 2011

MEMORANDUM

SUBJECT: Request for a Time-Critical Removal Action, at the Sun Clan Road Radiation Site, Village of New Laguna, Pueblo of Laguna, NM.

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THRU: for Ragan Broyles, Associate Director J Chris Petersen
Prevention and Response Branch (6SF-P)

TO: Samuel Coleman, P.E., Director,
Superfund Division (6SF)

I. PURPOSE

This memorandum requests approval for a time-critical removal action, pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., at the Sun Clan Road Radiation Site (the "Site") in the village of New Laguna, Pueblo of Laguna, located near Cibola County, New Mexico. The action includes the demolition and disposal of a residential structure (house) built with radiologically contaminated building materials, removal and disposal of contaminated soil/debris associated with the residential structure, and the construction of a replacement house that is consistent within the meaning of "decent, safe and sanitary" as described in the Uniform Relocation Assistance and Real Property Acquisition Policies for Federal and Federal Assistance Programs (URA), 42 USC §§ 4601 et seq. and its implementing regulations found in 49 CFR § 24.2(a)(8).

As described in Section III of this memorandum, the factors described in Section 300.415 of the National Contingency Plan (NCP), 40 CFR § 300.415, have been considered, and, based on those factors, a determination has been made that a removal action at the Site is appropriate. This Removal Action is not expected to exceed the statutory twelve-month time limit, nor is it expected to exceed the statutory $2,000,000 cost ceiling.

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II. SITE CONDITIONS AND BACKGROUND

CERCLIS ID:	NMN000607171
Category of Removal:	Time Critical
Site ID: No:	A6BE
Latitude:	35. 042491 N
Longitude:	-107. 41861 W

A. Site Description

1. Removal Site Evaluation

In March 2009, the Environmental Protection Agency, Region 6 Prevention and Response Branch (EPA PRB) received a verbal request for assistance from the Laguna Environmental Department in the evaluation of residential areas within the Pueblo that were potentially contaminated with radiation from the mining operations that occurred on the legacy Jackpile Uranium Mine (JUM) (*See* Attachment 2). Based on this request for assistance, the Superfund Technical and Response Team (START) III contractors were tasked by EPA PRB to conduct a Radiation Removal Assessment on the residential areas of the Laguna Pueblo. As part of this radiological assessment a quality assurance sampling plan (QASP) was developed for the project documenting standard operating procedures (SOPs), assessment protocols, and data decisions tree consistent with current EPA guidance and other best management practices.

The elevated concentrations of several radio-isotopes and their associated progeny in various uranium mine waste streams materials are contaminants of concern on this Site primarily from gamma and other forms of ionizing radiation associated with these radio-isotopes. Mine waste materials include waste streams such as overburden, sub-economic ore, broken/replaced infrastructure/mechanical elements, and/or soil/debris that has become contaminated with radioactive waste materials. Principally, contaminants of concern from the mine waste materials include radium-226 (^{226}Ra, hereafter to mean isotope and progeny) and radon-222 (^{222}Rn, hereafter to mean the isotope and progeny) primarily from the mining operations and the subsequent mine closure operations conducted on the JUM. In addition to ^{226}Ra and ^{222}Rn contamination, uranium-238 (^{238}U, hereafter to mean, all the isotopes and their progeny) generated from various mining operations associated with the JUM are also contaminants of concern. These radio-isotopes have been dispersed by the mining operations and various anthropogenic means throughout the Pueblo of Laguna (POL). The anthropogenic means include, but are not limited to the utilization of waste materials in residential landscaping (rock borders, rock gardens, etc.) and residential construction materials (i.e. foundations). The elevated concentrations of radio-isotopes and associated radioactivity above normal background levels, expressed in counts per minute (CPM) and micro-roentgens per hour (μR/hr) present on the POL appear to be the direct result of the mining operations, and/or the utilization of waste materials generated during the uranium mining operations conducted on the JUM.

2. Physical Location

The Site is located on approximately two acres of land on Sun Clan Road in the village of New Laguna on the Laguna Pueblo (*See* Attachment 3). The residential structure located on the Site is approximately 1300 square feet, and of traditional POL construction (rock and adobe mortar walls with plaster coating) (*See* Attachment 4). The structure was built in 1958 by the former owner (who still owned the property at the time of the Removal Assessment). In discussions with the former owner during the Removal Assessment, he stated that he obtained the rocks used in the foundation from the JUM where he was employed as an equipment operator. He further stated that the rocks used in the walls came from sources other than the JUM. The house on the Site has historically been utilized as a rental property, since the former owner currently resides in Leupp, AZ. During the Removal Assessment, the structure was vacant and renovations were being conducted by the former owner in preparation for new tenants. Since the completion of the Removal Assessment, the former owner has transferred ownership of the structure to his daughter, through traditional POL means. The current owner currently works and resides in Arizona, but plans to retire to the house on the Site in approximately two years. Since the results of the Removal Assessment indicated that the house was above acceptable gamma radiation dose and associated cancer risk rates for full-time occupants, the current owner chose not to rent the property and it is currently vacant, except on POL feast and other cultural activity periods, when she stays in the structure.

3. Site Characteristics

The EPA has completed investigation of the extent of contamination on the POL and this Site. Based on data from the Removal Assessment, it appears that the source of the radiological contamination on this Site is the JUM. The following information is a fairly accurate historical description of the JUM mining operations based on available federal, tribal, and state government regulatory records, discussions with former employees and residents of the POL when the JUM was operational. The Jackpile Uranium Mine is located on the Laguna Pueblo, immediately adjacent to the Village of Paguate. It was operated from 1952 until 1982, originally by Anaconda Mining, which was bought by ARCO in January 1977, and subsequently bought by British Petroleum in 2000. The JUM was the largest open pit uranium mine in North America at one point in its operational history. In addition to the open pit mining, two areas of underground mining were also conducted immediately west of the open pit mining operations, due to the close proximity of the Village of Paguate in these areas making surface mining impracticable. After closure of the mine in 1982, a settlement between the Pueblo, the United States Department of Interior (DOI) and ARCO releasing ARCO from its lease agreements was agreed to on December 5, 1986. This settlement turned the mine over to the Pueblo of Laguna for post reclamation maintenance and management for perpetuity.

As part of the larger mining operations conducted at the JUM, the mine maintained large overburden and/or sub-economic ore waste piles and at least one waste/debris area for general infrastructure/ mechanical wastes. During the course of the Removal Assessment the EPA OSCs had discussions with various Pueblo of Laguna officials and residents, including former miners, regarding the residential re-utilization of various mine and mine operations wastes streams by the Laguna Pueblo resident. It appears that this "salvage" or re-utilization process was common and if not approved by the mine operator, it was condoned. Since the JUM was the largest employer on the Pueblo of Laguna for a number of years, a disproportionally large fraction of the adult residents of the Pueblo had easy and ready access to the waste storage areas on the JUM. Reportedly, no warning signs or potential health impact advisories about the use of mine waste materials were present in these areas during the operational history of the mine. Several examples of residential re-utilization of radioactive waste materials were observed during the Removal Assessment on the POL, including but not limited to building materials, fill, landscaping accessories (rock gardens), and souvenirs.

As mentioned above, the EPA has completed the surface soil and structural (indoor) Removal Assessment on the Site. Surface radiological surveys were conducted utilizing a 2"x 2" gamma scintillation detector. Gamma radiation levels near the residence were as high as 35,000 CPM, as compared to the Village specific background of 8,300 CPM which was established by the START III Certified Health Physicists (CHPs) as per radiological best management practices and the quality assurance sampling plan (QASP) for the Site. Indoor gamma ionizing radiation data collected on the Site ranged as high as 37,000 CPM as compared to the aforementioned background levels of 8,300 CPM (*See* Interim Status Report, Attachment 5).

4. Release or Threatened Release Into the Environment of a Hazardous Substance, Pollutant or Contaminant

Uranium-238 and ^{226}Ra are also principal contaminants of concern on this Site based primarily on the gamma and other forms of ionizing radiation associated with these radio-isotopes. Radiological dose is measured in milli-rem per year (mrem/year). The *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, August 22, 1997 (OSWER Directive 9200.4-18) established a general, maximum acceptable radiological dose level of 15 mrem/year above background level for non NRC licensed facilities. Further, this guidance document states that 15 mrem/year above background levels, Total Effective Dose Equivalent (TEDE) represents an excess cancer risk of $3x10^{-4}$, and is considered essentially equivalent to the presumptively protective excess cancer risk level of $1x10^{-4}$. The referenced risk calculation utilizes a 30-year exposure period per lifetime and a 24 hour/day exposure rate. The risk calculation is based upon a risk conversion factor of 7% cancer incidence per 100 rem of exposure and comes from the National Academy of Sciences report on *The Biological Effects of Ionizing Radiation (BEIR V), 1990.* The *Protocol for Uranium Home Site Assessment, Grants Mineral Belt Uranium Project; Cibola and McKinley Counties, New Mexico, December 2009,* documents the regulatory consistency with EPA 1997, OSWER 9200.4-18 and the process used for conducting the radiological assessment on this property. The START III CHPs have evaluated the radiological data from the property collected to date, and have estimated the dose to a human residing in the house on the Site to range from 55 - 146 mrem/year using the ResRad computer model and input values determined from current site specific radiological measurements (*See* Attachment 5 for additional information). This estimated human dose is approximately 10 times the acceptable TEDE of 15 mrem/year above background levels, and the excess cancer risk level of $3x10^{-4}$ is exceeded by a similar factor.

As previously stated, the primary contaminants of concern at the Site, ^{238}U and ^{226}Ra and their associated progeny, including ^{222}Rn are hazardous substances as defined in Section 101(14) of CERCLA, 42 U.S.C. § 9601(14) and 40 CFR § 302.4. The following are the known health effects associated with exposure to the aforementioned hazardous substances on the Site.

Radium-226

Radium-226 is principally a source of alpha and gamma radiation, although some beta radiation is also produced during the decay process. According to the ATSDR *ToxFAQs for Radium* (July 1999) document, exposure to ^{226}Ra can cause adverse effects to the eyes (cataracts) and blood (anemia). Radium-226 has been identified by the EPA and the National Academy of Sciences as a known human carcinogen, being specifically linked to cancers of the bone and breast, and leukemia.

Exposure pathways are the routes that a contaminant can take in order to be assimilated by a human or animal. For example, incidental ingestion of contaminated soils through direct contact or the inhalation of contaminated airborne particles (dust) are both exposure pathways. The exposure pathways of concern at the Site are described below:

- The predominant exposure pathway related to ^{226}Ra was determined to be external gamma radiation, contributing over 90% of the total effective dose equivalent (TEDE) in the ResRad modeled scenario with ^{222}Rn removed for the Site. Radon-222 was removed from the TEDE calculation since it has specific action and clean-up levels established by EPA.

- Inhalation and ingestion are other potential exposure pathways at this Site. The contaminated soils on the Site tend to be fine grained and dusty, are easily airborne after wind or mechanical disturbances, and subject to inhalation and/or ingestion by humans. Inhalation and ingestion combined for a total of approximately 5% of the TEDE estimate in the ResRad modeled scenario for the Site.

Uranium

Uranium is a widespread mineral forming heavy metal that in nature is composed of three isotopes, ^{238}U, ^{235}U, and ^{234}U, with the ^{238}U isotope generally composing over 98% of the mixture. All of these isotopes are the same chemically, but they have different energy and decay properties. According to the ATSDR *ToxFAQs for Uranium* (October 1999) document, U is an alpha ionizing radiation emitter and in general, weakly radioactive. Exposure (acute and/or chronic) to excess levels of U can cause human tissue damage, primarily in the kidneys. Cancer risk from exposure to excess U levels appears to be low to none. The primary risk on this Site from U is cancer caused by exposure to the progeny generated by its decay.

5. NPL Status

This Site is not presently on the NPL. However, should the Site rank on the NPL, the current removal action will be consistent with any subsequent remedial activities that might be taken due to the fact that the proposed actions constitute a source control measure.

6. Maps, Pictures and Other Graphic Presentations

Attachment 1 - Enforcement Addendum (Enforcement Confidential/FOIA Exempt)
Attachment 2 - Site Location Map
Attachment 3 - Site Sketch
Attachment 4 - Interim Status Report, Sun Clan Road Radiation Structure Removal Assessment, July 27, 2011

B. Other Actions to Date

1. Previous Actions

No previous response actions have occurred on this Site to date.

2. Current Actions

Based on the Removal Assessment data and the health based dose calculations utilizing the ResRad model and a ration of dose to excess cancer risk assumed at the TEDE of 15 mrem/year above background level per risk of $3x10^{-4}$ discussed above, in Section II.A.4, the EPA has determined that conditions on this Site pose an unacceptable health risk.

C. Tribal and Local Authorities' Roles

1. Tribal and Local Actions to Date

No POL actions have been taken to date on this property. The EPA has conducted formal consultation with the POL regarding a broad range of radiological assessment activities related to the Jackpile Mine. Region 6 PRB has coordinated with the Laguna Environment Department (LED) on all Removal Assessment activities.

2. Potential for Continued Tribal/Local Response

The POL will not be able to provide a response action to physically address the actions described in this memorandum.

III. THREAT TO PUBLIC HEALTH OR WELFARE OR THE ENVIRONMENT

A. Threats to Public Health

The factors described in Section 300.415 of the National Contingency Plan (NCP), 40 CFR § 300.415, have been considered, and, based on those factors, a determination has been made that a removal action is appropriate to address the hazardous substances present in the contaminated wastes at the Site. Any or all of these factors may be present at a site yet any one of these factors may determine the appropriateness of a removal action.

1. Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants. 40 CFR § 300.415(b)(2)(i).

As discussed above, in Section II.A.3-4, elevated levels of ionizing gamma radiation have been detected in the residential structure and in the soils surrounding the structure. The EPA has determined that these conditions pose an unacceptable exposure rate to ionizing gamma radiation to any full-time occupants of the residential structure on the Site.

The fine and sandy/dusty texture of the contaminated soils surrounding the structure on the Site makes it easy for these contaminated soils to adhere to humans and animals that come into direct contact with them. For humans and especially children, the wastes may be subsequently ingested during normal hand-to-mouth (or plaything-to-mouth) activity, or it may be inhaled. Moreover, the dry climate and sparse vegetative cover in these areas may cause the fine-grained waste materials to become wind-borne. Given the frequent dust storms taking place seasonally on the Site potential for exposure is greatly increased. These dust storms can also cause indoor contamination (the dust is so fine that it can blow through small cracks), increasing the likelihood that humans, and especially children, may be exposed. In addition, during the brief wet periods following precipitation events, contaminated mud may be tracked into residences and/or vehicles. When the mud dries and is disturbed during human activities, such as routine cleaning, the airborne fraction of the dust contributes to further inhalation and/or ingestion exposure.

2. Weather Conditions That May Cause Hazardous Substances or Pollutants or Contaminants to Migrate or be Released. 40 CFR § 300.415(b)(2)(v).

As referenced above, the Site is located on the Pueblo of Laguna in northwest New Mexico. The Pueblo routinely experiences severe weather of varying degrees of intensity during Spring and Summer. Given that the referenced radiological contamination is located at or near the surface of the Site, and because the Site is located in semi-arid area, with limited vegetative cover, there is a high potential for migration of the aforementioned hazardous substances from the Site via the flash flooding rains in the Summer and/or strong wind (dust) storms that are associated with strong low pressure systems in the Spring increasing the likelihood of human exposure.

3. The Availability of Other Appropriate Federal or Tribal Response Mechanisms to Respond to the Release. 40 CFR § 300.415 (b)(2)(vii).

At this time, there are no other mechanisms available to respond to actions described in this memorandum in a timely manner so as to effectively reduce the imminent and substantial endangerment to public health posed by the hazardous substances located on the Site. The POL does not have the resources available to address the current dangerous conditions at the Site. If other mechanisms become available during the conduct of this response action, the EPA will evaluate those mechanisms as appropriate.

B. <u>Threats to the Environment</u>

The actions taken during this response are designed solely to address a public health threat resulting from the hazardous substances present on the Site derived from waste materials that appear to have originated from the historic uranium mining and/or mine closure operations at the JUM.

IV. ENDANGERMENT DETERMINATION

Actual or threatened releases of hazardous substances, pollutants or contaminants from the Site, if not addressed by implementing the response action selected in this Action Memorandum, will continue to present an imminent and substantial endangerment to public health or welfare or the environment.

V. PROPOSED ACTIONS AND ESTIMATED COSTS

A. Proposed Actions

1. Proposed Action Description

a. Distinction Between Action Levels and Clean-up Levels

The EPA uses the term "action level" to mean the contaminant concentration level in waste or contaminated environmental media (such as soil or groundwater) which triggers the need to take a response action. For example, hazardous wastes under the Resource Conservation and Recovery Act (RCRA), such as a drummed waste at a given site, which are not contaminating an environmental media, are not subject to a specific action level. They may simply be removed to prevent actual or potential exposures rather than treated to achieve a specific action level.

Action levels should not be confused with "cleanup levels." The cleanup level is the contaminant concentration level which the response action is designed to meet. That is, once the EPA has identified an environmental medium which contains concentrations of hazardous substance which exceeds the action level, the removal action calls for continued response until the concentration of the contaminant in the contaminated medium are below the established cleanup level.

For this removal action, both the action level and cleanup level is a 15 mrem/yr dose rate (above local background levels) for ionizing radiation generated from the decay of the aforementioned radioisotopes and their associated daughter progeny in the contaminated building materials and soils. As noted above, the 15 mrem/yr exposure level equates with a 3×10^{-4} risk level.

In developing the action levels and cleanup levels for the Site, EPA Region 6 considered the *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, August 22, 1997 (OSWER Directive 9200.4-18), EPA Region 9 Navajo Nation Radiological Structure Assessment data and procedures, and consulted with NMED to determine whether there were Applicable or Relevant and Appropriate Requirements (ARARs) within the meaning of CERCLA Section 121, 42 U.S.C. § 9621. After the action levels and cleanup levels for this Site were reviewed and found to be consistent with historic action levels and cleanup levels used by the EPA on similar sites, the OSC decided to utilize the aforementioned ionizing radiation dose rate and associated risk level as the action levels and cleanup levels for the radiological contamination on this Site.

b. Sun Clan Road Radiation Site

The EPA proposes to mitigate the imminent and substantial threats to human health, welfare, or the environment by taking steps to prevent the release of radium-226, uranium and external ionizing radiation from the sources on this Site. The removal action will include the following objectives to prevent direct human contact and excessive ionizing radiation exposure from the contaminated building materials and surrounding soils present on the Site:

- Remove the entirety of the contaminated residential structure on the Site.
- Remove the surficial (≤ 6 inches) radiological contamination from the Site by excavating soil identified in the Removal Assessment for the Site (≤ 50 cubic yards).
- Consolidate, transport and dispose of non-radiological demolition material in an approved off-site facility.
- Consolidate, transport and dispose of the radiologically contaminated soil, debris, and demolition material in an approved off-site facility.
- Replace excavated soils with clean fill and restore to pre-removal grade.
- Replace demolished residential structure with a structure that is consistent within the meaning of "decent, safe and sanitary" (DSS) as described in the aforementioned URA, 42 USC §§ 4601 et seq and its implementing regulations found at 49 CFR § 24.2(a)(8).
- Conduct confirmation radiological scanning, sampling, and analysis to ensure that the ionizing radiation exposure is below established the EPA allowable annual threshold.

Demolition and reconstruction of the radiologically contaminated residential structure, along with the removal of contaminated soils on the Site will achieve the stated goal of this removal action by reducing the ionizing gamma radiation dose (human) and associated cancer risk to less than the EPA aforementioned action/cleanup level established for this Site.

c. Compensation of Structure Owner

As discussed above, the current owner of the structure is not currently a full-time resident on the Site. She currently works in Arizona and her primary domicile is also in Arizona, but she does inhabit the structure on the Site during religious feast days and other cultural activities that occur on the Pueblo. Since the owner is not a full-time resident, EPA's April 2002 OSWER Directive 9230.0-97, *Superfund Response Actions: Temporary Relocations Implementation Guidance* (Temporary Relocation Guidance) and the definition of a "displaced person" and subsequent requirements of the URA found at 49 CFR 24.2(9)(i)-(ii) do not apply to this removal action. Since demolition and reconstruction are integral to this removal action, EPA Region 6 had to develop and document an appropriate and consistent method of compensation for the structure owner. In developing EPA Region 6's approach to compensating the owner of the residential structure that will be demolished as part of EPA's proposed removal action to address radiological contaminated structures within the Laguna Pueblo, Region 6 staff has consulted: 1)

EPA's July 30, 2004 OSWER Directive 93603-24, *Analyzing Compensation Alternatives for Partially or Completely Demolished Structures* (Compensation Policy); 2) the Uniform Relocation Assistance and Real Property Acquisition Policies for Federal and Federally Assisted Programs, 42 U.S.C. §§ 4601 *et seq.*, and its implementing regulations, 49 C.F.R. Part 24 (collectively URA); and 3) Region 9 personnel involved with similar removal actions with cultural sensitivity issues on the Navajo Nation and the *Region 9 Operating Principles: Access, Temporary Relocation and Compensation, Navajo Nation Radioactive Structures Removal Sites*, June 25, 2009.

The EPA's Compensation Policy (OSWER 93603-24) offers the following alternatives for compensating owners of partially or completely demolished structures: 1) property acquisition and permanent relocation (<u>except</u> at non-NPL sites under removal authority, such as this removal site); 2) providing the owner a financial settlement for the replacement value of the structure or demolished components, where the owner restores or rebuilds; 3) providing the owner "the appraised value of the property [e.g., the structure] but not the estimated cost to restore or rebuild" where the owner "prefers to receive the appraised value of the structure or the demolished components, and not rebuild but retain the land"; and 4) EPA restores or rebuilds the structure using government contractors (*See* Compensation Policy at p.4, including fn.6).

The EPA Compensation Policy requires prior Headquarters' approval if the Region selects options 2, 3, or 4 for completely demolished structures. Option 1 is not applicable at this removal site. The generally preferred EPA compensation under removal authority is to provide the owner with funds to manage the rebuild themselves, and the Policy emphasizes that rebuilding or conducting major restoration of the structures using government contractors is the least preferred method that should be done only in the "rarest of circumstances."

Importantly, the EPA Compensation Policy notes that there "is clearly no single compensation mechanism that works best for every situation." It adds that while "EPA strives to include consideration of the owner(s)' preference in the final [compensation] decision, **the owner(s)' preferences should be balanced with the Agency's responsibility to manage public funds appropriately and within its expertise. The [compensation] determination should be made on a case-by-case basis and is at the discretion of the Agency.**" In other words, the EPA is not required to provide owners with all of the options referenced in the Compensation Policy, and the EPA must take into consideration the particular circumstances of the site when selecting the type/form of compensation it will offer. The Compensation Policy also states that:

> The EPA is not responsible for providing an exact replica of the original structure, essentially "like for like." Rather, appropriate replacement housing should be consistent with the URA: decent, safe, and sanitary; meet applicable housing and occupancy codes; be functionally equivalent to the previous house; be adequate in size to accommodate the

occupants; and be within the financial means of the displaced persons.

The EPA Region 6 relied heavily on the EPA Compensation Policy and the Region 9 Operating Principles (referenced above) when developing its compensation options for this removal action. In developing these options certain modifications were needed to address the unique land ownership and real estate market that exists in the Laguna Pueblo. Notably, EPA Region 6 did not conduct an appraisal of the existing residential structure, as the structure is built upon real property that cannot be sold by the individual because the United States owns most of the Laguna Pueblo in Trust for the Laguna Pueblo. The Laguna Pueblo, as the beneficiary of the Trust Land, has the authority to issue or allocate homesites to individuals for residential use of the property. While the individuals do not own the underlying property in fee simple, they do own the "structures" or "improvements" that they build on the homesite.

While it is possible for individuals to sell or rent their homes to another Laguna Pueblo enrollee (Pueblo ordinance) and to obtain mortgages under certain circumstances either through the Laguna Housing Development and Management Enterprise (LHDME) or for modular or pre-fabricated homes, most of the existing residential structures are passed down to family members as per cultural tradition. Based on these circumstances, there is not an active real estate market in the area as contemplated by EPA's Compensation Policy amenable to securing a fair market value appraisal. Accordingly, Region 6, in consultation with ORC and OGC, determined that the resources required to conduct individual appraisals, assuming EPA could even locate professionals willing to conduct them, would not yield reliable results. In lieu of using appraisals, the EPA Region 6 based the value of the home to be demolished on its own market research and estimates for the "materials" (40% of total rebuild cost estimate) and "labor" (60% of total rebuild cost estimate) to rebuild a comparable DSS replacement structure. This value assessment methodology is very similar and consistent with the Region 9 Operating Principles referenced above.

Additionally, the EPA Region 6 decided to use its discretion and not to offer a financial settlement option based on the estimated cost to the EPA for the "materials and labor" for a comparable-sized structure when the resident opts to self rebuild. As stated above the structure owner currently lives out of state and uses the structure during religious and cultural events in the Village or POL. As such it would be very difficult for the owner to contract an acceptable local builder and conduct the rebuilding operations in a timely manner. Further, in consultation with the POL and LHDME there appears to be no licensed and bonded general construction contractors on POL. All qualified contractors would be from off the POL which leads to historic trust issues which are prevalent between the native and non-native communities. Additionally, the anticipated several month owner rebuild process would put an unreasonable demand on the On-Scene Coordinator's time monitoring the progress and appropriateness of the rebuilding process being conducted by the owner. Further, there is a substantial risk to the Government of not being able to ensure that the replacement home is built using quality materials and any defects in the home are corrected in a timely manner. Although, this option is the preferred option in the EPA Compensation Policy, the EPA Region 6 has deemed this option to be inappropriate, impracticable, and not in the best interest of the Government based on the aforementioned, unique set of conditions associated with this removal action. The EPA Region 9 reached a similar conclusion after implementing this option on their first round of removal actions on the Navajo Nation, and no longer offers this option as part of their compensation package for many of the reasons discussed above.

Based on the unique set of circumstances and facts regarding this removal action the EPA Region 6 has elected to use its discretion within the aforementioned the EPA Compensation Policy to make the following compensation offer to the owner of this residential structure that must be demolished as part of this removal action:

1) Owner does not want a rebuild – If the owner of the residential structure chooses not to return to the homesite and elects to establish a permanent residence at another location other than the homesite described above, the EPA Region 6 will offer a financial settlement based on the estimated cost of the "materials" for a comparable-sized DDS replacement structure (modular home). Based on market research, the EPA Region 6 has found that a comparable-sized DDS replacement structure and foundation would be $120,000 (taxes and fees not included). As noted on page 12, the total cost estimate for a comparable DDS replacement structure includes estimates for materials (40%) and labor (60%). The Region 6 financial settlement offer to the structure owner would therefore be $48,000 for the materials costs of the replacement structure. However, given the uncertainties of scheduling a self-rebuilding project, the continued cost to the government for oversight for an unknown period of time is unquantifiable.

2) Owner wants a rebuild - If the owner of the residential structure chooses to return to the homesite to re-establish permanent residence, a comparable-sized, functionally equivalent DSS structure (modular home) with a one year warranty on any defects will be built and/or installed by the EPA contractors. The estimated cost of $130,000 for this option includes the home, foundation, installation, utility hook ups, etc., for turn-key replacement of the residence.

d. Certain contaminated materials will be taken off-site

The contaminated soils excavated during the removal action will be consolidated with the contaminated demolition materials and taken off-site for disposal. The contamination found at the Site reportedly originated from the historic mining operations conducted on the JUM. These contaminated wastes described above are a solid waste, but not a hazardous waste under the Resource Conservation and Recovery Act (RCRA), because they are derived from the extraction, beneficiation, and processing of ores and minerals within the meaning of 40 CFR § 261.4 (b)(7). Although these wastes are not considered hazardous wastes under RCRA regulations, they have been determined to be CERCLA hazardous substances.

The off-site disposal of the CERCLA wastes generated from this removal will be in conformance with EPA's procedures for planning and implementing off-site response action, 40 CFR § 300.440. All off-site transportation of hazardous waste will be performed in conformance with applicable U.S. Department of Transportation (USDOT) requirements. Other requirements under the Occupational Safety and Health Act (OSHA) of 1970, 29 U.S.C. § 651 et. seq., and under the laws of States with plans approved under section 18 of the State's OSHA laws, as well as other applicable safety and health requirements, will be followed. Federal OSHA requirements include, among other things, Hazardous Materials Operation, 29 CFR Part 1910.120, as amended by 54 Fed. Reg. 9317 (March 5, 1989), all OSHA General Industry (29 CFR Part 1910) and Construction (29 CFR Part 1926) standards wherever they are relevant, as well as OSHA recordkeeping and reporting regulations, the EPA regulations set forth in 40 CFR Part 300, and other EPA policies/guidelines relating to the conduct of work at Superfund sites.

2. Contribution to Remedial Performance

The actions described above for this Site will completely remove all radiological contamination above the established clean-up level from this Site.

3. Description of Alternative Technologies

At this time, there are no other proven alternative technologies that could be feasibly applied at this Site. The appropriate action is to conduct the removal action on the Site as described in this memorandum. If an equally protective and less expensive technology is later identified, it may be considered.

4. Applicable or Relevant and Appropriate Requirements (ARARs)

The proposed removal action will be conducted to eliminate the actual or potential exposure to hazardous substances pursuant to CERCLA, in a manner consistent with the NCP, as required at 42 U.S.C. § 9604. As per 40 CFR Section 300.415(j), Superfund-financed removal actions under CERCLA § 104 and § 106 shall, to the extent practicable considering the exigencies of the situation, attain the applicable or relevant and appropriate requirements (ARARs) under Federal environmental law.

a. Chemical-specific ARARs – There were no chemical-specific Federal or State ARARs identified that were applicable to this removal action.

b. Location-specific ARARs - All proposed activities at the Site are compliant with any location-specific ARARs including the requirements of, the National Historical Preservation Act 16 USC Section 470 *et seq*. and its implementing regulations found at

36 CFR Part 800, Native American Graves Protection and Repatriation Act, 25 USC Section 3001 *et seq*. and its implementing regulations, 43 CFR Part 10, Archeological Resources Protection Act of 1979, 16 USC Section 47000 *et seq*. and its implementing regulations, 43 CFR Part 7 and the American Indian Religious Freedom Act, 42 USC Section 1996 *et seq*.

c. Action-specific ARARs - The uranium, radium-226 and related daughter progeny contamination in the demolition materials and related soil/debris is from the mining of uranium which is a solid waste, but not a hazardous waste under the Resource Conservation and Recovery Act (RCRA), because it is solid waste from the extraction, beneficiation, and processing of ores and minerals within the meaning of 40 CFR § 261.4 (b)(7). Since the materials are not a hazardous waste under RCRA, EPA does not consider RCRA hazardous waste management requirements to be applicable or relevant and appropriate, including without limitation the waste analysis requirements found at 40 CFR §§ 261.20 and 261.30, the RCRA manifesting requirements found at 40 CFR § 262.20, and the RCRA packaging and labeling requirements found at 40 CFR § 262.30. Since the removal action involves no on-site storage of hazardous wastes, storage requirements found at 40 CFR Part 265 are not applicable or relevant and appropriate.

Although the hazardous substances which are the subject of this removal action are solid waste and not hazardous waste under RCRA because they are solid waste from the extraction, beneficiation, and processing of ores and minerals, according to 40 CFR § 261.4(b)(7), it is useful in this Site-specific situation for EPA to use certain RCRA requirements to control and track waste sent off-site. Accordingly, RCRA waste analysis requirements found at 40 CFR §§ 261.20 and 261.30, RCRA manifesting requirements found at 40 CFR § 262.20, and RCRA packaging and labeling requirements found at 40 CFR § 262.30 are deemed to be relevant and appropriate requirements and will be used for off-site disposal of wastes and other contaminated material generated during this removal action. Because on-site storage of repackaged hazardous wastes is not expected to exceed ninety (90) days, specific storage requirements found at 40 CFR Part 265 are neither applicable nor relevant and appropriate. <u>See</u> 40 CFR § 262.34.

d. To-be-considered (TBCs) - In addition to ARARs, other advisories, criteria, or guidance that may be useful in developing the response were, as appropriate, identified and considered.

5. Project Schedule

The proposed actions for this time critical removal action are expected to be completed in less than 60 calendar days.

B. Estimated Costs

Extramural Costs

Removal Contractors..................	$ 413,000
START III Contractors...........	$ 50,000
Subtotal, Extramural Costs	$ 463,000
Extramural Costs Contingency (20%)	$ 92,600

TOTAL, EXTRAMURAL COSTS.................. $ 555,600

VI. EXPECTED CHANGE IN THE SITUATION SHOULD NO ACTION BE TAKEN OR ACTION BE DELAYED

Should the actions described in this Action Memorandum be delayed or not taken, the elevated gamma radiation dose from the contaminated structure and associated contaminated soils will continue to pose an imminent and substantial endangerment to public health, or welfare, or the environment.

VII. OUTSTANDING POLICY ISSUES

There are no outstanding policy issues associated with this removal action.

VIII. ENFORCEMENT

See the Enforcement Confidential Attachment #1, for details regarding potentially responsible parties (PRPs) associated with this Site. The total cost to EPA for this removal action, consisting of demolition/ replacement of the residential structure, the excavation of contaminated soil excavation and the disposal of the contaminated soil/demolition debris is **$878,030.**

(Direct Cost) + (Other Direct) + (42.63% of Total Direct {Indirect Cost}) = Estimated EPA Cost for a Removal Action

$575,600 + $60,000 + (40.81% x $635,600) = **$878.030**

Direct costs include direct extramural costs and direct intramural costs. Indirect costs are calculated based on an estimated indirect cost rate expressed as a percentage of site-specific direct costs, consistent with the Superfund full cost accounting methodology effective October 2, 2002.

IX. RECOMMENDATION

This decision document represents the selected removal action for the Sun Clan Road Radiation Site, in the valley of New Laguna, Pueblo of Laguna and is developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., and is not inconsistent with the National Contingency Plan (NCP), 40 CFR Part 300. This decision is based on the administrative record for the Site.

Conditions at the Site meet the NCP criteria for a removal found at 40 CFR § 300.415 (b) (2). We recommend your approval of the proposed removal action request. The total estimated EPA cost for the removal is $878,030. Of this, an estimated $575,600 comes from regional funds.

APPROVED: Pamela Phillips, Acting DATE: 9/26/11
Samuel Coleman, P.E., Director
Superfund Division

Attachments:

SEP 26 2011

MEMORANDUM

SUBJECT: Request for a Time-Critical Removal Action, at the Sun Clan Road Radiation Site, Village of New Laguna, Pueblo of Laguna, NM.

FROM: Warren Zehner, On-Scene Coordinator
Removal Team (6SF-PR)

Jon Rinehart, On-Scene Coordinator
Removal Team (6SF-PR)

THRU: Ragan Broyles, Associate Director
Prevention and Response Branch (6SF-P)

TO: Samuel Coleman, P.E., Director,
Superfund Division (6SF)

I. PURPOSE

This memorandum requests approval for a time-critical removal action, pursuant to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. § 9601 et seq., at the Sun Clan Radiation Road Site (the "Site") in the village of New Laguna, Pueblo of Laguna, located near Cibola County, New Mexico. The action includes the demolition and disposal of a residential structure (house) built with radiologically contaminated building materials, removal and disposal of contaminated soil/debris associated with the residential structure, and the construction of a replacement house that is consistent within the meaning of "decent, safe and sanitary" as described in the Uniform Relocation Assistance and Real Property Acquisition Policies for Federal and Federal Assistance Programs (URA), 42 USC §§ 4601 et seq. and its implementing regulations found in 49 CFR § 24.2(a)(8).

As described in Section III of this memorandum, the factors described in Section 300.415 of the National Contingency Plan (NCP), 40 CFR § 300.415, have been considered, and, based on those factors, a determination has been made that a removal action at the Site is appropriate. This Removal Action is not expected to exceed the statutory twelve-month time limit, nor is it expected to exceed the statutory $2,000,000 cost ceiling.

Webster	Broyles/Petersen	Capuyan	Johnson	Travis	Peycke
6SF-PR 9/23	6SF-P 9/26/11	~~6SF~~-TE 9/21/11	6SF-TE 9/23/11	6RC-S 9/21/11	6RC-S 6MO 9/22

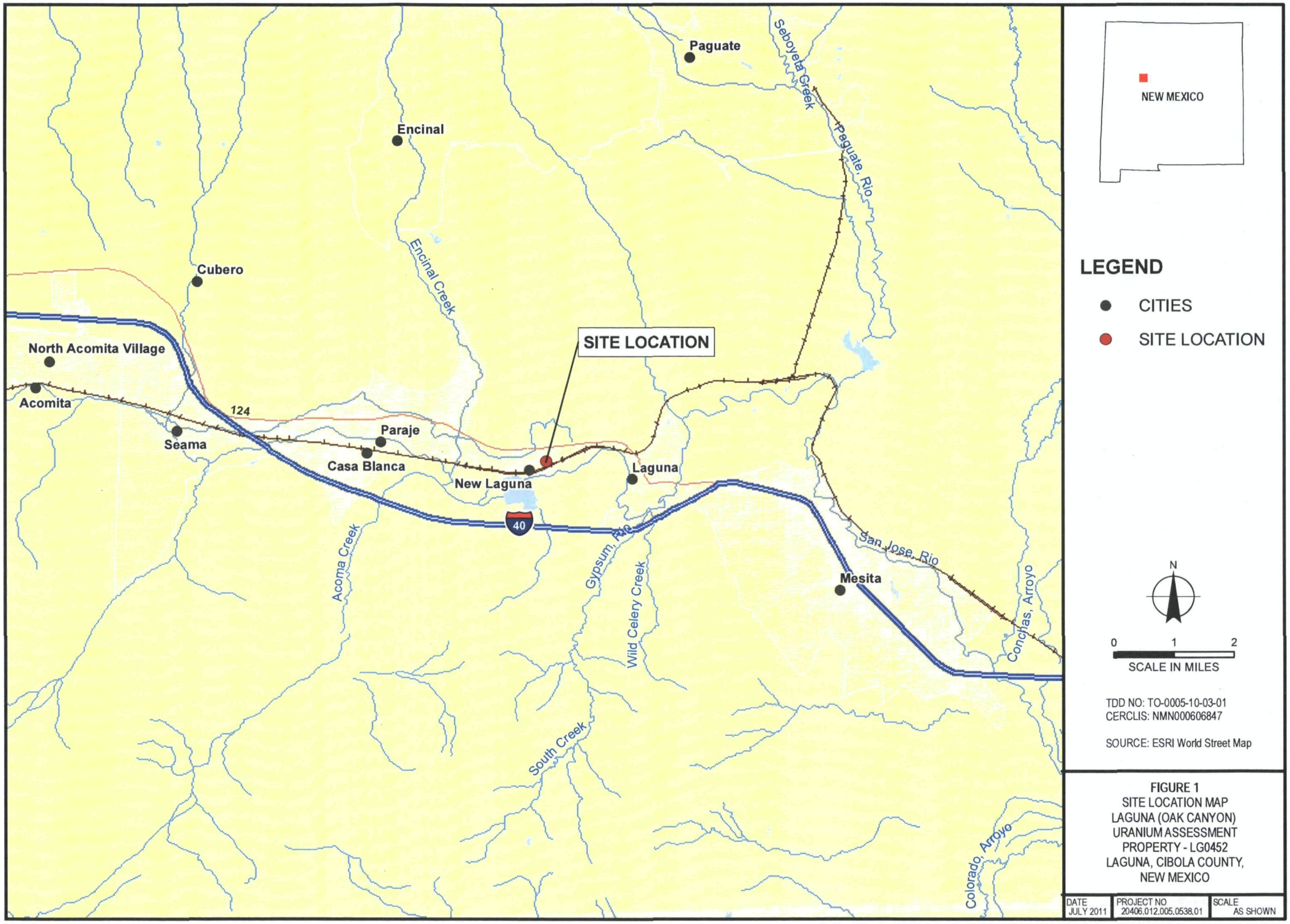
ATTACHMENT 1

ENFORCEMENT ATTACHMENT TO THE ACTION MEMORANDUM FOR the "Sun Clan Road Radiation Superfund Site" IS ENFORCEMENT SENSITIVE/FOIA EXEMPT

Note: **This document has been withheld as Enforcement Confidential and is located in Separate "CONFIDENTIALITY FILING" at U.S. EPA, Region 6**

Attachment 2

Site Location Map



TDD NO: TO-0005-10-03-01
CERCLIS: NMN000606847

SOURCE: ESRI World Street Map

FIGURE 1
SITE LOCATION MAP
LAGUNA (OAK CANYON)
URANIUM ASSESSMENT
PROPERTY - LG0452
LAGUNA, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JULY 2011	20406.012.005.0538.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-OAK CANYON\LAGUNA\LG0452\LG0452_FIGURE_1_SITE_LOCATION_MAP.mxd, 22-Jul-11 16:36, STARTGIS

Attachment 3

Site Sketch Map

FIGURE 2
SITE SKETCH MAP
LAGUNA (OAK CANYON)
URANIUM ASSESSMENT
PROPERTY - LG0452
LAGUNA, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JULY 2011	20406.012.005.0538.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-OAK CANYON\LAGUNA\LG0452\LG0452_FIGURE_2_SITE_SKETCH_MAP.mxd, 22-Jul-11 16:22, STARTGIS

LG0452

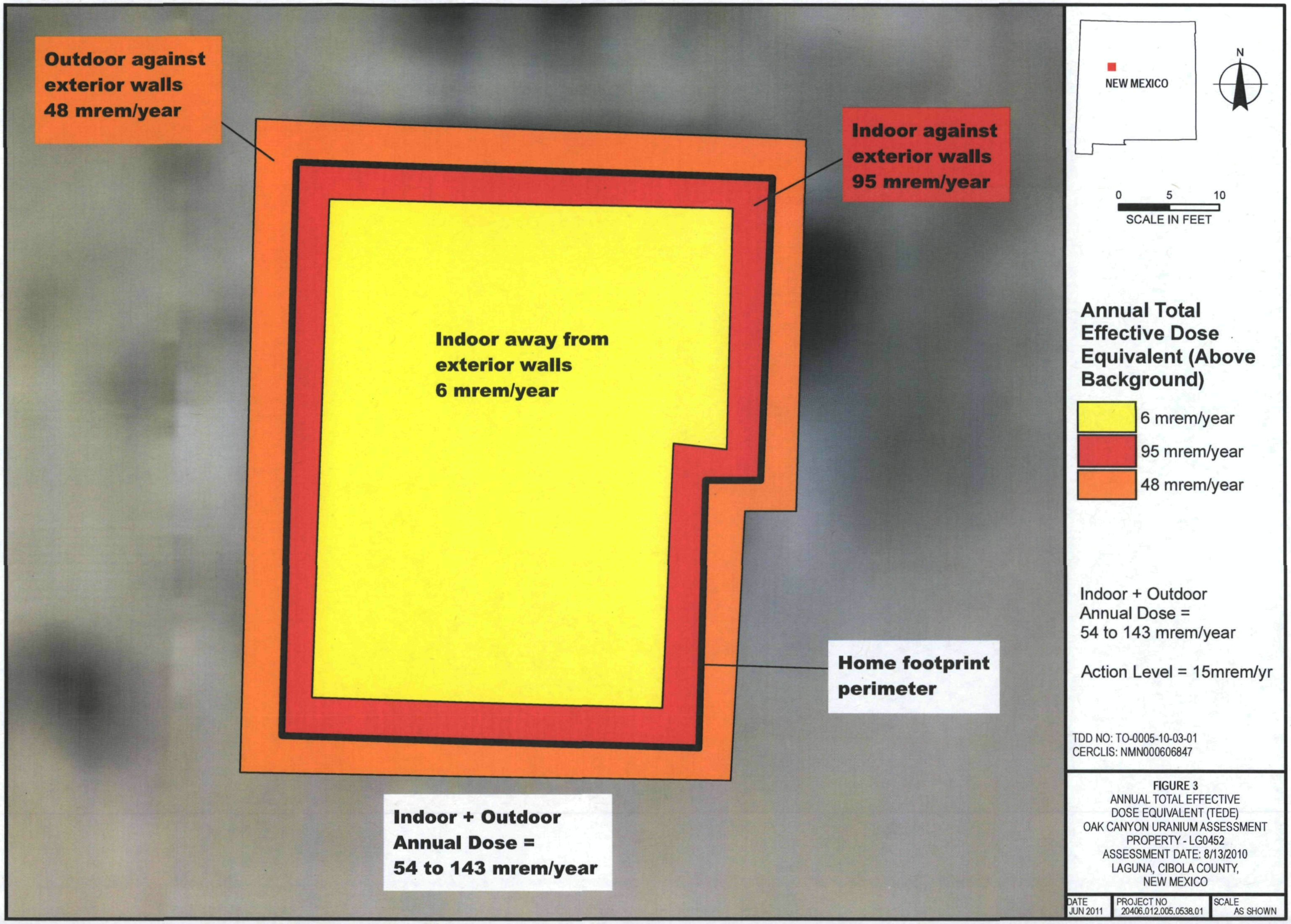


FIGURE 3
ANNUAL TOTAL EFFECTIVE DOSE EQUIVALENT (TEDE)
OAK CANYON URANIUM ASSESSMENT
PROPERTY - LG0452
ASSESSMENT DATE: 8/13/2010
LAGUNA, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JUN 2011	20406.012.005.0538.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-OAK CANYON\LAGUNA\LG0452\LG0452_FIGURE_3_INDOOR_TEDE.mxd, 20-Jul-11 15:38, STARTGIS

Attachment 4

Interim Status Report, Sun Clan Road Radiation Structure Removal Asset July 27, 2011

Weston Solutions, Inc.
4324 S. Sherwood Forest Blvd., Ste. B100
Baton Rouge, LA 70816
225-297-5403 • Fax 225-293-8339
www.WestonSolutions.com

WESTON SOLUTIONS
Restoring Resource Efficiency

July 27, 2011

Mr. Warren Zehner
On-Scene Coordinator, Region 6
U.S. Environmental Protection Agency
10625 Fallstone Road
Houston, TX 77099

Re: **Interim Status Report for property LG0452**
TDD: TO-0005-10-03-01
Work Order No.: 20406.012/016.005.0538.01

Mr. Zehner:

Please find attached an Interim Status Report for Phase 1 and Phase 2 Removal Assessment activities conducted at residential property LG0452 in 2010-2011. The subject property is one of several that was assessed as part of the Grants Mineral Belt Radiological Structures Assessment project centered around Grants, New Mexico and performed under the above-referenced TDD. The interim report is a segment of the Final Report under same TDD that will be forthcoming at a later date.

Sincerely,

Robert Sherman

Robert Sherman
EPA Region 6, START-3 Project Manager

INTERIM STATUS REPORT
REMOVAL ASSESSMENT – LG0452 (PROPERTY)
SSID: A6AH

July 26, 2011

Weston Work Order No.: 20406.012/016.005.0538.01

I. General Information

EPA Contract No.	EP-W-06-042
Task Order	0005
TDD No.	TO-0005-10-03-01
Project Location	Cibola County, Laguna, NM
Work Activity	Removal Assessment (RA)
EPA Work Assignment Manager	Warren Zehner/ Jon Rinehart
WESTON Site Manager	David Bordelon

II. Interim Status

The LG0452 property (Latitude: 35.042491; Longitude -107.41861) is located adjacent to Indian Service Road 50, approximately ¾ of a mile west of the intersection with Highway 124 (former Route 66) in the village of New Laguna, New Mexico (see Figure 1). The house is a traditional structure for the area, constructed with a rock foundation and walls made of rock held together with mud mortar. The owner of the property stated that the house was built in 1958, and that rocks from the Jackpile mine were used in the foundation, but not in the walls. The residence is currently unoccupied but renovations are being made in order to create a rental property.

<u>Phase 1</u>

The Phase 1 Outdoor Assessment consisted of a) a walking gamma scan (2-3 feet per second; 15 inches above ground surface) of residential soils utilizing a Model 44-10 2"x2" NaI probe attached to a Model 2210 count- meter, a laptop computer and a global positioning system (together referred to as the RAT system) all mounted in a modified baby buggy, b) the collection of 20 stationary 1-minute gamma measurements uniformly spaced throughout the assessment area utilizing the RAT system, c) the collection of grab 'hot spot' surface soil samples for laboratory analysis of Radium-226 where gamma scan readings exceeded the screening level (the derived concentration guideline level (DCGL)) of 3,648 counts per minute (cpm) above background, d) the collection of stationary 1-minute gamma measurements at 'hot spot' surface soil sample locations utilizing the RAT system , e) the procurement of a residential data information sheet detailing the resident's work relationship with local uranium mines and mills, structural elements of the residence and other buildings and consumption of home-grown produce, and f) the collection of two composite, surface soil samples (from the 20 stationary, 1-minute gamma measurement locations) for laboratory analysis of elemental Uranium (non-radiological/ non-carcinogenic). USEPA assessed approximately 12,000 square feet of the yard, an area that was determined as likely to be used by the resident on a regular basis.

The property was then subjected to four statistical tests, per Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) guidelines, to determine if the property exceeded the DCGL (3,648 cpm or 2.5 pico Curies per gram (pCi/g) above background) and warranted a Phase

2 Indoor Assessment. A background location in Laguna village was chosen for comparison to the property results. The background assessment included the collection of 20 stationary, 1-minute gamma measurements uniformly spaced throughout the assessment area utilizing the RAT system; and the collection of 20 five-minute, stationary gamma measurements utilizing a Pressurized Ionization Chamber (PIC) and 20 grab, surface soil samples for laboratory analysis of Radium-226 at the same 20 locations.

The Phase 1 outdoor assessment was conducted on June 22, 2010. The walking gamma scan revealed elevated readings along the western and northern walls of the house and two grab, surface (0"-6"), soil samples were subsequently collected from these areas. The soil sample results equaled 0.72 and 1.21 pico Curies per gram (pCi/g) [0.00 and 0.48 pCi/g above background] and were well below the USEPA screening-level (DCGL) of 2.5 pCi/g. Consequently, an extended Phase 1 outdoor assessment was conducted on September 7, 2010 in which two additional surface samples were collected, once more along the north and west walls of the house. The soil sample results were again well below the DCGL; however, subjected to the MARSSIM-defined Elevated Measurement Comparison or "Unity Rule" using the stationary, 1-minute gamma measurement collected at the soil sample location with the highest Ra-226 concentration, the property exceeded the DCGL of 3,648 cpm above background. A third, extended Phase 1 assessment was then conducted on the property on October 28, 2010, during which USEPA determined that the source of the elevated gamma readings discovered during the initial walking gamma scan emanated from the house foundation and not the soil. See Table 1 for a summary of all Phase 1 Assessment and statistical results, including background results. A graphic illustration of gamma scan results and soil sample locations is provided on Figure 2.

Phase 2

The Phase 2 Indoor Assessments consisted of a) the collection of 4 short-term (6-day) samples, utilizing activated charcoal adsorbent canisters, in four separate locations for laboratory analysis of Radon-222, b) the collection of two long-term (90-day) samples, utilizing track etch detectors, in two separate locations for laboratory analysis of Radon-222, c) the collection of 5-minute, stationary gamma measurements utilizing a PIC in the center of each room of the house, d) a walking gamma scan of the floor and walls of each room utilizing a Model 44-10 2"x2" NaI probe attached to a Model 2210 count- meter, and e) the collection of wipe samples for 'alpha tray counter' analysis in locations where gamma scan readings exceeded the house-specific screening level (quick, 'whole-house' scan average plus 1,900 cpm). The short-term radon canisters and long-term detectors were placed in the home from October 28 – November 3, 2010 and from October 28, 2010 – January 27, 2011, respectively; while the PIC measurements, gamma scan readings and wipe samples were collected on August 13, 2010.

An annual *indoor gamma dose above background* was then calculated using the highest room 5-minute average, the highest individual PIC reading, and the highest gamma scan reading assuming default values of 12 hours per day and 365 days per year spent indoors. An annual *outdoor gamma dose above background* was then calculated using the highest gamma scan reading (taken along the house exterior wall) assuming default values of 6 hours per day and 365 days per year spent outdoors. The annual gamma doses were converted from micro-Roentgens per year (μR/yr) to milli-Roentgens equivalent-in-man per year (mrem/yr) [1.5 R = 1 rem, determined by MicroShield Analysis provided as Appendix B] to determine if they exceeded the USEPA action-level Total Effective Dose Equivalent (TEDE) above background of 15 mrem/yr. The same background location in Laguna village that was utilized for Phase 1 assessment results was used for comparison to the Phase 2 results.

Short-term radon results ranged from 3.1 – 3.8 pico Curies per liter (pCi/l) and long-term radon results ranged from 3.1 – 3.3 pCi/l, all below the EPA and Center for Disease Control (CDC) acceptable exposure level of 4 picocuries pCi/L.

PIC 5-minute measurements ranged from 10.8- 12.2 micro-Roentgen per hour (μR/hr), with the highest average measured in the kitchen. The annual indoor gamma dose above background using the kitchen average of 12.2 μR/hr calculated to 3.3 mrem/yr. The highest, single PIC reading, also measured in the kitchen, was 13.1 μr/hr, with a corresponding annual indoor gamma dose above background calculating to 6.1 mrem/yr. Both annual doses calculated using PIC measurements are beneath the USEPA action-level of 15 mrem/yr.

Gamma scan readings ranged from a low of 7,400 cpm in the kitchen and southwest bedroom to a high of 37,000 cpm in the kitchen. The annual indoor gamma dose above background using the high kitchen average calculated to 97.4 mrem/yr. An annual *outdoor* gamma dose above background using the same high kitchen average calculated to 48.7 mrem/yr. Added together, a maximum annual dose above background calculated to 146.1 mrem/yr. The annual doses calculated using the highest gamma scan reading are well above the USEPA action-level of 15 mrem/yr.

Wipe samples were collected in each room of the house, with a high of 6 samples collected in the living room. Wipe sample results ranged from a low of 0.0 disintegrations per minute (dpm) in each room to a high of 3.2 dpm in the living room and kitchen. All wipe sample results were well below the 20 dpm per 100 square centimers removable release standard for Ra-226 in NRC Regulatory Guide 1.86.

See Table 2 for a summary of all Phase 2 Assessment and background results. A graphic illustration of the possible range of annual doses to which the property's residents are exposed is presented in Figure 3. Calculations for the range of annual doses were performed by a certified health physicist and are provided as Appendix C.

Finally, on January 21, 2011, a qualified, professional engineer (PE) conducted a structural investigation of the house to determine the feasibility of removing and replacing the foundation while leaving the structure intact. The engineer estimated that the removal and replacement of the foundation would cost a minimum of $70,000 (Appendix D).

TABLE 1										
Summary of Phase 1 Field Screening, Laboratory Analytical Results and MARSSIM Statistical Tests										
	Walking Gamma Scan Average (cpm)	**Standard Deviation: Gamma Scan (cpm)**	**20 Stationary, One-Minute Measurements Avg. (cpm)**	**Standard Deviation: 20 One-Minute Stationary Measurements (cpm)**	**'Hot Spot' Surface Soil Sample Results [Radium 226] (pCi/g)**	**'Hot Spot" Surface Soil Sample Location One-Minute Stationary Measurements (cpm)**	**MARSSIM Test 1[1]**	**MARSSIM Test 2[2]**	**MARSSIM Test 3[3]**	**MARSSIM Test 4[4]**
Background	n/a	n/a	8,244	353	0.73 [avg.] (*non-'hot spot'*)	8,244 [avg.] (*non-'hot spot'*)	n/a	n/a	n/a	n/a
LG0452	8,967	1,475	8,877	635	0.72	12,127	FAIL	PASS	PASS	FAIL
					1.21	**24,095**				
					0.80	12,652				
					0.87	13,877				

[1]MARSSIM Test 1: Property PASSes if Highest Property Gamma Scan measurement minus Lowest Background 1-minute measurement is < DCGL (3,648 CPM). If property PASSes, no need to conduct further tests. If property FAILs, proceed to MARSSIM Test 2.

[2]MARSSIM Test 2: Property PASSes if Property Gamma Scan avg. and Property Avg. of 20 one-minute stationary measurements minus Background avg. of 20 one-minute stationary measurements < DCGL (3,648 CPM). If property FAILs, no need to conduct further tests. If property PASSes, proceed to MARSSIM Test 3.

[3]MARSSIM Test 3 (Wilcoxon Rank Sum Test): **See Appendix A**. If property FAILs, no need to conduct further tests. If property PASSes, proceed to MARSSIM Test 4.

[4]MARSSIM Test 4 (Elevated Measurement Comparison or Unity Rule Test): Conducted only if concentrated, elevated 'hot spots' are present on a property. The Unity ratio represents the fraction of the DCGL above background that a property's contamination exhibits and provides for an 'adjusted DCGL' based on the area of the hot spot.

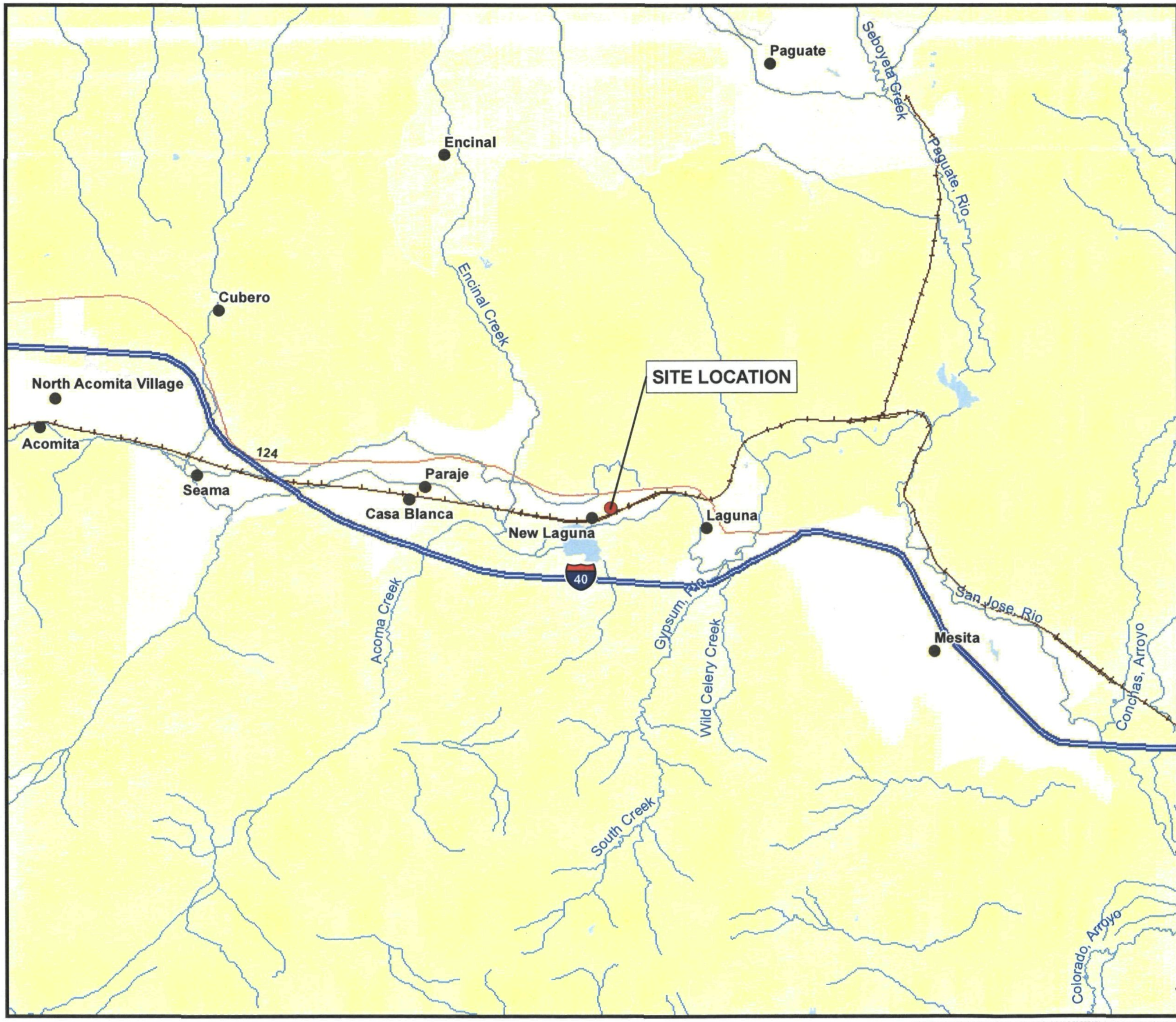
TABLE 2

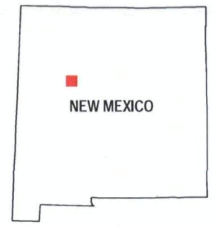
Summary of Phase 2 Laboratory Analytical Results and Field Measurements

	Short-term (6-day) Indoor Radon (pCi/L)	Long-term (90-day) Indoor Radon (pCi/L)	PIC 5-minute Avg. (µR/hr)	PIC: Annual Indoor Dose Above Bkgd. (Using 'Highest Room' Avg.; Assumes 12 hrs/day and 365 days/yr (mrem/yr)	PIC Highest Single Reading (µR/hr)	PIC: Annual Indoor Dose Above Bkgd. (Using Highest Single Reading; Assumes 12 hrs/day and 365 days/yr (mrem/yr)	Room-by-Room Gamma Scan Range (cpm)	Indoor Gamma Scan: Annual Indoor Dose Above Bkgd. (Using Highest Gamma Scan Reading; Assumes 12 hrs/ day and 365 days/ yr) (mrem/yr)	Indoor Gamma Scan: Annual *Outdoor* Dose Above Bkgd. (Using Highest Gamma Scan Reading; Assumes 6 hrs/ day and 365 days/ yr) (mrem/yr)	Maximum Annual Dose Above Background (Indoor + Outdoor) (mrem/yr)	Alpha Wipe Sample Results (DPM)
Background	n/a	n/a	11.0 (Avg. of 20 pts.)	48.3	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Living Room	3.8	3.3	10.8		11.4		7,800-22,000				0.0-3.2 6 samples
SW Bedroom	3.3	3.1	11.2		11.7		7,400-19,600				0.0-0.0 2 samples
Kitchen	3.1	n/a	**12.2**	3.3	**13.1**	6.1	7,400-**37,000**	97.4	48.7	146.1	0.0-3.2 3 samples
SE Bedroom	3.6	n/a	11.5		12.3		8,000-18,700				0.0-0.0 3 samples
Bathroom	n/a	n/a	11.2		12.0		7,600-32,000				0.0-0.0 3 samples

FIGURE 1

SITE LOCATION MAP





LEGEND

- CITIES
- SITE LOCATION

N

0 1 2
SCALE IN MILES

TDD NO: TO-0005-10-03-01
CERCLIS: NMN000606847

SOURCE: ESRI World Street Map

FIGURE 1
SITE LOCATION MAP
LAGUNA (OAK CANYON)
URANIUM ASSESSMENT
PROPERTY - LG0452
LAGUNA, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JULY 2011	20406.012.005.0538.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-OAK CANYON\LAGUNA\LG0452\LG0452_FIGURE_1_SITE_LOCATION_MAP.mxd, 22-Jul-11 16:36, STARTGIS

FIGURE 2

WALKING GAMMA SCAN RESULTS AND SURFACE SOIL SAMPLE LOCATIONS

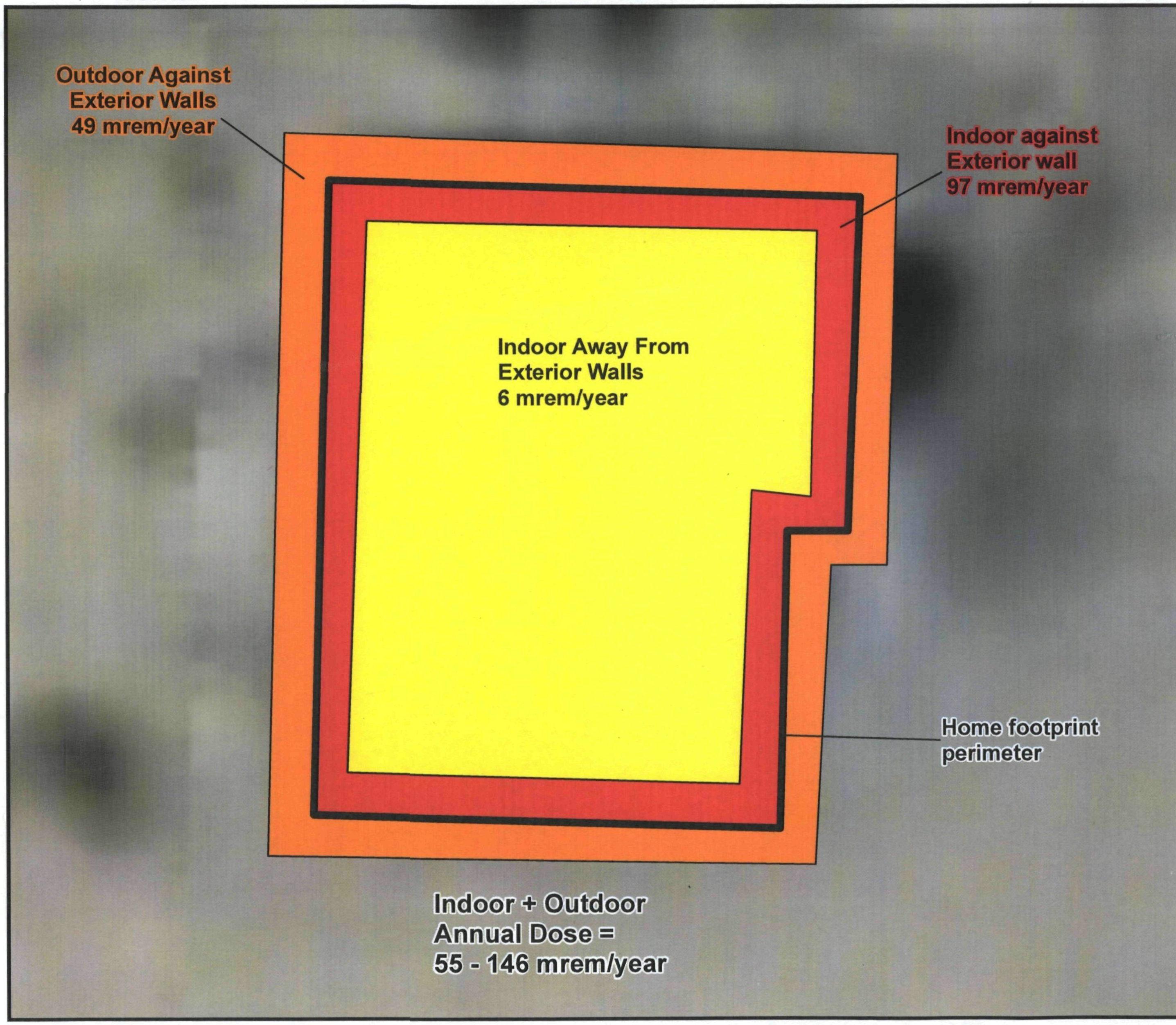
LG0452

File: \\fsnm01\Operations\Field Data\TDD-OAK CANYON\LAGUNA\LG0452\LG0452_FIGURE_1_PROPERTY_ASSESSMENT_RESULTS_MAP.mxd, 06-Jul-11 11:46, STARTGIS

FIGURE 3

ANNUAL INDOOR and OUTDOOR TOTAL EFFECTIVE DOSE EQUIVALENTS

LG0452



Annual Total Effective Dose Equivalent (Above Background)

Indoor + Outdoor
Annual Dose =
55 - 146 mrem/year

Action Level: 15 mrem/yr

TDD NO: TO-0005-10-03-01
CERCLIS: NMN000606847

FIGURE 3
ANNUAL TOTAL EFFECTIVE
DOSE EQUIVALENT (TEDE)
OAK CANYON URANIUM ASSESSMENT
PROPERTY - LG0452
ASSESSMENT DATE: 8/13/2010
LAGUNA, CIBOLA COUNTY,
NEW MEXICO

DATE	PROJECT NO	SCALE
JUN 2011	20406.012.005.0538.01	AS SHOWN

File: \\fsnm01\Operations\Field Data\TDD-OAK CANYON\LAGUNA\LG0452\LG0452_FIGURE_3_INDOOR_TEDE.mxd, 26-Jul-11 09:54, STARTGIS

APPENDIX A

MARSSIM TEST 3
WILCOXON RANK SUM TEST

From MARSSIM Manual, Section 8.4.1

Two-Sample Statistical Test

The comparison of measurements from the reference area and survey unit is made using the Wilcoxon Rank Sum (WRS) test (also called the Mann-Whitney test). The WRS test should be conducted for each survey unit. In addition, the EMC is performed against each measurement to ensure that it does not exceed a specified investigation level. If any measurement in the remediated survey unit exceeds the specified investigation level, then additional investigation is recommended, at least locally, regardless of the outcome of the WRS test.

The WRS test is most effective when residual radioactivity is uniformly present throughout a survey unit. The test is designed to detect whether or not this activity exceeds the $DCGL_W$. The advantage of the nonparametric WRS test is that it does not assume that the data are normally or log-normally distributed. The WRS test also allows for "less than" measurements to be present in the reference area and the survey units. As a general rule, the WRS test can be used with up to 40 percent "less than" measurements in either the reference area or the survey unit. However, the use of "less than" values in data reporting is not recommended as discussed in Section 2.3.5. When possible, report the actual result of a measurement together with its uncertainty.

The hypothesis tested by the WRS test is

> Null Hypothesis H_0: The median concentration in the survey unit exceeds that in the reference area by more than the $DCGL_W$
>
> versus
>
> Alternative Hypothesis H_a: The median concentration in the survey unit exceeds that in the reference area by less than the $DCGL_W$

The null hypothesis is assumed to be true unless the statistical test indicates that it should be rejected in favor of the alternative. One assumes that any difference between the reference area and survey unit concentration distributions is due to a shift in the survey unit concentrations to higher values (*i.e.*, due to the presence of residual radioactivity in addition to background). Note that some or all of the survey unit measurements may be larger than some reference area measurements, while still meeting the release criterion. Indeed, some survey unit measurements may exceed some reference area measurements by more than the $DCGL_W$. The result of the hypothesis test determines whether or not the survey unit as a whole is deemed to meet the release criterion. The EMC is used to screen individual measurements.

Two assumptions underlying this test are: 1) samples from the reference area and survey unit are independent, identically distributed random samples, and 2) each measurement is independent of every other measurement, regardless of the set of samples from which it came.

8.4.2 Applying the Wilcoxon Rank Sum Test

The WRS test is applied as outlined in the following six steps….

1. Obtain the adjusted reference area measurements, Z_i, by adding the $DCGL_W$ to each reference area measurement, X_i. $Z_i = X_i + DCGL_W$

2. The m adjusted reference sample measurements, Z_i, from the reference area and the n sample measurements, Y_i, from the survey unit are pooled and ranked in order of increasing size from 1 to N, where $N = m+n$.

3. If several measurements are tied (*i.e.*, have the same value), they are all assigned the average rank of that group of tied measurements.

4. If there are t "less than" values, they are all given the average of the ranks from 1 to t. Therefore, they are all assigned the rank $t(t+1)/(2t) = (t+1)/2$, which is the average of the first t integers. If there is more than one detection limit, all observations below the largest detection limit should be treated as "less than" values.[3]

5. Sum the ranks of the adjusted measurements from the reference area, W_r. Note that since the sum of the first N integers is $N(N+1)/2$, one can equivalently sum the ranks of the measurements from the survey unit, W_s, and compute $W_r = N(N+1)/2 - W_s$.

6. Compare W_r with the critical value given in Table I.4 for the appropriate values of n, m, and α. If W_r is greater than the tabulated value, reject the hypothesis that the survey unit exceeds the release criterion.

[3] If more than 40 percent of the data from either the reference area or survey unit are "less than," the WRS test *cannot* be used. Such a large proportion of non-detects suggest that the DQO process be re-visited for this survey to determine if the survey unit was properly classified or the appropriate measurement method was used. As stated previously, the use of "less than" values in data reporting is not recommended. Wherever possible, the actual result of a measurement, together with its uncertainty, should be reported.

APPENDIX B

MICROSHIELD ANALYSIS

(Roentgen (R) to Roentgen-Equivalent-in-Man (rem) Conversion)

Print

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.

	:1
File	:U-238soilSlab.ms6
ate	: May 25, 2011
ime	: 11:26:33 AM
tion	: 00:00:00

File Ref	:
Date	:
By	:
Checked	:

Case Title: U+chainSlab
Description: U-238 + chain slab
Geometry: 16 - Infinite Slab

Source Dimensions:

Thickness	15.0 cm	(5.9 in)

Dose Points

A	X	Y	Z
# 1	115 cm	0 cm	0 cm
	3 ft 9.3 in	0.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	Infinite	ANS soil 2011	1.5
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	_Ci/cm_	Bq/cm_
Bi-210	1.4990e-006	5.5464e-002
Bi-214	1.4993e-006	5.5476e-002
Pa-234	2.3993e-009	8.8772e-005
Pa-234m	1.4995e-006	5.5483e-002
Pb-210	1.4990e-006	5.5464e-002
Pb-214	1.4993e-006	5.5476e-002
Po-210	1.4990e-006	5.5464e-002
Po-214	1.4990e-006	5.5464e-002
Po-218	1.4996e-006	5.5487e-002
Ra-226	1.4996e-006	5.5487e-002
Rn-222	1.4996e-006	5.5487e-002
Th-230	1.4996e-006	5.5487e-002
Th-234	1.4995e-006	5.5483e-002
U-234	1.4996e-006	5.5486e-002

U-238	1.4995e-006	5.5483e-002

Buildup : The material reference is - Source
Integration Parameters

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm_/sec No Buildup	Fluence Rate MeV/cm_/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	4.281e-02	2.034e-05	2.102e-05	1.745e-06	1.803e-06
0.04	1.087e-07	2.822e-09	4.722e-09	1.248e-11	2.088e-11
0.05	2.925e-03	1.432e-04	3.334e-04	3.815e-07	8.882e-07
0.06	2.379e-03	1.794e-04	4.971e-04	3.563e-07	9.873e-07
0.08	1.287e-02	1.689e-03	6.226e-03	2.672e-06	9.853e-06
0.1	3.503e-03	6.578e-04	2.943e-03	1.006e-06	4.503e-06
0.15	6.623e-05	2.220e-05	1.137e-04	3.655e-08	1.872e-07
0.2	5.995e-03	2.976e-03	1.474e-02	5.252e-06	2.602e-05
0.3	1.145e-02	9.877e-03	4.263e-02	1.874e-05	8.087e-05
0.4	2.123e-02	2.721e-02	1.057e-01	5.302e-05	2.059e-04
0.5	9.991e-04	1.746e-03	6.028e-03	3.427e-06	1.183e-05
0.6	2.678e-02	6.037e-02	1.901e-01	1.178e-04	3.710e-04
0.8	5.427e-03	1.834e-02	4.905e-02	3.488e-05	9.329e-05
1.0	1.796e-02	8.322e-02	1.987e-01	1.534e-04	3.662e-04
1.5	1.057e-02	8.715e-02	1.696e-01	1.466e-04	2.853e-04
2.0	1.485e-02	1.833e-01	3.162e-01	2.835e-04	4.889e-04
Totals	**1.798e-01**	**4.769e-01**	**1.103e+00**	**8.228e-04**	**1.948e-03**

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\casefiles\U-238soilSlab.ms6
Case Title: U+chainSlab
This case was run on Wednesday, May 25, 2011 at 11:26:33 AM
Dose Point # 1 - (115,0,0) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm2/sec	5.109e-001	1.464e+000
Photon Energy Fluence Rate	MeV/cm2/sec	4.769e-001	1.103e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	8.228e-004	1.948e-003
Absorbed Dose Rate in Air	mGy/hr	7.183e-006	1.700e-005
"	mrad/hr	7.183e-004	1.700e-003
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.333e-006	2.001e-005
o Opposed	"	7.014e-006	1.647e-005
o Rotational	"	7.013e-006	1.646e-005
o Isotropic	"	6.274e-006	1.471e-005
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.781e-006	2.105e-005
o Opposed	"	8.416e-006	2.008e-005
o Rotational	"	8.415e-006	2.008e-005
o Isotropic	"	6.621e-006	1.556e-005
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	7.442e-006	1.779e-005
o Posterior/Anterior	"	6.777e-006	1.601e-005
o Lateral	"	5.335e-006	1.237e-005
o Rotational	"	6.099e-006	1.436e-005
o Isotropic	"	5.363e-006	1.252e-005

Print

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.

	:1
File	:Ra-226SoilSlab.ms6
Date	: May 25, 2011
Time	: 11:20:52 AM
tion	: 00:00:00

File Ref	:
Date	:
By	:
Checked	:

Case Title: Ra-226SoilSlab
Description: Ra226 infinite soil 15 cm slab
Geometry: 16 - Infinite Slab

Source Dimensions:

Thickness	15.0 cm	(5.9 in)

Dose Points

A	X	Y	Z
# 1	115 cm	0 cm	0 cm
	3 ft 9.3 in	0.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	Infinite	ANS soil 2011	1.5
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	_Ci/cm_	Bq/cm_
Bi-210	1.5206e-006	5.6261e-002
Bi-214	1.4997e-006	5.5489e-002
Pb-210	1.5205e-006	5.6260e-002
Pb-214	1.4997e-006	5.5489e-002
Po-210	1.5209e-006	5.6274e-002
Po-214	1.4994e-006	5.5478e-002
Po-218	1.5000e-006	5.5500e-002
Ra-226	1.5000e-006	5.5500e-002
Rn-222	1.5000e-006	5.5500e-002

Buildup : The material reference is - Source
Integration Parameters

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm_/sec No Buildup	Fluence Rate MeV/cm_/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.191e-02	1.041e-05	1.076e-05	8.931e-07	9.230e-07
0.05	2.892e-03	1.416e-04	3.297e-04	3.772e-07	8.782e-07
0.08	1.279e-02	1.679e-03	6.190e-03	2.657e-06	9.795e-06
0.1	7.532e-05	1.414e-05	6.328e-05	2.164e-08	9.682e-08
0.2	5.977e-03	2.967e-03	1.470e-02	5.237e-06	2.594e-05
0.3	1.145e-02	9.874e-03	4.262e-02	1.873e-05	8.084e-05
0.4	2.123e-02	2.721e-02	1.057e-01	5.302e-05	2.059e-04
0.5	9.912e-04	1.732e-03	5.981e-03	3.400e-06	1.174e-05
0.6	2.675e-02	6.031e-02	1.899e-01	1.177e-04	3.706e-04
0.8	5.244e-03	1.772e-02	4.740e-02	3.370e-05	9.015e-05
1.0	1.737e-02	8.051e-02	1.922e-01	1.484e-04	3.543e-04
1.5	1.056e-02	8.707e-02	1.694e-01	1.465e-04	2.851e-04
2.0	1.485e-02	1.833e-01	3.162e-01	2.835e-04	4.890e-04
Totals	**1.521e-01**	**4.726e-01**	**1.091e+00**	**8.141e-04**	**1.925e-03**

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.
Conversion of calculated exposure in air to dose
FILE: Case1
Case Title: Ra-226SoilSlab
This case was run on Wednesday, May 25, 2011 at 11:20:52 AM
Dose Point # 1 - (115,0,0) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm2/sec	4.968e-001	1.416e+000
Photon Energy Fluence Rate	MeV/cm2/sec	4.726e-001	1.091e+000
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	8.141e-004	1.925e-003
Absorbed Dose Rate in Air	mGy/hr	7.107e-006	1.681e-005
"	mrad/hr	7.107e-004	1.681e-003
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.246e-006	1.976e-005
o Opposed	"	6.948e-006	1.629e-005
o Rotational	"	6.947e-006	1.628e-005
o Isotropic	"	6.215e-006	1.454e-005
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	8.684e-006	2.079e-005
o Opposed	"	8.330e-006	1.985e-005
o Rotational	"	8.330e-006	1.985e-005
o Isotropic	"	6.555e-006	1.539e-005
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	7.367e-006	1.758e-005
o Posterior/Anterior	"	6.711e-006	1.583e-005
o Lateral	"	5.286e-006	1.224e-005
o Rotational	"	6.041e-006	1.420e-005
o Isotropic	"	5.313e-006	1.238e-005

Print

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.

	:1		
File	:Ra-226SoilConcrete.ms6	**File Ref**	:
)ate	: May 25, 2011	**Date**	:
Time	: 2:40:34 PM	**By**	:
tion	: 00:00:00	**Checked**	:

Case Title: Ra-226+found
Description: Ra-226 chain plus 15 cm foundation
Geometry: 16 - Infinite Slab

Source Dimensions:

Thickness	15.0 cm	(5.9 in)

Dose Points

A	X	Y	Z
# 1	130 cm	0 cm	0 cm
	4 ft 3.2 in	0.0 in	0.0 in

Shields

Shield N	Dimension	Material	Density
Source	Infinite	ANS soil 2011	1.5
Shield 1	15.0 cm	Concrete	2.1
Air Gap		Air	0.00122

Source Input : Grouping Method - Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Included
Library : Grove

Nuclide	_Ci/cm_	Bq/cm_
Bi-210	1.5206e-006	5.6261e-002
Bi-214	1.4997e-006	5.5489e-002
Pb-210	1.5205e-006	5.6260e-002
Pb-214	1.4997e-006	5.5489e-002
Po-210	1.5209e-006	5.6274e-002
Po-214	1.4994e-006	5.5478e-002
Po-218	1.5000e-006	5.5500e-002
Ra-226	1.5000e-006	5.5500e-002
Rn-222	1.5000e-006	5.5500e-002

Buildup : The material reference is - Shield 1
Integration Parameters

Results

Energy MeV	Activity Photons/sec	Fluence Rate MeV/cm_/sec No Buildup	Fluence Rate MeV/cm_/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	2.191e-02	0.000e+00	0.000e+00	0.000e+00	0.000e+00
0.05	2.892e-03	1.168e-10	6.039e-10	3.112e-13	1.609e-12
0.08	1.279e-02	4.030e-07	5.306e-06	6.377e-10	8.396e-09
0.1	7.532e-05	9.805e-09	1.760e-07	1.500e-11	2.693e-10
0.2	5.977e-03	1.053e-05	2.366e-04	1.859e-08	4.177e-07
0.3	1.145e-02	6.703e-05	1.252e-03	1.272e-07	2.375e-06
0.4	2.123e-02	2.825e-04	4.237e-03	5.505e-07	8.256e-06
0.5	9.912e-04	2.464e-05	3.058e-04	4.836e-08	6.002e-07
0.6	2.675e-02	1.099e-03	1.153e-02	2.144e-06	2.251e-05
0.8	5.244e-03	4.689e-04	3.685e-03	8.919e-07	7.008e-06
1.0	1.737e-02	2.804e-03	1.775e-02	5.170e-06	3.272e-05
1.5	1.056e-02	4.801e-03	2.050e-02	8.078e-06	3.450e-05
2.0	1.485e-02	1.342e-02	4.597e-02	2.075e-05	7.108e-05
Totals	**1.521e-01**	**2.298e-02**	**1.055e-01**	**3.778e-05**	**1.795e-04**

MicroShield v6.02 (6.02-00039)
AQ_Safety,_Inc.
Conversion of calculated exposure in air to dose
FILE: C:\Program Files\MicroShield\Examples\casefiles\Ra-226SoilConcrete.ms6
Case Title: Ra-226+found
This case was run on Wednesday, May 25, 2011 at 2:40:34 PM
Dose Point # 1 - (130,0,0) cm

Results (Summed over energies)	Units	Without Buildup	With Buildup
Photon Fluence Rate (flux)	Photons/cm2/sec	1.617e-002	9.486e-002
Photon Energy Fluence Rate	MeV/cm2/sec	2.298e-002	1.055e-001
Exposure and Dose Rates:			
Exposure Rate in Air	mR/hr	3.778e-005	1.795e-004
Absorbed Dose Rate in Air	mGy/hr	3.299e-007	1.567e-006
"	mrad/hr	3.299e-005	1.567e-004
Deep Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	3.761e-007	1.805e-006
o Opposed	"	3.278e-007	1.540e-006
o Rotational	"	3.278e-007	1.540e-006
o Isotropic	"	2.943e-007	1.378e-006
Shallow Dose Equivalent Rate	(ICRP 51 - 1987)		
o Parallel Geometry	mSv/hr	3.955e-007	1.901e-006
o Opposed	"	3.826e-007	1.831e-006
o Rotational	"	3.826e-007	1.831e-006
o Isotropic	"	3.083e-007	1.451e-006
Effective Dose Equivalent Rate	(ICRP 51 - 1987)		
o Anterior/Posterior Geometry	mSv/hr	3.383e-007	1.617e-006
o Posterior/Anterior	"	3.138e-007	1.482e-006
o Lateral	"	2.547e-007	1.179e-006
o Rotational	"	2.840e-007	1.337e-006
o Isotropic	"	2.533e-007	1.181e-006

Date: 5-25-2011

To: Nels Johnson

From: Rick Haaker

SubjectMicrosohield Calculations of Exposure rate and dose equivalent rate

---

On May 10 , 2009 I provided a technical memo entitled *Response Estimates for a 2"x2" NaI Detector to Ra-226 That is Distributed in Soil.* The last paragraph of that memo was a discussion of conversion factors between soil concentration, exposure rate, and effective dose equivalent rate for the U-238 decay chain. This memo elaborates on that final paragraph. In determining the conversion factors, the geometry assumed was an infinite slab of soil having a thickness of 15 cm and a density of 1.5. A simplified soil composition derived from ANSI/ANS 6.6.1-1997[1] was used in the Microshield® 6.02 modelling[2], see Table 1.

Table 1 Simplified Soil Composition from ANSI/ANS 6.6.1.

Element	Weight Percent
Hydrogen	0.954
Oxygen	54.4
Aluminum	12.9
Silicon	31.8

Three cases were considered for the Microshield calculations:

- an infinite slab of soil 15 cm thick containing U-238 plus progeny through Po-210 in decay equilibrium, and
- an infinite slab of soil 15 cm thick containing Ra-226 plus progeny through Po-210 in decay equilibrium.
- an infinite slab of soil 15 cm thick containing Ra-226 plus progeny through Po-210 in decay equilibrium covered by a 15-cm thick concrete foundation.
-

A circular slab of uniformly contaminated soil that is 20 meters in diameter is approximately "infinite" with respect to the Microshield calculations. Microshield also will also model other, non-infinite geometries.

Each time a Microshield calculation was performed, the corresponding "Conversion of Calculated Exposure in Air to Dose" report was generated via the Microshield software package.

Results for a U-238 at 1 pCi/g Plus Progeny

Table 2 provides results for the U-238 decay chain

Table 2. Results for 1 pCi/g U-238 with decay chain in equilibrium

---

1 ANSI/ANS-6.6.1-1987, Calculation and Measurement of Direct and Scattered Gamma Radiation from LWR Nuclear Power Plants. American Nuclear Society, La Grange Park, Il, 1987.

2 Microshield 6.02, Grove Engineering, Framatone ANP, Rockville, MD, 2003.

Exposure rate	1.948 μR/h
EDE rate in isotropic field	1.252 μREM/hr
Ratio	1.56 μR/μREM

Results for a Ra-226 at 1 pCi/g Plus Progeny

Table 3 provides results for the Ra-226 decay chain

Table 3. Results for 1 pCi/g Ra-226 with decay chain in equilibrium

Exposure rate	1.925 μR/h
EDE rate in isotropic field	1.238 μREM/hr
Ratio	1.55 μR/μREM

Results for a Ra-226 at 1 pCi/g Plus Progeny and 15 cm Foundation

Table 4 provides results for the Ra-226 decay chain assuming a 15 cm thick concrete foundation covers the entire site.

Table 4. Results for 1 pCi/g Ra-226 with decay chain in equilibrium plus concrete foundation.

Exposure rate	0.1795 μR/h
EDE rate in isotropic field	0.1181 μREM/hr
Ratio	1.52 μR/μREM

Use of estimates indoors

A house is a complicated object, it is constructed of materials that serve to shield the occupant to some degree from the terrestrial gamma radiation field. The degree of shielding that a structure provides an occupant will depend on the materials of construction, their thickness and radiation attenuating properties and other factors.

The RESRAD software package3 accounts for external radiation attenuation by a structure via an external radiation transmission factor, and the RESRAD default value of 0.7 was used for all RESRAD calculations we have performed; this is probably a reasonable value for frame houses.

3 C. Yu et al. ,User's Manual for RESRAD Version 6, ANL/EAD-4, Argonne National Laboratory, Argonne, IL, 2001.

Another source, NCRP Report 94 suggests an external gamma transmission factor of 0.8.4

As a limiting case, a Microshield calculation was performed assuming a 15-cm thick concrete foundation covers the infinite slab of contaminated soil. The μR/μREM ratio decreased insignificantly to 1.52 μR/μREM; see Table 4. Thus it is concluded that any attenuation of external gamma radiation, which is caused by the structure will affect EDE and exposure to a similar degree.

In addition, the materials of construction will contain Ra-226, Ra-228, and K-40, and these will contribute to the external dose of an occupant to some degree. NCRP Report 94 reports that in Europe where masonry houses are prevalent, the structural materials increase indoor gamma radiation exposures by about 20% relative to terrestrial background.

Limitations of estimates

These estimates utilize Microshield 6.02, and so they inherit all of its limitations. Microshield quickly does simple radiation attenuation and build-up calculations, which otherwise would be tedious to do in a spreadsheet. It does not account for:

- surface roughness,
- bremstrahlung arising from beta emitters,
- more than one radiation source at a time,
- complicated radiation behaviors like backscatter or skyshine, or
- dose buildup in more than one model element at a time.

Equilibrium in the decay chain has been assumed, comparison of table 2 and table 3 shows that the amount of U-238 through U-234 in the chain is unimportant. Some radon (Rn-222) is usually lost from near surface soil and this may cause both the external EDE rate and exposure rates to be lower per pCi/g of Ra-226 than have been estimated.

4 Exposure of the Population of the United States and Canada from Natural Background Radiation, NCRP Report 94, National Council on Radiation Protection and Measurements. Bethesda, MD, 1992.

APPENDIX C

TOTAL EFFECTIVE DOSE EQUIVALENT
(Indoor + Outdoor)

Calculations Performed by Certified Health Physicist

LG0452 Estimate of Dose to Resident

July 26, 2011

Surveys performed using 2" x 2" gamma scintillation detectors during the initial site visits by the Region 6 START team indicated areas around or near the residence (LG0452) that range up to 35,000 counts per minute (cpm) on contact with some ground-level sections of the residence exterior walls compared to background measurements of about 8,300 cpm. Those readings indicated that contaminated materials were used in the construction of the stem walls of at least some parts of the house. Readings taken at the center of rooms inside the residence (per protocol requirements) with an RSS-111 Pressurized Ion Chamber (PIC) ranged as high as 13 μR/hour compared to background levels that were about 11 μR/hour. Those PIC readings were lower than would be expected if taken along the walls where the highest gamma readings were discovered.

Radon readings in the residence were consistent and ranged between 3.1 and 3.8 pCi/l for four short-term samples collected over a 7-day period, and between 3.1 and 3.3 pCi/l for two long-term (91-day) samples. Those values are less than the EPA limit above which actions should be taken to mitigate radon concentrations, but are sufficient to contribute to the residential dose. Radium concentrations measured in soil samples collected around the exterior of the residence averaged 0.88 pCi/g, which is not significantly elevated above the average background concentration of 0.73 pCi/g when compared to the Protocol limit of 2.5 pCi.g above background.

The protocol developed for this project used RESRAD software to calculate the Total Effective Dose Equivalent (TEDE) from soil radionuclide concentrations. However, the sources of elevated dose rates at this property are not in the soils around or under the house, but rather are in the walls. Additionally, the contribution to total dose equivalent from radon inhalation cannot be determined using RESRAD without an elevated radium concentration in soil as the basis for the RESRAD calculations. Thus, the estimated residential dose for this property is hand calculated and is based only on external gamma dose.

An indoor dose calculation using the PIC data resulted in a value of about 6 mrem/yr, but that does not provide a conservative estimate because the PIC values were taken at the center of the room, away from the walls where the highest gamma readings were found. The positions that a resident may occupy within the home for significant periods of time (such as kitchen tables, chairs, sofas, and beds) are often near walls where the highest gamma readings in the home were detected. It would seem reasonable to accommodate these higher gamma levels for our calculations. Also, the total dose equivalent should include a dose component for time spent outdoors at the property.

An alternate, maximum value was determined for the indoor component of gamma dose using the highest reading along the walls measured with the gamma scintillation detector. To convert the gamma scintillation measurement (in cpm), comparative measurements performed at the indoor PIC measurement locations (PIC vs. scintillator) were used to come up with an empirically determined factor of 0.00116mR/hr per 1000 cpm that was used to convert readings in cpm to mR/hr. Using the highest measured gamma value of 37,000 cpm, subtracting 8,244 cpm for background, and converting to mR/hr and then to mrem/yr, a worst case indoor component of 97 mrem/yr was determined. The difference between the two values is the result of the PIC location in the centers of the rooms. The higher dose equivalent using the near-wall gamma scintillation measurements is overly conservative because occupants are not expected to spend all their time sitting against the wall. A reasonable estimate of the indoor dose equivalent is between 6 and 97 mrem/yr.

Using the same maximum value of 37,000 cpm for the outdoor gamma level, and an occupancy period of 25% of the year resulted in a worst case outdoor component of 49 mrem/yr. Combining the outdoor component with the indoor values of 6 and 97 mrem/yr resulted in a range for the total dose equivalent of 55 to 146 mrem/yr for LG 0452.

This calculation does not follow the basic scenario that was developed for the project protocol, and excludes components associated with inhalation of radon and dust, and ingestion of food items. The exclusion of these components is justified because of the "encapsulated" nature of the contamination that appears to be trapped within the residence walls.

Data used for this evaluation, and the associated calculations, are contained in the property's electronic file spreadsheet.

APPENDIX D

STRUCTURAL INVESTIGATION AND COST ESTIMATE FOR REPLACEMENT OF FOUNDATION

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INTRODUCTION

This is the report of a study to determine the estimated cost of replacing part or all of the foundation of a single story house located on the Laguna Indian Reservation in west central New Mexico.

DESCRIPTION OF HOUSE

With the exception of the foundation, the house is of conventional construction typical of the 1950s and 1960s. The roof is framed using wood sheathing supported on metal-plate connected wood trusses. The walls are wood studs supporting gypsum board sheathing finished with stucco on the exterior. The floor is framed using plywood decking on wood joists with a shallow "crawl space" (approximately 12 inches from the bottom of the joists to grade).

The foundation consists of individual stones of various sizes laid in adobe mortar. In addition to the foundation around the perimeter of the house, there are also interior foundations which support interior bearing walls.

An attached carport, open on three sides, is connected to the south side of the house.

In its present condition, the house is uninhabitable although there are signs of some recent renovations, reportedly made by the owner with the intent of living in the house at some future time.

POSSIBLE FOUNDATION REPLACEMENT ALTERNATIVES

A limited structural study of various foundation systems has been made to provide a basis for preparing a cost estimate for modifying the foundation. Some of the rocks used to construct the foundation may have traces of radioactivity. The percentage of the rocks which are radioactive and the location in the foundation of the rocks which are radioactive is not presently known. In preparing this report, it has been assumed that all of the foundation must be removed. If it is determined that only a few of the rocks are radioactive, then it may be possible to replace only those few. However, this will be difficult because of the type of foundation construction and it may be more cost effective to remove the entire foundation and the remainder of this report is based on the assumption that the entire foundation will be replaced.

Typical foundation construction for this type of structure consists of cast-in-place concrete in the shape of an inverted tee reinforced both horizontal and vertically. With proper detailing, at least some structural continuity of the foundation could be attained to minimize possible differential settlement of the structure above.

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Although sequential foundation replacement may be possible, it has its own problems. There is at best only limited structural continuity in the existing foundation. This could be considered to be an advantage because it will be relatively easy to remove portions of the foundation at one time. Replacing the foundation one segment at a time may result in damage to the structure resulting from differential movement. It may be necessary to support the entire structure even though only one portion of a new foundation is under construction at any one time. To completely support the structure above the existing foundation will require the removal of a portion of the flooring and floor decking as well as a portion of the wall sheathing in order to place the shores and jacks necessary to support the house while the new foundation is being placed. This will be necessary at both the exterior walls and at interior bearing walls.

FOUNDATION REPLACEMENT

At the beginning of this investigation, it appeared that replacing the existing foundation with a conventional cast-in-place concrete inverted tee foundation consisting of a strip footing supporting a cast-in-place concrete stem wall. This is the most common type of foundation used in this area for both residential and commercial construction. If this type of system is used, it will be necessary to construct formwork for at least the stem wall. Both the footing and the stem wall could be placed in sections with reinforcing rods and keyways used to achieve continuity between adjacent sections.

It quickly became obvious that there are significant technical and logistical problems with this type of system and that the cost would almost certainly exceed the value of the house.

Among the problems is the location of the house. Ready-mix concrete is not available in the near vicinity of the house although it is available in both Grants and Albuquerque. However, unless the entire footing or the entire stem wall were placed at one time, amount required for any one placement would be relatively small and there would probably be a premium.

As an alternative, it might be possible to mix small batches on site. This might be a viable solution although there still remain other problems with a cast-in-place system.

Other possible alternates which might be considered if it is determined that a concrete system is required include using a grade beam which would act as both the footing and the stem wall. This would probably require a larger quantity of concrete but might be more economical because of the reduction in the amount of formwork required. Unless the grade beam under the entire house was placed at the same time, it would be necessary to provide a method to ensure structural continuity between adjacent pours.

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It might also be possible to use a system consisting of a series of precast grade beams spanning between and supported on cast-in-place reinforced concrete spot footings placed at intervals. The spacing of the spot footings, their size and their reinforcing would be a matter for design. The precast grade beams could be constructed either on or off site. Placing the grade beams would be problem, particularly under interior bearing walls. Connections between the grade beams and between the grade beams and the footings may also be a problem.

The second basic type of replacement foundation considered is a permanent wood foundation. Many of the same considerations that apply to concrete foundations also apply to wood foundations but there are some advantages.

After evaluating the various possibilities, the conclusion was reached that the best solution would be combination concrete and permanent wood foundation system. The concrete would be used for strip or spot footings and the wood would be used for stem walls.

A first advantage of this system is that the quantity of concrete required would be significantly reduced, making on-site mixing of concrete more practical.

Some references suggest using a gravel bed instead of a concrete strip footing. The gravel would be significantly less expensive than the concrete but I am concerned that there might be some differential settlement of the house as the gravel consolidates under load. At the least, this would result in cracking of the wall sheathing which it would then be necessary the repair or replace.

The wood stem walls could also be built on site, in lengths which would permit them to be placed without requiring the using of mechanized equipment. The design of the wood beams would be dependent on the type of foundation used - continuous strip footings or spot footings at intervals. Connections of the wood beams to each other or the wood beams to the footing would remain a concern as it would if a system using precast concrete beams were used.

The cost estimate which is attached to this report is based on the combination system using concrete footing.

As a final consideration, there is a real possibility that there will be damage to the framing of the house regardless of the system used. It is almost certain that the house will be subject to different loadings than has been the case in the past. As has been illustrated in recent seismic and high wind events, wood framed houses and other wood framed structures can tolerate a significant amount of overload and movement without failure but not without damage.

Foundation Replacement Cost Estimate - House at Laguna Pueblo
All concrete system
Prepared by: Charles Bacchus
Date Prepared: April 4, 2011

					Material		Labor/Equipment			ACTIVITY
Notes	**ACTIVITY**	Item	Units	Quantity	Unit cost	Total	Unit cost	Total	Total	**SUBTOTALS**
	Demolition									
Note 1	1	Excavation	BCY	100	$0.00	$0.00	$25.00	$2,500.00	$2,500.00	
Note 2	2	Foundation Removal	CY	20	$0.00	$0.00	$25.00	$500.00	$500.00	
	3	Flooring and Floor Decking	SF	400	$0.00	$0.00	$10.00	$4,000.00	$4,000.00	
	4	Wall Sheathing	SF	400	$0.00	$0.00	$15.00	$6,000.00	$6,000.00	
	5	Contingency (10%)	LS			$0.00		$1,300.00	$1,300.00	$14,300.00
	Shoring and Jacking									
	6	Floor	LS	1	$500.00	$500.00	$1,500.00	$1,500.00	$2,000.00	
	7	Walls	LS	1	$500.00	$500.00	$1,000.00	$1,000.00	$1,500.00	
	8	Contingency (15%)	LS			$150.00		$375.00	$525.00	$4,025.00
	Foundation									
Note 3	9	Concrete-in-Place	CY	15	$200.00	$3,000.00	$250.00	$3,750.00	$6,750.00	
	10	Anchor rods in place	EA	50	$2.50	$125.00	$5.00	$250.00	$375.00	
	11	Contingency (25%)	LS			$781.25		$1,000.00	$1,781.25	$8,906.25
	Wood Stem Walls									
	12	Fabrication	SF	500	$10.00	$5,000.00	$15.00	$7,500.00	$12,500.00	
	13	Installation	SF	500	$0.00	$0.00	$10.00	$5,000.00	$5,000.00	
	14	Contingency (10%)	LS			$500.00		$1,250.00	$1,750.00	$19,250.00

	Backfill / Compaction									
Note 5	**15**	Placement	CY	60	$0.00	$0.00	$15.00	$900.00	$900.00	
	16	Compaction	CY	60	$0.00	$0.00	$20.00	$1,200.00	$1,200.00	
	17	Contingency (10%)	LS			$0.00		$210.00	$210.00	$2,310.00
	Finishes									
	18	Floor / Floor Decking	SF	400	$10.00	$4,000.00	$5.00	$2,000.00	$6,000.00	
	19	Interior Walls	SF	400	$5.00	$2,000.00	$5.00	$2,000.00	$4,000.00	
	20	Contingency (10%)	LS			$600.00		$400.00	$1,000.00	$11,000.00
	Subtotals					$17,156.25		$42,635.00		$59,791.25
	Contractor OH&P					$2,573.44		$8,527.00		$11,100.44
						15.00%		20.00%		
								TOTAL		$70,891.69

NOTES:

1 Some excavation will be required at the interior of the house to deepen the crawl space to permit shores and jacks to be installed. All of the interior excavation and at least some of the exterior excavation will be by hand.
To perform the interior excavation, it will be necessary to remove some of the flooring and floor decking. See Activity #4.

2 The foundation removal will require a large amount of hand labor. The unit prices include an allowance for working with hazardous material. The allowance was mostly a guess and It may be possible/necessary to adjust it.

3 The unit price for concrete material assumes that the concrete will be produced on-site in small batches and that forming will not be required. The price for concrete includes reinforcing and finishing of the top surface. Anchor rods (see Activity 10) will be placed before the concrete has attained its first set.

4 The wood stem walls can be fabricated on or off site at the Contractor's option. The stud walls can be produced in short lengths (8 feet long +/-) which will make tham easier to handle but it will be necessary to include in the design a method to connect them together and to the foundation.

5 It has been assumed that the excavated material (other than the foundation itself) can be used for backfill. Some of the backfill can be placed using backhoes or front end loaders but a signicant percentage of the placement and most of the compaction (Activity 16) will have to be done by hand. It will be difficult to attain good compaction at the interior.

6 Finishing consists of replacing the floor decking and flooring to match the existing adjacent portions of the floor and of replacing the wall sheathing and finishing the wall to match the rest of the wall.