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REMOTELY OPERATED EXCAVATOR NEEDS ASSESSMENT / SITE VISIT SUMMARY

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December 2, 1992

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Needs Assessment/Site Visit Summary

The Uranium in Soils Integrated Demonstration (ID) under the U.S. Department of Energy (DOE) Office of Technology (OTD) requested an assessment of soil excavation needs relative to soil remediation. Across the DOE complex there is a wide variety of excavation needs, some which dictate remote and/or precision excavation of soils due to hazardous and/or radioactive constituents. Tele-operated excavators will be needed to function in areas unsuitable for personnel; where temperature exceed 80°F and Ti-Vex anti-contamination coveralls with independent breathing air supplies required for operators.

Working in these extreme conditions inherents three hours of productive work per eight hour shift. By remotizing an excavator activated, personnel are removed from immediate danger of contamination and can operate equipment for several additional hours per shift from a comfortable work station when unpleasant weather conditions would normally deter operations.

In areas where a soil skimming operation removes the contaminated soil, back mixing control is necessary to reduce cross contamination and the increased volumes that would normally occur under conventional excavation operators. Such an excavator could be used for soil cleanup throughout the DOE complex.

Any site-specific excavation requirements identified from the documents collected or during actual site visits are detailed in the appendixes. The following appendix list identifies the DOE sites assessed:

<u>Appendix</u>	<u>Site</u>
B.	Mound Laboratory
C.	Paducah Gaseous Diffusion Plant
D.	Portsmouth Gaseous Diffusion Plant
E.	Nevada Test Site
F.	Lawrence Livermore National Laboratory
G.	Rocky Flats Plant
H.	Los Alamos National Laboratory
I.	Sandia National Laboratory
J.	Idaho National Engineering Laboratory
K.	Hanford Site
L.	Fernald Site

Summary/Conclusions

The reviewed sites fall into one or more of the following three categories: production, EPA National Priorities List, or CERCLA (superfund) designation. As a result, the sites were in different stages of waste characterization. Several sites have reached identification and/or characterization of contaminated areas and have designated remediation groups for those areas. Those sites still in production are planning and implementing relatively small remediation activities focused on specific identified problems.

Only three of the sites appear to have the need for a remotely operated excavator. Hanford and Idaho Falls have areas of high-level radioactive contamination either buried or in/under buildings. At Idaho Falls in the

Radioactive Waste Management Complex, readings of radiation have been measured at 10^8 counts per minute. Hanford will have to remediate high-level radioactive material during demolition of nuclear reactors. The Fernald site has a need for remote operated equipment of different types. It is their feeling that remote equipment can be used to remove the health dangers to humans by removing them from the area. It is also felt that an increase in productivity would be achieved from remotely operated equipment, from the estimate that people working in anti c's and respirators only perform three hours of productive work in an eight hour shift. The majority of the contamination at the other sites is low-level which has a lower related health risk due to exposure time. Therefore, the need to excavate without human exposure was not necessary at these sites.

When site, representatives were asked whether they thought the development of a remotized excavator should be pursued, most interviewees stated that characterization technologies needs are more immediate concern over excavation. Not only does the ability to need real time field characterization exist, but analytical results need to be verified. It should be noted that characterization is a focus area and is being addressed in the Fernald Uranium in Soil Integrated Demonstration.

In addition, the sites do not have similar geographic conditions which would aid in the development of a generic precision excavator. For example, the Mound site has hilly terrain with large amounts of grass as compared to Idaho Falls which is a flat desert with little vegetation. The design of an excavator for use on up to 12% grade slopes in clay soil would differ from the design for use in flat desert areas that require greater dust control.

In conclusion, the sites visited were not ready to utilize or provide the required design information necessary to draft a performance specification. This is only because the two sites that will find remote excavation necessary (Idaho Falls and Hanford) are not to the point of knowing what requirements are needed. The lack of information that would support a remote excavator is partly due to the lack of site characterization. This, along with the dissimilar geographic conditions, creates a strong case against the development of one type of ROPE for use at these sites. Assuming soil characterization technology/methodology is improved sufficiently to allow accurate and real time field characterization, then development of a precision excavator might be pursued based on FEMP needs, since the FEMP's sole scope of work is remediation. The excavator could then be used/tested and then later modified for other sites as warranted.

SITE SUMMARY

Mound Laboratory

The Mound site did not express a need for the development of a Remote excavator. The site already utilizes remotely operated Bobcats inside buildings where human exposure is not desired. Also, excavation at a minimal of 2 inches has already being achieved where conditions permitted. This, plus the fact that remediation is not the main scope of Mound and only limited remediation activities are in progress, suggests the development of the remote excavator was not cost effective for Mound.

Paducah Gaseous Diffusion Plant

The Paducah site did not express an interest in a remotely operated precision excavator. The site was still in a production mode and only limited environmental remediation activities were being pursued. Precision has not been an issue during excavation activities, and conventional excavation methods were deemed sufficient. In addition, as far as future remediation work, it was stated that currently in situ treatment/disposal with minimal excavation is the preferred alternative.

Paducah expressed an interest in the development of instrumentation capable of producing accurate real time characterization in the field to speed up remediation work expected in the future. The process/site history is fairly well documented, therefore, areas of potential contamination as well as probable contaminants are known, but the site will still need detailed characterization for final remediation.

Portsmouth Gaseous Diffusion Plant

The Portsmouth site is still in production and there opinion is that remote operated excavation was not necessary at this time. It was felt that the levels of contamination at the site did not pose a health risk with the proper protective clothing. There was more of a need for real time characterization to complete the remediation in a more timely manner. It was felt that with the site still in production that full attention is not on remediation. At this time, Portsmouth is not a CERCLA site and is not required to follow many of the CERCLA regulations that are required of CERCLA sites. When they have become a CERCLA site the opinion on remote excavation may change.

Nevada Test Site

The Nevada Test Site felt that a remote excavator would not be necessary to support remediation of the site. This is because, on areas that the site has a clear focus on the necessary remediation activities deal with fixed contaminants and low exposure levels. One of the biggest areas of concern are the control of dust that may spread the contamination. The atmospheric tests have deposited contamination over square miles on the surface soil and the annual rain fall of approximately 5 inches per year creates a dust problem. The site does have a road-o-mill that has been tested to remove the surface soil for treatment. The road-o-mill has had an additional dust control system installed and can remove the surface soil to an accuracy of +/- 1/4 inch. However, the mill is not remotely operated because the area that it is to be used in does not have high radiation level.

The site does have documented areas of buried waste and groundwater contamination. Currently, reviewing historical data and interviewing past employees to document all areas of contamination.

Lawrence Livermore National Laboratory

Lawrence Livermore, being an engineering laboratory and not a production

facility, felt that there was not sufficient radioactive material needed to be excavated to require a remote excavator. The majority of the waste material that needs remediation is from VOC's as a result of chemical spills or gasoline tank leakage. These types of spills do not present an opportunity for remote excavation.

Rocky Flats Plant

The Rocky Flats Plant did not show interest in remote excavation because they felt that the contamination levels did not cause a health risk with the proper protective equipment. It was felt that anti "c" and respirators would be sufficient protection for workers. Also the contamination levels at the site are not of a serious level that remote excavation would be beneficial.

The site has stopped production but is on a "stand by" mode. The site is currently changing over from a production mode to a remediation mode. The restoration departments are finding themselves understaffed and looking for people to fill the positions.

Los Alamos National Laboratory

The Los Alamos site is also a research and development laboratory so there is not the larger scale problem of contamination. The site does have areas that require remediation and they do have many different types of radioactive material and high explosives, metals, organic, and hazardous materials.

Sandia National Laboratory

Sandia National Laboratory currently focuses on nuclear weapons development and engineering. As a result, remediation has not been the primary concern and a detailed site characterization document is not yet compiled. Therefore, Sandia cannot ascertain areas potentially suitable for remote excavation. Information available to date, however, does not suggest any opportunities.

Idaho National Engineering Laboratory

Idaho National Engineering Laboratory, by virtue of being on the National Priorities List (NPL), is in the process of characterizing the site. It is felt that there is a current need for remote excavation due to the high levels of radioactivity. The Radioactive Waste Management Complex (RWMC) is a designed buried waste complex, with many different types of radioactive material stored there. The RWMC does have reactor parts buried in the area and covered with a soil berm. Remote excavation is a positive method of removal of the berm without exposing workers to the high radiation levels as the soil is removed. The level of precision required for the remote equipment is currently not known because at the time of the interview there was no determination of what are acceptable contamination levels in soil.

Hanford Site

The Hanford site is on the National Priorities List and is proceeding with characterization of the site. Historical documentation available has indicated that remote excavation may be justifiable. Remote operated equipment may be used for the dismantling of the reactors as well as remote excavation of contaminated soils. The Hanford site during production has placed waste material into cribs, trenches, pits, and tanks, that now needs to be remediated.

Fernald Site

The Fernald Site has completed more site characterization than any other DOE site. Production at the Fernald site stopped in July of 1989, cleanup activities of the facilities started in 1986 ahead of other DOE sites. This may be the reason the Fernald site has a positive attitude toward remote excavation. The time loss and high cost of having people work in anti "c" and respirators along with the added health risk to the individual workers has created a recognized need for remotely operated equipment. This health risk was the main concern in a discussion with the OU 3 representative in the removal of the transite siding (containing 40% asbestos) used for most of the buildings on site. The excavation of the waste pits was another area identified as a potential remote excavation location as well.

APPENDIX A

SITE NEEDS ASSESSMENT

CONTAMINATED SOIL/BURIED WASTE EXCAVATION

DOE SITE:

DATE:

INTERVIEWER:

SITE REP/DEPT:

GENERAL

Q1 : Has there been a documented site assessment at your site indicating areas of soil contamination or designated waste burial areas containing hazardous or radioactive constituents?

A1 : _____

Q2 : Could a copy be made available of such an assessment?

A2 : _____

Q3 : Who was involved in putting the document together?

A3 : _____

Q4 : Who on site is the focal point of responsibility for soil and buried waste clean-up?

A4 : _____

SOILS

Q5 : Briefly describe areas of known or potential contaminants (i.e. under buildings, open flat terrain)

A5 : _____

Q6 : If it is a soil contamination, what definitive characterization has been done to date (depths, boundaries, extent of contaminant migration)?

A6 : _____

Q7 : If you were to excavate or retrieve a contaminated area, what conventional means would be the most practical approach to do the job (i.e. Bobcat Bulldozer)?

A7 : _____

Q8 : To what level of precision is needed to reduce back mixing and a minimization of clean soil retrieval during excavation? What is economically feasible?

A8 : _____

Q9 : What is characteristic of the type of soil in the geographic area? (sand, silty, clay, vegetation, subsurface strata)

A9 : _____

BURIED WASTE

Q10: If there are constructed waste pits or underground waste storage units, what are the configurations (i.e. depth, width, volume, etc)?

A10: _____

Q11: Caps or liners? what type?

A11: _____

Q12: What is the contaminant, concentrations?

A12: _____

Q13: What other things may have been buried with the hazardous constituent?

A13: _____

Q14: Were there any standard container(s) used during burial? If so what were they (dimensions)?

A13: _____

Q15: Was the waste dumped or strategically stacked?

A15: _____

Site Specific Information

The following is the information obtained/interpreted by the team during the site visits.

APPENDIX B

Mound Laboratory

Mound Laboratory was established as part of the weapons chain currently under the direction of the DOE. Mound is currently in operation although it has been stated that the mission may change to one of remediation in the near future. Mound has already begun identifying and remediating some of the known contaminated areas of the site although Mound is not a CERCLA (Superfund) site.

The Mound representatives that were interviewed included an engineering field specialist with a geology background and a project engineer. Both were from the Decontamination and Decommissioning (D&D) group at the Mound site. The D&D group was described as being concerned with radioactive contamination at the site. A site tour focusing on 23 identified contamination areas was conducted.

The following information is based on the OTD questionnaire used to conduct the interview (see Appendix A):

Answers:

- 1-3. There has been a documented site assessment at Mound which identifies 23 specific areas of contamination. It is known as the Weston Report, dated April 1991. If a copy of the report is desired contact Dr. Ralph Jaeger (513 865-3275), the manager of D&D at Mound. Mr. Geichman (513 865-3833) of Mound was involved with putting the report together.
4. Dr. Jaeger and Mr. Richard Neff (513 865-3616), the manager of Environmental Restoration (ER) at Mound, are the focal point of responsibility for soil and buried waste cleanup at Mound. As the D&D group's main concern is radioactive contamination, the ER group's main concern is hazardous constituent contamination.
5. Currently, 23 areas of known soils contaminated with radioactive substances have been identified and are discussed in the Weston report. The radiological contaminants (mostly alpha emitters) mentioned during the interview included uranium, thorium, and plutonium. Additional areas which are not in the Weston report are in the process of being defined. As the site's direction changes from production to cleanup, many more areas of contamination will be identified. Some examples of the contaminated areas are underground pipelines, soils underneath and surrounding buildings, open areas (areas without trees or buildings), crushed drums buried underneath an asphalt parking lot (approximately 15,000 in two different areas), and

a sanitary landfill. Each of the 23 areas are described in the Weston report. A site map (Attachment 1) outlining the 23 areas of contamination was obtained.

6. Definitive characterization of the contaminated areas is included in the Weston report.
7. Currently, excavation at Mound is done using a track excavator, remotely operated and manually operated Bobcats (some are electric for indoor use) and large backhoe and bull dozers. Precision is achieved by utilizing smaller buckets. The method of excavation was described as "muck and truck".
8. Currently, 8 to 12 inches of soil at a time are removed during normal excavation activities. The Bobcat can remove as little as 2 inches at a time, conditions permitting. It was of the Mound representatives' opinions that usage and success of precision excavation depends on the accuracy and confidence of the characterization.
9. Clay is the main type of soil at the Mound site. The site does not have much soil overburden. Not only is the bedrock close to the surface, there is a lot of loose rock as well.
- 10-15. The only underground storage areas that were mentioned are the crushed drum (standard sized drums) burial areas, the sanitary landfill, and some underground storage tanks (USTs). The drums are contaminated with thorium residues. Apparently, the drums were crushed using primitive means and dumped into areas which were later covered (an asphalt parking lot now covers one of the drum areas). The drum areas were not constructed waste pits with liners or caps. The sanitary landfill is abandoned and it is suspect hazardous. USTs containing diesel fuel and possibly other hazardous constituents are located on the site property. It is possible that underground leakage is occurring from the tanks.

Note 1: It should also be noted that the Mound site has very limited containerized waste storage space especially since their off-site shipments are currently halted.

APPENDIX C

Paducah Gaseous Diffusion Plant

The Paducah site was established as part of the weapons chain currently under the direction of the DOE. The site is currently in operation although plans for specific remediation activities are in the process of being developed. As a regulatory requirement, potential source areas of off-site contamination are being identified and investigated (the investigation is pathway oriented).

The Paducah representatives that were interviewed included an engineer, an engineering specialist for the Remedial Action program at Paducah, and the Paducah site Program Manager for the Environmental Restoration Division of the U.S. DOE. A site tour was not provided during this site visit.

The following information is based on the OTD questionnaire (Attachment 1) used to conduct the interview:

Answers:

1. A complete site assessment has not been done at Paducah. The process/site history is fairly well documented, therefore, areas of potential contamination as well as probable contaminants are known despite the lack of detailed characterization.

Specific areas believed to be responsible for off-site contamination are being identified and investigated. Twenty-one areas have been investigated and the results are being reported in a multi-volume document (DOE-OR-1013) which is to be issued in the near future.
2. When the document mentioned above is issued, a copy can be obtained by contacting Mr. Edwards of the DOE.
3. SAIC and CH2M Hill from Oak Ridge were involved in generating the document.
4. Mr. Dennis Cope of Martin Marietta Energy Systems, Inc., the ER Director at the Paducah site, is the focal point of responsibility for soil and buried waste cleanup.
- 5-6. Some of the 21 areas identified were described as open flat areas, areas around buildings, subsurface scrap piles, effluent ditches feeding local creeks, areas containing drums - full and empty (some crushed), and a burn pit area.

Some of the contaminants mentioned were uranium, trichloroethylene, PCBs, Technetium-99, and waste oils.

Specifically, an Oil Land Farm which includes two areas totaling 2400 ft² of open soil area contains PCB, uranium, and trichloroethylene, contaminated waste oil. The area was plowed to a 1 ft. to 2 ft. depth.

Specifics of all 21 areas are available in the document mentioned in the response to question 1.

- 7-8. Currently, excavation is done by backhoe conventional methods (backhoe). Precision is not an issue at Paducah at this time. In fact, in situ treatment/disposal is the preferred remediation method (off-site shipment is not planned). Plans are to practice minimal excavation tasks as a remediation alternative to in situ.

It was the opinion of the Paducah site representatives that the need for remote operation of an excavator was not apparent in supporting Paducah's soil cleanup activities based on what they perceive.

9. The site is located on a Class I gravel aquifer. The site is basically flat and is located on an alluvial plain. The soil is a mixture of silt and clay to 30 to 40 feet in depth. Vertical sand lenses extending 45 to 50 feet are also one of the geographic characteristics.
- 10-15. There are a total of 14 underground storage tanks (USTs) at Paducah mainly used to store petroleum. Presently, two have been removed - one for storage of diesel fuel, the other for gasoline. Remediation of the surrounding soil is planned using conventional excavation methods. Removal of a third tank (an old railroad car, once used to store sulfuric acid, containing uranium and PCBs) is planned. Presently, there are no plans for the other 11 USTs. It was mentioned that the USTs were buried as deep as 30 feet.

Two other areas used for burying waste are known as C-404 and C-749. C-404 is an above ground impoundment with dimensions of 140 ft. by 380 ft. by 6 ft. high (clay walls). It was previously a lagoon and now has a 6 inch RCRA clay cap. C-749 is 160 ft. by 200 ft. and has a 7 to 17 ft. depth. A variety of wastes were disposed of in these two areas including drums containing uranium turnings in PCB contaminated oils. The drums were stacked.

There are also two permitted landfills on site - one used for sanitary waste, the other for construction waste. Both of these will eventually be capped and closed.

In summary, the development of a remotely operated precision excavator for use at the Paducah site was not supported. On the other hand, interest was expressed for the development of instrumentation capable of producing accurate real time characterization in the field.

APPENDIX D

Portsmouth Gaseous Diffusion Plant

The Portsmouth site was established as part of the weapons chain currently under the direction of the DOE. The site is currently in operation. It is anticipated that the site will be designated a CERCLA site by the year 2010.

The Portsmouth representatives that were interviewed included a civil engineer and the Project Manager of Environmental Restoration. A site tour was conducted.

The following information is based on the OTD questionnaire (Attachment 1) used to conduct the interview:

Answers:

1. The following documents provide limited site assessment information for the Portsmouth site: RFI-Corrective Measure Study, X-701B Soil Boring Program, Corrective Implementation Study (CMI, CIS), RFI-Final Draft Report Quad I & II, Quad I & II Task VII Report, Quad III & IV Task III Report.
2. Copies of the above documents can be obtained from the Public Record Library for the Portsmouth site.
3. Geraghty & Miller, Inc. generated the above documents.
4. Mr. Richard Snyder is the ER manager at Portsmouth.
5. The following information was provided as a description of specific contaminated areas:

X-701B: Contamination levels range from 0 to 4,392 ppb for TCE, 0 to 1,000 ppm uranium, 0 to 10,000 dpm/gram technetium. The depth intervals for uranium are as follows:

2 ft	-	100 ppm
4 ft	-	1,000 ppm
6 ft	-	100 ppm
8 ft	-	10 ppm
10 ft	-	10 ppm.

The depth intervals for technetium (a beta emitter) are as follows:

4 ft	-	10,000 dpm/gram
6 ft	-	1,000 dpm/gram
8 ft	-	1,000 dpm/gram (some plume volume depletion)

10 ft - 400 dpm/gram.

X-231B: This area is an oil bio-degradation plot with an HDPE cover applied. It is contaminated mainly with Volatile Organic Compounds (VOCs) (0 to 100 ppm VOCs) with small amounts of uranium. The area is presently under closure procedures. An in situ soil mixing demonstration is planned for the summer of 1992.

X-744 Storage Yard: There is a plan to surface strip this area to a 2 foot depth as the remedial action. It is anticipated that this will produce a waste volume of approximately 25,000 cubic yards. The waste will be boxed and stored on site.

X-740: This area consists of contaminated soil around a 2000 ft² building. The contamination is due to previous spills.

UST Soil Heap: As the name describes, this is a pile of contaminated soil which was excavated during the removal of a UST. The remaining pit is considered RCRA.

X-752: This area consists of contaminated soil (approximately a 6 ft swath) around a building. The volume is approximated at 160 to 200 cubic yards.

6. See the response to question 1.
7. Standard excavation equipment with no special requirements is currently used at the Portsmouth site.
8. The level of precision required was not known. The interviewees stated that it depends on the level of characterization detail and approach.
9. The soil in the geographic area of the Portsmouth site, ranging from 30 to 50 feet above the bedrock, is made up of Minford clay, Minford silt, Galius sand, Sunbury shale, Berea sandstone, and Cuyahoga shale.
- 10-15. The Portsmouth site has a sanitary landfill (1,000 ft by 300 ft) and a classified landfill (900 ft by 300 ft). The classified landfill is capped and bermed and it contains methane vents.

APPENDIX E

Nevada Test Site

The Nevada Test Site (NTS) has been the location for testing nuclear weapons in the United States since 1951. It has become the nations primary site for testing new nuclear weapons and studying the effects of nuclear explosions on structures and military equipment. Other nuclear energy projects at the NTS have been the study of safety requirements for storing and transporting nuclear weapons. The exploration of peaceful uses of nuclear explosives, and development of nuclear rockets and ramjets. In all, more than 700 nuclear explosions have taken place at the NTS as part of these programs. Radionuclides in Surface Soil at the Nevada Test Site by Richard D. McArthur, Desert Research Institute University of Nevada Systems, August 1991, Publication #45077,1

One result of these explosions is that the surface soil in many parts of the NTS contains measurable amounts of several long-lived radionuclides. Almost all of the 100 above ground tests contaminated the soil near ground zero (GZ). Several underground tests were cratering experiments that threw radioactive rock and soil hundreds of feet from the GZ, and some deeper underground tests vented radioactive material to the surface. A few safety tests, in which a nuclear device was destroyed by conventional explosives, scattered plutonium (and in some cases uranium) over the nearby ground. Finally, radioactive debris from many tests was deposited as fallout over the northern and eastern parts of the NTS. [Radionuclides in Surface Soil at the Nevada Test Site by Richard D. McArthur, Desert Research Institute University of Nevada System, August 1991, Publication #45077,1]

Although it is not yet a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) site, the Nevada Test Site began identifying contaminated areas during the 1970's when several studies of radionuclide distribution were done. A series of aerial radiological surveys measured gamma-exposure rates, but not individual radionuclides. Studies which did measure individual radionuclides usually focused on americium and plutonium and were limited to relatively small areas near GZs and safety shot sites. The data for those studies were obtained by collecting and analyzing large number of soil samples. Furthermore, during the mid-1970's, scientists from Lawrence Livermore National Laboratory (LLNL) and the DOE Environmental Measurements Laboratory developed in-situ spectrometry as a technique for measuring gamma-emitting radionuclides in surface soils. This method proved to be useful for surveying large areas much faster and cheaper than using other methods. [Radionuclides in Surface Soil at the Nevada Teat Site by Richard D. McArthur, Desert Research Institute University of Nevada System, August 1991, Publication #45077, 1-2]

The NTS has received a Hazard Ranking System (HRS) score and will most likely be proposed for the Superfund's (CERCLA) National Priorities List (NPL).

Answers:

- 1-3 There have been site assessments at NTS documenting soil contamination and designed waste burial areas containing radioactive or hazardous constituents. In 1981, the DOE began a project using in-situ spectrometry to carry out a thorough radiological survey of the surface soils. This project, the Radionuclide Inventory and Distribution Program (RIDP), took five years of field work and another three years of data analysis. The methods and results of the RIDP were published in a series of five reports:

<u>Report #</u>	<u>Regions Covered</u>	<u>Reference</u>
1	Galileo (Area 1)	McArthur and Kordas, 1983
2	Areas 2 and 4	McArthur and Kordas, 1985
3	rest of Yucca Flat	McArthur and Mead, 1987
4	Areas 18 and 20	McArthur and Mead, 1988
5	rest of NTS	McArthur and Mead, 1989

[Radionuclides in Surface Soil at the Nevada Test Site by Richard D. McArthur, Desert Research Institute University of Nevada System, August 1991, Publication #45077, 2]

The report Radionuclides in Surface Soil at the Nevada Test Site updates and summarizes those results with the aim of presenting an integrated description of the current levels of radioactivity in the surface of the NTS.

Furthermore, a five volume document titled Inventory of Inactive and abandoned Facilities and waste Sites deals with Areas 1-4. This document was produced by Don Wrubbe of PAI. Tom Buquo was involved with the preliminary assessment.

All of these documents should be available through the DOE.

4. Stephen Mellington, Chief of the Environmental Restoration Branch, Environmental Restoration and Waste Management Division, DOE (702) 295-0844 and John Hall, Chief of the Technology Development Branch, DOE are the people responsible for soil and buried waste clean-up.
5. Eight Waste Groups (WAGs) have been defined for the NTS.

Nuclear Testing Areas - This testing has resulted in releases to the atmosphere, contamination of soils and structure with residual radionuclides, and the release of a number of radionuclides and metals into the environment immediately around each test location. There are five Waste Area Groups that include NTS areas where underground nuclear tests have been conducted: 1) Yucca Flat; 2) Frenchman Flat; 3) Pahute Mesa; 4) Rainier Mesa; and 5) Shoshone Mountain (see figure 2).

1. Yucca Flat (over 190 square miles) is a closed basin that drains

inward to the Yucca Lake playa at the southern end of the basin. The Yucca Flat Test Area contains approximately 511 release sites both atmospheric and underground tests. The Yucca Flat is still actively used for nuclear testing.

2. Frenchman Flat (over 25 square miles) is a closed desert basin that drains inward to a large playa. The Frenchman Flat contains 30 release sites where underground and atmospheric nuclear weapons tests were conducted between 1951 and 1968. Frenchman Flat is no longer used for nuclear testing.

3. Pahute Mesa (over 194 square miles) is a large plateau in the northwestern part of the NTS. The area contains 80 release sites where underground nuclear weapons were conducted. Nuclear testing continues at this site.

4. Rainier Mesa (over 6 square miles) is an upland area in the north central part of the NTS. The area contains 55 release sites where underground nuclear weapons tests were conducted from 1957 to the present.

5. Shoshone Mountain (over 3 square miles) is an upland area in the central part of the NTS. Tests were conducted in drilled horizontal borings. The tunneling and testing operations have generated moderate quantities of muck and mining tailings contaminated with low levels of radioactivity. Underground testing of nuclear weapons were conducted at the site from 1962 through 1971.

The primary pathway for movement of nongaseous radionuclides in the subsurface is through downward and/or horizontal migration of groundwater. The extent of groundwater contamination has not yet been determined.

Active Tunnel Ponds - includes the active tunnel pond and muck piles resulting from underground nuclear testing in tunnels at the NTS site.

Sumps and injection Wells - includes 18 sumps and injection wells that were used at the NTS for disposal of incidental wastes generated during nuclear testing and supporting NTS operations.

Inactive Tanks - 17 storage tanks at the NTS have been used for water, fuel, and radioactive and hazardous materials storage

Contaminated Waste Sites- includes 10 inactive waste disposal sites on the NTS that were used for disposal of incidental wastes of a radioactive nature generated as the result of nuclear testing operations.

Inactive Leachfields - includes the 8 inactive leachfields at the NTS where potential contamination of soils may have occurred.

Muck piles and Inactive Tunnel Ponds - includes inactive tunnel ponds

and muck piles at E-Tunnel at the NTS where drilling wastes and groundwater discharge were disposed and after tunnel construction.

Plutonium-Contaminated Soils - includes areas where surface soils have been contaminated with plutonium during safety tests of nuclear devices.

Alaska Remedial Action - The Amchitka Island site was the site for three underground nuclear tests between 1965 and 1971. Subsurface contamination with radioactivity has been reported. Studies have shown that no escape of radionuclides to the surface has occurred except for trace quantities, principally tritium, in the area of one of the tests.

[Environmental Restoration and Waste Management Site Specific Plan
Fiscal Years 1993-1997, August 1991, DOE/NV-336, 49-50.]

6. The definitive characterizations of contaminated soils which have been done to date are available from the following documents:

Radionuclides in Surface Soil at the Nevada Test Site by Richard D. McArthur

Environmental Plutonium on the Nevada Test Site and Environs, Nevada Applied Ecology Group, June 1977.

7. Currently the respondents believe that conventional equipment will suffice for cleaning up contaminated soils and excavating buried waste. The site is not characterized adequately yet although it is known that there are trains, jeeps, reactors, and vacuum cleaners buried on the site. Furthermore, it is anticipated that some radioactive dumps may be found where the nuclear rocket engine was developed.
8. The respondents stated that level of precision needed is not yet known.
9. The areas are primarily sandy loam soils.
- 10-13 In order to understand the answer to this question one first needs to know the management structure of the organization for the DOE, Nevada. Under DOE is the Environmental Restoration and Waste Management Division which is divided into three branches - Defense Waste Branch (DWB), Environmental Restoration Branch (ERB), and the Technology Development Branch (TDB). Among other duties, the Defense Waste Branch manages and directs the defence low-level radioactive waste, mixed waste, and hazardous waste operations at the NTS; oversees storage operations of some special materials that are radioactive, and transuranic wastes to be sent to the Waste Isolation pilot Plant (WIPP); and manages and directs research and analyses studies for

disposal. Consequently, DWB personnel who were not interviewed by the team are responsible for constructed waste pits or underground waste storage units. [Environmental Restoration and Waste Management Site Specific Plan Fiscal Years 1993-1997, August 1991, DOE/NV-336,11]

When discussing these questions with ERB personnel, they responded that Area 25 contains trucks, pipe, steel, locomotives from the old rocket engine tests, and cables. At least one injection well is reported to be full of vacuum cleaners from the clean up of a building. Furthermore, they reported that classified sites probably have these problems.

According to the Environmental Restoration and Waste Management Site Specific Plan Fiscal Years 1993 - 1997, the following areas are listed which are pertinent to questions 10 -13.

Sump and Injection Well RI/FS

In support of the NTS testing operation and associated experimentation, radioactive and suspected mixed wastes have been disposed of in 18 inactive sumps and injection wells. The contaminants of concern include tritium, plutonium and other transuranic radionuclides, cesium, strontium, radioactive iodine, heavy metals, solvent and potentially PCBs.

Inactive Tank RI/FS

Seventeen abandoned above and below ground tanks have been identified, which were used for storage of water, fuel, radioactive, and other hazardous materials. Federal and state regulations require that all tanks taken permanently out of service longer than 12 months must either be removed or filled with inert material, and a site assessment conducted. The RI/FS work will determine if any regraded materials are stored in the tanks and the extent and magnitude of contamination that may have been released from the tanks or spills in the area of the tanks.

Contaminated Waste Site RI/FS

Prior to 1963, soils contaminated during the atmospheric nuclear testing were consolidated and disposed of in fill areas. Soils and equipment contaminated with radionuclides as a result of drillback or tunnel operations were also disposed of in the drill areas at the NTS. The RI/FS will, in part, rely on information to be collected during the groundwater characterization survey.

Leachfield RI/FS

Eight inactive leachfields have been identified where contamination may have resulted from disposal of decontamination waste water or liquid wastes. Suspected wastes include radionuclides, mixed waste, solvents, acids, and caustics.

Inactive Muck pile and Tunnel Ponds RI/FS

Following nuclear testing, radioactive muck tailings from drillback operations at E-tunnel Area 12 were disposed of in muckpiles, and perched groundwater encountered in tunnels has been discharged into ponds located outside the tunnel portals. The exact number of inactive tunnel ponds is uncertain because older ponds may have been covered as the muckpile expanded. The muckpile was covered with clean soil to prevent any releases of contamination into the air. Radioactive wastes are known to exist at these sites and mixed wastes are suspected. The groundwater discharging from the tunnel was found to contain elevated levels of tritium, and other radionuclides are likely to be present.

RI/FS at the Tonopah Test Range, and Nellis Air Force Range Area 13

During safety shots conducted on these sites, chemical explosives were used to determine if such an explosion could cause nuclear detonation. Tests resulted in plutonium contamination of surface soils over approximately 2,895 acres at levels in excess of 40 pCi/g.

Atmospheric Testing Debris Disposal Compliance Documentation

In 1989, NV determined that the clean up under the Atmospheric Testing Debris Disposal Program constitutes a planned removal and is subject to the National Contingency Plan (NCP) and CERCLA compliance documentation. This activity provides for a complete inventory, assessment and documentation to satisfy the NCP requirements for the excavation and disposal of the radioactive debris.

Closure Plan Development and Implementation at the NTS

This activity provides for the closure plan development and implementation for the Area 6 Decontamination Pond, Area 23 Building 650 Leachfields, Area 23 Hazardous Waste Trenches, Area 3 U3fi Injection Well, U2bu Crater, Area 2 Bitcutter Retip Shop, and the Area 27 Explosive Ordinance Disposal Site.

Post Event Location Characterization

This activity provides for a complete characterization of sumps used for disposal of drilling fluids and mud at the nuclear test location. Radioactively contaminated drilling fluid have been disposed of into drillback sumps, and may contain RCRA hazardous materials.

Groundwater Characterization Project

The project provides for the design and implementation of a comprehensive groundwater, hydrology and underground contaminate characterization program at the NTS. The primary purpose of these wells is to provide data in support of the RI/FS efforts at the Underground Testing area Waste Area Groups. The total number of

wells, currently planned at 98, will increase or decrease based upon the results of the program and discussions with the regulators.

14. No standard containers were used during burial. Everything from small drums to cars and locomotives were buried.
15. The waste was, on the whole, dumped.

APPENDIX F

Lawrence Livermore National Laboratory

The 811 acre main Lawrence Livermore National Laboratory (LLNL) site is located east of San Francisco in Livermore, California. The laboratory is a government owned research facility operated by the University of California for the DOE. The main LLNL site was added to the EPA's National Priorities List (NPL) in July 1987 as a result of VOC contamination of the ground water.

A second site, site 300, is a 7,000 acre facility about 15 miles southeast of Livermore. Current operations at Site 300 include hydrodynamic testing, charged particle beam research, physical environmental and dynamic testing, high explosives formulation and fabrication, facility operations support at the General Service Area, and environmental restoration research.

At the request of the LLNL, a site visit was not conducted, but reference material was supplied for the use of completing the OTD questionnaire.

Answers:

- 1-3. There has been site assessments at LLNL documenting soil contamination and designed waste burial areas. The assessment is the CERCLA Remedial Investigations Report for the LLNL Livermore Site, volume 2 section 4, May, 1990. This document was provided by the Environmental Restoration Division at LLNL, who is the focal point for the clean up activity.
5. Within each of the areas investigated, specific sites have been identified as being associated with some past activity that could possibly have caused a release of hazardous material. A summary description of each of the 15 potential source areas is provided below (see figure 3 for site map).

Arroyo Seco Storm Sewer Discharge Area

Arroyo Seco, Originating in the hills southeast of LLNL, flows northwest across Sandia National Laboratory, Livermore prior to entering the southwest corner of LLNL. The possible release areas of hazardous materials are from TCE, xylene, and toluene spills, the storm drain outlets have discharged liquids to the southwest portion of LLNL since 1942. Also PCBs from ruptured transformers, abandoned sewer lines and dumping of construction debris and solvents by the U. S. Navy in and/or near Arroyo Seco on DOE property.

Building 212 Area

Building 212 was constructed by the U. S. Navy in the early 1940s and

SOURCE INVESTIGATION AREAS

Old Areas

- ① BUILDING 141 AREA
- ② ARROYO SECO AREA
- ③ BUILDING 510 AREA
- ④ BUILDING 514 AREA
- ⑤ BUILDING 412 AREA
- ⑥ EASTERN LANDING NAT. STOR. AREA
- ⑦ BUILDING 297/200 AREA
- ⑧ OLD SALVAGE YARD AREA

New Areas

- ⑨ CHRONUM STUDY AREA
- ⑩ NORTH FARM BOUNDARY AREA
- ⑪ NORTHERN BURNING AREA
- ⑫ HELIPAD AREA
- ⑬ BUILDING 571 AREA
- ⑭ EAST OAT DRIVE AREA
- ⑮ BUILDING 490 AREA
- ⑯ NW 501 AREA
- ⑰ BUILDING 293 AREA
- ⑱ BUILDING 202 AREA
- ⑲ BUILDING 543 AREA
- ⑳ EAST TANK STRIP/TRAILER 5475 AREA
- ㉑ BUILDING 511 AREA
- ㉒ UNLINED DRAINAGE DITCHES
- ㉓ ARROYO LAS POSITAS AREA
- ㉔ BUILDING 410 AREA
- ㉕ DRAINAGE RETENTION BASIN AREA
- ㉖ BUILDING 331 AREA

9-13-91 MSI

FIGURE 13

used as a drill hall and gymnasium. From the early 1950s to the present, LLNL used the building for accelerator research. The possible release sites are the mercury reclaimer, ruptured transformer, drum racks, and storage tanks.

Building 321 Area

The Building 321 complex were designed for the operation of various machines, plating, and small support shops as well as the Material Fabrication Division. The suspected sources of releases are from the plating shop sump and spills, plating shop chemical storage area, storm drains which received coolant and oils, and radiation was detected by an aerial survey in 1975.

Building 141 Area

This area was primarily used as a staging area for material destined for the Nevada Test Site. The electrical department and circuit board shop has been the principal occupant since 1960. The area was investigated for possible release points because of dumping of oils and solvents on the ground just east of building 141, an abandoned gasoline tank which was filled with sand in 1960, releases from the plating shop sump, and the TCE found in an unlined drainage ditch.

East Traffic Circle Area

The East Traffic Circle Area was formerly one of the unpaved parking aprons flanking the runways of the Livermore Naval Air Station. The parking aprons were often used to clean and repair airplanes, as well as for paint stripping. The U. S. Navy primarily used TCE to clean airplanes. Other areas of possible releases are from the liquid waste storage area, evaporation ponds, and disposal pits.

East Taxi Strip Area

The East Taxi Strip Area was a concrete paved taxiway used by the Livermore Naval Air Station. LLNL used a strip of this taxiway along with about 55 ft. of unpaved land along the edge, from 1953 to 1976 to store and process radioactive liquid wastes. Carboys, evaporation ponds, and small disposal pits were used in these activities. Tritium is reported in the local ground water in wells MW-206 and MW-363 near building 531. Soil containing radioactivity was excavated and disposed at the Nevada Test Site.

Old Salvage Yard Area

The Old Salvage Yard Area began in 1958 for salvage operations and storage of reclaimable materials (chemicals, solvents, oils, mercury, scrap metal, etc.) were stored there. The unpaved area of the salvage yard was reportedly used to drain residue from empty barrels and drums. The old salvage yard is now occupied primarily by parking lots.

Eastern Landing Mat Storage Area

The Eastern Landing Mat Storage Area was a strip of land parallel to the East Taxi Strip. The landing mat was used by LLNL for salvage and storage of nonradioactive chemicals and oils. Historical information indicates that the unpaved area east of the landing mat was also used to drain residual liquid from barrels and drums.

Building 612 Area

Building 612 was constructed in 1966 by LLNL and services as a solid waste holding and shipment facility for both radioactive and hazardous wastes. The surface area has documented evidence of hazardous material release along with miscellaneous transport equipment. A chemical storage drum containing an acid plating solution erupted in 1984 resulting in a spill covering a surface area of about 30 X 60 ft.

Building 514 Area

Building 514 was constructed in 1943 by the U. S. Navy as a facility to test and repair aircraft engines. The building was converted to a waste disposal and decontamination facility for both radioactive and hazardous wastes when LLNL acquired the operation in 1954. Historical information shows that numerous small spills occurred at the drum rack. The evaporation pits were lined with plastic and frequently leaked. Liquid waste was stored in glass carboys that leaked due to breakage until the carboys were replaced with an above ground storage tank. Solvents, oils, and fuel was released from the aircraft engine repair and test facility.

Building 518 Area

Building 518 was constructed in 1959 for use as a gas cylinder, solvent, and oil drum storage area. Anecdotal information indicates that damaged drums, which occasionally leaked or were ruptured by forklifts, were taken to the southeast corner of the facility and allowed to drain onto unpaved ground. It appears reasonable that damaged drums were also allowed to drain at any convenient location east of the facility. Building 518 site is presently paved and bermed.

Gasoline Spill Area

Between 1952 and 1979, about 17,000 gallons of leaded gasoline leaked from the southern mast of four 10,000 gallon underground fuel tanks located near now destroyed Building 403, in the south central part of LLNL. All four tanks were taken out of service and filled with sand in 1980.

Estimates of hydrocarbon mass were based on chemical analyses of saturated and unsaturated soil and ground water indicate that about 6000 gallons existed in the vadose zone. About 10,000 gallons were

present in saturated sediments, and about 100 gallons were dissolved in ground water. Since 1988, test vacuum induced venting has removed about 5000 gallons of fuel hydrocarbons from the vadose zone.

6. A fairly extensive characterization and monitoring has been completed through soil samples and monitoring wells in areas in need of remediation.
7. To excavate a contaminated area a bulldozer would be sufficient.
8. A level of precision of approximately 6 inches is needed.
9. The soil is made up of sand, clays, salts, and gravel.
- 10-14. Nine landfills are present at Site 300 that contain miscellaneous chemical wastes, gas cylinders, TCE PCBs, explosive debris, glove boxes, and other wastes. The total areal extent of the landfills is about 50 acres.
15. There is not information on how the waste was buried.

APPENDIX G

Rocky Flats Plant

The Rocky Flats Plant (RFP) is part of a nationwide nuclear weapons complex owned by the DOE and located northwest of Denver, Colorado. The facility is contractor-operated by EG&G Rocky Flats, Inc. (EG&G) and was operated until January 1992 as a nuclear weapons research, development, and production complex. The RFP fabricated components for nuclear weapons from plutonium, uranium, beryllium, and stainless steel. Support activities included chemical recovery and purification of recyclable transuranic radionuclides as well as research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics.

The RFP is currently in transition from a defense production facility to one whose planned future missions include:

- o environmental restoration
- o waste management
- o maintaining production contingency
- o eventual decontamination and decommissioning.

A transition plan is due to Congress in July 1992. This plan will better define the activities and actions necessary to effect the transition.

A site-wide radiometric survey was performed from 1977 to 1984 using hand-held FIDLER instruments. The purpose of the survey was to detect extremely contaminated areas of the plant site. By 1984, over 11 million square feet of the RFP was surveyed and relative concentrations of plutonium in the surficial materials were mapped. Although arrangements for removal or cleanup of discrete areas were made if the detected contamination was considered an immediate hazard, cleanup was not intended to be an integral part of the survey. The identification of "hot spots" prompted consideration in the development of subsequent environmental activities.

RFP operations generated nonhazardous, radioactive, and mixed hazardous and radioactive streams. Hazardous substances detected in the environment, as a result of RFP operations include various radionuclides, nonradioactive metals, volatile organic compounds (VOCs), semi-volatile organic compounds, and inorganic ions. These substances were released to the environment through past waste management practices (e.g., waste incineration or burial) and unplanned events such as leaks, spills, and fires. Herbicides which were applied in the past have also been detected.

The RFP conducts routine radiological and nonradiological environmental monitoring of effluent air, ambient air, surface water, groundwater, tap water, stream sediment, and soil. Specific sampling and analysis programs for the various media have evolved throughout the history of RFP operations. Since

1970, results from most of these monitoring programs have been summarized monthly and/or annually in RFP environmental monitoring reports.

A 1973 study was initiated by the U.S. Atomic Energy Commission (AEC) and focused on potentially contaminated soils on the RFP site. The study was performed through a combination of RFP records/literature review and employee interviews. A draft report was submitted in October 1973.

The RFP is on the National Priorities List (NPL) and, consequently, documentation must be in accordance with CERCLA. The Interagency Agreement (IAG) among the U.S. Environmental Protection Agency (EPA), the Colorado Department of Health (CDH), and the DOE describes the general response processes for the Individual Hazardous Substance Sites (IHSSs) at the RFP. The identification, investigation, and remediation of these sites are being conducted under the DOE Environmental Restoration (ER) Program. The ER Program is designed to identify, investigate and, if necessary, remediate contaminated sites at DOE facilities. The program involves five major activities, as follows:

- o Activity 1: Installation assessments, including preliminary assessments and site inspections to assess potential environmental concerns.
- o Activity 2: Remedial investigations, including the development and implementation of field sampling programs to determine the magnitude and extent of contamination at specific sites, evaluate contaminant fate and mobility in the environment, and perform baseline risk assessments.
- o Activity 3: Feasibility studies to evaluate remedial alternatives and develop remedial action plans, as necessary, to remediate sites identified during Activity 2
- o Activity 4: Remedial designs/remedial actions, including design and implementation of site-specific remedial actions selected on the basis of Activity 3 Feasibility Studies.
- o Activity 5: Compliance and verification to monitor and assess the performance of remedial actions implemented under Activity 4 and to document their efficacy.

As part of Activity 1, Historical Release Report, EG&G Rocky Flats, 21100-TR-12501.01, June 1992, presents a summary of information on previously identified Individual Hazardous Substance Site (IHSS) and newly identified Potential Areas of Concern (PACs).

The majority of the information contained in this needs assessment was gleaned from this document as well as from interviewing James P. Koffer, Remedial Actions Manager, and Scott R. Grace of the Environmental Restoration Division, Department of Energy, Building 116, P.O. Box 928, Golden, CO 80402-0928. The following information is based on the OTD questionnaire (See Attachment 1) which was used for the interviews.

Answers:

1. The Historical Release Report, EG&G Rocky Flats, 21100-TR-12501.01, June 1992 and the RCRA Part B permits are documented site assessments at the RFP.
2. The interviewers were given a copy of the Historical Release Report.
3. The EG&G Environmental Management staff assembled the document with the help of former RFP employees.
4. The focal point of the site for soil and buried waste clean-up is the EG&G EM Department, specifically the Remediation Action Division.
5. The areas of known or potential contamination are the ground process areas in both low and high security areas as well as the open terrain which extends onto private property east of the plant (see figure 4 and 5 for site maps).

All 117 existing Rocky Flats Plant Individual Hazardous Substance Sites are Potential Areas of Concerns. Each PAC has been assigned a unique alphanumeric PAC reference code consisting of two alpha-numeric series separated by a dash. Because PACs can be arranged based on geographical location, the PAC numbering system incorporates the general location of the PAC. The RFP-related area was subdivided into fourteen areas for this purpose. The numbered RFP areas refer to the established geographical area designations of the RFP manufacturing facility. The RFP buffer zone quadrants (northeast, NE; northwest, NW; southeast SE; and southwest; SW) are subdivided by a projection of Central Avenue as the north-south dividing line and a projection of Eighth Avenue as the east-west dividing line. The buffer zone quadrant identifications only apply to those PACs which are located outside of the numbered manufacturing facilities. Offsite releases from the RFP are specifically identified as such. In addition to the fourteen geographic areas, potential under building contamination (UBC) sites were identified, as well as potential incidents of concern (PIC) sites.

We shall take each area and list the contamination related to soils, buried waste, and/or radionuclides and any other information pertinent to this Needs Assessment.

Northeast Buffer Zone

Uranium and plutonium contamination is present in the sludge in Trench T-2 through T-11. Approximately 300 drums which had previously contain contaminated oils were flattened and could be present in Trenches T-3 through T-11. A sediment study conducted by the Colorado State University (CSU) resulted in data that indicated radioactive contamination of sediments in the B-Series drainage. Plutonium activity in Pond B-1 sediment in June 1973 varied from 10 to 502 pCi/g of dry sediment based on the CSU sampling.

REFERENCE: DRAWING PROVIDED BY DOT & ASSOCIATES, FIGURE NO. 3-1,
12/17/91, PROJECT NO. 506-10.

NORTHEAST

900

SOUTHEAST

SCALE
0 1650 3300 FEET

PREPARED FOR: U.S. DEPARTMENT OF ENERGY Rocky Flats Plant Golden, Colorado			
FIGURE 3-1			
TITLE: PAC AREA BOUNDARIES			
REVISED 5/22/92			
PROJ. NO.	304944	DWG. NO.	304944-8121
DESIGN BY	A. VIRGIL	CHECKED	AKS
DRAWN BY	A. VIRGIL	APPROVED	FJB
DATE	12/18/91	SCALE	AS SHOWN

SHEET
OF

48448125 05/22/92 10:40am CAG

FIGURE #5

FIGURE #5

An RFP study completed in June 1973 indicated radioactive contamination of sediments upstream from the drainage ponds. This study found an average concentration of 40 dpm/g from the "west culvert" (the culvert west of the Building 995 outfall) to the "east culvert" (the culvert immediately east of the Building 995 outfall). The area of contaminated soil/sediment was estimated to cover an area approximately 650 feet in length with an estimated width of 6 feet.

Although the Soil Dump Area (between the A-Series drainage and B-Series drainage) is a PAC, no documentation was found that contained analyses of the soil from the Part V project or from the Pond B-5 modification work.

In the trenches south of the present landfill the older sludge would have primarily uranium contamination with the newer sludge having an increasing amount of plutonium contamination. Total long-lived alpha activity present in the sludge has been reported between a minimum of 382 pCi/g in August 1964 to a maximum of 3,591 pCi/g in June 1960. Analysis of soil samples collected during exploratory drilling did not indicate any radioactivity.

Northwest Buffer Zone

Radioactively contaminated sludge from the sanitary wastewater treatment plant (Building 995) was routinely disposed of at the present landfill from August 1968 through May 1970. The contamination consisted of uranium and plutonium which entered the sanitary sewage system via laundry water. Approximately 2,200 pounds of sludge containing an estimated 8 milligrams of plutonium were buried in the landfill. This sludge also contained depleted uranium. This disposal practice was discontinued in May 1970 when offsite shipment of sludge as low-level waste began.

An unknown radioactively contaminated powder was spilled at the PU&D Storage Yard. Other releases may have occurred from leaking batteries and drums, and areas within the yard could be contaminated. No additional documentation was found to further detail releases to the environment.

Miscellaneous solid and liquid hazardous non-radioactive wastes containing organic solvents and PCBs are stored at the Inactive Hazardous Waste Storage Area. Controls which met regulatory standards were installed to prevent leaks and spills. Spills of less than reportable quantities may have occurred from the drums during transfer of materials into and out of the drums. Analytical results of the materials stored in the area suggest that contamination may be limited to metals, PCBs, and radionuclides absorbed into surficial soils and volatile organic compounds present at shallow depths in the surficial materials. The presence or absence of these constituents is unknown.

Southeast Buffer Zone

Pond C-1 sediments are known to contain low levels of plutonium, americium, and uranium contamination.

Southwest Buffer Zone

In addition to depleted uranium, the original landfill received waste materials with unknown concentrations of polychlorinated biphenyl (PCBs) in the 1960s. The material consisted of no-carbon required (NCR) paper, transformer and vacuum pump clean-up paper and rags, and small capacitors and fluorescent lights.

Two drums of uranium oxide and soil were recovered from the original landfill. In response to the July 1979 incident, a survey was performed by Radiation Monitoring. Three locations of depleted uranium were identified. One box of contaminated soil was removed.

In 1970, four burial sites were located south of the incinerator area. The trenches were used for disposal of ash from the incinerator which operated from 1952 to 1968. The trenches are approximately 150 to 200 feet long, 12 feet wide, 10 feet deep, and covered with 3 feet of earth. The ash dump south of the plant was monitored in 1959. Activities of 4,000 cpm alpha and 30 mr/hr beta were observed. In September 1954, five samples of ashes resulting from the burning of Building 991 wastes were collected from Ash Pits 1-4. The average value for the results was 4.5×10^7 dpm/kg of dry ash. The ashes were about 100 times higher in alpha activity than the usual ashes sampled from the incinerator. In 1956, special monitoring was performed during and after burning contaminated waste in the plant incinerator. Ash samples showed 1.9 grams of material (depleted uranium) per kilogram of ash. Smear surveys of the incinerator before and after burning showed no increase in contamination. It was estimated that approximately 30,000 cubic feet of soil and ash are contained in Pit 9.

An estimated 100 grams of depleted uranium were burned at the incinerator with the general combustible wastes. Until 1959, the ashes and noncombustible material were placed around the incinerator and to the south near the concrete wash pad area. After 1959, they were placed in trenches to the south and southwest of the incinerator. An unknown quantity of depleted uranium contaminated material was burned in the incinerator, but it was estimated to contain at least 100 grams of depleted uranium. Residual ash has been sampled and found to be radioactive.

000 Area

Radioactively contaminated aluminum scrap was disposed in the solar ponds. Also, for a period of time, waste radiography solutions were drummed for disposal in the solar ponds; and lithium scrap was sprayed

with water for destruction of the lithium metal between the solar ponds.

Only indirect information exists for the area referred to as Radioactive Site 700 Area Site #2. During 1974, monitoring activities of pavement on Eighth Street identified several radioactively contaminated spots. The area designated as the West Spray Field is approximately 105 undeveloped acres. The unit operated from April 1982 to October 1985. Liquids contained in Solar Evaporation Ponds 207B North and 207B Center were applied to the West Spray Field. The liquids were comprised of treated sanitary wastewater and collected groundwater. Water sprayed over the area was characterized by high nitrate concentrations, trace levels of volatile organic compounds, and elevated gross alpha and gross beta activity.

100 Area

No contamination related to soils or buried waste are included

300 Area

Approximately 250 cubic yards of contaminated soil (3 - 704 dpm/g) were removed from behind Building 334.

400 Area

At the South Loading Dock, Building 444 constituents which may have contaminated the soils around the south dock include enriched and depleted uranium, beryllium and chlorinated hydrocarbon solvents. High winds in 1953 resulted in direct uranium activity readings as high as 7,500 dpm/100 cm² and smear readings with a maximum of 350 dpm. In 1954, air count results during extinguishing operations were as high as 33,000% of the maximum permissible limit (MPL) average on the dock. Direct counts in the dock area were as high as 1,372 dpm. Analytical results of soil samples taken at two to four inches below ground surface indicated 350 to 1,000 micrograms of beryllium per gram of soil due to dumping of chlorinated hydrocarbon solvents. Normal concentrations are 0.01 to 2 micrograms per gram of soil.

There are two interconnected underground storage tanks south of Building 441, each with a capacity of 3,000 gallons. Because the tanks are known to have stored process waste from Buildings 441 and 123, radionuclides and nitrates would be present.

Unit 400-136.1 consists of two cooling tower ponds. Small amount of uranium may have been buried at this site.

Radioactive Site North contains Building 442 which was used as a laundry facility to clean contaminated clothing from 1953 until approximately 1972 when it was converted to a filter test laboratory. As early as September 1953, contamination associated with the handling and steaming of contaminated rags was observed in the soil around the

building. A special survey conducted October 14, 1953 in the ditches north and west of Building 442 found maximum contamination of the soil to be 5×10^5 d/m/kg. Both radioactive and chemical materials including depleted uranium, enriched uranium, and beryllium may have contributed to the contamination around the building.

At Radioactive Site South prior to 1973, the soils surrounding Building 44, Building 447, Building 440, and Building 439 were known to contain low levels of uranium and chemical contamination. The principal materials which have contributed to contamination are depleted and enriched uranium, beryllium, chlorinated hydrocarbon solvents, hydraulic oil, and carbon tetrachloride.

500 Area

At the Scrap Metal Site - 500 Area in approximately 1958, scrap metal components, mostly from the original plant construction program, were buried in trenches west of Building 559. Some of the scrap metal material recovered from the process areas and buried in the trenches could possibly have been radioactively contaminated.

600 Area

This area contains no contaminated soils or buried waste.

700 Area

In Radioactive Site - 700 Area Site #1 as a result of an explosion in Building 776 in June 1964, an area of approximately 1,500 square feet of soil at the exit of the gas bottle dock was contaminated with plutonium; some areas had activities greater than 200,000 dpm/67 cm². A later account states that 40 square feet of soil north of Building 776 was contaminated with plutonium due to the June 1964 explosion incident. An area 20 by 100 feet on the west end of the north side of Building 776 was radioactively contaminated during the course of firefighting activity in May 1969. Tracking by personnel around Door 17 of the dock area resulted from use of the door as a major access to the building at the time of the May 1969 fire.

The Concrete Process Waste Tanks leaked and overflows aqueous solution with plutonium, uranium, acids, and caustics. About 200 cubic yards of soil removed from around the tanks contained contamination levels up to 2,500 dpm/g gross alpha activity. Another 60 cubic yards of soil removed averaged about 250 dpm/g.

Several spills and/or leaks affecting soils have occurred at the Radioactive Site North of Building 771. In October 1964 a barrel leak resulted in contamination of the ground near the carpenter shack and Building 770. The east dock of Building 774 was also contaminated. A June 11, 1968 drum leak incident resulted in the contamination of 500 square feet of ground surface north of Building 771 west dock with levels up to 50,000 cpm. Four barrels of soil were removed. In

August 1972, a punctured scrap box stored inside Building 770 contaminated 3,600 square feet inside the building and 500 square feet outside. Levels of radioactivity ranged up to 200,000 dpm/cm². Removal of asphalt and soil for off-site disposal began immediately following the incident.

800 Area

The CEARP Phase 1 report indicates that an area east of Building 881 was used for disposal of unknown liquids and drums. This report does not resolve the exact location of the pit or its dimensions.

Building 886 is a facility for Nuclear Safety Research and Development and is part of Radioactive Site 800 Area Site No. 2 Building 886 Spills. The soil under and around the building is contaminated from uranium spills.

In 1958, at the Radioactive Site South of Building 883 soil samples were taken at the northwest corner of Building 881 and 20 feet west of the building. Analysis indicated total activity of 4.5×10^4 d/m/kg and 1.5×10^5 d/m/kg, respectively with some plutonium. During the excavation in 1978, the soil samples were found to contain uranium-235.

900 Area

Trench T-1 is the site of approximately 25,000 kilograms of depleted uranium chips are contained in 125 buried drums. In 1958, authorization was granted for the additional disposal of over 15,000 pounds of depleted uranium chips from Building 444. In 1962, authorization was given for the disposal of approximately 7,500 pounds of depleted uranium chips. It is unclear whether this entire amount was buried in the trench or in the nearby mound. A radiometric survey was performed in the area in October 1977 and identified four small hot spots ranging from 500 to 18,000 cpm of activity. The spots were marked and mapped. A radiometric survey was performed in June 1980 identifying numerous hot spots suspected to be depleted uranium.

Trench T-2 contains sewage sludge contaminated with uranium and plutonium. The radioactivity in the sludge ranged between 8.4×10^5 dpm/kg in August 1964 to 7.9×10^6 dpm/kg in June 1960, and contained a total alpha radioactivity on the order of 100 to 150 millicuries. The trench is approximately 10 feet deep and covered with approximately 2 feet of soil.

At the 903 Pad approximately 150 grams of plutonium leaked into the soil. Some was covered by the asphalt pad and some contaminated soil outside the boundary of the plant. In 1971 it was determined that the pad area presented no immediate public health hazard and that the plutonium contaminated soil under and around the pad would be removed eventually.

In the Mound Area, contamination was the result of organic liquid waste. Radioactive elements of the waste were in the forms of depleted uranium and enriched uranium, with some limited plutonium. As a result of a punctured drum in 1959, an unknown amount of soil in the mound area was contaminated to a level greater than 100,000 cpm. In 1970, the mound was excavated. Soil from the excavation was graded and excess was placed in the present landfill.

The Contaminated Soil Disposal Area East of Building 881 contains about 250 cubic yards of plutonium-contaminated soil and asphalt from a 1969 fire. Further, in 1972, approximately 60 cubic yards of plutonium-infiltrated soil was placed in the same area and covered with 3 feet of soil.

The Sludge Dispersal Unit contains a series of gravel and sand-lined drying beds. Although the configuration of these beds has changed several times since 1952, they have been in regular operation. Several incidents have occurred where sludge overflowed from the drying beds. The western boundary of this PAC is proposed to be extended to include the area of the sludge drying beds because the beds are not lined with an impermeable layer and excess liquid from the sludge comes in direct contact with the underlying soil. The impact the sludge drying beds have had on the environment is the subject of a study prompted by the March 1991 NPDES FFCA. As a result, groundwater and vadose zone monitoring plans were developed and groundwater and soil water in the sludge drying bed area will be monitored.

Contamination from the 903 drum storage areas has spread to adjacent soil.

This adjacent area around the pad is referred to as the 903 Lip Area. Approximately 16 grams of plutonium-239 was distributed by wind and surface water runoff in an area exceeding 2,000 acres. In 1969, prior to the installation of the asphalt pad on the 903 storage area, it was estimated that 1.2 million square feet of soil onsite was contaminated above 500 dpm/g.

Under Building Contamination

Soil beneath the buildings may be contaminated. The Historical Release Report gives a list of some events that may have led to under building contamination.

6. The definitive characterization done to date for these soils includes gamma spectroscopy over flights, soil sampling, borehole sampling, and other characterizations as outlined in the environmental monitoring reports.
7. With the low contamination (< 10 pCi/gm Pu) over a large area remote excavation would not be necessary.
8. Because the concentrations are low, low levels of precision would be

adequate for the clean-up.

9. The soil in question is a sandy, silty, cobbly soil with a clay matrix. It's in situ hydraulic conductivity is 10^{-5} to 10^{-6} cm/sec.
10. There are numerous trenches which were used primarily for the disposal of sanitary wastewater treatment plant sludge. The sanitary sludge disposal trenches are reported to be approximately 10 feet deep and are provided with two feet of soil cover. The total amount of sludge disposed in Trenches T-2 through T-11 is estimated at 125,000 kilograms.

The Original Landfill, with a volume of approximately 2 million cubic feet, received general plant wastes and unknown nonradioactive hazardous chemical wastes. Approximately 60 kilograms of depleted uranium were inadvertently buried in the landfill around May, 1965. In addition to depleted uranium, the landfill received waste materials with unknown concentrations of polychlorinated biphenyl (PCBs) in the 1960s.

11. No caps or liners are part of the original landfill or the trenches.
12. The contaminants include depleted uranium and PCBs.
13. Trash and sludge may also be buried with the hazardous constituents.
14. No standard containers were used for burial.
15. The waste was dumped as opposed to stacked.

APPENDIX H

LOS ALAMOS NATIONAL LABORATORY

The Los Alamos National Laboratory is located in Los Alamos, New Mexico. Its primary mission is nuclear weapons research and development. Programs include weapons development, nuclear fission and fusion research, nuclear safeguards and security, and verification and control technologies.

All of the information concerning Los Alamos National Laboratory (LANL) below is taken from:

RTDP Los Alamos Site Visit, Department of Energy, Office of Technical Development, Robotics Applications Assessment Team, August 13-14, 1992.

Technology Needs Assessment Final Report, DOE/ID/12584-92 Vol. 1 and Vol. 2, August, 1991.

By the request of LANL a site visit could not be made, but the above documents were provided to complete the OTD questionnaire.

Answers:

1. a. Los Alamos National Laboratory has been primarily a research and development laboratory during the lifetime of the weapons complex. No large scale production was ever done at LANL, therefore the problems here are on a smaller scale in comparison to other sites. However, LANL does have ER/WM problems in nearly every category including buried waste (trenches and shafts), storage tanks, facility retirement, etc. Potential robotics applications include the excavation and handling of hazardous materials, organic, metal, high explosives, and all type of radioactive materials (both separate and mixed). Specific needs are undetermined at this time, as LANL is in the process of discovering its ER/WM situation.

There are separate Environmental Remediation documents as well as Waste Management documents which describe the problem. The SWMU Report describes the 2250 Solid Waste Management Units. The Roadmap and Crosswalk Needs Assessment also provide documentation of ER/WM needs at Los Alamos.

-
- b. MSA-C is composed of six radioactive pits, one chemical pit, and 107 shafts. Radioactive waste includes building debris, routine contaminated trash, sludge from waste treatment plants and depleted uranium chips. Plutonium contaminated sodium loops were buried in the shafts. The chemical pit contains a variety of chemicals, pyrophoric metals, hydrides and powders, sealed vessels containing sodium potassium alloys or compressed gases, and equipment not suitable for salvage. No high explosives were disposed of in the pit. Natural uranium

contaminate objects were placed in the pit. Approximately 200 gas cylinders were which full or partially full were placed in the pit and covered with ten feet of compact fill. Records indicate that some full carbonyl cylinders may have been put into the chemical pit. Carboys of di- or triethylbenzene were deposited on the ground near the solar panels that previously existed. Parts of the Clementine Reactor are also buried at this site.

SWMU Report #50-009

E.R. Release site info. Tsk 5: 32-42

1986 DOE Environmental Survey (Environmental Problem 22)

c. TA-16, Building 260. Old high explosive manufacturing facility. Outfall from piped HE sludge has contaminated approximately 2 acres of soil. Inside the facility, HE has diffused into the walls and ceilings. Stalagmites of HE have been Reported growing down from the ceilings. Contaminated soil is reportedly as high as 30% HE, and will explode on drop test.

3. The reports were authored by the following personnel:
Hugh Murphy, LANL TPM
Roger Ferenburhg, LANL M-8 - LANL Point of Contact
Robert M. Hollen (CAA)
Gary Eller, INC-9
4. Roger Ferenbaugh, (505) 667-5021 listed above
5. At Los Alamos, 2250 Solid Waste Management Units (SWMUs) have been identified, which are scattered over 45 square miles. These 2250 SWMUs have been divided into 85 Operable Units to facilitate management. In addition, there are old buildings and facilities that will be retired that were used in the weapons program.

b. Approximately 3,365,000 cubic feet of wastes are buried in 11.8 acres.
6. High explosives are the contaminant of concern, although low levels of radioactive contamination also occur, mostly uranium.

Concentrations extremely non-homogeneous; dispersion is more intense closest to soil, and dispersion tends to occur in chunks of varying sizes.
7. No information pertaining to excavating or retrieving contaminated soil or buried waste is contained in the report.
8. The level of precision necessary during excavation is not discussed in the report. However, it is quite clear that extreme caution and precision would be necessary in dealing with the high explosive wastes.
9. The soil in the Los Alamos area is volcanic in origin and may range from very soft, water absorbent, to very hard volcanic rock. The surrounding

terrain is also widely variable. Canyons, mesas, dry flats, swampy areas, and mountains are all present. The soil is mostly sands, salts, clay, and gravel.

10. Yes. See answer 1 b.
11. No information is given in the report about caps and liners.
12. Pu Uranium MFP MAP H-3
Organic solvents, heavy metals CF&D Hazardous Wastes Rad - LL/LLM/TRU
Waste is not homogeneous except for soils, sludge or containerized liquids. Variable, concentration of contaminants - careful excavation important, based on non-evasive mapping.
13. Not included in the report
14. Some wastes were buried in drums.
15. No information is given concerning whether the waste was dumped or stacked.

APPENDIX I

Sandia National Laboratory

The Sandia National Laboratory (SNL) is located in Albuquerque, New Mexico. Its primary mission is nuclear weapons development and engineering.

Answers:

- 1-4. The SNL has not completed a detailed site characterization document. Characterization is currently being completed in the RFI. SNL has sighted two main areas of contamination, Chemical Waste Landfill and Mixed Waste Landfill. Information on the site contamination areas has been obtained and is available. Environmental Restoration is responsible for the soil and buried waste clean up.
- 5-6. The explosives/weapons test site is contaminated with metals and may have some radioactive mixed waste. This material is scattered over a very large area and believed to be low level waste. The area has not been characterized but it is considered low priority because the contamination is in solid form and poses little chance of migration.
- 7-8. At this time, very little information on the soil contamination is known therefore the type or the precision of any excavation is unknown.
9. The soil at SNL is predominately sand and gravel, intermixed with silt, clay and cobble layers. The ground water is approximately 500 feet below the surface.
- 10-13. The Chemical Waste Landfill was used from 1962 to 1985 to dispose of segregated waste forms in unlined disposal cells. The cells are 10 feet by 40 feet by 8 feet deep and are capped with native soils to ground level. The Chemical Waste Landfill area is a fenced area two acres in size. The landfill contains acids, reactive, organic, and metals. Sampling has revealed chromium to a depth of 75 feet below one of the disposal cells, and TCE has been detected in the ground water monitoring wells of 20 ppb

The Mixed Waste Landfill was used from 1959 to 1988 to dispose of classified and unclassified low level and mixed radioactive waste. The disposal cells are unlined pits 10 feet by 10 feet by 25 feet and trenches 40 feet wide by 30 feet deep by 100 feet long. The trenches have been mounded with soil and the pits have pipe indicators to identify them. The Mixed Waste Landfill area is only 2 acres in size.
- 14-15. The waste was buried in a range of containers from glass jars to 55 gallon drums. The waste was dumped into the landfills.

APPENDIX J

Idaho National Engineering Laboratory

The Idaho National Engineering Laboratory (INEL) is located in southeastern Idaho. It encompasses 890 square miles of semi-arid unpopulated land near the Lemhi and Lost River mountain ranges. The activities at INEL primarily involve nuclear development and safety; however, research and development activities are also conducted in environmental sciences, chemical and biological technologies, geosciences, materials sciences, nuclear waste management, energy conservation, and alternative energy resources.

INEL is on the National Priorities List (NPL). With the large size of the INEL site and the number of facilities in operation, the site is divided into geographically distinct Waste Area Groups (WAGs).

The following information is based on the OTD questionnaire used to conduct the interview.

Answers:

1-4. On the Idaho Falls site a site assessment has only been completed on a portion of the area. The site clean up is under the Environmental Restoration department, which has been divided into distinct Waste Area Groups (WAGs). These WAGs have then been broken up into Operable Units to manage the clean up of each area (see figure 6).

5. WAG 1 has a leach field where paint wastes, including solvents and heavy metals, were disposed; burn pits contaminated with metals and organic, diesel and gasoline spills, and sumps, ponds, pits, and tanks where acids and caustics were stored and disposed. It also consists of 11 radioactively contaminated sites. Five sites are tanks or piping systems to be closed within the next three years. Two sites contain buried radioactive rubble and metal.

WAG 2 contains the Paint Shop Ditch which is an open ditch where paint shop wastes such as paints, thinners, and spent solvents may have been discarded. In the WAG 2 area a number of small spills have taken place. The spills consist of PCB, diesel fuel and other petroleum products, and sulfuric acid. At the Material Test Reactor a canal in the basement was used to store spent fuel elements.

WAG 3 consists of the Idaho Chemical Processing Plant. The area has been contaminated with hexane, kerosine spills, paint and paint solvent

FIGURE #6

LE #7

discharges, mercury contamination, fly ash pits, and abandoned gasoline tank. The contaminant in the various areas are Cr, Hg, Cd, Se, Sr90, Cs137, U234, Pu239, Pu241 and Co60

WAG 4 contains three drum docks for storage prior to disposal. It is suspected that some chemicals may have leaked on the ground. A pond in the area may contain mercury and two other area may contain lead contamination from the lead shop. French drains were installed adjacent to labs and received lab effluent that may have contained acids, solvents, and radionuclides. The sewage system received effluent containing some low level radioactivity from laundry operations.

WAG 5 includes the Special Power Excursion Reactor Test I (SPERT-I) leach pond, which received radioactive contaminated waste water from the reactor; the SPERT-III large leach pond, which received low level radioactively contaminated water from the reactor. The ARA-I chemical evaporation pond is contaminated with organic and acids.

WAG 6 includes the BORAX-I burial site, a trash dump, fuel oil tanks, septic tanks, and a leach pond.

WAG 10 includes regional Snake River Plain Aquifer that cannot otherwise be addressed on a WAG specific basis. WAG 10 has other surface disposal sites and ponds that are not included in specific areas. The boundaries of WAG 10 are the INEL boundaries or beyond if necessary. Some specific areas of WAG 10 include the Organic Moderated Reactor Experiment Leach Pond, Liquid Corrosive Disposal Area (LCCDA), and the LCCDA Limestone Treatment and Disposal Pit.

- 7-8. The excavation of the contaminated soil would be completed by a bulldozer or bobcat but the removal of the soil cap in the Radioactive Waste Management Complex may need to be remotely operated because of the high radiation levels. The level of precision has not been determined due to the fact that the level of contamination for back fill has not yet been determined.
- 9. The soil at INEL consist mainly of silts, clays, sands, and some gravel.
- 10-13 WAG 5 includes the ARA-II Stationary Low Power Reactor I burial ground, a 35 acre area where the Stationary Low Power Reactor I demolished reactor building was buried. The site contains an estimated 80,000 cubic yards of contaminated soil. Also from the PBF reactor area warm waste injection well that was used for low level radioactive cooling water disposal.

WAG 7 is the Radioactive Waste Management Complex (RWMC), a controlled area for disposal of solid radioactive wastes generated by DOE operations at the INEL and other DOE sites (see figure 7). The RWMC is broken up into two areas, the Subsurface Disposal Area (SDA) and the Transuranic Storage Area (TSA). One area of the SDA contains soil vaults, which are cylindrical holes drilled into the ground for disposal of waste with radiation levels in excess of 500 mR/hr at three feet from

the container surface. Transuranic wastes are buried in trenches T1 - T10, Pits P1 - P6 and P9 - P12. The total volume of contaminated wastes and soils are estimated at 12,059,707 cubic feet. Also in the pits are nonradioactive hazardous materials. Pad A is an asphalt pad at SDA built because near surface basalt was unsuitable for subsurface disposal. Plywood boxes and metal drums containing mixed waste were stacked on the pad, covered with plywood/polyethylene, and covered with soil. The TSA is a 56 acre area consisting of four aboveground storage pads and soil vaults.

WAG 10 has a non-decontaminated reactor involved in an accident is buried, covered by lead shielding and soil. Some surficial soil is radiologically contaminated.

14. The waste is buried in any type of container, from metal drums to cardboard boxes.
15. The waste was dumped in some areas and stacked in other areas.

APPENDIX K

Hanford Site

The Hanford site is located near Richland, Washington. The 560 square mile site is surrounded primarily by agricultural property.

Operation at the Hanford site began as part of the World War II Manhattan Project. Nuclear facilities constructed at the Hanford site include plutonium reactors, research reactors, chemical separation and processing plants, laboratories, and support facilities. In later years, site programs became more diversified and waste management supported research and development for advanced reactors, renewable energy technologies, and contamination cleanup. Site activities are now directed at maintaining a waste management capability for current and future missions and implementing treatment and final disposal of generated wastes.

The Hanford site is divided into five main areas: 100, 200, 300, 400, and 1100 (see figure 8). The EPA has included all but the 400 Area on the National Priorities List.

The Hanford site will have other waste problems to consider besides soil and buried waste. Waste will come from D&D of 8 nuclear reactors and 20 ancillary structures. The radiation levels inside the block are 200 R/hr and less than 1 mR/hr outside. In the 200 Area the D&D of chemical process facilities are highly radioactive (U Plant, Z plant, B plant, T plant, PUREX, and REDOX facilities) as well as the underground and above ground piping that contains radioactive sludge, surface water, and low level contaminated metal.

The following information is based on the OTD questionnaire. At the request of the Hanford site, a site visit was not conducted, but reference material supplied by the site used.

Answers:

- 1-4. The site has not had extensive characterization of the soil. They are in the transition from materials production to environmental restoration. Environmental Restoration is responsible for clean up of the CERCLA and RCRA areas, Waste Management is responsible for the single shell tanks.
- 5-6. 100 Area surface soil is contaminated with low level waste, Cs137, Hg, and PCBs, covering a 120 acre area. The depth of contamination is estimated at the maximum depth 10 ft. with most within 1 ft. The concentration of radioactivity is 450 - 2500 counts per minute over 80% of the area with the remaining 20% of the area at several mR. The area contains a number of large ground water plumes in five operational areas

FIGURE #8

that are contaminated with tritium, nitrates, chromium, and strontium-90. The 100 Area also has a large volume of contaminated soil that includes mixed waste from near surface liquid disposal wastes and reactor coolant discharge have contaminated the vadose zone at 10 to 50 feet below the surface with Cr, Cs137, Sr90, Cobalt, and nitrates. Most of the contamination is thought to be retained in 22 cribs, 12 drains, 7 retention basins, and 23 other spills or leaks. Nine underground storage tanks are still in place with one leaking petroleum based hydrocarbons.

200 Area has high level waste, low level waste, hazardous, and mixed waste composed of sludge, sediments, and fluids from 149 single shell tanks (SST), 66 of which may leak. Significant amounts of plutonium are present and a potential hydrogen build up in the tanks presents an explosion potential. The volume in the tanks is estimated at 37,000,000 gallons. Also in the 200 Area are 87 cribs, 29 french drains, 63 trenches, 9 injection wells, 499 disposal units, and 205 other spills consisting of 1,000,000 tons of contaminated soil. This soil is contaminated with metals, inorganic, organic, and radionuclides. There are 18 underground storage tanks of petroleum products, with at least three tanks suspected to be leaking. There is the potential for mixed LLW and chemical waste from the area sanitary and laboratory sewers.

300 Area ponds, trenches, cribs, and vadose zone are contaminated with uranium and other radionuclides. It is unknown what the volume of soil is contaminated in these areas, but it is thought that wind blown contamination has spread over 30 surface acres. The area has the potential for mixed wastes from laboratory and sanitary sewers.

1100 Area piping sludge, sediments, surface water, metal, and masonry from D&D will be a source of waste. The vadose zone is contaminated with acids, paints, solvents, and antifreeze.

600 Area soil is contaminated with Sr90, Cs137, pesticides, sodium chromate, and acids in cribs, pits, trenches, and landfills. The volume is unknown at this time.

- 7-8. How to excavate this soil is yet undetermined, but the use of a bulldozer or bobcat would be necessary with the possibility that remote operation is required.
9. The soil on the Hanford site consists of approximately 50% gravel, 40% sand, and <10% silt and clay.
- 10-13. The 100 Area ground water is contaminated with H3, Cr, Sr90, Tc99, U, Hg, nitrates, PCB, and TCE. The water table is 30 to 50 feet below the surface and the area of contaminated plumes 1.5 sq. km Areas 100B and 100C, 4.5 sq. km at 100K, 10 sq. km at 100N and 100D, 1.5 sq. km at 100H, 2 sq. km at 100F. The buried material is unsegregated waste at 40% combustible and 60% noncombustible. There are numerous burial grounds throughout the 100 Area. These burial grounds cover 78 acres but the depth is unknown.

200 Area burial grounds consists of 155 acres of unsegregated waste and 131 acres of LLW.

300 Area burial grounds consists of 65 acres of unsegregated waste with the potential of having radionuclides, mixed wastes, organic, and heavy metals.

1100 Area ground water is contaminated with nitrates, TCE, and unspecified radionuclides. The TCE plume covers .7 sq. km with concentrations of 110 ppb. The burial ground in the area consists of construction waste and office debris. The waste is unsegregated but non-radioactive.

- 14-15. It is unknown at this time what type of containers were used to bury the waste if any or if the waste was dumped or stacked.

APPENDIX L

FERNALD SITE

The Fernald Site is a CERCLA Superfund Site. The Site mission is now on clean up.

When the Fernald Site was in production a wide variety of chemical and metallurgical process steps for the conversion of uranium ore concentrates and recycle materials to either uranium oxides for shipment to the gaseous diffusion plants or machined uranium ingots and billets for extrusion into tubular form for fabricating fuel cores and target fuel elements.

The principal product from the Fernald Site operations is uranium metal in various forms having several standard isotopic assays and purity controlled at a high level. Although some derby metal was shipped directly to DOE facilities at Oak Ridge and Rocky Flats, most of the production stream metal is cast into ingots, which are center drilled and surface machined for extrusion into tubes on the DOE extrusion facilities located at the RMI Company, Ashtabula, Ohio. Some extrusions are returned to the Fernald Site, where tube blanks undergo heat treating and fabrication into target element cores for DOE reactors at the Savannah River Plant. Other extruded material is further processed into fuel billets, via an upset forge operation at RMI for shipment to the Hanford Site. Both fuel cores and target elements are used in government reactors for the generation of electricity and the production of plutonium.

Fernald was not only used for the production of uranium and cast uranium product, it was also use for the storage of thorium for the country. Fernald also would receive waste from other sites including the material from the Manhattan project, that is stored in one of the silos.

The Fernald site has been broken up into five operable units, each with its own boundaries and problems. The operable units are responsible for the remediation in their area.

Answers:

- 1-3. The Fernald site being split up into five operable units have each completed or are in the process of completing a Restoration Identification/Feasibility Study (RI/FS). Copies of the RI/FS are available for review. The RI/FS reports were prepared by independent engineering firm.
4. J. P. Hopper, Environmental Restoration Manager is responsible for the clean up at the Fernald site.

5. The site has been broken up into 5 operating units to perform the site clean up.

Operable Unit 1 covers the waste pits 1-6, the Clearwell, the Burn Pit, berms, liners, and associated contaminated soil within the operable unit boundary.

Waste Pit 1 was constructed in 1952 and in 1959 was back filled and covered with clean soil. The waste pit is 17 feet deep with a surface area of 82,693 sq. feet, with an estimated 33,676 cubic yards of buried waste. It contains neutralized waste filter cake, flyash, 55-gallon drums, scrap graphite, brick scrap, sump liquor, sump cake, and depleted slag. Within these materials is an estimated 115,352 pounds of uranium. The pit is lined with clay.

Waste Pit 2, constructed in 1957, was excavated to a depth of 17 feet and lined with compacted clay. The pit was taken out of service in 1964 and backfilled with clean soil. Waste Pit 2 has a 44,896 sq. foot surface area with an estimated 18,478 cubic yards of buried waste. It contains neutralized waste filter cake, graphite, flyash, 55-gallon drums, brick scrap, sump liquor, sump cake, and depleted slag. An estimated 2.66 million pounds of uranium and 890 pounds of thorium are contained within these materials. A large quantity of construction rubble is buried in the pit.

Waste Pit 3, was constructed in 1959, with a depth of 27 feet and added a clay layer along the pit walls. Waste Pit 3 has a 241,373 sq. foot area with an estimated 237,053 cubic yards of buried waste. It contains lime neutralized raffinate, raffinate concentrate, slag, slag leach residues, filter cake, flyash, lime sludge, and 55-gallon drums. Within this material are an estimated 288,041 pounds of uranium and 881 pounds of thorium.

Waste Pit 4 contains an estimated 53,706 cubic yards of buried waste. The pit contains process residues, filter cake, slurries, raffinates, scrap graphite, noncombustible trash, asbestos, and an estimated 23,500 pounds of barium choride. Within the material is an estimated 6.7 million pounds of uranium, 136,000 pounds of thorium metal in 55-gallon drums.

Waste Pit 5, was constructed in 1968, and lined with a 60 mil thick Royal Seal ethylene propylene diene monomer elastomeric membrane. The pit has an estimated 98,841 cubic yards of waste. The pit contains solids from neutralized raffinate, slag leach slurry, sump slurry, and lime sludge. Within these materials are an estimated 111,737 pounds of uranium and 37,445 pounds of thorium. The pit is partially covered with an estimated 750,000 gallons of water ranging in depth from three feet near the west end.

Waste Pit 6, with a 24 foot depth, was constructed in 1979 in a manner similar to Waste Pit 5 and is lined with an EPDM elastomeric membrane. The pit is estimated at 11,556 cubic yards of waste. It contains green

salt, filter cake, slag, process residues, and asbestos. These materials contain an estimated 1.9 million pounds of uranium. The pit is currently cover with water.

The Burn Pit was constructed in 1957 at the site previously used to excavate the clay liner material for Waste Pits 1 and 2. The boundaries of the Burn Pit are no longer discernible from the boundaries of covered Waste Pit 4. The maximum depth of the pit is believed to be about 20 feet and contains approximately 9074 cubic yards of waste. The pit was used to dispose of and burn laboratory chemicals, including pyrophoric and reactive chemicals, as well as waste oils and other low level contaminated combustible materials. The Burn Pit is overgrown with grass and is fairly level.

The Clearwell was constructed at the time Waste Pit 1 was excavated, and receives surface water runoff from Pits 1,2, and 3 as well as excess storm water from Pit 5. Before March 1987, the Clearwell was used as a final settling basin for process water that passed through Waste Pit 3 and 5 before discharge to the Great Miami River. The depth of sediment remaining in the Clearwell is presently estimated at 11 feet.

Operable Unit 2 covers the fly ash piles, other Southfield areas,, the lime sludge ponds, the solid waste landfill, berms, liners, and associated contaminated soil within the operable unit boundary.

The solid waste landfill covers approximately one acre, is organized into the original disposal area, five individual cells, and an evaporation pond. The solid waste landfill was used for the disposal of cafeteria waste, rubbish, and other types of waste from nonprocess areas. Materials reportedly accepted include nonburnable and nonradioactive solid wastes, nonradioactive construction rubble, and double bagged and bulk qualities of nonradioactive asbestos. Activity at the solid waste landfill occurred as early as 1954 and was halted early in 1986. Uranium is the primary radionuclide detected in the surface media from the solid waste landfill. Total uranium was detected at levels as high as 990 mg/kg within the area. Surface samples taken north and northwest of the waste area exhibited uranium concentrations of 2932 mg/kg and 1180 mg/kg suggesting that the surface soil contamination is widespread and extends beyond the boundaries of Operable Unit 2. The subsurface soil was found to be contaminated with uranium, but not to the levels found in the surface soil. Borings were made of the area to a depth of 15 feet where uranium concentrations were found up to 37 mg/kg, these concentrations were eight times higher than that or the soil immediately above it, indicating the heterogeneous distribution of uranium near the soil fill interface.

The North and South Lime Sludge Pond are unlined ponds of approximately 125 by 225 by 11.5 feet that received spent lime sludges from the water treatment operations, sludges from the neutralization of boiler plant blowdown, and coal pile storm water runoff. The North Lime Sludge Pond is 90% filled and is partially covered with water up to 7 feet in depth. The pond has lime sludge residue estimated at 5,500 cubic yards. The

South Lime Sludge Pond is dry and overgrown with grass and shrubs. This ponds volume of lime sludge residue is estimated at 11,700 cubic yards. The radionuclides in the ponds are from uranium and thorium. The total uranium range from 14 mg/kg to 492 mg/kg, with the total amount of thorium ranging from <0.9 mg/kg to 164 mg/kg. Both ponds were tested for organic compounds, metals and inorganic compounds, and the Hazardous waste toxicity characteristic thresholds (40CFR261.24) were not exceeded.

The Active Flyash Pile and Inactive Flyash Pile are located just east of the South Field. Flyash from the coal fired boiler plant is loaded into dump trucks and transported to the flyash site. Both the active and inactive flyash pile are contaminated with low levels of uranium.

The South Field was reportedly used as a burial site for construction and demolition rubble and soils that may contained low levels of radioactivity. The slope has long been used as the backdrop for a firing range.

Operable Unit 3 covers the production area and production associated facilities and equipment (includes all above and below grade improvements) including, but not limited to, all structures, equipment, utilities, drums, tanks, solid waste, waste, product, thorium, effluent lines, K-65 transfer lines, wastewater treatment facilities, fire training facilities, scrape metal piles, feedstocks, the coal pile, parking lots, and roads.

OU3 has not completed its RI/FS activity, but an OU3 Work Plan Addendum is available. This work plan contains information of contaminated areas based on process knowledge.

Plant 1 the sampling plant principal capabilities were shipping, receiving, sampling, and storing large amounts of depleted, normal, and enriched uranium materials in open and covered areas. Dry crush, mill, grind, and classify feed materials for processing. Digestion of enriched feeds assaying up to 10% U^{235} , open unirradiated fuel pins containing enriched uranium dioxide pellets. Recondition steel drums for reuse and bale deteriorated drums for salvage. The Plant 1 area is potentially contaminated with uranium, uranium oxides, uranium tetrafluoride, thorium, thorium oxalate, ore concentrates, HF, lead, chromium, cadmium, arsenic, cesium-137, radium-226, americium-241, ammonia, 1,1,1-trichloroethane, carbon tetrachloride, and sump cakes.

Plant 2 & 3 is the refinery principal capabilities were to digest ore concentrates and recycles materials in nitric acid ,perform liquid-liquid countercurrent solvent in extraction, and perforated-plate pulse columns for purification. Concentrate the purified uranium solution in stainless steel thermo-syphon and tank evaporators. Calcine the concentrated uranium liquor to UO_2 in denigration pots. Convert purified uranium solution, assaying up to 10% U^{235} , to black oxide by an integrated evaporator-calcine unit. The potential contaminants in the refinery are uranium metal, uranyl nitrate, ore concentrations, high and

low grade residues, uranium oxides, kerosene, ammonia, and solvents.

Plant 4 or the green salt plant converts UO_2 to uranium tetrafluoride, UF_4 , in continuous flow reactor banks designed and staged for gas-solids reactions. Blending and packaging depleted green salt for the metals production plant. Operate the tank farm to supply the sites production plants with bulk quantities of required liquid chemical agents. The potential contaminates in the plant are anhydrous ammonia, uranium oxides, uranium tetrafluoride, anhydrous HF, mercury, and solvents.

Plant 5, the metals production plant providing tonnage level production operations for reducing UF_4 to high purity depleted, normal, and enriched uranium derby metal. Remelting derby and recycle metals for casting into ingot shapes in vacuum induction furnaces. Ingot sawing and saw sharpening, machining graphite into any shape. Milling magnesium fluoride slag byproduct for reuse in lining reduction pots. The potential contaminates in the plant are uranium metal, uranium oxides, uranium tetrafluoride, magnesium, zirconium, zirconium oxide, hydraulic oils, lubricating oils, and cooling oils.

Plant 9, the special products plant principal capabilities are machining as-cast ingots and billets for extrusion. Cast derby and high grade recycle metals into large diameter ingots. Chemical decladding of unirradiated fuel elements. Miscellaneous specialized metal reduction, briquetting, pickling, and machining operations to satisfy nonroutine requests. The potential contaminates in the plant are uranium, uranium oxides, thorium, aqueous HF, ammonia, copper, zirconium, nickel, aluminum, lithium, potassium carbonate, magnesium, PCBs, uranyl nitrate, oils, and coolants.

Plant 6, the metals fabrication plant principal capabilities are rolling as-cast ingots into rod having close dimensional tolerances. Finish machining of target element cores. Neutral salt, NuSal, and salt-oil heat treating. Metal pickling and chip briquetting and final inspection for product quality assurance and control. The potential contaminates are uranium metal, uranium oxides, uranyl nitrate, ammonia, cadmium, chromium, lead, benzene, toluene, sodium chloride, hydraulic oil, machining oil, cooling oil, and solvents.

Plant 8, the scrap recovery plants principal capabilities are furnacing various recycle materials from an-site generation and off-site receipt to remove moisture, oils, graphite, and metallic impurities. Wet chemical processing of low-grade recycle materials for upgrading uranium assays for refinery processing. Crushing, milling, and screening recycle materials. Filtering large volumes using rotary vacuum, precoat filters and drum washing operations. The potential contaminates are uranium, uranium oxides, ammonium diuranate cakes, mercury, calcium fluoride, scrape cake, arsenic, wet low grade sump cake, oils and solvents.

The pilot plant principal capabilities are purification and conversion of thorium nitrate solution to various thorium compounds. Caustic

decladding aluminum jackets from unirradiated fuel cores. High temperature gas-solid reduction reaction for converting UF_6 to UF_4 . Miscellaneous operations for shot blasting uranium derby metal and plasma spray coating casting crucibles. The potential contaminants are uranium, uranium oxides, thorium, uranium tetrafluoride, ammonia, kerosene, mercury, copper, nickel, barium, cadmium, HF, barium chloride, barium sulfate, oils, and solvents.

Operable Unit 4 covers silos 1, 2, 3, and 4, berms, the radon treatment system, the decant tank system, and associated contaminated soil within the operable unit boundary.

The K-65 silos (Silos 1 and 2) were used for the storage of radium-bearing residues formed as by-products of uranium ore processing. The silos received residues from 1952 to 1958. Raffinates were pumped into the silos, where the solids would settle. The free liquid was decanted through a series of valves placed at various levels along the height of the silo wall. This process was performed until the material was four feet from the top. The silos are domed and are 80 feet in diameter, 36 feet high to the center of the silo dome, and 27 feet high to the top of the walls. The walls are eight inch concrete, as are the outer part of the dome. The K-65 silos have constructed a berm to a three to one slope in the early 1980's to maintain the integrity of the silos.

The primary radioactive constituents so the silos are radium, radon, uranium, and thorium. The majority of the material is silica and metallic compounds. A temporary radon removal system was installed to reduce radiation exposure to the workers. There is no evidence that any of the contaminants have migrated into the environment from the silos, except that radon has diffused into the berm. It is believed that the berm and subsoils contain elevated levels of Pb-210 and Po-210 as a result from the decay of the radon.

Silo 3 contains uranium, thorium, silica, a very small amount of radium, and other metal oxides. Silo 3 is not a significant radon source because the material is dry and powdery. It is, however, still a source of radioactivity and a potential airborne contaminant hazard due to its dry, powdery consistency.

Silo 4 is empty.

Operable Unit 5 covers perched and regional groundwater, surface water, soils, not associated with other operable unit definitions, sediments, flora, and fauna.

6. The aquifer beneath the site has been contaminated with uranium. The aquifer has moved the uranium contamination off the site to the south. There is a project under way to pump the water from the aquifer then treat it and pump it the Miami River.

7. The excavation of the contaminated areas on the site could be completed with different types of equipment because of the different areas of contamination.
8. The level of precision needed to perform the work would be to control the device to one inch.
9. The soil at the Fernald site is mainly clay with some overburden and loose rock.
10. The waste pits vary in configuration as described in the answer to question 4.
11. The caps for the pits are made of native soil and the pits are lined with clay or an EPDM membrane.
- 12-15. Uranium is the main contaminant in the pits, but there are many other contaminants also. The waste pits contain chemicals, metals, inorganic, and organic in varied concentrations. The waste pits also have some 55 gallon drums buried in them, but the majority of the waste was dumped.

APPENDIX M

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