Xcel Energy℠

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December 21, 2004

U.S. Nuclear Regulatory Commission
ATTN: Chad Glenn
TWFN, Mail Stop T 7F-27
11545 Rockville Pike
Rockville, MD 20852

Pathfinder Generating Plant
Docket No. 030-05004
Byproduct Materials License No. 22-08799-02

Subject: USNRC Request For Additional Information

Reference: Letter from C. Glenn, NRC, U.S. NRC Staff Request for Additional Information Regarding the Decommissioning Plan for Xcel Energy's Pathfinder Facility in Sioux Falls, South Dakota, September 30, 2004

Dear Mr. Glenn:

By the above reference, the NRC staff communicated a set of questions that arose from their technical review of the Pathfinder Decommissioning Plan (the Plan). Xcel Energy is providing an enclosure to this letter to respond to this Request for Additional Information (RAI).

The responses to the RAI have necessitated a revision to the Plan that is included in the enclosure. A revised main body of the Plan is included. In addition, the revised Plan includes new Appendices F and G. Appendix F is the revised Pathfinder Final Status Survey Plan (FSSP). The FSSP was submitted separately by letter dated July 13, 2004. The revised FSSP has been incorporated directly into the Plan as Appendix F. Similarly, the RAI response itself has been incorporated directly into the Plan as an appendix. Appendix G of the Plan includes the Xcel Energy RAI responses.

In addition to revisions that result from the RAI responses, Xcel Energy has included a revised schedule for planning purposes. This schedule reflects our adjusted resource plan for 2005 and 2006. This schedule also shows that, barring any unforeseen circumstances; a request for license termination can reasonably be completed within 24 months of initiation of the decommissioning in accordance with 10CFR30.36(h)(1).

Please call me at 612.337.2183 if you have any questions.

Sincerely,

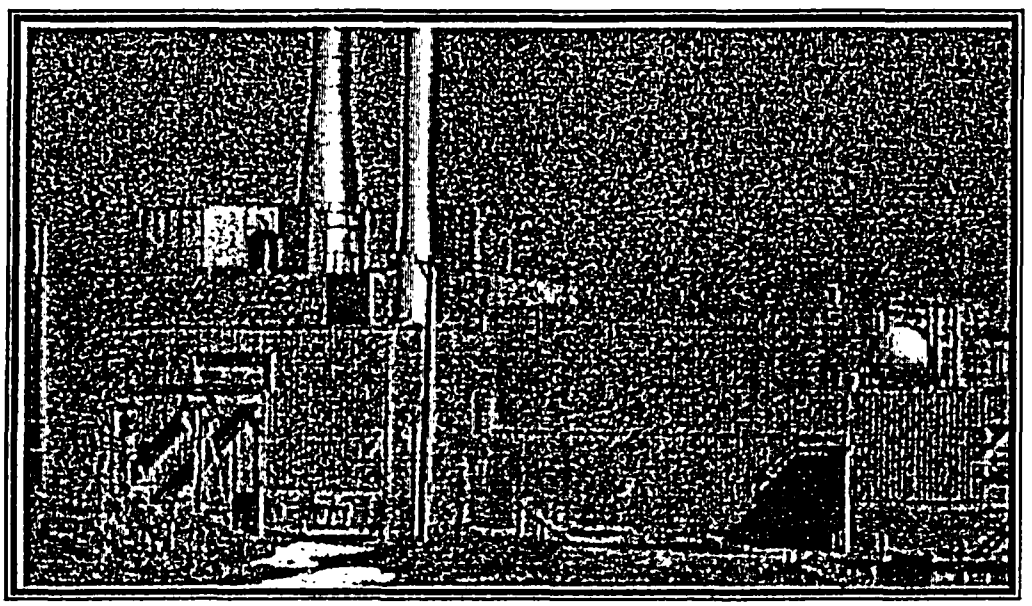
Charles Bomberger

General Manager, Nuclear Asset Management
Xcel Energy

Enclosure:
Pathfinder Decommissioning Plan Replacement Pages

Cc: Xcel Energy
Charles Bomberger
Joel Beres
Chuck Donkers (w/o Encl.)
Duratek Inc.
Doug Schult
NMC
Herb Giorgio
Pathfinder File

PATHFINDER DECOMMISSIONING PLAN



Prepared by

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414 Nicollet Mall
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Appendices F and G
Added December 2004

Enclosure

Pathfinder Decommissioning Plan
Replacement Pages

Pathfinder Decommissioning Plan Changes

Previous Page	Replacement Page(s)
Cover	Cover
Table of Contents Section	Revised Section
Main Document Section	Revised Section
Environmental Information Addendum	
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11	11
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21	21 (blank)
New Appendices	
NA	Appendix F – Revised FSSP
NA	Appendix G – RAI Response

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EXECUTIVE SUMMARY

Xcel Energy is providing this decommissioning plan as part of its license amendment request to incorporate decommissioning activities. The present license does not include the necessary provisions to decommission the site. The decommissioning activities, release criteria, and methods to ensure worker protection are detailed herein. Environmental information is provided in a separate addendum submitted with this document. The plan format is in accordance with the guidance for a Group 3 Decommissioning as described in Section 10.2 of NUREG 1757, *Consolidated NMSS Decommissioning Guidance*, Volume 1, Decommissioning Process for Materials Licensees.

The proposed decommissioning activities are relatively simple and pose very low risk to the public and the environment. The largest portion of the radioactive material at the Pathfinder site was removed by previous remediation activities in 1991. Only a very small fraction of the contamination from reactor operations is present at the site, and the radiological history of the site is well documented. Annual surveys have been conducted since 1969, and the site radiological profile was recently updated in detail by a comprehensive characterization survey. This survey demonstrated that the remaining radiation levels at the site are relatively low. The contamination is fixed and primarily localized to surfaces within the basement of one site building. In addition, the site's soil, groundwater, and surface waters are not contaminated and do not require any remediation.

Xcel Energy is proposing to remediate the contaminated areas to permit unrestricted use of the Pathfinder site. The dose assessment method for the Pathfinder site employs the application of screening criteria using predefined models for Derived Concentration Guideline Levels (DCGLs). This method will be used to demonstrate compliance with the radiological release criteria of 10 CFR Part 20, Subpart E. A site-specific dose analysis is not required.

When decommissioning activities are complete, a Final Status Survey will be conducted to demonstrate compliance with dose criteria for unrestricted release. Xcel Energy will then submit a request to terminate the Pathfinder Byproduct Material license in accordance with regulatory requirements.

1. FACILITY OPERATING HISTORY

Licensing History

Northern States Power, now a wholly owned subsidiary of Xcel Energy, obtained an operating license (DPR-11) for the operation of the Pathfinder Atomic Power plant in 1964. Low power testing was conducted under this license from March 1964 to September 1967. Economic and other factors resulted in a decision to shutdown the nuclear plant and place it in SAFSTOR. The nuclear fuel was transferred offsite, the operating license was terminated, and the current byproduct materials license (22-08799-02), which is still in effect, was issued on August 9, 1972 under the provisions of 10 CFR 30. The license was subsequently amended to allow for a decommissioning of the reactor side of the plant and the fuel storage facilities in 1992. The termination of this byproduct materials license is the ultimate goal of the Pathfinder decommissioning effort.

Operational History

The Pathfinder Atomic plant was designed to generate 66 MW of electrical energy. The reactor vessel had a unique design that employed in-core superheaters. Outside of the vessel, the plant configuration was similar to modern day boiling water reactors. Initial criticality was achieved on March 24, 1964. The plant commenced commercial operations on August 1, 1966 and was permanently shutdown soon after on September 16, 1967. Most of the operation during this period involved phased testing, and sustained full power operation at the design power level was never achieved. All radioactive releases during this period were within regulatory limits. There were no indications of fuel failures during plant operation.

The brief operating period introduced a relatively small amount of radioactive contamination into the Balance of Plant systems (BOP) from translocation. The BOP has not been subject to any additional radioactivity from reactor sources since the nuclear plant was permanently shutdown. The residual radioactivity contained within the BOP is a byproduct of materials activated during operation of the Pathfinder nuclear reactor.

Only one significant radiation event occurred during this brief operational period. A condenser tube leak occurred simultaneous with the final shutdown in 1967. This leak resulted in contamination of a portion of the service water system and the cooling tower basin. The affected equipment was decontaminated. The primary radioactivity was from radionuclides with short half lives (Zn-65 and Na-24). A comprehensive examination of the cooling tower concluded that no significant residual radioactivity remained in the cooling tower in 1982. This was later confirmed by an NRC sponsored survey. See Section 3.2 of Ref. 1.

In 1968, the Pathfinder BOP was decontaminated and disconnected from the reactor plant. Phosphoric acid (30%) solution was used to decontaminate the turbine, the condenser, an inlet steam line, and two of the feedwater heaters (Section C.3 of Ref. 1).

This decontamination effort removed 500 mCi from the turbine and condenser (mostly Zn-65), 300 mCi from turbine parts, and 500 mCi from feedwater heaters. A total of 1300 mCi was packaged and shipped offsite. All contaminated material that had been stored in the Turbine Building was removed and stored on the reactor side of the plant or shipped offsite. The nuclear plant and associated systems were isolated from the Turbine Building. Steam, reactor feedwater, and other nuclear process lines were cut and capped. The BOP was then integrated into a fossil-fueled peaking plant. Three new gas/oil package boilers housed in a new Boiler Building supplied steam to the BOP to operate the turbine. Commercial operation of this new power configuration, known as the Pathfinder Peaking Plant, commenced in May 1969 and continued until July 2000.

The nuclear fuel was shipped offsite in 1970 and the plant was placed in SAFSTOR in 1971. In 1991 a decommissioning of the reactor plant and fuel storage facilities was conducted. The details of this decommissioning are presented in Section 2.2.1 herein.

The Pathfinder Peaking Plant continued to operate until July 13, 2000, when the cooling tower collapsed in a storm. Due to economic reasons, the decision was made to cease operations of the peaking plant and commence decommissioning activities. The suspension of activities such as boiler and turbine maintenance will effectively prevent future use of existing peaking plant equipment for electrical generation without major modifications and capital expenditures. By letter dated February 21, 2003, Xcel Energy notified the NRC that power operation at the Pathfinder Peaking Plant had permanently ceased. None of the Pathfinder Peaking Plant power systems such condensate, feed, or steam systems are in current usage. These systems contain most of the fixed contamination at Pathfinder.

The Angus Anson fossil plant, which consists of two simple cycle combustion turbines, was constructed on the eastern end of the Pathfinder site outside of the secured area. The plant commenced commercial operations in September 1994. These two units continue to operate. An additional simple cycle unit is planned for installation in 2005. The Angus Anson plant operates separately from the steam and condensate BOP systems of the Pathfinder Peaking Plant except for an auxiliary services connection to the former Pathfinder cooling water system for fire protection services. The cooling water system line has been cut and capped and isolated from the Pathfinder condenser by a recent modification.

2. FACILITY DESCRIPTION

2.1 Site Location and Description

The Pathfinder Site is owned and operated by Northern States Power Company, a wholly owned subsidiary of Xcel Energy Inc. The Pathfinder site is located at 7100 East Rice Street, Sioux Falls, SD 57110. The Xcel Energy corporate headquarters are located at 414 Nicollet Mall, Minneapolis, MN 55402.

Although Xcel Energy owns additional land that surrounds the Pathfinder

location, the Pathfinder site as referred to herein principally includes the secured area shown in Figures 2-1 and 2-2. The areas outside of the secured area of the Pathfinder have not been impacted by licensed operations at the Pathfinder facility. The buildings and the areas enclosed within the secured area and the influent and effluent pathways to the Big Sioux River (e.g. settling ponds and diversion ditch) are the subjects of this decommissioning plan. Three of the existing buildings have been previously decommissioned and approved for unrestricted release (Ref. 2). These buildings include: 1) the Reactor Building, which was demolished above grade and backfilled below grade, 2) the Fuel Handling Building including the Fuel Transfer Vault, and 3) the Temporary Loading and Storage Building (both of which are in use today to support Angus Anson operations).

2.2 Radiological Status of the Facility

2.2.1 Previous Radiological Characterizations

Baseline Characterization

In 1980, Battelle's Pacific Northwest Laboratory prepared a radionuclide inventory for Pathfinder for the NRC under an agreement with the US Department of Energy (Ref. 1). This survey was conducted as part of a pilot program to provide the NRC with information on types, quantities, and locations of radionuclides at retired power plants. The study is referenced in several correspondences between the NSP and the NRC and included as Appendix C to this decommissioning plan.

Among other areas, this investigation included soil sampling (Section 3.1), cooling tower sampling (Section 3.2), surveys of auxiliary buildings (Section 3.3), and Turbine Building concrete samples (Section 3.4.2). These sampling efforts are relevant to the proposed decommissioning activities. Section C.3 describes the 1980 radiological status of the Turbine Building, which is the main focus of this decommissioning plan. According to this study, the activity in the Turbine Building was the result of fixed contamination from translocated activated corrosion products in piping and metal surfaces. A decay calculation applied to the estimated inventories of Co-60 and Zn-65 provided in the Battelle study resulted in the byproduct radioactivity amounts in the current license, which is 40 mCi and 1mCi respectively.

Previous Decommissioning of Reactor Plant and Fuel Storage Facilities

In 1991, the reactor plant and fuel storage facilities were decommissioned. This effort removed approximately 562 Ci. The effects of the 1991 decommissioning activities did not result in any adverse effects to the environment or spread of contamination.

The radiological release criteria for the 1991 decommissioning was based on Regulatory Guide 1.96, Termination of Operating Licenses for Nuclear Reactors, June 1974. Table 1 of this guide provides the acceptable surface contaminated levels for unrestricted use.

The guide does not specify a dose equivalent for unrestricted release, and the resultant dose from the 1991 decommissioning was therefore not specifically determined.

The NRC contracted a radiological survey to confirm the results of decommissioning surveys reported by NSP. The survey was performed by the Oak Ridge Institute for Science and Education (ORISE) and completed in November 1992 (Ref. 3). The confirmatory study included soil sampling. All samples were demonstrated to be below the requirements of Regulatory Guide 1.86. By letter dated Nov. 10, 1992 (Ref. 2) the NRC staff authorized unrestricted release of the decommissioned buildings and demolition of the reactor building.

By letter dated February 15, 1993 (Ref. 4), NSP provided the NRC staff with an evaluation of radionuclide release data to the environment in compliance with Condition 14 of the Material License. This evaluation was submitted subsequent to the completion of decommissioning activities. This report showed that no liquid releases occurred. Gaseous releases were filtered, and samples of continuously monitored ventilation exhausts all were well below the allowed limits. Most of the reported Continuous Air Monitor (CAM) activity was attributed to naturally occurring radon daughters.

Historical Environmental Monitoring

After 20 years of comprehensive liquid effluent sampling, environmental monitoring of liquid releases was discontinued due to extremely low levels of radiation. This action was permitted in 1992 by Amendment 11 to the Pathfinder Materials License (Ref. 2 and Ref. 5). A separate and extensive radiological monitoring program was also in effect during the decommissioning activities conducted in 1992. Radiological measurements were taken of samples of ambient air, ground water, surface water, drinking water, bottom river sludge, raw milk, fish, plants, and soil. No detectable radionuclides attributable to licensed activities were found (Ref. 5). Since the liquid sampling program was suspended and the previous decommissioning was completed, there has been no transport of significant amounts of contaminated material to the environment from routine operations and maintenance or from an unplanned event such as a fire or explosion.

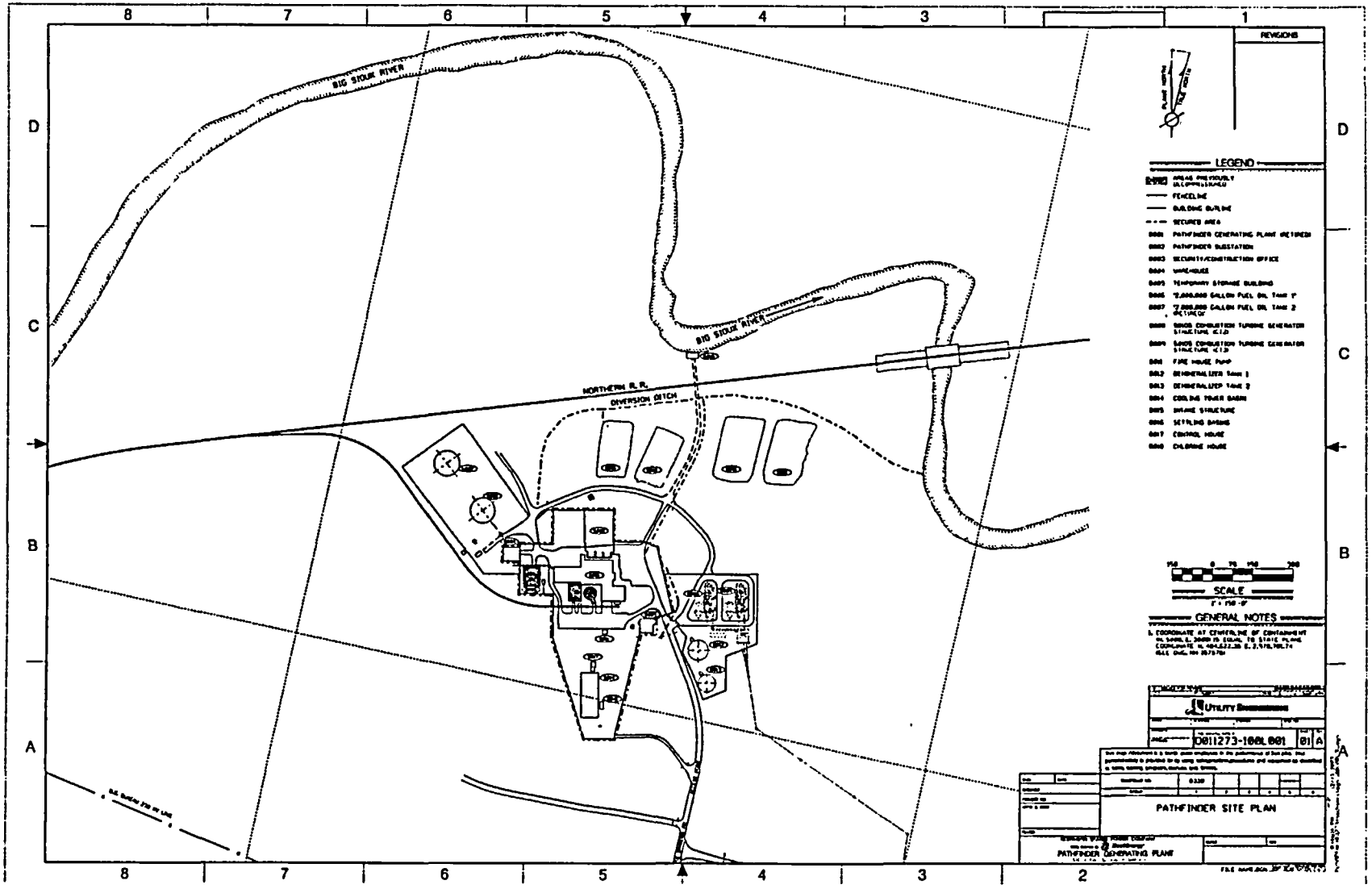


Figure 2-1
Pathfinder Site Plan

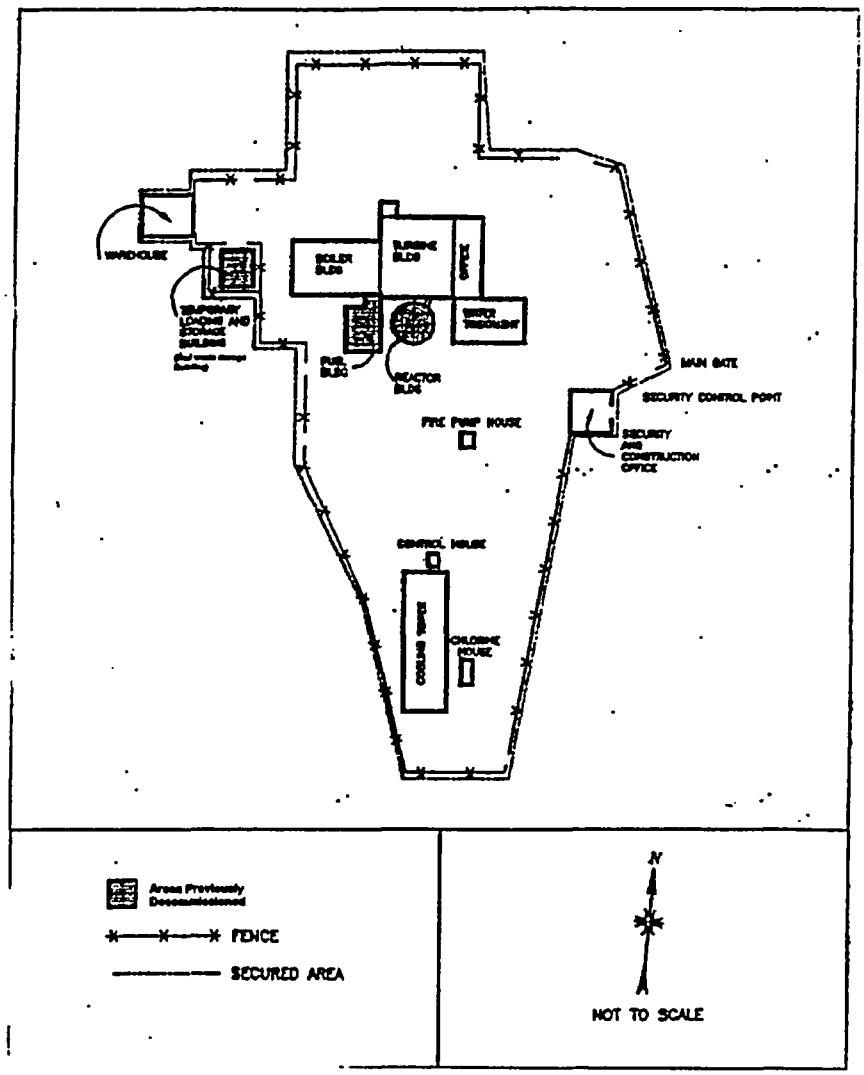


Figure 2-2
Pathfinder Secured Area

2.2.2 Ongoing Radiological Characterizations

Radiological surveys of the Turbine Building and Boiler Building have been performed annually in accordance with license requirements since the BOP was converted into the Pathfinder Peaking Plant in 1968. These surveys will continue to be performed until the byproduct materials license is terminated. The records of these surveys were examined as part of the Historical Site Assessment. The trends and radiation levels from these surveys correspond well with the most recent characterization study conducted in October 2003. See Appendix D. Detailed results of the characterization data are available for inspection.

2.2.3 Present Radiological Status of the Pathfinder Site

This section of the decommissioning plan discusses the present radiological status of the Pathfinder Site. It is based on the results of a comprehensive characterization survey of the site performed by the project consultant, Duratek Inc. in October 2003. The resulting survey report is included as an Appendix D to this decommissioning plan. The detailed survey results are available for inspection.

The characterization survey was performed in accordance with a site-specific plan based in part on information obtained from the Historical Site Assessment. The site assessment identified numerous locations and systems where radioactivity was known to exist, or had the potential to exist. These areas were specifically included in the characterization survey. The characterization survey included the interior portions of the HP turbine, steam piping, feedwater, and condensate piping. Various peaking plant systems were disassembled to facilitate the performance of the characterization survey.

The results of the characterization survey indicate that the amount of residual activity remaining within the Pathfinder Peaking Plant is relatively small and largely confined to several well-defined areas within the plant. There are no known instances of spills or burials of radioactive materials from the plant. The samples collected in the environs surrounding the plant did not identify any radioactivity attributable to licensed activities.

A preliminary DCGL of 5,000 dpm/100 cm^2 was established for building surfaces to facilitate the characterization survey. Table 2-1 below identifies those areas in which fixed activity in excess of the preliminary DCGL was identified.

Table 2-1
Areas With Residual Radioactivity In Excess of the
Preliminary DCGL

Area Surveyed	Number Of Measurements	Mean dpm/ 100 cm^2	Maximum dpm/ 100 cm^2	Standard Deviation dpm/ 100 cm^2
Floor Drain Line Upstream Of Condenser	16	1,999	8,143	2,397
Floor Drain Line Downstream Of Condenser	27	10,253	38,714	7,233
Circ Water Piping Near Flange	15	1,292	12,631	3,174
Floor Under Condenser	20	969	8,075	1,731
Condenser Hot Well Bottom	20	1,518	5,849	1,869
Condenser Expansion Joint	30	1,872	12,757	3,662

The information provided in Table 2-1 is further amplified below.

Only the drain lines beneath the condenser could be effectively surveyed due to a blockage. It is possible that additional residual activity is present in the floor drain system beneath the basement floor on the hot side of the Turbine Building. These remaining lines were conservatively assumed to be contaminated for planning purposes.

The activity in the floor drain lines, hotwell, and condenser expansion joint may be higher than reported due to attenuation and self absorption. In addition, any debris remaining in the floor drain system may be contaminated.

Only the floor area beneath the condenser in the basement of the Turbine Building appears to contain fixed contamination. The remaining floor surfaces in the basement of the Turbine Building did not have fixed activity in excess of the preliminary DCGL.

The affected area within the circulating water system piping near the flange appears to be limited to a small area. The affected area is limited to a small portion of the retired intake water pipe inside the Turbine Building. A recently installed blank flange isolates this piping from the cooling tower basin.

Biased samples were collected throughout the plant as part of the characterization survey. Table 2-2 below identifies those areas where residual activity attributable to licensed activities in excess of the Minimum Detectable Activity (MDA) were found.

Table 2-2
Biased Sample Analysis Results in Excess of MDA

Sample Location	Radionuclide	Activity (pCi/g)	MDA (pCi/g)
Condenser Expansion Joint (Turbine Building)	Co-60 Zn-65	2.35 E2 1.31 E0	2.70 E-1 7.62 E-1
Mud Drum (Boiler Building)	Co-60	1.05 E1	8.76 E-2
Condenser Hotwell (Turbine Building)	Co-60	9.09 E0	1.48 E-1
Condensate Pump Sump (Turbine Building)	Ag-108m Co-60 Eu-155	3.18 E3 2.12 E0 4.42 E1	2.09 E0 1.28 E0 2.88 E0
Turbine Building Sump Hot Side (Turbine Building)	Co-60 Cs-137 Eu-152 Eu-155	8.25 E0 8.65 E-1 2.08 E0 1.45 E0	9.34 E-2 8.98 E-2 7.76 E-1 2.27 E-1
		Activity (pCi/l)	MDA (pCi/l)
Hydrogen Cooler (Turbine Building)	H-3	1.40 E4	3.58 E-2

As Table 2-2 above shows, the radionuclides of interest for the decommissioning include: H-3, Co-60, Zn-65, Ag-108m, Cs-137, Eu-152, and Eu-155. This list of radionuclides will be reviewed prior to performing a final status survey in order to account for additional radioactive decay, the presence of previously unidentified radionuclides, and the effects of any remediation activities.

Table 2-3 below lists the half lives of the radionuclides identified during the characterization survey.

Table 2-3
Half Lives Of Identified Radionuclides

Radionuclide	Half Life Years
H-3	12.28
Co-60	5.27
Zn-65	0.67
Ag-108m	127
Cs-137	30.17
Eu-152	13.6
Eu-154	8.8

2.3 Contaminated Building Surfaces

There is presently no indication of significant radioactive contamination from reactor-originated sources on the building surfaces or structures at the Pathfinder Site other than certain portions of the Turbine Building and Boiler Building. The surfaces with fixed contamination in the Turbine Building include the following.

- The condenser hotwell and expansion joint
- The condensate pump area sump in the Turbine Building floor
- The turbine room sump (hot side) in the Turbine Building floor
- The Turbine Building floor under the condenser
- The Turbine Building floor drain piping (hot side)

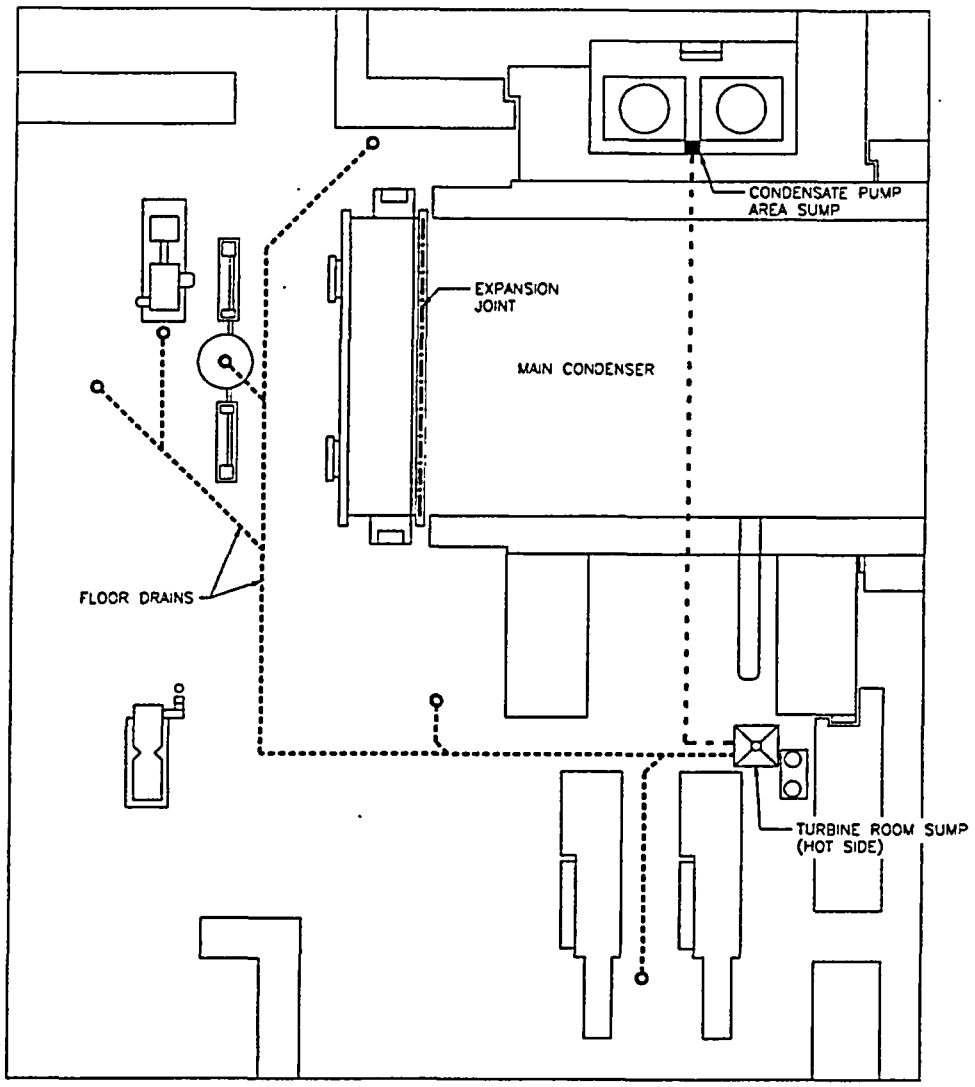
The above areas can be considered as parts of the permanent structures of the Turbine Building. The condenser is considered to be a permanent part of the Turbine Building structure. The condenser weighs approximately 225 tons. The condenser hotwell is a large rectangular shaped box that forms the bottom of the condenser. The expansion joint is a large metallic section located between the water box and condenser shell that extends outward approximately 8 inches along the periphery of these two interfaces. During the construction of the Pathfinder Turbine Building, the Turbine Building basement was poured with concrete and the condenser was set in place. The remaining floors of the Turbine Building, which includes the mezzanine and the turbine operating deck, were built around the condenser. The sumps listed above are integral rectangular sections of the Turbine Building floor, which are recessed from the floor level to collect drains. The floor drain piping is encased within the basement floor. Figure 2-3 shows the location of contaminated Turbine Building surface areas.

The contaminated building surfaces in the Boiler Building include the following.

- The boiler mud drums

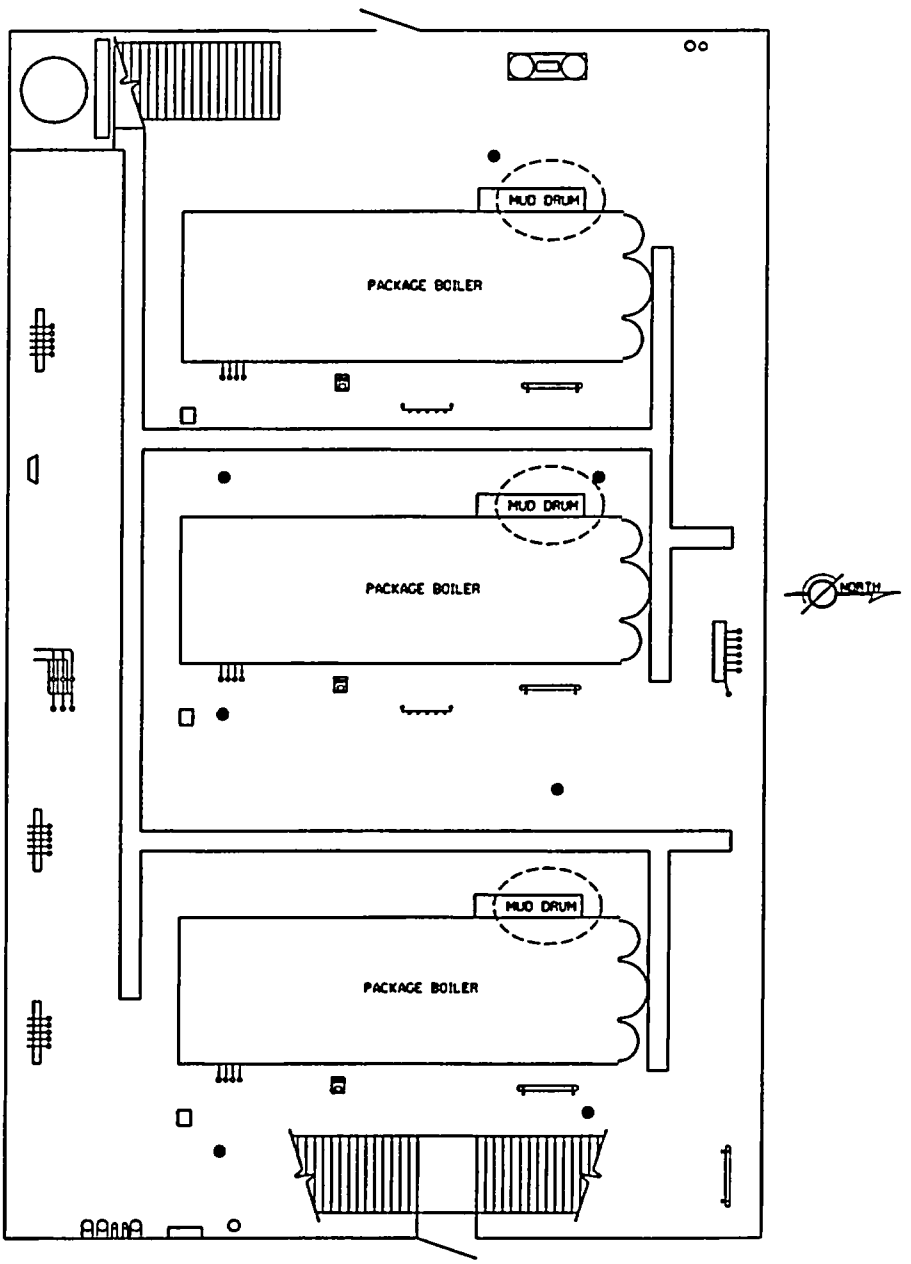
The boiler mud drums can also be considered as permanent structures. These drums are large heavy cylinders that are integral to the boiler and affixed to the boiler room floor. Figure 2-4 shows the location of the mud drums in the Boiler Building.

Figure 2-3
Contaminated Building Surfaces (Turbine Building)



TURBINE BUILDING
HOT SIDE – BASEMENT
(NOT TO SCALE)

Figure 2-4
Contaminated Building Surfaces (Boiler Building)



BOILER BUILDING
GROUND FLOOR
(NOT TO SCALE)

2.4 Contaminated Systems and Equipment

Based on recent characterization surveys, there is presently no indication of radioactive contamination of systems and equipment from licensed activities in excess of the DCGL criteria for unrestricted release at the Pathfinder facility. This is consistent with the survey history of the facility. System and equipment include non-permanent portions of the Pathfinder Peaking Plant. No remediation activities of systems and equipment are planned.

2.5 Surface Soil Contamination

Based on recent characterization surveys, there is presently no indication of radioactive contamination of soil from licensed activities at the Pathfinder facility. This is consistent with the survey history of the facility. No remediation activities of soil at the site will occur. The decommissioning activities are restricted to activities located within the boiler and Turbine Buildings. The appropriate controls will be implemented to prevent cross-contamination of site soil from cutting, grinding, or cleaning of contaminated surfaces and equipment or from the storage and transportation of radwaste.

2.6 Surface Water and Groundwater Contamination

Based on recent characterization surveys, there is presently no indication of radioactive contamination of surface or groundwater from licensed activities at the Pathfinder building surfaces. This is consistent with the survey history of the facility. No remediation activities of surface or groundwater will occur. The decommissioning activities are restricted to certain equipment located within the Turbine Building. The appropriate controls will be implemented to prevent cross-contamination of site surface water and groundwater from cutting, grinding, or cleaning of contaminated surfaces and equipment or from the storage and transportation of radwaste.

3. UNRESTRICTED RELEASE CRITERIA

This section of the decommissioning plan provides the criteria that will be used to demonstrate that the Pathfinder Site can be released for unrestricted use. Please see the response to Question 5 in Appendix G for a detailed discussion of elevated measurement criteria. The response to Question 6 in Appendix G contains information on how the Pathfinder site meets the qualifications for using the screening approach for developing the DCGL values for building surfaces and soil. The response to Question 7 in Appendix G shows that the dose contribution from residual radioactivity from past decommissioning activities is insignificant and does not affect the DCGL determination.

Subpart E of 10 CFR 20 allows license termination and the release of a site for unrestricted use if the residual radioactivity that is distinguishable from background does not result in a total effective dose equivalent to an average member of the critical group in excess of 25 mrem per year and the residual radioactivity has been reduced to levels that are as low as reasonably achievable, ALARA. Appendix B of NUREG-1757, Volume 1 provides radionuclide specific screening values that may be used to demonstrate compliance with the requirements of Subpart E of 10 CFR 20.

3.1 Building Surfaces

For building surfaces the criteria for release for unrestricted use will generally be those found in Appendix B of NUREG-1757, Volume 1. The criteria for radionuclides not contained within Appendix B will be calculated using the NRC's D&D Code, Version 2.1. The criteria for radionuclides not contained in either Appendix B or available within the NRC's D&D Code will be calculated using RESRAD BUILD, Version 3.21. The assumptions of the models were verified applicable to the Pathfinder site. The only radionuclide identified during the characterization survey not contained in either Appendix B or available within the NRC's D&D Code is Ag-108m. Since Ag-108m was identified in only one area within the plant and that area will be remediated, it is quite possible that Ag-108m will not be a radionuclide of interest during the final status survey.

Table 3-1 lists the criteria that will be used for building surfaces to demonstrate that the Pathfinder Site is acceptable for release for unrestricted use.

The criteria for building surfaces will be applied to building surfaces, which includes permanent structures. Examples of permanent structures within the Pathfinder Peaking Plant include items that are encased within or permanently affixed to building surfaces such as embedded piping, large steam lines, the main condenser, and package boilers.

The criteria specified for building surfaces is in terms of total activity. When applying the criteria it will be verified that the removable activity does not exceed 10% of the criteria for total activity. When more than one radionuclide is present the sum of the fractions rule will apply as will allowances for hard to detect radionuclides.

Table 3-1
Criteria For Demonstrating Building Surfaces Are Acceptable
For Release For Unrestricted Use

Radionuclide	Criteria dpm/100 cm^2
H-3	1.2 E8 [1]
Co-60	7.1 E3 [1]
Zn-65	4.8 E4 [2]
Ag-108m	1.7 E4 [3]
Cs-137	2.8 E4 [1]
Eu-152	1.3 E4 [2]
Eu-154	1.1 E4 [2]
Eu-155	1.6 E5 [2]

Source:
[1] Appendix B to NUREG-1757 Volume 1
[2] Derived from a calculation using NRC's D&D Code Version 2.1. Radionuclide specific computer runs are included in Appendix A.
[3] Criteria calculated using RESRAD BUILD Version 3.21. A radionuclide specific computer run is included in Appendix B.

3.2 Soils - Including Open Land Areas

For soils at the Pathfinder Site, the criteria for release for unrestricted use will generally be those found in Appendix B of NUREG-1757, Volume 1. The criteria for radionuclides not contained within Appendix B will be calculated using the NRC's D&D Code, Version 2.1.

Table 3-2 lists the criteria that will be used for soils to demonstrate that the Pathfinder Site is acceptable for release for unrestricted use.

The criteria for soils will be applied to open land areas surrounding the Pathfinder Plant and to soils that may be encountered within the plant during remedial activities. The criteria may also be applied to limited volumes (i.e. less than 100 ft^3) of volumetrically contaminated concrete. If more than 100 ft^3 of volumetrically contaminated concrete is encountered, and if the contaminated concrete will remain following remediation, a site-specific dose evaluation will be prepared and forwarded to the NRC for approval.

When more than one radionuclide is present the sum of the fractions rule will apply as will allowances for hard to detect radionuclides.

Table 3-2
Criteria For Demonstrating Soils Are Acceptable For
Release For Unrestricted Use

Radionuclide	Criteria (pCi/g)
H-3	1.1 E2[1]
Co-60	3.8 E0[1]
Zn-65	1.1 E1[2]
Cs-137	1.1 E1[1]
Eu-152	8.7 E0[1]
Eu-154	8.0 E0[1]
Eu-155	2.8 E2[2]

Source:
[1] Appendix B of NUREG-1757, Volume 1
[2] Calculated value using D&D Code Version 2.1. Radionuclide specific computer runs are included in Appendix B.

3.3 Systems and Equipment

For systems and equipment, the criteria for release for unrestricted use will be taken from NRC Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors. Table 3-3 lists the criteria that will be used for systems and equipment to demonstrate that the Pathfinder Site is acceptable for release for unrestricted use. Examples of systems and equipment within the Pathfinder

Peaking Plant are non-permanent items such as small pumps and valves, work benches, etc. When more than one radionuclide is present the sum of the fractions rule will apply as will allowances for hard to detect radionuclides.

The criteria specified above for systems and equipment is in terms of total activity. When applying the criteria it will be verified that the removable activity does not exceed 10% of the criteria for total activity.

Table 3-3
Criteria For Demonstrating Systems and Equipment Are Acceptable For Release For Unrestricted Use

Radionuclide	Criteria dpm/100 cm^2
H-3	5,000
Co-60	5,000
Zn-65	5,000
Ag-108m	5,000
Cs-137	5,000
Eu-152	5,000
Eu-154	5,000
Eu-155	5,000

3.4 Planned Remediation Activities

This section of the plan discusses the remediation activities to be undertaken as part of the decommissioning of the Pathfinder Site. Prior to and throughout the decommissioning, surveys will be performed to validate the results of the characterization survey, monitor the progress of the remediation, verify that exposures to both the decommissioning staff and members of the public are within administrative limits, assure releases to the environment are as low as reasonably achievable, and verify any assumptions used to design the final status survey plan. If previously unidentified contamination is identified, the affected and surrounding areas will be evaluated. If appropriate, the scope of the remediation will be expanded to address this newly identified contamination.

The results of the characterization survey were used to plan the remediation activities. Section 2 of this document lists those areas within the plant in which residual activity was identified. Section 3 provides the criteria to be used to demonstrate that the Pathfinder Plant meets the criteria for release for unrestricted use. The planned remedial activities are intended to ensure that the areas with residual activity will meet the criteria for release for unrestricted use. Although use of the screening values in NUREG-1757 obviate the need to demonstrate that doses from residual activity are ALARA, some areas will be remediated even

though they are likely to meet the criteria for unrestricted use in their present condition.

Listed below are the areas within the Pathfinder Plant that will be remediated along with a brief description of planned remedial activities in each area. Based on the results of the surveys to be performed during the remediation, the list of areas to be remediated may be expanded and the remedial actions modified as appropriate. See Section 5 herein for radiological controls. See the response to Question 4 in Appendix G for information on procedural controls. No remedial activities are planned for the environs surrounding the plant since the characterization survey did not identify any radioactivity attributable to licensed activities.

Floor Drain System Piping

The floor drain lines beneath the basement floor on the hot side of the Turbine Building will be remediated. It is anticipated that the concrete floor above the drain lines will be sectioned and removed. The concrete will either be free released or packaged for disposal as radioactive waste. The cement material surrounding the drain lines will be removed by a jackhammer and stock piled. This material will either be used for fill or packaged for disposal as radioactive waste. Material to be used as fill will be covered to minimize the potential for cross contamination. To allow for sampling or assessment, excavation areas will not be backfilled prior to notifying the NRC. The contaminated portions of the drain lines will be sized to fit into standard B-25 boxes, capped, removed, and packaged for disposal as radioactive waste. The trenches resulting from the remediation of the floor drain lines will be left exposed to allow for confirmatory measurements if required. Steel plates and/or barricades will be erected to minimize safety hazards. See the response to Question 16 in Appendix G.

Circulating Water System Piping Near Flange

If the results of the characterization survey can be verified to show contamination above action levels, the affected portion of the condensate system will be remediated. If necessary remedial actions will likely include the use of abrasive pads and appropriate decon solutions. If necessary the affected piping portion will be removed and disposed of as radwaste.

Condensate Pump Sump

The small condensate pump sump located between the two condensate pumps in the basement of the Turbine Building will be remediated. A sample collected for analysis from within the sump revealed the presence of Ag-108m. This was the only area where Ag-108m was identified. If practical, the sump will be remediated to the extent that Ag-108m does not need to be considered during the final status survey. Since the condensate pump sump is constructed of poured

concrete, the remedial actions will likely include the use of needle guns. If needle guns are used, HEPA ventilation and HEPA vacuums will be used to minimize the potential for spreading contamination. If the condensate sump cannot be successfully remediated, its small size (2-3 ft^3) will allow for complete removal and disposal as radioactive waste.

Turbine Building Sump

The sump on the hot side of the Turbine Building will be remediated. Due to the possible presence of liquids, the contents of the sump will be segregated for treatment prior to disposal as radioactive waste. Since the sump is constructed of poured concrete, the remedial actions will likely include the use of needle guns. If needle guns are used, HEPA ventilation and HEPA vacuums will be used to minimize the potential for spreading contamination. At the end of the remedial activities the sump will be completely emptied to facilitate the performance of the final status survey.

Condenser Hotwell

The condenser hotwell can be accessed from the basement of the Turbine Building and will be remediated. The dried sludge in the bottom of the hotwell will be removed and disposed of as radioactive waste. The hotwell will be remediated, as necessary, using abrasive pads and appropriate decon solutions. If required, sections of the hotwell can be removed and disposed of as radioactive waste.

Floor Under Condenser

Certain sections of the floor under the condenser in the basement of the Turbine Building will be remediated. Since the floor is constructed of poured concrete the remedial actions will likely include of the use of needle guns. If needle guns are used, HEPA ventilation and HEPA vacuums will be used to minimize the potential for spreading contamination.

Condenser Expansion Joint

The condenser expansion joint can be accessed from the basement on the hot side of the Turbine Building and will be remediated. The expansion joint is a metal joint with a channel that extends around the periphery of the connection between the water box and the condenser shell. The Pathfinder condenser is equipped with only one expansion joint. This joint will be cut out, packaged, and disposed of as radioactive waste. The remainder of the expansion joint not accessible to cutting will be opened to expose its internal surface. These surfaces will be cleaned to facilitate the performance of the final status survey.

Mud Drums

The boiler mud drums located in the Boiler Building will be remediated as necessary. The mud drums will be vacuumed using a HEPA vacuum to remove all loose debris. All of the mud drums were considered to have fixed contamination for planning purposes.

3.5 Schedule for Decommissioning Activities

The schedule for decommissioning activities is presented in Figure 3-1. Xcel Energy expects to complete all decommissioning activities within the timeliness guidelines contained in Section 2.1 of NUREG 1757, Consolidated NMSS Decommissioning Guidance, Vol. 3, Financial Assurance, Record Keeping and Timeliness. This includes submittal of a request for license termination within 24 months of NRC approval of the decommissioning plan.

4. DECOMMISSIONING ORGANIZATION AND ADMINISTRATION

4.1 General

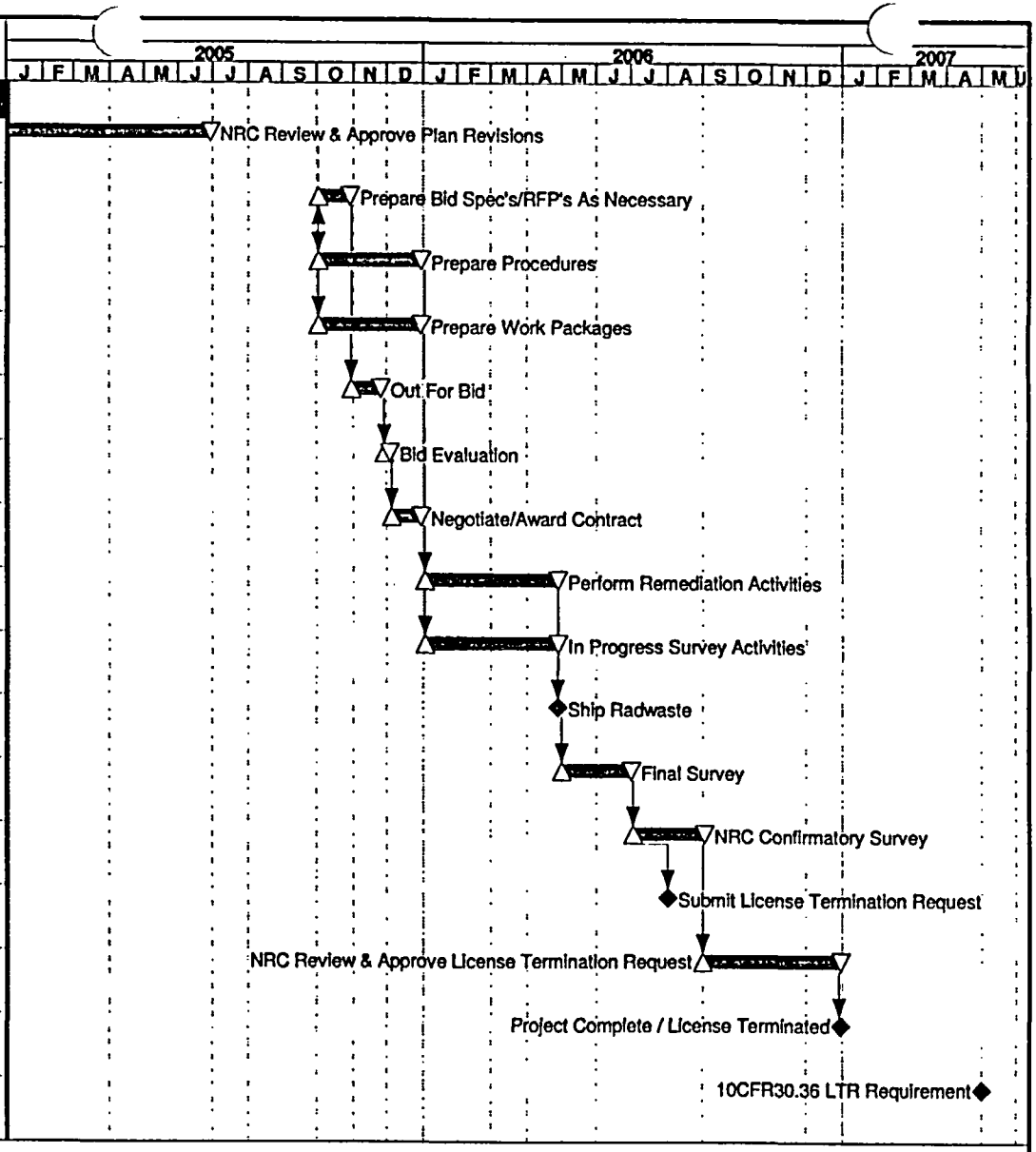
An organizational diagram of the Pathfinder Decommissioning Project is presented in Figure 4-1.

4.2 Corporate Management

The Xcel Energy Nuclear Asset Management division has primary responsibility for Pathfinder decommissioning activities. The General Manager of Nuclear Asset Management is responsible for overall oversight and management of these activities. Nuclear Asset Management is also responsible for oversight of the Prairie Island and Monticello nuclear power plants. Utility Engineering, a wholly owned Xcel Energy subsidiary, is responsible for project management.

The Pathfinder Peaking Plant is located on the same site as Xcel Energy's Angus Anson simple cycle plant. Access to the site for decommissioning activities is controlled. According to the license, the Pathfinder Plant Manager, who also oversees the Angus Anson plant, has overall responsibility for the retired Pathfinder plant. All decommissioning activities are coordinated through the Pathfinder/Angus Anson Plant Manager.

Activity ID	Activity Description	Rem Dur	% Comp	Early Start	Early Finish
Pathfinder Decommissioning Project					
A1290	NRC Review & Approve Plan Revisions	129	65	02FEB04A	29JUN05
A1330	Prepare Bid Spec's/RFP's As Necessary	20	0	03OCT05*	28OCT05
A1310	Prepare Procedures	65	0	03OCT05*	30DEC05
A1320	Prepare Work Packages	65	0	03OCT05*	30DEC05
A1340	Out For Bid	20	0	31OCT05	25NOV05
A1350	Bid Evaluation	5	0	28NOV05	02DEC05
A1360	Negotiate/Award Contract	20	0	05DEC05	30DEC05
A1400	Perform Remediation Activities	85	0	02JAN06	28APR06
A1410	In Progress Survey Activities	85	0	02JAN06	28APR06
A1420	Ship Radwaste	0	0		28APR06
A1500	Final Survey	45	0	01MAY06	30JUN06
A1650	NRC Confirmatory Survey	45	0	03JUL06	01SEP06
A1600	Submit License Termination Request	0	0		01AUG06
A1700	NRC Review & Approve License Termination Request	86	0	01SEP06	29DEC06
A1800	Project Complete / License Terminated	0	0		29DEC06
A1900	10CFR30.36 LTR Requirement	0	0		30APR07*



Start Date	19JUL04
Finish Date	30APR07
Data Date	31DEC04
Run Date	01DEC04 07:32

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PAF5 Sheet 1 of 1

Xcel Energy
Pathfinder Decommissioning Project
2005 / 2006

Date	Revision	Checked	Approved

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Xcel Energy

Pathfinder Project Organization

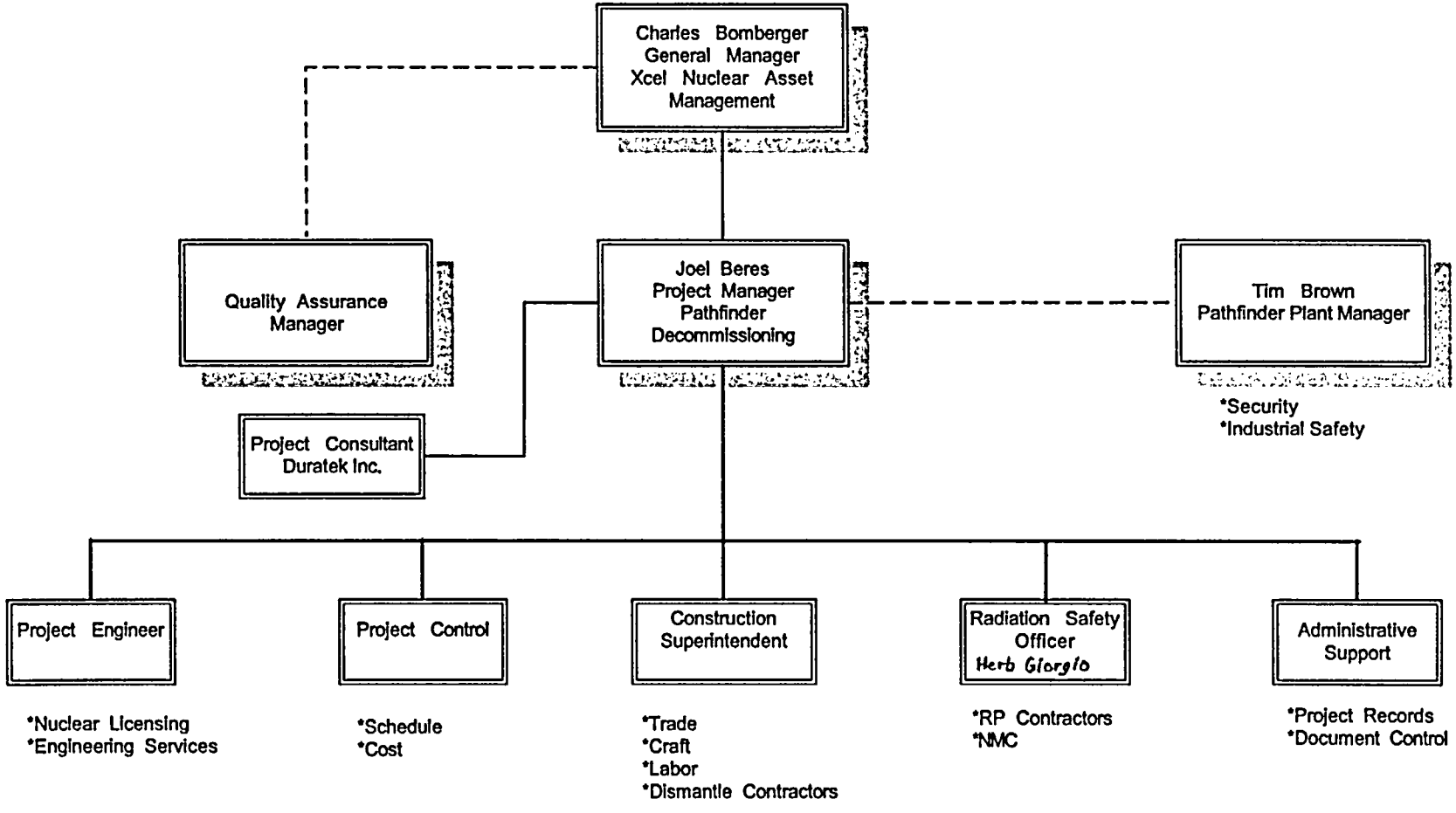

Figure 4-1
Organizational Chart

Xcel Energy's corporate environmental services group provides support on environmental matters to the project. There are persons from this group who have specific Pathfinder experience including direct experience with previous Pathfinder decommissioning activities.

4.3 Project Management

The Pathfinder Decommissioning Project Manager, an Xcel Energy employee, is directly responsible for planning, developing, and implementing the decommissioning project. The Project Manager reports to the General Manager of Nuclear Asset Management. The Project Manager coordinates the services of the Environmental, Construction, Administrative, Licensing, and Radiation Protection/Radwaste groups that are assigned to the Pathfinder project.

The Radiation Safety Officer (RSO) is responsible for the radiation safety program at Pathfinder. The RSO is responsible for radiation work permits, procedures, surveys, and radiation monitoring for decommissioning. The qualifications of the RSO were submitted to the NRC by letter dated June 16, 2003. The RSO qualification requirements are given in Section 5.2.

The construction superintendent is responsible for coordinating with Angus Anson plant staff and managing equipment dismantling activities.

4.4 Contractor Support

Xcel Energy has obtained the services of Duratek Inc. to assist in the planning and execution of the decommissioning activities. Duratek has extensive experience with decommissioning activities. Duratek was also the principal contractor for the characterization survey, which is attached herein. Duratek will work under the direction of the Decommissioning Project Manager and the RSO.

Xcel Energy is also employing the services of Nuclear Management Company (NMC), the operator of Xcel Energy's Monticello and Prairie Island nuclear power plants, to plan and implement the decommissioning project. NMC has demonstrated competencies in quality assurance, radiation safety, and radwaste handling. NMC may also provide independent audit support for the project. Depending on the level of outsourcing for the project, NMC also may provide health physicists to support the dismantling and sampling activities.

5. RADIATION SAFETY AND HEALTH PROGRAM

5.1 Radiation Safety Controls and Monitoring for Workers

Introduction

The radiation safety and health program will be implemented during decommissioning activities to ensure that exposure to radioactive material by members of the decommissioning staff and members of the public, and potential release of radioactivity to the environment are maintained as low as reasonable achievable (ALARA). Given the results of the characterization survey, the primary radiological concern during the decommissioning will be the potential intake of radioactive materials by members of the decommissioning staff. There is also some potential for skin exposure resulting from a contamination incident. Significant whole body external exposures hazards are not expected. No one is expected to receive a total effective dose equivalent, TEDE, in excess of 0.5 rem during the decommissioning effort.

Xcel Energy will employ administrative and engineering controls to control the spread of radioactive materials will minimize potential exposures to members of the decommissioning staff. The decommissioning staff will use personal protective clothing as necessary. In the unlikely event that engineering controls are not deemed sufficient to reduce airborne concentrations to acceptable levels, respiratory protection may be used to minimize potential intakes.

These controls will prevent any radiation release beyond the plant boundary such that the members of the public are not expected to receive any dose from the proposed decommissioning activities.

Implementation

All members of the decommissioning staff are required to comply with the requirements of this plan, related procedures, and applicable regulations contained within 10 CFR 20. Each member of the decommissioning staff will be responsible for maintaining their exposure ALARA and notifying managers of potential radiological hazards, improper practices, or issues of noncompliance. Each member of the decommissioning staff will be encouraged to identify potential changes to current procedures and or practices especially those that may reduce exposures or improve worker safety.

Managers and supervisors supporting the decommissioning will implement the radiation safety and health program set forth in this decommissioning plan and develop related the procedures and controls necessary to maintain compliance with 10 CFR 20. Managers and supervisors will:

- Ensure that all members of the decommissioning staff have received training related to the Radiation Safety and Health Program
- Take appropriate action to correct issues of noncompliance
- Document violations with the requirements of this plan, related procedures, and applicable regulations contained within 10 CFR Part 20

5.2 Radiation Safety and Health Organization

The radiation safety and health organization will consist of a Radiation Safety Officer (RSO), a Health Physicist, Radiological Engineers/Specialists, and Health Physics Technicians. The RSO is an employee of Nuclear Management Company (NMC), the company that operates the nuclear power plants owned by Xcel Energy. The Health Physicist, Radiological Engineers/Specialists, and Health Physics Technicians will be likely be employees of Duratek Inc. and supplied under contract to Xcel Energy. The RSO will report to the Decommissioning Project Manager. Functionally the Health Physicist will report to the Radiation Safety Officer and administratively to the Decommissioning Project Manager. Staffing levels associated with the radiation safety and health organization will be reviewed periodically to ensure adequate staffing levels are maintained to support planned activities.

The RSO is responsible for overseeing the implementation of the radiation safety and health program. The RSO ensures that all activities involving potential exposure to radioactive material are conducted in compliance with specific license requirements, this plan, related procedures, and applicable regulations contained within 10 CFR Part 20.

The minimum qualifications for the RSO are as follows.

- A four year degree in health physics or related field
- Certification by the American Board of Health Physics
- Ten years of supervisory experience
- Twenty years of experience related to radiation safety

The Health Physicist, HP, is responsible for implementing the radiation safety and health program. The HP will supervise and coordinate the activities of the radiation safety and health organization.

The minimum qualifications for the Health Physicist are as follows.

- A four year degree in health physics or related field
- Certification by the American Board of Health Physics
- Five years of supervisory experience
- Ten years of experience performing radiological decommissionings including final status surveys

5.3 Occupational Dose Limits

Subpart C to 10 CFR 20 specifies the following annual limits for individuals occupationally exposed to ionizing radiation.

- A total effective dose equivalent of 5 rem
- The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, of 50 rem
- A shallow dose equivalent to the skin or to any extremity of 50 rem
- An eye dose equivalent of 15 rem

The occupational dose limits will apply to all decommissioning staff members entering radiologically controlled areas. Prior to being allowed to enter a radiologically controlled area, each member of the decommissioning staff shall supply a written estimate/record of their year to date occupational dose. Only those individuals whose year to date occupational doses are less than 50% of the applicable occupational dose limits will be allowed to enter a radiologically controlled area without written authorization from the RSO.

5.4 Administrative Dose Limits

Administrative dose limits are used to control doses to ensure regulatory limits are not exceeded and that occupational doses are maintained ALARA. The following administrative dose limits have been established for each member of the decommissioning staff.

- A total effective dose equivalent of 0.1 rem per month or 0.5 rem decommissioning activities
- The sum of the deep dose equivalent and the committed dose equivalent to any individual organ or tissue, other than the lens of the eye, of 0.5 rem per month or 2.5 rem during the coarse of the decommissioning

If an administrative dose limit is exceeded, the affected member(s) of the decommissioning staff shall not be allowed to enter a radiologically controlled area without written authorization from the RSO.

5.5 Personnel Monitoring

Subpart F to 10 CFR 20 requires the use of individual monitoring devices if the individual is likely to exceed 10% of the occupational dose limits from sources of radiation external to the body. It also requires that potential intakes and the resulting committed effective dose be evaluated for occupationally exposed individuals if the individuals are likely to exceed in a year 10% of the applicable annual limit on intake(s), ALI(s) listed in Appendix B to 10 CFR 20.

The recent characterization survey did not identify any significant external radiation hazards. No individual is expected to receive 0.5 rem from external sources, therefore, individual monitoring devices will likely not be provided to members of the decommissioning staff. If radiological conditions change such that a member of the decommissioning staff is likely to exceed 10% of the occupational dose limits from sources of radiation external to the body, that particular decommissioning activity would cease until individual monitoring devices were provided. In addition, any doses received prior to issuance of the individual monitoring devices would be evaluated and the results of the evaluation documented.

The potential for intakes of radioactive material by members of the decommissioning staff will be evaluated through the implementation of a comprehensive air sampling program. Air samples will generally be taken as follows.

- During breaches of radioactive systems
- During entries into known or potential airborne radioactivity areas
- During decommissioning activities in areas with loose surface contamination in excess of 10,000 dpm/100 cm^2
- At the exhaust of HEPA ventilation units

General and breathing zone air samples will be collected. Lapel air samplers will be employed if members of the decommissioning staff plan to make extended entries into known or potential airborne radioactivity areas (>0.3 DAC). All entries into known airborne radioactivity areas will require the use of DAC-hr tracking to document potential intakes. Airborne contamination limits are provided in Table 5-3.

Although not expected, if an intake in excess of 5% of the applicable annual limit on intake(s), ALI(s), listed in Appendix B to 10 CFR 20 is suspected, the affected individual(s) will be requested to provide bioassay samples and may be required to obtain a whole body count in order to more accurately assess the intake. In addition to potential exposures from radiation sources external to the body and potential exposures from intakes of radioactive materials into the body the potential for exposure due to radioactive materials on the body also exists. Skin and personnel clothing contamination in excess of 10,000 dpm/100 cm^2 will be evaluated.

5.6 Respiratory Protection

If required, respiratory protection will be used to protect personnel from airborne contamination. The use of respiratory protection will support the goal of keeping individual exposures (both internal and external) ALARA. In deciding to use respiratory protection non-radiological impacts such as physiological and psychological stresses will be evaluated. In general, respiratory protection will not

be used unless there is a potential for an individual to receive an intake in excess of 2 DAC-hrs in a day or 10 DAC-hrs in a week. Airborne contamination limits are provided in Table 5-3. If respiratory protection is required, Xcel Energy will prepare a written policy statement addressing its use and will approve the procedures necessary to implement a respiratory protection program. The procedures will address the following.

- The means to ensure the proper equipment is selected based on the potential hazards
- Training requirements
- Medical surveillance requirements
- The use of only equipment certified by the Bureau of Mines/National Institute of Occupational Safety and Health, NIOSH
- The means to evaluate the respiratory programs effectiveness
- The means to track potential intakes

Each individual required to use respiratory protection shall have been fit tested within the previous 12 months using the specific model and size of respirator to be used to ensure that the individual can obtain an adequate seal. Fit test shall only be performed on individuals who are clean shaven, have obtained medical approval to use respiratory protection within the previous 12 months, and who have attended respiratory protection training within the previous 12 months.

If required, the use of respiratory protection will be specified on the RHWP used to control access to a specific radiologically controlled area.

5.7 Radiological Surveys

Subpart F of 10 CFR 20 requires surveys to be performed to comply with the regulations and to evaluate radiological conditions. Radiological surveys will be performed throughout the decommissioning in order to identify, quantify and evaluate potential hazards associated with the radiological conditions within a given area. The survey results will be used to determine posting requirements, evaluate the need for and the effectiveness of engineering controls, determine appropriate protective clothing requirements, and to help ensure that exposures to radioactive materials are maintained ALARA.

The radiological surveys to be performed during the decommissioning will include surveys for fixed contamination, removable contamination, exposure rates, and airborne contamination. In addition samples will be collected to assess the contamination levels in various media and to determine the radionuclides of interest and their relative fractions in the various media or within a given area. Based on the results of the characterization survey it is expected that the majority of the surveys for fixed and removable contamination will be for beta activity. If alpha activity is identified the survey protocols will be modified as appropriate.

Both routine and job specific surveys will be performed. The routine surveys will be performed to identify changing conditions and/or adverse trends. The routine surveys will be performed at least weekly. More frequent surveys will be performed in areas having a high potential for significant changes in radiological conditions. Routine surveys will be performed within radiologically controlled areas and in areas immediately abutting such areas. Job specific surveys will be performed to facilitate job planning activities, to assess the effectiveness of controls and to ensure there are no releases of radioactive materials from the effected area. Surveys will generally be performed as follows.

- Prior to initiating remediation activities in a given area
- During the performance of remediation activities in a given area
- During the breach of known or suspected radioactive systems
- At the conclusion of decommissioning activities in a given area
- At the exhaust of HEPA ventilation units
- At ingress/egress points to a given area
- To support the shipment of radioactive materials
- To support the release of materials from radiologically controlled areas
- At radwaste collection areas

Radiation survey results shall be legible and documented in a timely manner. The survey documentation shall include the following.

- The date, time, and location of the survey
- The instruments used and their calibration status
- The name of the surveyor(s)
- The results of all measurements and analyses

All survey documentation shall be reviewed by the HP or a qualified designee. Survey results that indicate adverse trends or the presence of radioactivity outside of a radiologically controlled area shall be reported to the Radiation Safety Officer.

5.8 Instrumentation

All instrumentation shall be calibrated on a semiannual basis using National Institute of Science and Technology, NIST, traceable sources and test equipment. Calibration labels showing the instrument's identification number, calibration date, and calibration due date shall be attached to all instruments. The presence of the instrument's calibration label shall be verified by the user prior to each day's use. In addition, each instrument shall be source checked or its efficiency determined prior to each day's use.

The radionuclides used for the source checks and efficiency determinations depend on the type of radiation the instrument is designed to detect. Table 5-1 lists the radionuclides to be used for source checks and efficiency determinations.

Table 5-1
Radionuclides For Source Checks And Efficiency Determinations

Type Of Radiation To Be Detected	Radionuclide Used
Alpha	Th-230
Beta	Tc-99
Gamma	Cs-137

5.9 Radiation/Hazardous Work Permits

A radiation/hazardous work permit, RHWP, is a document that will be used to inform individuals of the radiological conditions in a given area and identifies any potential safety hazards associated with the area. The RHWP specifies the requirements for entering an area and performing specific activities within the area. Once decommissioning activities are initiated, an RHWP will be required to enter any radiologically controlled area. Each RHWP shall contain the following.

- A unique identification number
- A description of the activities to be performed
- A description of the area in which the activities will be performed
- Actual and/or expected radiological conditions within the area
- A list of non radiological hazards within the area
- Personnel monitoring requirements (if applicable)
- Personnel protective clothing requirements
- Specific engineering and/or administrative controls (if applicable)
- Survey requirements
- The estimated person-rems for the activities to be performed
- Pre-job briefing requirements
- The date and time the RHWP is effective
- The date and time the RHWP will expire
- The name and signature of the individual preparing the RHWP
- The signature of the RSO approving the RHWP

Each individual entering a radiologically controlled area shall log in and out using a RHWP sign in sheet attached to the RHWP. In addition, prior to their initial entry, each individual must attend an RHWP briefing and sign the briefing attendance sheet signifying that they attended the briefing, understood the information presented at the briefing, and agree to comply with the requirements of the RHWP while in the radiologically controlled area.

5.10 Contamination Control Program

The purpose of the contamination control program is to specify the requirements for identifying, evaluating, and controlling radioactive contamination. Radioactive contamination control measures will be established to minimize the spread of contamination, to minimize the need for protective clothing (including respiratory protection) and to maintain exposures ALARA. The control of radioactive contamination will be accomplished by the following methods.

- Promptly identifying sources of contamination by performing surveys for fixed, removable, and airborne contamination
- Minimizing sources and potential sources of contamination
- Planning and performing work activities in ways that will minimize the creation and spread of contamination
- Implementing good house keeping practices
- Requiring the use of appropriate personal protective equipment
- Monitoring personnel, materials, and equipment prior to removing them from a potentially contaminated area

Any area with fixed or removable contamination in excess of the limits in Table 5-2 shall be posted and controlled as a contaminated area.

Table 5-2
Fixed and Removable Contamination Limits

Type of Radiation	Fixed	Removable
Alpha	2,000 dpm/100 cm^2	100 dpm/100 cm^2
Beta	20,000 dpm/100 cm^2	1,000 dpm/100 cm^2

Any area with airborne contamination, or with the potential for airborne contamination, in excess of the limits specified in Table 5-3 shall be posted and controlled as an airborne contaminated area.

Table 5-3
Airborne Contamination Limits

Radionuclide	Activity Concentration (uCi/ml)
Co-60	3E-9
Zn-65	3E-8
Ag-108m	3E-9
Cs-137	2E-8
Eu-152	3E-9
Eu-154	2E-9
Eu-155	1E-8

The airborne contamination limits equate to 30% of the applicable DAC values. When more than one radionuclide is identified the sum of the fractions rule shall apply. If the airborne activity is to be estimated based on a gross beta analysis, it shall be assumed that the radionuclide of interest is Co-60.

The size and number of contaminated areas should be kept to a minimum, as should the amount of materials brought into a contaminated area. Contamination control measures such as bagging, sleeving, and coating should be considered as applicable. All items to be removed from a contaminated area shall be surveyed for free release. Items not able to be free released shall be kept in a radiologically controlled area.

All contaminated areas shall be posted, including potential airborne contaminated areas. Unless the area is surrounded by walls, its boundaries shall be marked using yellow and magenta rope or tape. Access points shall be equipped with step off pads. The step off pads shall be considered non contaminated and all protective clothing shall be removed prior to stepping onto the step off pad. All access points shall also be equipped with contamination monitors and all individuals exiting a contaminated area shall monitor themselves for contamination prior to leaving the area. Receptacles shall be placed by the step off pads for the collection of reusable protective clothing and trash. The receptacles shall be clearly labeled.

Any accidental spread of contamination or release of radioactive material shall require immediate action to minimize its impact. These include the following.

- Attempting to stop the spread of contamination or the release of radioactivity, if it is safe to do so
- Warning others to avoid the effected area
- Isolating potentially effected areas
- Assisting in the removal and decontamination of any individuals that may have been present in the effected area at the time of the event

Surveys of the affected area and surrounding areas should be performed as soon as practical and plans made to remediate the effected area.

If required, only HEPA filtered vacuum cleaners and ventilation systems will be used in radiologically controlled areas. Such vacuum cleaners and ventilation systems must have had a documented DOP test performed within the previous 12 months. These vacuum cleaners and ventilation systems shall be labeled and controlled as appropriate.

5.11 Free Release Of Items From Radiologically Controlled Areas

All items to be free released from radiologically controlled areas shall be surveyed to ensure that the item is not contaminated with detectable activity attributable to licensed activities. Each item to be free released shall be surveyed for both fixed and removable contamination. No items shall be released if the survey results exceed the minimum detectable activity (MDA) associated with the survey protocols. The survey protocols shall be established to ensure that the MDAs do not exceed those specified in Table 5-4.

Table 5-4
Minimum MDAs Required For Free Release Surveys

Type Of Radiation	Fixed	Removable
Alpha	1,000 dpm/100 cm^2	100 dpm/100 cm^2
Beta	5,000 dpm/100 cm^2	500 dpm/100 cm^2

The MDA is defined as the smallest amount, or concentration, of radioactive material that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity. The MDA is dependent upon count times, geometry, sample size, detector efficiency background, and for the scanning rate and the efficiency of the surveyor.

Fixed and removable alpha measurements will only be taken on items if they are being removed from an area known or suspected to contain alpha contamination in excess of the free release criteria

Beta scans for fixed contamination will be performed by positioning the detector a half inch or less from the item being scanned and scanning at a rate not to exceed 1 detector width per second. Monitoring the audible output of the survey meter will result in an MDA in the range of 4,000 dpm/100 cm^2 to 5,000 dpm/100 cm^2.

Direct Measurements

The equation used for calculating the MDA for direct measurements is:

$$MDA = \frac{\frac{2.71}{t_s} + 3.29\sqrt{\frac{R_b}{t_s} + \frac{R_b}{t_b}}}{E\left(\frac{A}{100}\right)}$$ Equation 5.11.1

Where:
- MDA = Minimum Detectable Activity (dpm/100 cm^2)
- R_b = Background Count Rate (cpm)
- t_b = Background Count Time (min)
- t_s = Sample Count Time (min)
- A = Detector Area (cm^2)
- E = Detector Efficiency (c/d)

Beta Scans

The equation used for calculating the MDA for beta scans is:

$$MDA = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{E_i * E_s * \sqrt{p} * \frac{A}{100}}$$ Equation 5.11.2

Where:
- MDA = Minimum Detectable Activity (dpm/100 cm^2)
- d' = Decision error taken from Table 6-5 of MARSSIM
- i = Observation counting interval (scan speed divided by the detector width)
- b_i = Background count per observation interval
- E_i = Detector Efficiency (c/d)
- E_s = Surface Efficiency (typically around 50%)
- p = Surveyor Efficiency (typically 50%)
- A = Detector Area (cm^2)

6. ENVIRONMENTAL MONITORING PROGRAM

6.1 Effluent Monitoring and Control

By Amendment 11 to the Byproduct Material License (Ref. 2), the NRC allowed NSP to modify the Pathfinder radiological surveillance program. The effluent monitoring portion of this program had included 20 years of liquid effluent sampling. Discharges were well below allowed levels and regular periodic sampling was suspended. Sampling for special events was retained. In addition, an extensive radiological monitoring program was in effect during decommissioning of the Reactor Building and Fuel Handling Building. Radiological measurements were taken from samples of ambient air, groundwater, surface water, drinking water, bottom river sludge, raw milk, fish, plants, and soil. No detectable isotopes of attributable to licensed activities were found.

Since the decommissioning of the reactor plant and fuel storage facilities were completed in 1992, there have been no events or conditions that would have allowed for any significant transfer of the fixed contamination within the fossil system to the environment. Notwithstanding this consideration, NSP has taken samples of from site wells, soils, ditches, and settling ponds as part of the characterization survey. No significant contamination was found.

Environmental monitoring outside of the boundaries of the Turbine Building is not necessary for Pathfinder decommissioning activities. Only trace amounts of low airborne radioactive particles, if any, will be generated from decontamination activities. The spread of these particles will be programmatically controlled and locally confined to the remediation areas and will not affect the public. Doses to workers will be maintained ALARA and below the NRC requirements of 10 CFR 20. Releases of contaminated liquids to environmental pathways are not expected.

6.2 Airborne Radioactive Effluents

Cutting and grinding activities have the potential for generating airborne radioactivity. These activities will be monitored locally using portable air samplers or Continuous Air Monitors (CAMs) if necessary. Vacuum cleaners may be used to suppress dust and control airborne releases. These cleaners will be equipped with a High Efficiency Particulate Air-Purifying (HEPA) filter if necessary. See Section 5.10 herein for a description of the airborne controls within the Contamination Control Program.

6.3 Liquid Radioactive Effluents

No significant volumes of liquid radioactive wastes are expected to occur from decommissioning activities. There are currently no contaminated liquids stored on site. The site's groundwater and surface water are not contaminated. Only a few gallons of ordinary cleaning fluids or water will be used, if necessary, for simple decontamination and remediation purposes. Decommissioning activities may include the use of a few gallons of liquid chemical cleaners. These liquids will be collected and isolated from the normal liquid waste stream (the Turbine Building sumps). If these liquids become contaminated they will be appropriately disposed of in separate containers. Spills will be controlled to prevent contamination.

7. RADIOACTIVE WASTE MANAGEMENT

Radiologically controlled areas will be controlled to minimize the potential for spreading and generating radioactive waste. Whenever possible items in radiological controlled areas will be surveyed for free release and removed form the area. Items that cannot be adequately surveyed or items that do not meet the criteria for free release will be disposed of as radioactive waste.

All radioactive waste will be wrapped or placed in approved containers at the point of generation to minimize the spread of contamination. To the extent practical and in keeping with good radiological practices, various waste streams (liquids, used protective clothing, sludge, metals, etc.) will be surveyed and segregated. The waste will then be moved to an approved storage location where it will be packaged in approved shipping containers and staged for shipment. The waste will be packaged to minimize void spaces while ensuring that the design specifications of the shipping container are not exceeded. Waste containers staged for shipment will be surveyed, weighed, and labeled.

Based on the characterization data and the planned remediation activities, Xcel Energy estimates that less than 1,200 ft^3 of dry radioactive waste will be generated from decommissioning activities. A small amount of liquid radioactive waste may be generated from general cleaning activities and from sump cleaning activities. The amount of liquid waste, if any, is estimated to be less than less than 100 ft^3. This limited volume should require only one radioactive waste shipment to an off site treatment and disposal facility using an exclusive use vehicle. None of the waste is expected to exceed the criteria for low specific activity waste given in 49 CFR 173.403.

All radioactive waste generated during the decommissioning will be sent to Duratek's licensed facility in Oak Ridge, Tennessee for treatment and/or disposal. If necessary, some waste may be transshipped for disposal to the Envirocare facility in Clive, Utah using Duratek's pre-approved waste profiles. If appropriate, some waste may be surveyed and disposed of in an industrial landfill in Tennessee in accordance with

Duratek's license requirements. Treatment options include metal melt, incineration, and compaction. All secondary waste generated during treatment will be disposed of at Envirocare or provided to another license for beneficial reuse.

According to NUREG-0586, Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities, most of the dose to members of the public arising from the decommissioning of licensed facilities is due to the transportation of radioactive waste to the disposal site. Since the activity of the radioactive waste to be disposed of as a result of decommissioning the Pathfinder site is relatively small, the dose to members of the public due to the transportation of the resulting waste is expected to be negligible. A calculation was performed to estimate the potential dose. The results of this calculation indicate that a person in the vicinity of the waste (approx. 3 ft.) would be exposed to a dose of approximately 30 μR/hr. To further bound the potential dose, the Pathfinder decommissioning was compared to the decommissioning of the reference research reactor discussed in NUREG-0586, which included shipping spent fuel which is considerably more radioactive than the expected Pathfinder radwaste. According to NUREG-0586, the dose to members of the public due to the transportation of radioactive resulting from the decommissioning of the reference research reactor is negligible (< 0.1 man-rem).

8. FACILITY RADIATION SURVEY

8.1 Plan and Form of Final Status Survey

Final Status Survey Plan

A final status survey will be performed to demonstrate that the Pathfinder Site meets the criteria for release for unrestricted use. The Final Status Survey Plan is contained in Appendix G herein. The survey plan has been developed in accordance with guidelines delineated in NUREG-1757 Vol. 1, Section 15.4.3 and NUREG-1757 Vol. 2, Section 4.4.

Description of Final Status Survey

The results of final status surveys will be compiled into a report and submitted to the staff as part of a future license amendment request to terminate the Pathfinder Byproduct Materials License. This report will document the results of the final survey. The data from the final status survey will provide a record of the site radiological status. A comparison of the radiological status with the unrestricted release criteria will be provided. The format and content of the report will be in accordance with Section 4.5 of Volume 2 of NUREG-1757.

9. FINANCIAL ASSURANCE

9.1 Demonstration of Financial Assurance

By letter dated October 15, 2003 (Ref. 6), Xcel Energy provided the staff with an updated decommissioning financial assurance funding plan. This letter informed that the staff that Xcel Energy would increase the Pathfinder decommissioning funding letter of credit from $750K to $3M. This increase became effective on October 21, 2003. The $3M amount was greater than the site-specific cost estimate with considerable margin. The associated cost estimate provided within Reference 6 to support the funding increase was based on conservative assumptions on the nature and extent of the radioactive inventory at the Pathfinder Site and the related scope of remediation activities.

Since this plan was submitted, the detailed characterization survey indicates that the radioactive inventory, and therefore the scope of the proposed remediation activities, has decreased considerably. The cost estimate for the funding plan included an assumption that a significant portion of steam and condensate equipment located with the peaking plant would be removed and that 10% of that amount would be shipped offsite as radwaste. In light of recent characterization data, only a small amount of equipment will be removed, and the amount of radwaste to be shipped (approximately 1300 ft^3) will be considerably less than the previously estimated amount.

The other key assumptions for the cost estimate remain conservative and valid. In addition, costs to date for the decommissioning project have been paid by internal funds and have tracked according to forecast. The remediation portion of the decommissioning project is scheduled for completion by the end of 2005. The forecasted costs for 2004 decommissioning activities have not changed and are likely to be conservative. The estimated costs for the 2005 remediation effort, which is the largest decommissioning cost activity, are a function of the radioactive inventory. Barring any unforeseen circumstances, remediation costs will be significantly less than forecasted in the site specific cost estimate. Consequently, the financial assurance amount as presented by Xcel Energy by its letter dated October 15, 2003 letter is more than sufficient to cover the cost of the Pathfinder decommissioning activities and will not require adjustment.

Xcel Energy has used the guidance of Part A.18 to Appendix A of NUREG 1757, Consolidated NMSS Decommissioning Guidance, Vol. 3, Financial Assurance, Recordkeeping, and Timeliness, in demonstrating financial assurance for decommissioning. The financial assurance mechanism is a letter of credit (#NZS3361111- Wells Fargo) and standby trust agreement.

Since the Pathfinder decommissioning project is an active project that will remain active from now until decommissioning is complete, the site-specific cost estimate will be subject to ongoing periodic budget reviews. These comprehensive reviews will be conducted at least annually. The decommissioning activities are scheduled for completion no later than December 31, 2005.

10. QUALITY ASSURANCE

Xcel Energy has developed a Quality Assurance Project Plan (QAPP) to assure compliance with regulatory requirements. The QAPP is provided as Appendix E to this decommissioning plan. Decommissioning activities that affect quality are subject to applicable controls of the QAPP. Activities subject to the QAPP will be identified on the implementing documents such as procedures and instructions.

The QAPP includes descriptions of the Quality Assurance organization, document control, and other features of the Quality Assurance program. The program permits the use of contractor's procedures for activities such as survey methodology, chain of custody, and instrumentation selection and calibration. These procedures will be developed under an approved and current Quality Assurance plan that meets the requirements of the Pathfinder QAPP.

11. RESTRICTED USE AND ALTERNATE CRITERIA

Xcel Energy does not request termination of its material license using either restricted use or alternate criteria provisions of 10CFR20 Subpart E.

12. REFERENCES

1. Topical Report, Residual Radionuclide Distribution and Inventory at the Pathfinder Generating Plant, D.E. Robertson et al, Prepared for the USNRC under a Related Services Agreement with the US Department of Energy, Pacific Northwest Laboratory, Richland Division of Low-Level Waste Management and Decommissioning Headquarters Office, USNRC, June 1982 (Appendix C attached)

2. Letter from L. Callan, NRC, to T. Parker, NSP, November 10, 1992

3. B.M. Smith, Oak Ridge Institute for Science and Education, Confirmatory Radiological Survey of Portions of the Pathfinder Generating Station Sioux Falls, South Dakota, Prepared for the Division of Low-Level Waste Management and Decommissioning Headquarters Office, USNRC, November 1992

4. Letter from T. Parker, NSP, to USNRC, Evaluation of Decommissioning Radionuclide Release Data, February 15, 1993

   Letter from T. Parker, NSP, to USNRC, Amendment Request No.11, May 22, 1992

5. Letter from C. Bomberger, Xcel Energy, to USNRC, Financial Assurance for Pathfinder Decommissioning, October 15, 2003

6. Characterization Survey Report for the Pathfinder Plant in Sioux Falls South Dakota, December 2003, Rev. 0 (Appendix D attached)

Pathfinder Decommissioning Plan

Environmental Information Addendum

December 2004

groundwater is encountered at a depth of 71/2 feet and flows NE towards the river. The aquifer follows the river axis and pinches out along the flood plain edges where the shale is less eroded and found at a higher elevation.

The water-bearing portion of the Split Rock Creek Aquifer consists primarily of the deeper pink sand unit, which is thought to result from the weathering of Sioux Quartzite. This sand unit ranges in thickness from 0 to 60 feet. Upward flow direction has been documented for this aquifer at the Pathfinder site, which further protects it from contamination due to onsite infiltration.

Figure 3-3 illustrates the ground water flow patterns typically seen within the Big Sioux Aquifer. Continuous ground water elevation monitoring has shown variation in river elevation has little effect on flow direction. The Big Sioux River is predominately a gaining stream. Ground water travel velocities are estimated to range from 400 to 700 ft/yr.

Surface Water

The primary surface water in the vicinity of the Pathfinder site is the Big Sioux River. Usés of the water include casual drinking by cattle in pastures along the river and recreational fishing. The Big Sioux River is not a municipal water supply at any point between the plant and the rivers confluence with the Missouri River.

Average flow for the Big Sioux River is 270 cfs. Flooding is extremely flashy and generally endures less than a few days. They usually occur in the spring and often carry ice with them. Local damming and unnaturally high stages are, therefore, possible. These factors supported the adoption of a conservatively high flood stage for the design of the Pathfinder facilities.

Please see the response to Questions 8A through 8D in Appendix G of the Decommissioning Plan for additional information on hydrology.

3.4 Meteorology

The plant site is located east of Sioux Falls, South Dakota. It experiences a high plains continental climate with a large seasonal variation in temperature and precipitation. Upper level winds bring warm, dry air from the southwest and cold dry air from the Canadian interior. A southerly wind during the summer months brings moisture from the Gulf of Mexico; thus approximately 41 percent of the yearly precipitation falls during June, July, and August.

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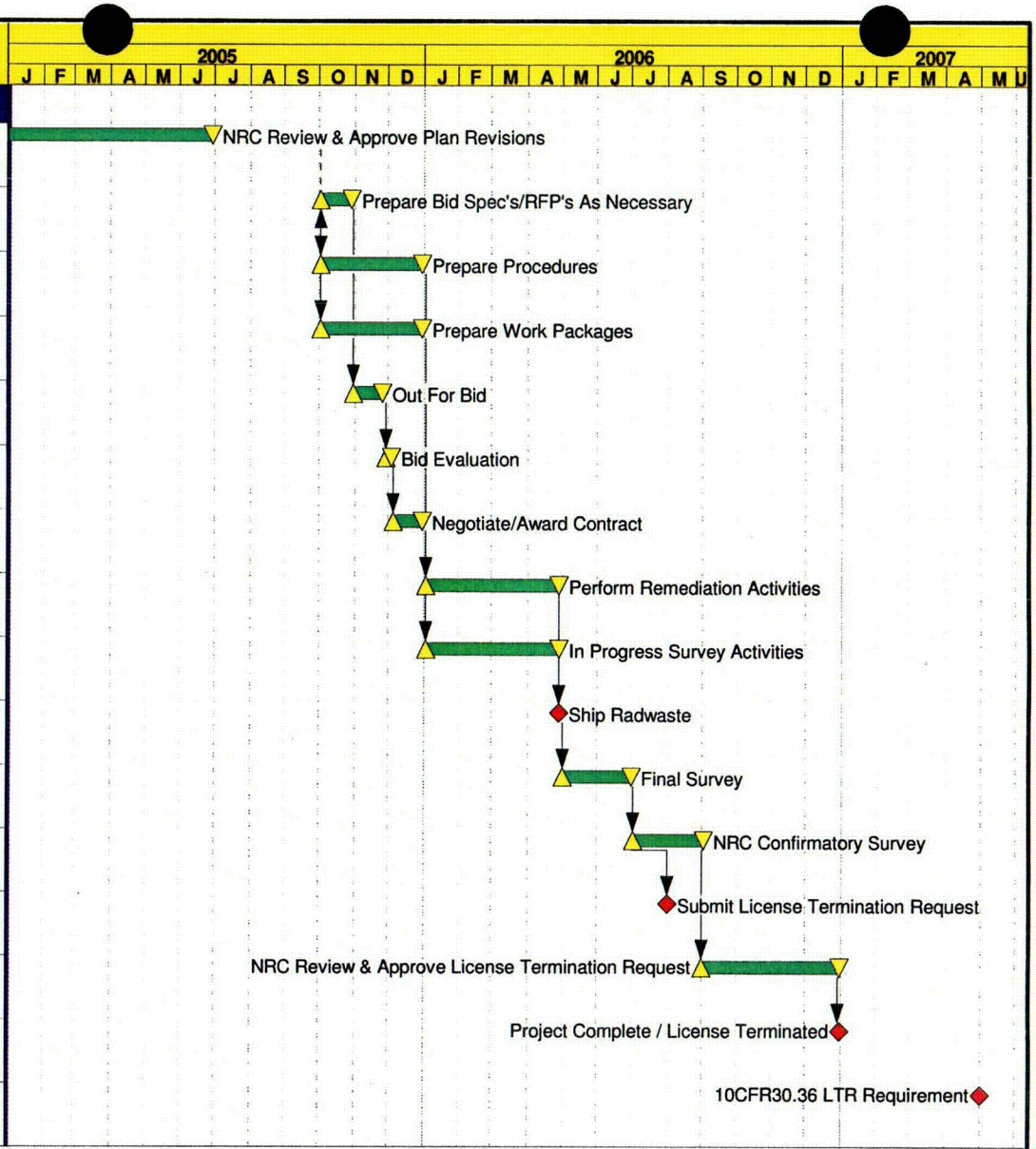
Activity ID	Activity Description	Rem Dur	% Comp	Early Start	Early Finish
Pathfinder Decommissioning Project					
A1290	NRC Review & Approve Plan Revisions	129	65	02FEB04A	29JUN05
A1330	Prepare Bid Spec's/RFP's As Necessary	20	0	03OCT05*	28OCT05
A1310	Prepare Procedures	65	0	03OCT05*	30DEC05
A1320	Prepare Work Packages	65	0	03OCT05*	30DEC05
A1340	Out For Bid	20	0	31OCT05	25NOV05
A1350	Bid Evaluation	5	0	28NOV05	02DEC05
A1360	Negotiate/Award Contract	20	0	05DEC05	30DEC05
A1400	Perform Remediation Activities	85	0	02JAN06	28APR06
A1410	In Progress Survey Activities	85	0	02JAN06	28APR06
A1420	Ship Radwaste	0	0		28APR06
A1500	Final Survey	45	0	01MAY06	30JUN06
A1650	NRC Confirmatory Survey	45	0	03JUL06	01SEP06
A1600	Submit License Termination Request	0	0		01AUG06
A1700	NRC Review & Approve License Termination Request	86	0	01SEP06	29DEC06
A1800	Project Complete / License Terminated	0	0		29DEC06
A1900	10CFR30.36 LTR Requirement	0	0		30APR07*



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PAF5 Sheet 1 of 1

Xcel Energy
Pathfinder Decommissioning Project
2005 / 2006

Date	Revision	Checked	Approved

ENVIRONMENTAL ADDENDUM

C01

Pathfinder Decommissioning Plan

December 2004

FINAL STATUS SURVEY PLAN

FOR THE

PATHFINDER PLANT

IN

SIOUX FALLS, SD

December 2004

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Executive Summary

This final status survey design plan is being submitted to supplement the discussion on the final status survey contained in the Pathfinder Decommissioning Plan, Reference 9.1. This plan describes the process that will be used to demonstrate that the Pathfinder site meets the criteria for release for unrestricted use. The facility operating history and facility description, including the radiological status of the Pathfinder site, is included in Sections 1 and 2 respectively of the Decommissioning Plan.

The primary scope of this final decommissioning effort is the low level contamination on surfaces contained within the Balance of Plant (BOP) systems. Several outbuildings that may have been used to support licensed activities are also included as well as the effluent discharge pathway leading to the Big Sioux River. A final status survey will be performed in each of these areas to demonstrate that they meet the criteria for release for unrestricted use. In addition, a final status survey will be performed within the fuel handling building to demonstrate that it continues to meet the criteria for release for unrestricted use. The Angus Anson Plant power block, which consists of two simple cycle combustion turbines, was constructed on the Pathfinder Site and placed into service in September 1994. The Angus Anson power block and the lands surrounding the Pathfinder Peaking Plant do not have a history of licensed activities will not receive a final status survey.

1.0 INTRODUCTION

This final status survey plan describes the process that will be used to demonstrate that the Pathfinder Site meets the criteria for release for unrestricted use. It was prepared in accordance with the guidance contained in NUREG-1575, and Volumes 1 and 2 of NUREG-1757. The survey design was based primarily on the results of the characterization survey performed in 2003, Reference 9.3. Following the completion of the final status surveys, a final status report will be prepared documenting that the Pathfinder Site meets the criteria for release for unrestricted use.

2.0 FACILITY DESCRIPTION

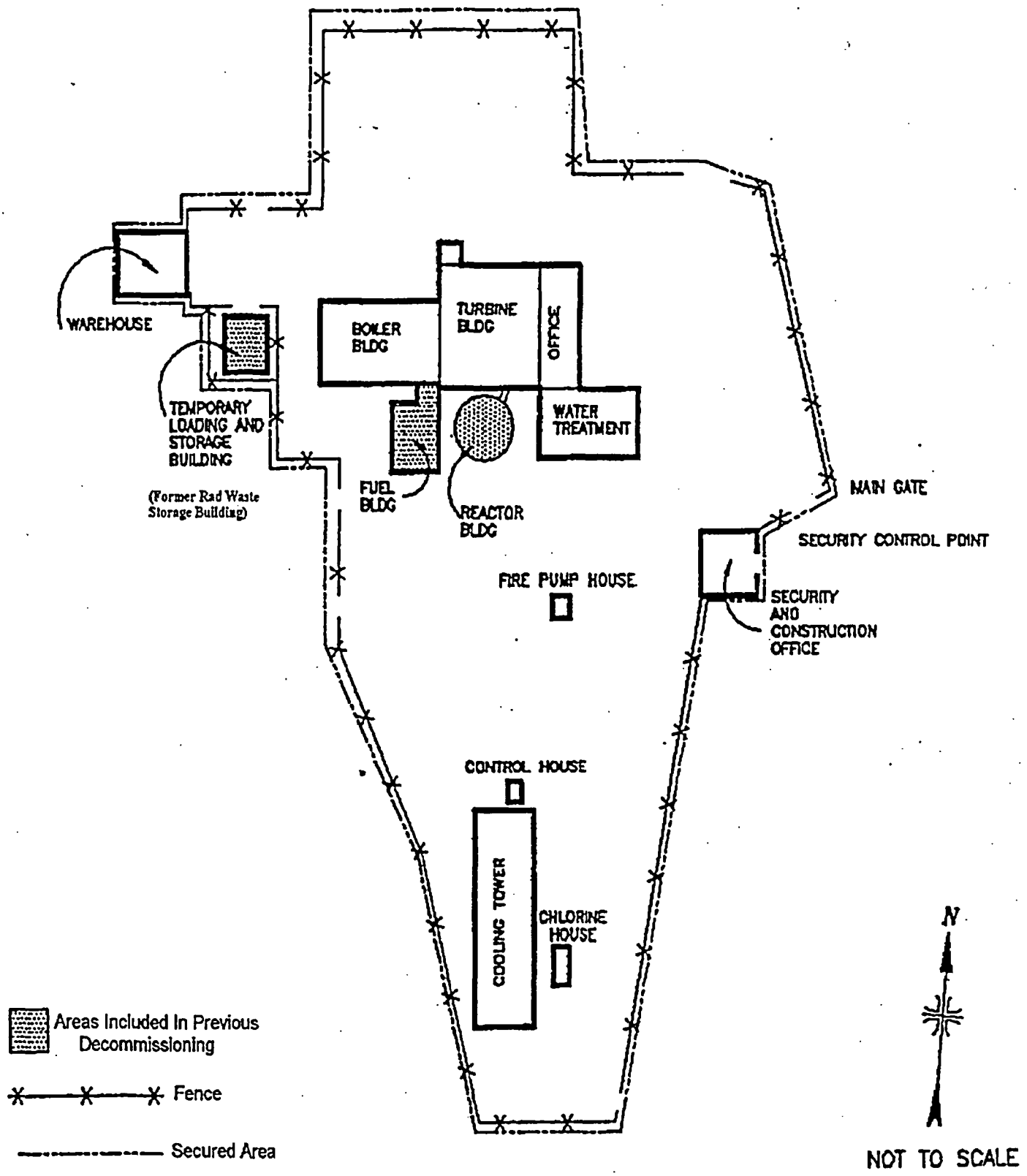
The Pathfinder Peaking Plant is located near Sioux Falls, South Dakota in Minnehaha County. The plant is currently owned and managed by Xcel Energy. The Pathfinder Plant was originally designed as an atomic power plant. The Pathfinder reactor achieved initial criticality on March 24, 1964, began commercial operation on August 6, 1966, and ceased operation on September 16,1967 due to a steam separator failure. The nuclear steam supply system (NSSS) was a 66 MWe (203 MWth) boiling water reactor designed by Allis-Chalmers Manufacturing Company of Milwaukee, Wisconsin. The reactor never achieved sustained full power operation. During the final shutdown, a condenser tube leak resulted in the contamination of the service water system and cooling tower basin. These systems were subsequently remediated. The nuclear fuel was shipped off site in 1970 and the plant was placed in SAFSTOR in 1971. During operation, plant effluents were discharged to the Big Sioux River.

Once operation of the reactor ceased the reactor was isolated from the balance of the plant, BOP, and the BOP decontaminated in preparation for its conversion into a gas/oil fired peaking station. The reconfigured plant began commercial operation in May 1969. The Pathfinder Peaking Plant consisted of three package boilers that burned natural gas and/or number six fuel oil. The steam cycle consisted of the boilers, turbine, condenser, low-pressure heaters, deaerator, feed pumps, and high-pressure heater. It continued to operate until July 2000 when the cooling tower collapsed during a storm.

In June 1990 the NRC approved the Decommissioning Plan for the Reactor Building, the Fuel Handling Building, and the Fuel Transfer Vault. Decommissioning of these structures was completed in May 1992. Following decommissioning the Reactor Building above grade was demolished and backfilled and capped. Figure 2.1 shows the current configuration of the Pathfinder plant.

Figure 2.1

Pathfinder Secured Area



The Pathfinder Peaking Plant is currently licensed by the NRC, license number 22-08799-02, to possess up to 41 millicuries (mCi) of byproduct materials.

In February 2003, the NRC was notified that operation of the Pathfinder Peaking Station had been terminated. Decontamination and decommissioning (D&D) activities were initiated with the intent of releasing the site for unrestricted use and termination of license 22-08799-02.

The Angus Anson Plant, which consists of two simple cycle combustion turbines was constructed on the Pathfinder site and placed into operation in September 1994. The Angus Anson Plant and the Pathfinder Peaking Plant share a common fire water system. A construction lay down area located behind the plant was used to dispose of non-radioactive waste.

See Section 2 of the Decommissioning Plan for additional information.

3.0 RADIOLOGICAL STATUS OF FACILITY

The current radiological status of the Pathfinder Site is based on the results of a comprehensive characterization survey of the site performed in October 2003.

The characterization survey was performed in accordance with a site specific characterization plan, based in part on information obtained from the Historical Site Assessment. The Historical Site Assessment identified numerous locations and systems where radioactivity was known to exist, or had the potential to exist. These areas were specifically included in the characterization survey. The characterization survey included the interior portions of the turbine, steam piping, the feedwater system, and the condensate system. Various plant systems were disassembled to facilitate the performance of the characterization survey.

The results of the characterization survey indicate that the amount of residual activity remaining within the Pathfinder Peaking Plant is relatively small and largely confined to several well-defined areas within the plant. The samples collected in the environs surrounding the plant did not identify any radioactivity attributable to licensed activities.

See Section 2.2 of the Decommissioning Plan for additional information.

3.1 Building Surfaces

A preliminary DCGL of 5,000 dpm/100 cm^2 was established for building surfaces to facilitate the characterization survey. Table 3.1 identifies those areas in which fixed activity in excess of the preliminary DCGL was identified.

Table 3.1
Areas With Residual Radioactivity In Excess of the Preliminary DCGL

Area Surveyed	Number Of Measurements	Mean dpm/ 100 cm^2	Maximum dpm/ 100 cm^2	Standard Deviation dpm/ 100 cm^2
Floor Drain Line Upstream Of Condenser	16	1,999	8,143	2,397
Floor Drain Line Downstream Of Condenser	27	10,253	38,714	7,233
Circ Water Piping Near Flange	15	1,292	12,631	3,174
Floor Under Condenser	20	969	8,075	1,731
Condenser Hotwell Bottom	20	1,518	5,849	1,869
Condenser Expansion Joint	30	1,872	12,757	3,662

The information provided in Table 3.1 is discussed further below.

Only the drain lines beneath the condenser could be effectively surveyed due to a blockage. It is possible that additional residual activity is present in the floor drain system beneath the basement floor on the hot side of the Turbine Building. These remaining lines were conservatively assumed to be contaminated for planning purposes.

The activity in the floor drain lines, hotwell, and condenser expansion joint may be higher than reported due to attenuation and self absorption. In addition, any debris remaining in the floor drain system may be contaminated. Only the floor area beneath the condenser in the basement of the Turbine Building appears to contain fixed contamination. The remaining floor surfaces in the basement of the Turbine Building did not have fixed activity in excess of the preliminary DCGL. The guidelines of NUREG-1757, Vol. 2, Appendix E.4 Sampling, will be adhered to if floor joints and cracks are encountered.

The affected area within the circulating water system piping near the flange appears to be limited to a small area. The affected area is limited to a small portion of the retired intake water pipe inside the Turbine Building. A recently installed blank flange isolates this piping from the cooling tower basin.

Biased samples were collected throughout the plant as part of the characterization survey. Table 3.2 below identifies those areas where residual activity attributable to licensed activities in excess of the Minimum Detectable Activity (MDA) were found.

Table 3.2
Biased Sample Analysis Results in Excess of MDA

Sample Location	Radionuclide	Activity (pCi/g)	MDA (pCi/g)
Condenser Expansion Joint (Turbine Building)	Co-60 Zn-65	2.35 E2 1.31 E0	2.70 E-1 7.62 E-1
Mud Drum (Boiler Building)	Co-60	1.05 E1	8.76 E-2
Condenser Hotwell (Turbine Building)	Co-60	9.09 E0	1.48 E-1
Condensate Pump Sump (Turbine Building)	Ag-108m Co-60 Eu-155	3.18 E3 2.12 E0 4.42 E1	2.09 E0 1.28 E0 2.88 E0
Turbine Building Sump Hot Side (Turbine Building)	Co-60 Cs-137 Eu-152 Eu-155	8.25 E0 8.65 E-1 2.08 E0 1.45 E0	9.34 E-2 8.98 E-2 7.76 E-1 2.27 E-1
		Activity (pCi/l)	**MDA (pCi/l)**
Hydrogen Cooler (Turbine Building)	H-3	1.40 E4	3.58 E-2

As Table 3.2 above shows, the radionuclides of interest for the decommissioning include: H-3, Co-60, Zn-65, Ag-108m, Cs-137, Eu-152, and Eu-155. This list of radionuclides will be reviewed prior to performing a final status survey in order to account for additional radioactive decay, the presence of previously unidentified radionuclides, and the effects of any remediation activities.

Table 3.3 below lists the half-lives of the radionuclides identified during the characterization survey.

Table 3.3
Half Lives Of Identified Radionuclides

Radionuclide	Half Life Years
H-3	12.28
Co-60	5.27
Zn-65	0.67
Ag-108m	127
Cs-137	30.17
Eu-152	13.6
Eu-154	8.8

There is presently no indication of significant radioactive contamination from reactor-originated sources on the building surfaces or structures at the Pathfinder Site other than certain portions of the Turbine Building and Boiler Building. The surfaces with fixed contamination in the Turbine Building include the following.

- The condenser hotwell and expansion joint
- The condensate pump area sump in the Turbine Building floor
- The turbine room sump (hot side) in the Turbine Building floor
- The Turbine Building floor under the condenser
- The Turbine Building floor drain piping (hot side)

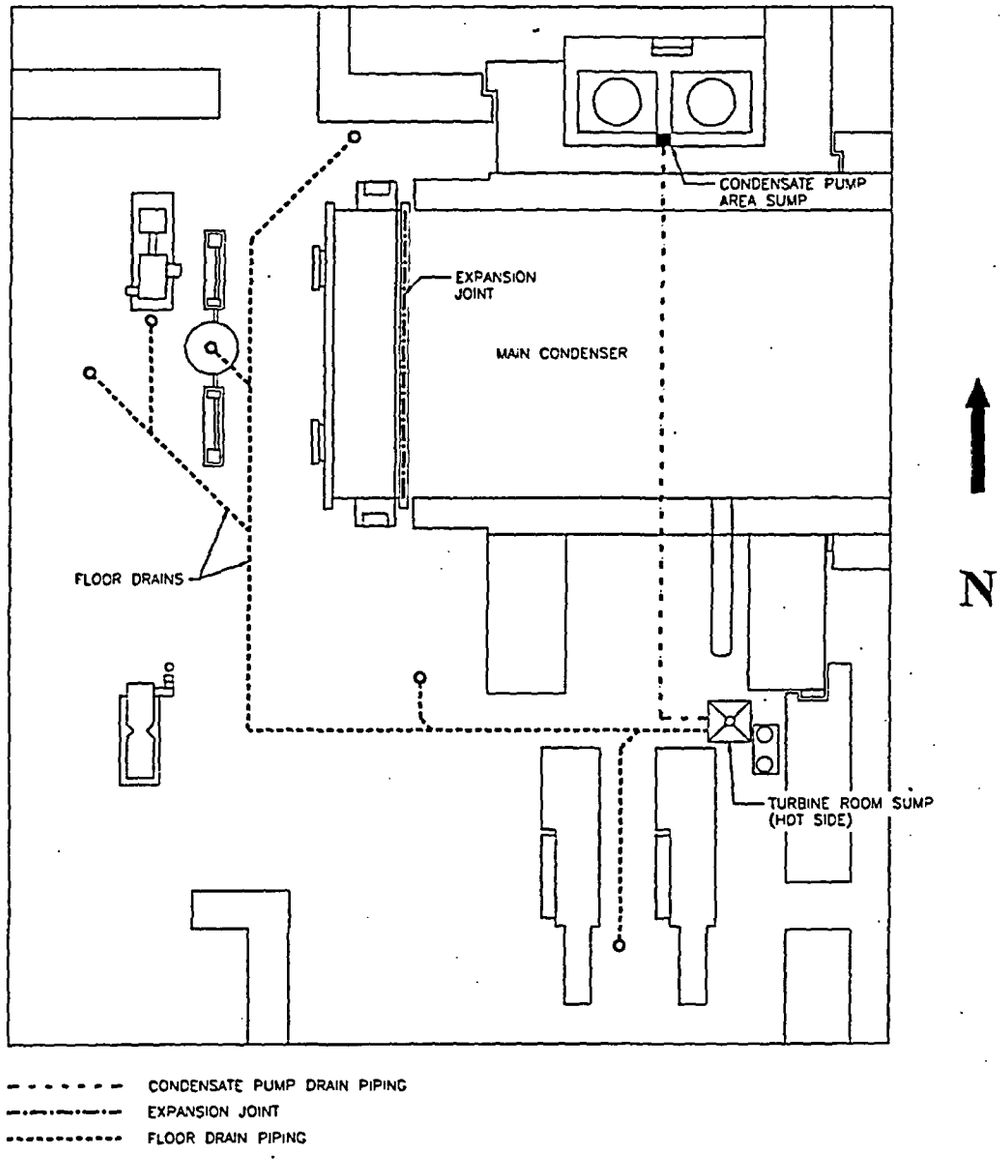
The above areas can be considered as part of the permanent structures of the Turbine Building. The condenser is considered to be a permanent part of the Turbine Building structure. The condenser weighs approximately 225 tons. The condenser hotwell is a large rectangular shaped box that forms the bottom of the condenser. The expansion joint is a large metallic section located between the water box and condenser shell that extends outward approximately 8 inches along the periphery of these two interfaces. During the construction of the Pathfinder Turbine Building, the Turbine Building basement was poured with concrete and the condenser was set in place. The remaining floors of the Turbine Building, which includes the mezzanine and the turbine operating deck, were built around the condenser. The sumps listed above are integral rectangular sections of the Turbine Building floor, which are recessed from the floor level to collect drains. The floor drain piping is embedded within the basement floor. Figure 3.1 shows the location of contaminated Turbine Building surface areas.

The contaminated building surfaces in the Boiler Building include the following.

- The boiler mud drums

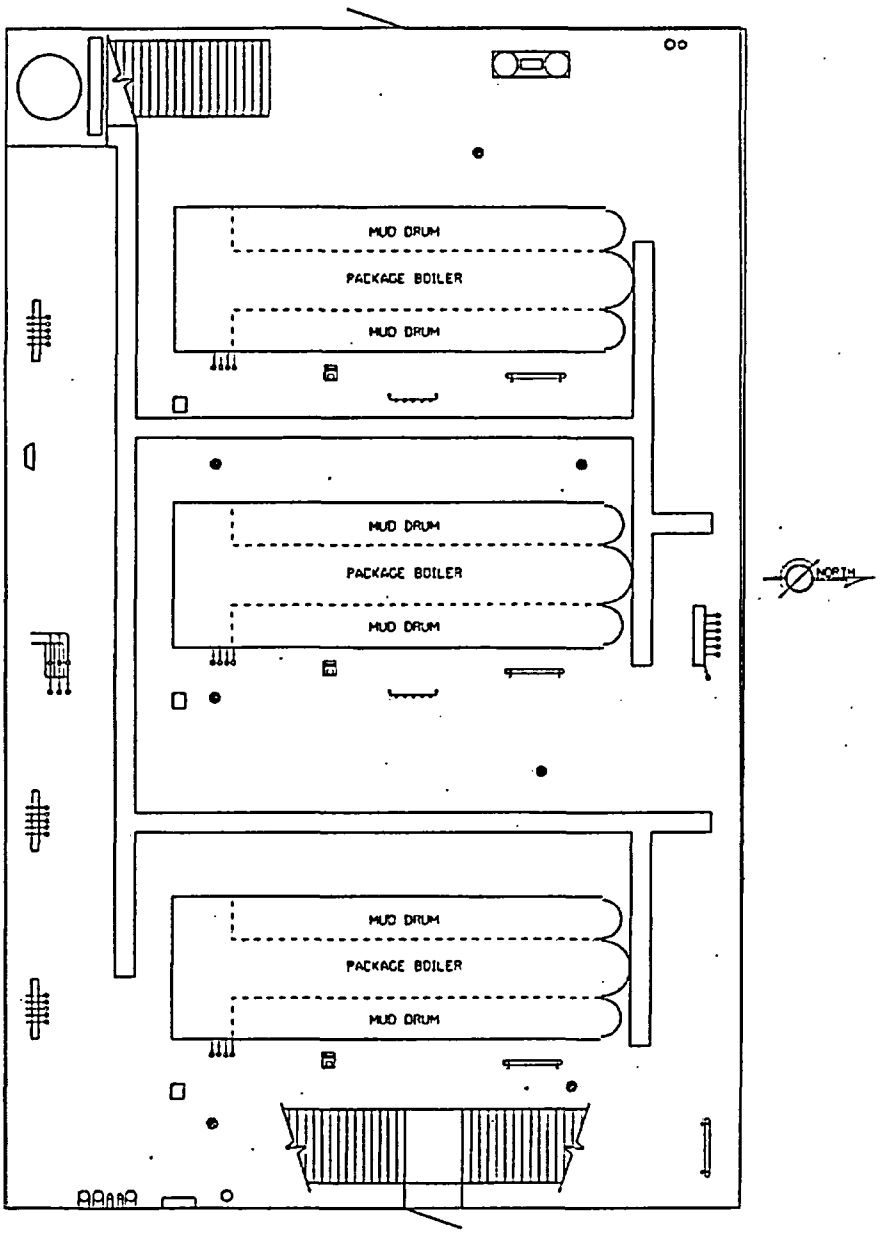
The boiler mud drums can also be considered as permanent structures. These drums are large heavy cylinders that are integral to the boiler and affixed to the boiler room floor. Figure 3.2 shows the location of the mud drums in the Boiler Building.

Figure 3.1
Contaminated Building Surfaces (Turbine Building)



TURBINE BUILDING
HOT SIDE – BASEMENT
(NOT TO SCALE)

Figure 3.2
Contaminated Building Surfaces (Boiler Building)



BOILER BUILDING
GROUND FLOOR
(NOT TO SCALE)

3.2 Systems and Equipment

Based on recent characterization surveys, there is presently no indication of radioactive contamination of systems and equipment from licensed activities in excess of the preliminary DCGL at the Pathfinder facility. This is consistent with the survey history of the facility. System and equipment include non-permanent portions of the Pathfinder Peaking Plant. No remediation activities of systems and equipment are planned.

3.3 Soil

Based on recent characterization surveys, there is no indication of radioactive contamination of soil from licensed activities at the Pathfinder facility. This is consistent with the survey history of the facility. No remediation activities of soil at the site will occur. The decommissioning activities are restricted to activities located within the Boiler and Turbine Buildings. Appropriate controls will be implemented to prevent cross-contamination of site soil from cutting, grinding, or cleaning of contaminated surfaces or from the storage and transportation of radwaste.

3.4 Surface Water and Groundwater

Based on recent characterization surveys, there is presently no indication of radioactive contamination of surface or groundwater from licensed activities at the Pathfinder building surfaces. This is consistent with the survey history of the facility. No remediation activities of surface or groundwater will occur. The decommissioning activities are restricted to certain equipment located within the Turbine Building. Appropriate controls will be implemented to prevent cross-contamination of site surface water and groundwater from cutting, grinding, or cleaning of contaminated surfaces or from the storage and transportation of radwaste.

4.0 UNRESTRICTED RELEASE CRITERIA

Subpart E of 10 CFR 20 allows license termination and the release of a site for unrestricted use if the residual radioactivity that is distinguishable from background does not result in a total effective dose equivalent to an average member of the critical group in excess of 25 mrem per year and the residual radioactivity has been reduced to levels that are as low as reasonably achievable, ALARA. Appendix B of NUREG-1757, Volume 1 provides radionuclide specific screening values that may be used to demonstrate compliance with the requirements of Subpart E of 10 CFR 20. See also the response to Question 11 in Appendix G of the Decommissioning Plan.

4.1 Building Surfaces

For building surfaces, the criteria for release for unrestricted use will generally be those found in Appendix B of NUREG-1757, Volume 1. The criteria for radionuclides not contained within Appendix B will be calculated using the NRC's D&D Code, Version 2.1. The criteria for radionuclides not contained in either Appendix B or available within the NRC's D&D Code will be calculated

using RESRAD BUILD, Version 3.21. The assumptions of the models were verified applicable to the Pathfinder site. The only radionuclide identified during the characterization survey not contained in either Appendix B or available within the NRC's D&D Code is Ag-108m. Since Ag-108m was identified in only one area within the plant and that area will be remediated, it is quite possible that Ag-108m will not be a radionuclide of interest during the final status survey.

The criteria for building surfaces will be applied to building surfaces, which includes permanent structures. Examples of permanent structures within the Pathfinder Peaking Plant include items that are encased within or permanently affixed to building surfaces such as embedded piping, large steam lines, the main condenser, and package boilers.

The criteria specified for building surfaces is in terms of total activity. When applying the criteria it will be verified that the removable activity does not exceed 10% of the criteria for total activity. When more than one radionuclide is present the sum of the fractions rule will apply as will allowances for hard to detect radionuclides.

Table 4.1 lists the criteria that will be used for building surfaces to demonstrate that the Pathfinder Site is acceptable for release for unrestricted use.

Table 4.1
Criteria For Demonstrating Building Surfaces Are Acceptable For Release For Unrestricted Use

Radionuclide	Criteria dpm/100 cm^2
H-3	1.2 E8 [1]
Co-60	7.1 E3 [1]
Zn-65	4.8 E4 [2]
Ag-108m	1.7 E4 [3]
Cs-137	2.8 E4 [1]
Eu-152	1.3 E4 [2]
Eu-154	1.1 E4 [2]
Eu-155	1.6 E5 [2]

[1] Taken from Appendix B to NUREG-1757, Volume 1
[2] Derived from a calculation using the NRC's D&D Code, Version 2.1
[3] Derived from a calculation using RESRAD BUILD, Version 3.21.

The D&D and RESRAD BUILD computer runs used to calculate the criteria for release for unrestricted use were provided as Appendixes of the Pathfinder Decommissioning Plan.

4.2 Soils - Including Open Land Areas

For soils at the Pathfinder Site, the criteria for release for unrestricted use will generally be those found in Appendix B of NUREG-1757, Volume 1. The criteria for radionuclides not contained within Appendix B were calculated using the NRC's D&D Code, Version 2.1.

The criteria for soils will be applied to open land areas surrounding the Pathfinder Plant and to soils that may be encountered within the plant during remedial activities. The criteria may also be applied to limited volumes (i.e. less than 100 ft^3) of volumetrically contaminated concrete. If more than 100 ft^3 of volumetrically contaminated concrete is encountered, and if the contaminated concrete will remain following remediation, a site-specific dose evaluation will be prepared and forwarded to the NRC for approval. When more than one radionuclide is present the sum of the fractions rule will apply as will allowances for hard to detect radionuclides.

Table 4.2 lists the criteria that will be used for soils to demonstrate that the Pathfinder Site is acceptable for release for unrestricted use.

Table 4.2
Criteria For Demonstrating Soils Are Acceptable For Release For Unrestricted Use

Radionuclide	Criteria (pCi/g)
H-3	1.1 E2[1]
Co-60	3.8 E0[1]
Zn-65	1.1 E1[2]
Cs-137	1.1 E1[1]
Eu-152	8.7 E0[1]
Eu-154	8.0 E0[1]
Eu-155	2.8 E2[2]

Source:
[1] Taken from Appendix B of NUREG-1757, Volume 1
[2] Derived from a calculation using the NRC's D&D Code Version 2.1.

The D&D computer runs used to calculate criteria for release for unrestricted use were provided as an Appendix of the Pathfinder Decommissioning Plan.

4.3 Non-Permanent Structures

For non-permanent structures, the criteria for release for unrestricted use will be taken from NRC Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors. Table 4.3 lists the criteria that will be used for systems and equipment to demonstrate that the Pathfinder Site is acceptable for release for unrestricted use. Examples of non-permanent structures within the Pathfinder Peaking Plant include small pumps and valves, work benches, etc. When more than one radionuclide is present the sum of the fractions rule will apply as will allowances for hard to detect radionuclides.

The criteria specified for non-permanent structures are in terms of total activity. To be consistent with the criteria for release for unrestricted use of building surfaces, when applying the criteria for non-permanent structures it will be verified that the removable activity does not exceed 10% of the criteria for total activity.

Table 4.3
Criteria For Demonstrating Systems and Equipment Are Acceptable For Release For Unrestricted Use

Radionuclide	Criteria dpm/100 cm^2
H-3	5,000
Co-60	5,000
Zn-65	5,000
Ag-108m	5,000
Cs-137	5,000
Eu-152	5,000
Eu-154	5,000
Eu-155	5,000

4.4 Gross Activity Measurements

When gross activity measurements are used to demonstrate compliance with the criteria for release for unrestricted use, as will be done to evaluate building surfaces and non-permanent structures, a gross activity guideline value, GV, will be calculated as follows.

$$GV = \frac{F}{\left(\frac{f_1}{C_1} + \frac{f_2}{C_2} + \frac{f_3}{C_3} + \ldots \frac{f_n}{C_n}\right)}$$ Equation 4.1

Where:

GV = The gross activity guideline value that equates to 25 mrem/yr (dpm/100 cm^2)

F = The fraction of the radionuclide mix which is considered detectable based on the radionuclide beta yields and end-point energies relative to the radionuclide used to calibrate the detector (unitless)

f_i = The relative fraction of radionuclide *i* in the mix (unitless)

C_i = The radionuclide specific criteria for release for unrestricted use (dpm/100 cm^2)

The relative fraction of the radionuclide mix (f_i) will be obtained from representative samples analyzed for all radionuclides of concern. If the relative fractions for different samples vary greatly, either area dependent GVs will be calculated or the most conservative GV used.

4.5 Radionuclide Specific Activity Measurements

When radionuclide specific activity measurements are used to demonstrate compliance with the criteria for release for unrestricted use, as will be done to evaluate soil samples collected from open land area, the sum of fractions will be used as follows.

$$SF = \frac{A_1}{C_1} + \frac{A_2}{C_2} + \frac{A_3}{C_3} + ... \frac{A_n}{C_n} \qquad \text{Equation 4.2}$$

Where:

SF = Sum of the Fractions (unitless)

A_i = The activity concentration of radionuclide i (pCi/g)

C_i = The radionuclide specific criteria for release for unrestricted use (pCi/g)

5.0 SURVEY OVERVIEW

5.1 Data Quality Objectives

The objective of the final status survey is to obtain data that will demonstrate that the Pathfinder Site meets the criteria for unrestricted use. To ensure that this objective is met, the survey plan will:

- ensure that only properly trained, experience individuals participate in the final status survey,
- ensure that the instrumentation selected is appropriate for the radionuclides of interest,
- ensure that the instrumentation is operated such that the required minimum detectable activities are achieved,
- ensure that a statistically significant number of measurements and or samples are collected from each survey unit,
- ensure that the resulting survey data is properly analyzed,
- ensure that outliers or areas of elevated activity are investigated, and
- ensure that proper documentation is maintained to define and justify survey protocols

Surveys and data evaluation will be based on the guidance in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, and include measurements for total surface activity, removable activity and exposure rates.

5.2 Non Parametric Statistics

5.2.1 Building Surfaces

Compliance with the release for unrestricted use of building surfaces will be demonstrated by total beta activity measurements. Since these measurements are not radionuclide specific, it may be necessary to use the Wilcoxon Rank Sum Test to evaluate the resulting data. The Wilcoxon Rank Sum Test will be used to evaluate survey data from survey units in which the average of the beta measurements are less than the criteria for release for unrestricted use but which have individual measurement results exceeding the criteria. Each survey unit evaluated using the Wilcoxon Rank Sum Test will be compared to an appropriately chosen Reference Area.

If an individual measurement result exceeds the DCGL, the area from which the measurement was collected will also be evaluated using the elevated measurement criteria.

5.2.2 Soils

Most of the radionuclides of interest are not expected to be present in background. For those that may be present, the criteria for release for unrestricted use are large relative to the expected background activity concentrations. For these radionuclides it will be assumed, for the purpose of evaluating final survey data, that they are not present in background. Since compliance with the criteria for release for unrestricted use for soils will be demonstrated by gamma spectroscopy, which is a radionuclide specific analysis, the results of the final status survey for soils will be evaluated using the Sign Test if necessary. The Sign Test does not require the use of reference background areas.

The Sign Test will be used to evaluate survey data from survey units in which the average sample analysis results exceed the criteria for release for unrestricted use, which have individual analysis results exceeding the criteria.

If an individual sample analysis result exceeds the criteria for release for unrestricted use, the area from which the sample was collected will also be evaluated using the elevated measurement criteria.

5.3 Decision Errors

There are two types of decision error applied to analytical results: Type I (α) and Type II (β) errors. A Type I error, or false positive, is the probability that a survey result/measurement is above the release criteria when in fact it is not, while a Type II error, or false negative, is the probability of determining that a result/measurement is below the release criteria when it is not. The probability of

making decision errors can be controlled by adopting an approach called hypothesis testing.

The null hypothesis (H_0) is treated like a baseline condition and is defined by MARSSIM as:

H_0 = residual radioactivity in the survey exceeds the release criterion.

This means that the site or survey area is assumed contaminated until proven otherwise. For the purpose of this final status survey, both Type I (α) and Type II (β) errors will be set at 0.05 or 5 percent.

5.4 Relative Shift

The relative shift is defined as Δ / σ, where Δ is the DCGL - LBGR (Lower Bound of the Gray Region) and σ is the standard deviation of the contaminant distribution. In order to calculate the relative shift, the DCGL must be determined and two assumptions made to estimate the LBGR and the standard deviation of the measurement distribution. MARSSIM suggests that the LBGR be set at approximately 50% of the DCGL but can be adjusted later to provide a value for the relative shift between the range of 1 to 3. The standard deviation may be calculated from preliminary survey data, prior surveys of similar areas and materials or the standard deviation of a reference background area. It should be noted that σ represents the standard deviation prior to release after all area decontamination is thought to be complete. If no reference data is available to make a reasonable estimate, MARSSIM suggests using 30% of the mean survey unit background.

5.5 Number Of Samples and/or Measurements

The number of samples and/or measurements to be collected in each survey unit is dependent on the non-parametric statistics to be used to test the null hypothesis, acceptable decision errors, and the relative shift. In cases where scanning sensitivities are not adequate to see the criteria for release for unrestricted use, the number of samples and measurements will need to be increased. Since non-radionuclide specific direct beta measurements will be used to evaluate the criteria for release for unrestricted use on building surfaces and non-permanent structures, they may be evaluated using the Wilcoxon Rank Sum Test. The Sign Test may also be used if appropriate.

Soil samples will be evaluated by gamma spectroscopy in order to quantify the activity concentration of the radionuclides of interest. Since the results of a gamma spectral analysis are radionuclide specific, the Sign Test may be used to evaluate the analysis results.

See the response to Question 10 in Appendix G herein for information regarding the background determination and methodology.

5.5.1 Wilcoxon Rank Sum Test

Once the relative shift, Δ / σ, has been determined and the decision errors defined, Table 5.1 can be used to determine the number of measurements or samples required to evaluate a given survey unit. The interpolated value of N/2 gives the number of measurements required within a given survey unit. An equal number, N/2, of measurements are required from within the reference area.

Table 5.1
Values Of N/2 For The Wilcoxon Rank Sum Test
When α Equals β Equals 0.05

Δ / σ	N/2 Number Of Measurements Or Samples
0.1	2726
0.2	685
0.3	307
0.4	175
0.5	114
0.6	81
0.7	61
0.8	48
0.9	39
1.0	32
1.1	28
1.2	24
1.3	22
1.4	19
1.5	18
1.6	16
1.7	15

Regardless of the value of Δ / σ, a minimum of 15 measurements or samples will be collected in each survey unit.

5.5.2 Sign Test

Once the relative shift, Δ / σ, has been determined and the decision errors defined, Table 5.2 can be used to determine the number of samples required to evaluate a given survey unit. The interpolated value of N gives the number of measurements required within a given survey unit. When using the Sign Test, samples are not required from a reference area.

Table 5.2
Values Of N For The Sign Test
When α Equals β Equals 0.05

Δ / σ	N Number Of Measurements Or Samples
0.1	2048
0.2	518
0.3	234
0.4	136
0.5	89
0.6	65
0.7	50
0.8	40
0.9	34
1.0	29
1.1	26
1.2	23
1.3	21
1.4	20
1.5	18
1.6	17
1.7	17
1.8	16
1.9	16
2.0	15

Regardless of the value of Δ / σ, a minimum of 15 measurements or samples will be collected in each survey unit.

5.6 Elevated Measurement Criteria

Measurement and sample analysis results that exceed the DCGLs will require that the area from which the result was obtained be evaluated using the elevated measurement criteria. The elevated measurement criteria is size dependent. Once the size of the area associated with the elevated activity is determined, it is input along with the elevated measurement result into the computer code used to calculate the DCGL. The resulting annual dose divided by the criteria for release for unrestricted use, 25 mrem/yr, is the elevated measurement criteria. If the measurement/sample analysis result divided by the DCGL exceeds the elevated measurement criteria, the survey unit in question does not meet the criteria for release for unrestricted use. Please see Question 5 of Appendix G to the Decommissioning Plan and Addendum A herein for a detailed discussion of area factors and elevated measurement criteria.

6.0 SURVEY DESIGN AND IMPLEMENTATION

6.1 Instrumentation

Survey instrumentation and count times will be selected to ensure that their sensitivities are sufficient to detect the identified radionuclides at the minimum detection requirements. Table 6.1 provides a list of the instruments to be used during the final status survey.

The Ludlum Model 2350 Data Logger was used in combination with a large area gas flow proportional detector for obtaining measurements of total beta activity and for performing beta scans. The data logger is a portable microprocessor computer based counting instrument. The data logger is designed to operate with a wide variety of detectors. It will also be used in combination with sodium iodide detectors for obtaining exposure rate measurements and with a series of gas flow and/or GM pipe probes for obtaining total beta activity measurements within pipes, drains, etc.

Analysis for removable beta activity was performed using an Eberline BC-4 or analyzed off site using an automated smear counter.

Instruments used to measure total and/or removable beta activity will be calibrated using Tc-99 sources. The use of instrumentation calibrated to Tc-99 is considered conservative at this time. If appropriate, the efficiencies of field instrumentation will be adjusted to account for lower counting efficiencies typically observed when making field measurements due to self attenuation and self-absorption in accordance with the guidance contained in NUREG-1507.

Table 6.1
Survey Instrumentation

Instrument/Detector	Detector Type	Radiation Detected	Calibration Source	Use
Ludlum Model 2350 with. 43-68 detector	Gas-Flow proportional ($126cm^2$)	Alpha Beta	^{230}Th ^{99}Tc	Total Alpha and Beta Measurement and Beta Scans.
Eberline BC-4	Shielded GM	Beta	^{99}Tc	Smear Counting
Eberline SAC-4	Zinc Scintillator	Alpha	^{230}Th	Smear Counting
Ludlum Model 2350 with 44-2 or 44-10 detector	NaI (Tl) Scintillator	Gamma	^{137}Cs	Exposure Rates
Ludlum Model 2350 with PSL 3R detector	Gas-Flow Proportional Pipe Detector	Beta	^{99}Tc	Total Beta Activity Measurements

The data loggers, associated detectors, and all additional portable instrumentation are calibrated on a semi-annual basis using National Institute of Technology, NIST, traceable sources and calibration equipment. Procedures for calibration, maintenance, accountability, operation, and quality control of instrumentation will implement the appropriate guidance established in American National Standard Institute, ANSI, standards ANSI N323-1978 and ANSI N42.17A-1989. The protocols and efficiencies for the Ludlum 2350 are discussed in the response to Question 12 in Appendix G herein.

Calibration typically includes the following.

- High voltage calibration
- Discriminator/threshold calibration
- Window calibration
- Alarm operation verification
- Scaler calibration verification

Detector calibration includes the following.

- Operating voltage determinations
- Calibration constant determinations
- Dead time correction determinations

Calibration labels showing the instrument identification number, calibration date, and calibration due date will be attached to all instruments. All instrumentation will be inspected and source checked daily, before use, to verify calibration status and proper operation. Control charts and/or source check criteria will be established prior to the initial use of the instrument.

Sources

All sources used for calibration or efficiency determinations for the survey will be representative of the instrument's response to the expected radionuclides and will be traceable to NIST.

Health physics technicians will control all radioactive sources used for instrument response checks and efficiency determination. Sources will be stored in a secure location when not in use.

Off Site Sample Analysis

Eberline Services will analyze all samples collected during the characterization survey, with the exception of smears collected for accessing removable alpha and beta activity. All samples, with the exception of smears for accessing removable activity, will be analyzed by gamma spectroscopy in order to identify and quantify gamma-emitting radionuclides that may be present. Liquid samples, and selected smears will be analyzed for H-3.

6.2 Minimum Detectable Activity

Minimum Detectable Activity (MDA) is defined as the smallest amount or concentration of radioactive material that will yield a net positive count with a 5% probability of falsely interpreting background responses as true activity. The MDA is dependent upon count times, geometry, sample size, detector efficiency background, and for the scanning rate and the efficiency of the surveyor. Per MARSSIM guidance, the specified MDAs are considerably less than the release criteria. The MDAs for direct beta measurements and for the analyses of removable beta activity during the final status survey will be less than 1,000 dpm/100 cm^2 and 200 dpm/100 cm^2 respectively.

Beta scans will be performed by positioning the detector a half inch or less from the surface being scanned and scanning at a rate not to exceed 1 detector width per second. Monitoring the audible output of the survey meter will result in an MDA of approximately 5,000 dpm/100 cm^2.

Direct Measurements

The equation used for calculating the MDA for direct measurements is:

$$MDA = \frac{\frac{2.71}{t_s} + 3.29\sqrt{\frac{R_b}{t_s} + \frac{R_b}{t_b}}}{E\left(\frac{A}{100}\right)}$$ Equation 6.1

Where:
- MDA = Minimum Detectable Activity (dpm/100 cm^2)
- R_b = Background Count Rate (cpm)
- t_b = Background Count Time (min)
- t_s = Sample Count Time (min)
- A = Detector Area (cm^2)
- E = Detector Efficiency (c/d)

Beta Scans

The equation used for calculating the MDA for beta scans is:

$$MDA = \frac{d' * \sqrt{b_i} * \frac{60}{i}}{E_i * E_s * \sqrt{p} * \frac{A}{100}}$$ Equation 6.2

Where:
- MDA = Minimum Detectable Activity (dpm/100 cm^2)
- d' = Decision error taken from Table 6-5 of MARSSIM

i = Observation counting interval (scan speed divided by the detector width)
b_i = Background count per observation interval
E_i = Detector Efficiency (c/d)
E_s = Surface Efficiency (typically around 50% for beta contamination on concrete)
p = Surveyor Efficiency (typically 50%)
A = Detector Area (cm^2)

Table 6.2 summarizes the radionuclide specific MDAs required of the off site laboratory supporting the final status survey.

Table 6.2
Minimum Detectable Activities for Radiochemical Analysis

Radionuclide	MDA
Co-60, Cs-137, Ag-108m	0.1 pCi/g
H-3	10 pCi/g

MDAs for field measurements are shown in table 6.3

6.3 Survey Units

Survey units are discrete areas, consisting of building surfaces or land areas, of a specific size and shape for which separate decisions relative to the criteria for release for unrestricted use are made. All impacted areas are divided into survey units based on the area's history, potential for residual contamination, and physical characteristics. Impacted areas are those areas that had a potential of being contaminated. Non-impacted areas are areas that did not have a potential for being contaminated and are not surveyed as part of the final status survey.

All areas to be surveyed as part of the final status survey will be divided into survey units to facilitate survey planning, performance of the survey and the analysis of the survey results. Survey units are defined based on physical characteristics, history, and potential for residual contamination following remedial activities.

All survey units are classified as Class 1, 2, or 3 based on the following.

- A Class 1 survey unit is a survey unit that has or had prior to remediation contamination levels approaching >75% or exceeding the criteria for release for unrestricted use. The Fuel Storage Building, which was remediated and free released during the previous decommissioning, is the sole exception to this classification. It will initially be classified as a Class 3 survey unit.
- A Class 2 survey unit is a survey unit that does not have contamination approaching >75% or exceeding the criteria for release for unrestricted use. Typically Class 2 survey units are not remediated. If remediation is required the survey unit will be reclassified as a Class 1.

- A Class 3 survey unit is a survey unit that is not expected be contaminated or is expected to have contamination exceeding a small fraction (<25%) of the criteria for release for unrestricted use.

Survey areas are limited in size to ensure adequate survey coverage. The size limits are specified in Table 6.3.

Table 6.3
Survey Area Size Limits

Survey Unit Classification	Size Limit, m^2
Class 1	
Building Surfaces	< 100
Land Areas	< 2,000
Class 2	
Building Surfaces	<1,000
Land Areas	< 10,000
Class 3	
Building Surfaces	No limit
Land Areas	No limit

Table 6.4 provides a list of impacted areas, which will be divided into survey units, and their anticipated classification based on the historical site assessment and the characterization survey results, Reference 9.3.

Table 6.4
Impacted Areas

Area Description	Classification
Turbine Building Basement Hot side	1*
Turbine Building Basement Cold Side	2
Turbine Building Basement Floor Beneath Condenser	1
Turbine Building Basement Floor Drain Lines And Hot Side Sump	1
Condenser Hotwell	1
Turbine Building Stairwells	2
Turbine Building Elevator	2
Turbine Building Mezzanine	2
Turbine Building Mezzanine Rad Waste Storage Room	1
Water Treatment Building	2
Maintenance Shops	2
Administrative Building	3
Control Room	3
Turbine Deck	3

Table 6.4
Impacted Areas (cont.)

Area Description	Classification
Turbine	2
Fuel Storage Building	3
Boiler Building First Floor	2*
Boiler Building Second Floor	3
Boiler Building Mud Drums	2
Boiler Building Floor Drain Lines And Sump	2
Turbine Building and Fuel Handling Building Roofs	3
Warehouse	3
Temporary Loading and Storage Building	2*
Security and Construction Office	3
Fire Pump House	3
Cooling Tower Basin	2
Effluent Discharge Pathway Including Settling Basins	2
Construction Laydown Area	2
Open Land Areas Surrounding the Pathfinder Plant and Extending to the Big Sioux River	3
Paved Areas surrounding the Pathfinder Plant	3

* Increment this classification by one for walls and ceilings above 2 meters

Depending on the size and complexity of the areas listed in Table 6.4, some areas may be subdivided into multiple survey units.

6.4 Survey Packages

Survey packages will be developed for each survey unit. The survey package will include survey instructions, list the appropriate location codes for tracking the data, and identify any abnormal conditions or safety concerns that may be encountered during the survey. As the survey progresses, the survey results and the results of any analyses will be placed in the survey package. Signatures will be required of those individuals completing specific portions of the survey and of those reviewing the specific portions. The signature blocks will be used to track the progress of the survey.

6.5 Gridding

All class 1 and 2 survey units will be gridded. The grid spacing for the measurement and samples will be determined assuming a square grid pattern as follows.

$$L = \sqrt{\frac{A}{N}} \qquad \text{Equation 6.3}$$

Where A = Survey unit area (m^2)
N = Number of measurements
L = Grid spacing (m)

Once the survey unit has been gridded, the measurement and sampling locations within each grid will be determined by generating a pair of random numbers. The random number pair will be multiplied by the grid spacing, L, to provide an offset from the grid reference point using an x y coordinate system. The reference point for each grid will generally be the southwest corner of the grid. The same offset from the grid reference point will generally apply to all the grids in a given survey unit. If by chance the designated measurement or sampling location in a given grid is not acceptable an alternative pair of random numbers may be used to provide an offset from the grid reference point as long as the need for the alternate pair of random numbers is recorded in the appropriate survey package.

Once gridded, it will be verified that the number of grid locations satisfies the calculated number of measurements. If not, then smaller grid spacing will be used to ensure the appropriate number of measurements and samples are obtained.

6.6 Survey Protocols

The final status survey of the building will consist of beta scans, fixed beta measurements, and smears for gross alpha and gross beta analysis. The survey of the facility grounds will consist of gamma scans and soil sampling for gamma spectroscopy analysis. Surveys will be performed as follows.

6.6.1 Surface Scans

Beta Scans

For class 1 survey units, beta scans will be performed over 100% of the accessible building surfaces using a gas-flow proportional detector while listening to the audible output of the instrument. For class 2 survey units, beta scans will be performed over approximately 50% of the accessible building surfaces. For class 3 survey units, beta scans will be performed over approximately 10% of the accessible building surfaces. Areas of elevated activity will be identified for further investigation and potential decontamination. If appropriate the affected

survey unit will be reclassified. Any area exceeding the criteria for release for unrestricted use will be identified. Scan speeds will be established such that contamination at levels exceeding the criteria for release for unrestricted use will be detected.

Beta scans will also be performed on all non-permanent structures within each survey unit. In general the scan coverage will be the same as for building surfaces, however, it is anticipated that some non-permanent structures may have limited accessibility.

Gamma Scans

Gamma scans will be performed on the open land areas surrounding the Pathfinder Plant. For class 2 survey units, gamma scans will be performed over approximately 50% of the accessible areas. For class 3 survey units gamma scans will be performed over approximately 10% of the accessible areas. Areas of elevated activity will be identified for further investigation and potential decontamination. Any area exceeding the criteria for release for unrestricted use will be identified and decontaminated. Scan speeds will be established such that contamination at levels exceeding the criteria for release for unrestricted use will be detected.

Although not anticipated, any open land areas classified as a class 1 survey unit will receive a gamma scan over approximately 100% of its accessible surface.

6.6.2 Total Beta Activity Measurements

Total beta activity measurement will be taken on building surfaces within and outside of the Pathfinder Plant. For the purpose of the final status survey, paved/asphalted areas outside of the plant will be considered to be building surfaces. The number of measurements and spacing will be determined in accordance with MARSSIM and this Plan.

a. Number of Measurements

The number of measurement for each survey unit will be determined in accordance with section 5.5.1 of this plan. A relative shift of between 1 and 3 should be used, resulting in approximately 15-30 measurements per survey unit.

The number of measurements determined in accordance with section 5.5.1, N/2, represents the number of measurements to be collected from each survey unit. An equal number of measurements, N/2, needs to be collected from an appropriate reference area in order to evaluate the final survey data using the Wilcoxon Rank Sum Test.

Total beta activity measurements will also be collected on all non-permanent structures within each survey unit. The number of measurements will depend on the number and size of the non-permanent structures. Typically 15 to 30 biased measurements will be collected on or within each structure.

6.6.3 Removable Activity Measurements

Smears will be taken at each total beta activity measurement location for gross alpha and gross beta analysis.

6.6.4 Soil Sampling

Surface (0-15 cm) soil samples will be collected from the open land areas surrounding Pathfinder Plant. The number of samples and their spacing will be determined in accordance with MARSSIM and this plan.

The number of samples for each survey unit will be determined in accordance with section 5.5.2 of this plan. A relative shift of between 1 and 3 should be used, resulting in approximately 15-30 samples per survey unit.

6.7 Reclassification

Some survey units may be reclassified prior to their being surveyed. Survey units may be reclassified and resurveyed based on the results of the final status surveys performed within a given survey unit. Survey units will be reclassified if residual activity is encountered as follows.

- A Class 3 survey unit will be reclassified to a Class 2 survey unit when the survey results exceed 25% of the criteria for release for unrestricted use.
- A Class 2 survey unit will be reclassified to a Class 1 survey unit when the survey results exceed 75% of the criteria for release for unrestricted use.

6.8 Reference Areas

If reference areas are required for evaluating the total beta activity measurements, areas within the power block of the Angus Anson Plant, which was constructed on the Pathfinder Site and placed into service in 1994, will likely be used as the reference areas. Reference areas will be required when evaluating data using the Wilcoxon Rank Sum Test. The Wilcoxon Rank Sum Test will be used to evaluate total beta activity measurements from survey units in which the average of the beta measurements are less than the criteria for release for unrestricted use but which have individual measurement results exceeding the criteria.

7.0 QUALITY ASSURANCE AND CONTROL

Quality Assurance/Quality Control Programs ensure that all quality and regulatory requirements will be satisfied. All activities affecting quality will be controlled by this plan and approved implementing procedures. These documents include the following Quality Control measures as an integral part of the survey process.

7.1 Selection of Personnel

Project management and supervisory personnel are required to have extensive experience with the implementing procedures and be familiar with the requirements of this final status survey plan. Management must have prior experience with the radionuclide(s) of concern and a working knowledge of the instruments used to detect these radionuclides.

Supervisory personnel selected to direct the final status survey will have had experience performing final status surveys at other NRC licensed facilities and in implementing the guidance contained in NUREG-1575.

Health Physics Technicians who will perform the final status survey will have experience with the implementing procedures. They will have had experience performing final status surveys and in implementing the guidance contained in NUREG-1575. The Certified Health Physicist, supervisory personnel, and the Senior Health Physics Technicians will meet or exceed the requirements of Sections 4.3.3, 4.4.6 and 4.5.3.2 of ANSI/ANS-3.1-1993, (Selection, Qualification, and Training of Personnel for Nuclear power Plants) respectively, with the exception of the requirements for on-site experience at the Pathfinder site.

7.2 Training

All project personnel will receive site-specific training to identify the specific hazards present in the work and survey areas. Training will also include a review of the requirements of this final status survey plan and applicable implementing procedures. Records will be maintained documenting these training requirements.

7.3 Written Procedures

All survey tasks, which are essential to survey data quality, will be controlled by this final status survey plan and/or approved implementing procedures.

7.4 Instrumentation Selection, Calibration and Operation

Instruments will be selected that have proven to reliably detect the radionuclides present at the facility. Instruments will be calibrated using approved procedures and calibration sources traceable to the National Institute of Standards and Technology (NIST).

All instruments and detectors will be inspected and source checked daily when in use to verify proper operation. Control charts and/or source check criteria will be established at the beginning of the project for reference.

Procedures for calibration, maintenance, accountability, operation and quality control of radiation detection instruments implement the guidelines established in American National Standard Institute (ANSI) standard ANSI N323-1978 and ANSI N42.17A-1989.

7.5 Survey Documentation

Survey packages will be the primary method of controlling and tracking the hard copy records of survey results. Records of surveys will be documented and maintained in the survey package for each area according to Duratek procedures. Each survey measurement will be identified by the date, technician, instrument type and serial number, detector type and serial number, location code, type of measurement, mode of instrument operation, and Quality Control (QC) sample number, as applicable.

7.6 Chain of Custody

Procedures establish responsibility for the custody of samples from the time of collection until results are obtained. If samples are shipped off site for analysis, they will be accompanied by a chain-of-custody record to track each sample.

7.7 Records Management

Generation, handling and storage of survey data packages are controlled by an approved procedure.

7.8 Duplicate Review of Survey Results

The survey package and survey data from each survey area will be reviewed by two separate individuals to verify all documentation is complete and accurate. This will include the surveyor and either the Project Manager or designee.

7.9 Sample Analysis

Quality assurance and quality control checks will be performed on 5% of all samples (except smears). This will consist of the analysis of split and/or duplicate samples. Split samples will be analyzed if an ample amount of material is collected in a sample. The sample will be homogenized and split into two separate samples for analysis. Duplicate analysis will be performed on samples where there was not enough material collected to prepare two separate

samples. The same sample will be analyzed twice at different times and different detectors if possible to check the quality of the analyses.

8.0 FINAL STATUS SURVEY REPORT

Following the completion of the final status survey a final status survey report will be prepared documenting that the Pathfinder Site meets the criteria for release for unrestricted use and that the radiological criteria for license termination is met.

9.0 REFERENCES

9.1 Pathfinder Decommissioning Plan, February 17, 2004

9.2 B.M. Smith, Oak Ridge Institute for Science and Education, Confirmatory Radiological Survey of Portions of the Pathfinder Generating Station Sioux Falls, South Dakota, Prepared for the Division of Low-Level Waste Management and Decommissioning Headquarters Office, USNRC, November 1992

9.3 Characterization Survey Report for the Pathfinder Plant in Sioux Falls South Dakota, December 2003, Rev 0

9.4 NUREG-1575, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), August 2000

9.5 NUREG-1757, Consolidated NMSS Decommissioning Guidance, Volume 1, Decommissioning Process For Material Licensees, Final, September 2002

9.6 NUREG-1757, Consolidated NMSS Decommissioning Guidance, Volume 2, Characterization, Survey, and Determination Of Radiological Criteria, Draft For Comment, September 2002

9.7 NUREG-1507, Minimum Detectable Concentrations With Typical Radiation Survey Instruments for Contaminants and Field Conditions, June 1998

FINAL STATUS SURVEY PLAN

FOR THE

PATHFINDER PLANT

IN

SIOUX FALLS, SD

Addendum A
Area Factors and Elevated Measurement Criteria
For
Building Surfaces and Soils

December 2004

Discussion

Area factors are determined for a specific radionuclide and a specific area. Section 8.4 of NUREG-1505, *A Nonparametric Statistical methodology for the Design and Analysis of Final Status Decommissioning Surveys*, specifies that area factors should be calculated using dose pathway models and assumptions that are consistent with those used to calculate the criteria for free release for unrestricted use. Screening values published in NUREG-1757, Consolidated NMSS Decommissioning Guidance, and DandD version 2.1.0 were used for establishing the criteria for release for most radionuclides. The criteria for release for Ag-108m was generated using RESRAD Build Version 3.21 for building surfaces and RESRAD Version 6.22 for surface soils. NUREG 1757, Volume 2, section I.3.3.3.5 (Area Factors) describes that the use of DandD version 2.1 may be used and generally results in conservative area factors. Because DandD was used for most of the screening values it is also used here for calculation of area factors.

The area factor is calculated as the ratio of the dose from the default area to the dose for the area of elevated measurements. First the dose due to a given radionuclide is calculated for the same area used to calculate the criteria for unrestricted use (default area). For indoor areas the default floor area (defined as "unlimited area" in DandD) is 10 m^2. Next, the dose is calculated due to a specified smaller area of concentration. The equation for calculating the Area Factor is:

$$AF,\ AreaFactor = \frac{dose\ calculated\ for\ first\ (default)\ area}{dose\ calculated\ for\ smaller\ area}$$

The dose was calculated using DandD version 2.1 using the same parameters that were used for the nuclide specific building surface screening criteria, modifying only the contaminated area. Area factors were generated for 10 m^2 (the DandD default), 9 m^2, 4 m^2, and 1 m^2. The dose for each radionuclide was calculated assuming an initial surface activity of 1,000 dpm/100 cm^2.

Because DandD treats the reduced area by reducing the activity by the reduction in area, the resulting Indoor Area Factors are not radionuclide dependent and the resulting area factors for all radionuclides are the same. Table A.1 below shows the area factors for building surfaces. DandD runs are provided for the 9 m^2, 4 m^2, and 1 m^2 for the first seven radionuclides. Additional DandD runs are not required to generate area factors for areas in between the values calculated since the area factor becomes the ratio of 10 m^2 to the area of concern. The table has been expanded to included area factors for additional areas and for Ag-108m.

Table A.1
Indoor Area Factors

Radionuclide	10 m^2	9 m^2	8 m^2	7 m^2	6 m^2	5 m^2	4 m^2	3 m^2	2 m^2	1 m^2
H-3	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Co-60	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Zn-65	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Cs-137	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Eu-152	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Eu-154	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Eu-155	**1.0**	**1.11**	1.25	1.43	1.67	**2.0**	**2.5**	**3.33**	**5.0**	**10**
Ag-108m (note 1)	1.0	1.11	1.25	1.43	1.67	2.0	2.5	3.33	5.0	10

Bolded values are those for which DandD runs were performed.
Note1: Although Ag-108m is not in the DandD code's list of potential contaminants, it is assumed to have the same resulting area factors as those calculated for the other radionuclides.

Outdoor area factors were calculated similarly. Because the outdoor (surface soil residential scenario) area factors are not proportional to the contaminated area they are calculated for each radionuclide for each area of concern. DandD was used to generate the area factors show in Table A.2. Factors for Ag-108m were generated using RESRAD v6.22 and found to be much higher than the conservative area factors for other radionuclides generated using DandD. Ag-108m area factors are assumed to be conservatively estimated using DandD runs from other radionuclides.

Table A.2
Outdoor Area Factors

Radionuclide	100 m^2	30 m^2	10 m^2	3 m^2	1 m^2
H-3	1.00	1.00	1.00	2.45	7.33
Co-60	1.00	1.00	1.00	2.44	7.32
Zn-65	1.00	1.00	1.00	2.41	7.23
Cs-137	1.00	1.00	1.00	2.45	7.36
Eu-152	1.00	1.00	1.00	2.40	7.20
Eu-154	1.00	1.00	1.00	2.40	7.22
Eu-155	1.00	1.00	1.00	2.42	7.26
Ag-108m	1.00	1.00	1.00	2.40 (10.1)	7.20 (22.1)

Ag-108 values in parentheses represent values calculated using RESRAD v6.22

The elevated measurement criteria, EMC is the criteria for free release for unrestricted use multiplied by the area factor. The EMC is used for performing elevated measurement comparisons to evaluate "hot spots" during data assessment.

Investigation of elevated measurements found within a survey unit includes determining the elevated area and evaluating the measurements against the EMC for the specific area size. The survey unit will then need to be evaluated using the unity rule considering the average measurements in the survey unit and the concentration in the elevated area. The equation for this is:

$$\frac{\delta}{criteria\ for\ release} + \frac{(average\ concentration\ in\ elevated\ area - \delta)}{EMC} < 1$$

Where:

δ = average concentration over the rest of the survey unit.

Attachment A1: DandD runs for indoor area factors (building surfaces)

Attachment A2: DandD run (detailed report) for Co-60 demonstrating how DandD handles the reduction in contaminated area by reducing the activity

Attachment A3: DandD runs for outdoor area factors (surface soils – residential scenario)

Attachment A4: RESRAD Version 6.22 runs for Ag-108 area factors for 3 m^2 and 1 m^2

Attachment A1

DandD runs for indoor area factors (building surfaces)

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 11:47:21 AM
Site Name: Pathfinder
Description: Inside area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFH310.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.02E-04 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.88E-04 to 2.20E-04 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 11:52:06 AM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFH39.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.82E-04 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.69E-04 to 1.98E-04 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 11:54:37 AM
Site Name: Pathfinder
Description: Indoor area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFH34.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.09E-05 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 7.52E-05 to 8.81E-05 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 11:56:12 AM
Site Name: Pathfinder
Description: Indoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFH31.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.02E-05 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.88E-05 to 2.20E-05 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:03:23 PM
Site Name: Pathfinder
Description: Indoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCo6010.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.55E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.50E+00 to 3.61E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:05:23 PM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCo609.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.19E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.15E+00 to 3.25E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:08:08 PM
Site Name: Pathfinder
Description: Indoor area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCo604.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.42E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.40E+00 to 1.44E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:30:16 PM
Site Name: Pathfinder
Description: Indoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCo601.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.55E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.50E-01 to 3.61E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:32:23 PM
Site Name: Pathfinder
Description: Inside area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFZn6510.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 5.20E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 5.17E-01 to 5.24E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:33:43 PM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFZn659.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 4.68E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 4.66E-01 to 4.72E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:35:11 PM
Site Name: Pathfinder
Description: Inside area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFZn654.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.08E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.07E-01 to 2.10E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:36:19 PM
Site Name: Pathfinder
Description: Indoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFZn651.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 5.20E-02 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 5.17E-02 to 5.24E-02 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:37:59 PM
Site Name: Pathfinder
Description: Indoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCs13710.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.93E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.85E-01 to 9.02E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:39:36 PM
Site Name: Pathfinder
Description: Indoor area factor
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCs1379.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.03E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 7.97E-01 to 8.11E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:41:06 PM
Site Name: Pathfinder
Description: Indoor area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCs1374.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.57E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.54E-01 to 3.61E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:42:13 PM
Site Name: Pathfinder
Description: Indoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCs1371.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.93E-02 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.85E-02 to 9.02E-02 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 8:56:26 AM
Site Name: Pathfinder
Description: Indoor area factors 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu15210.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.97E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.92E+00 to 2.03E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 8:58:24 AM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1529.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.77E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.73E+00 to 1.83E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 8:59:48 AM
Site Name: Pathfinder
Description: Indoor area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1524.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 7.86E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 7.67E-01 to 8.11E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:01:03 AM
Site Name: Pathfinder
Description: Indoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1521.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.97E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.92E-01 to 2.03E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:03:51 AM
Site Name: Pathfinder
Description: Indoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu15410.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.18E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.12E+00 to 2.26E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:05:46 AM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1549.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.96E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.90E+00 to 2.03E+00 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:07:08 AM
Site Name: Pathfinder
Description: Indoor area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1544.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.72E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.46E-01 to 9.03E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:08:36 AM
Site Name: Pathfinder
Description: Indoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1541.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.18E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.12E-01 to 2.26E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:11:01 AM
Site Name: Pathfinder
Description: Indoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu15510.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	UNLIMITED	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factors		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.60E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.51E-01 to 1.71E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:12:20 AM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1559.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.44E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.36E-01 to 1.54E-01 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:13:38 AM
Site Name: Pathfinder
Description: Indoor area factor 4 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1554.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	4	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 6.39E-02 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 6.04E-02 to 6.84E-02 mrem/year

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:14:37 AM
Site Name: Pathfinder
Description: Indoor area factors
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFEu1551.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	1	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Site Specific Parameters:

General Parameters:

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.60E-02 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.51E-02 to 1.71E-02 mrem/year

Attachment A2

DandD run (detailed report) for Co-60 demonstrating how DandD handles the reduction in contaminated area by reducing the activity

DandD Building Occupancy Scenario

DandD Version: 2.1.0
Run Date/Time: 10/25/2004 2:05:23 PM
Site Name: Pathfinder
Description: Indoor area factor 9 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\AFCo609.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	9	CONSTANT(dpm/100 cm**2)
Justification for concentration: calculate area factor		Value 1.00E+03

Chain Data:

Number of chains: 1

Chain No. 1: 60Co
Nuclides in chain: 1

Nuclide	Chain Position	Half Life	First Parent	Fractional Yield	Second Parent	Fractional Yield	Ingestion CEDE Factor (Sv/Bq)	Inhalation CEDE Factor (Sv/Bq)	Surface Dose Rate Factor ((Sv/d)/(Bq/m^2))	15 cm Dose Rate Factor ((Sv/d)/(Bq/m^3))
60Co	1	1.93E+03					7.28E-09	5.91E-08	2.03E-10	6.26E-12

Initial Concentrations:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Nuclide	Surface Concentration (dpm/100 cm**2)
60Co	9.00E+02

Model Parameters:

General Parameters:

Parameter Name	Description	Distribution
To:Time In Building	The time in the building during the occupancy period	CONSTANT(hr/week)
Default value used		Value 4.50E+01
Tto:Occupancy Period	The duration of the occupancy exposure period	CONSTANT(days)
Default value used		Value 3.65E+02
Vo:Breathing Rate	The average volumetric breathing rate during building occupancy for an 8-hour work day	CONSTANT(m**3/hr)
Default value used		Value 1.40E+00
RFo*:Resuspension Factor	Effective resuspension factor during the occupancy period = RFo * Fl	DERIVED(1/m)
Default value used		
GO*:Ingestion Rate	Effective secondary ingestion transfer rate of removable surface activity from building surfaces to the mouth during building occupancy = GO * Fl	DERIVED(m**2/hr)
Default value used		
Tstart:Start Time	The start time of the scenario in days	CONSTANT(days)
Default value used		Value 0.00E+00
Tend:End Time	The ending time of the scenario in days	CONSTANT(days)
Default value used		Value 3.65E+02
dt:Time Step Size	The time step size	CONSTANT(days)
Default value used		Value 3.65E+02
Pstep:Print Step Size	The time steps for the history file. Doses will be written to the history file every n time steps	CONSTANT(none)
Default value used		Value 1.00E+00
AOExt:External Exposure Area	Minimum surface area to which occupant is exposed via external radiation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOInh:Inhalation Exposure Area	Minimum surface area to which occupant is exposed via inhalation during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AOIng:Secondary Ingestion Exposure Area	Minimum surface area to which occupant is exposed via secondary ingestion during occupancy period	CONSTANT(m**2)
Default value used		Value 1.00E+01
AO:Exposure Area	Minimum surface area to which occupant is exposed during the occupancy period	DERIVED(m**2)
Default value used		
Fl:Loose Fraction	Fraction of surface contamination available for resuspension and ingestion	CONSTANT(none)
Default value used		Value 1.00E-01
Rfo:Loose Resuspension Factor	Resuspension factor for loose contamination	CONTINUOUS LOGARITHMIC(1/m)
Default value used		Value Probability

		9.12E-06 1.10E-04 1.46E-04 1.62E-04 1.85E-04 1.90E-04	0.00E+00 7.67E-01 9.09E-01 9.50E-01 9.90E-01 1.00E+00
GO:Loose Ingestion Rate	The secondary ingestion transfer rate of loose removable surface activity from building surfaces to the mouth during building occupancy	CONSTANT(m**2/hr)	
Default value used		Value	1.10E-04

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.19E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.15E+00 to 3.25E+00 mrem/year

Detailed Results:

Note: All reported values are the upper bound of the symmetric 95% confidence interval for the 0.9 quantile value

Concentration at Time of Peak Dose:

Nuclide	Surface Concentration (dpm/100 cm**2)
60Co	8.43E+02

Pathway Dose from All Nuclides (mrem)

All Pathways Dose	External	Inhalation	Secondary Ingestion
3.25E+00	2.78E+00	4.39E-01	2.63E-02

Radionuclide Dose through All Active Pathways (mrem)

Nuclide	All Pathways Dose
60Co	3.25E+00
All Nuclides	3.25E+00

Dose from Each Nuclide through Each Active Pathway (mrem)

Nuclide	External	Inhalation	Secondary Ingestion
60Co	2.78E+00	4.39E-01	2.63E-02

Attachment A3

DandD runs for outdoor area factors (surface soils – residential scenario)

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:50:00 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters (unlimited)
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFH3100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.72E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.36E+00 to 3.76E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:53:57 AM
Site Name: Pathfinder
Description: Outdoor are factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFH330.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	30	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.72E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.36E+00 to 3.76E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:55:38 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFH310.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.72E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.36E+00 to 3.76E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:58:25 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFH33.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
3H	3	CONSTANT(pCi/g)	
Justification for concentration: calculate area factor		Value	1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.11E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 9.55E-01 to 1.50E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 9:59:53 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFH31.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
3H	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.71E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.18E-01 to 4.99E-01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:07:08 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters (unlilmited)
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCo60100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 6.60E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 6.55E+01 to 6.68E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:10:01 AM
Site Name: Pathfinder
Description: Outdoor area factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCo6030.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	30	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 6.60E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 6.55E+01 to 6.68E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:11:29 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCo6010.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 6.60E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 6.55E+01 to 6.68E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:37:12 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCo603.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	3	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.71E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.68E+01 to 2.74E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:14:02 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCo601.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
60Co	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 9.02E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.93E+00 to 9.15E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:22:40 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters (unlimited)
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFZn65100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.14E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.96E+01 to 2.46E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:24:14 AM
Site Name: Pathfinder
Description: Outdoor area factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFZn6530.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	30	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.14E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.96E+01 to 2.46E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:25:30 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFAn6510.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.14E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.96E+01 to 2.46E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:28:53 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFZn653.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	3	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.88E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 7.95E+00 to 9.86E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:32:22 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFZn651.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
65Zn	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.96E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.65E+00 to 3.29E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:41:08 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters (unlimited)
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCs137100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.20E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.14E+01 to 2.30E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:43:04 AM
Site Name: Pathfinder
Description: Outdoor area factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCs13730.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	30	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.20E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.14E+01 to 2.30E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:44:30 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCs13710.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.20E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.14E+01 to 2.30E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:45:49 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCs1373.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	3	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.98E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.63E+00 to 9.38E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:47:22 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFCs1371.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
137Cs	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.99E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.88E+00 to 3.13E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:59:26 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters (unlimited)
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu152100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.88E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.88E+01 to 2.88E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:50:25 AM
Site Name: Pathfinder
Description: Outdoor area factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu15230.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	30	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.88E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.88E+01 to 2.88E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:52:03 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu15210.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 2.88E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 2.88E+01 to 2.88E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:53:35 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEU1523.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	3	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.20E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.19E+01 to 1.21E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/26/2004 10:55:26 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu1521.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
152Eu	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 4.00E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.98E+00 to 4.03E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:19:40 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu154100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.12E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.12E+01 to 3.12E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:21:44 AM
Site Name: Pathfinder
Description: Outdoor area factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu15430.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution	
154Eu	30	CONSTANT(pCi/g)	
Justification for concentration: calculate area factor		Value	1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.12E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.12E+01 to 3.12E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:23:33 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu15410.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.12E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.12E+01 to 3.12E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:25:23 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu1543.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	3	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.30E+01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.29E+01 to 1.31E+01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:27:05 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu1541.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
154Eu	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 4.32E+00 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 4.29E+00 to 4.35E+00 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:34:31 AM
Site Name: Pathfinder
Description: Outdoor area factor 100 square meters (unlimited)
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu155100.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	UNLIMITED	CONSTANT(pCi/g)
Justification for concentration: calculate area factors		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.78E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.76E-01 to 8.83E-01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:57:53 AM
Site Name: Pathfinder
Description: Outdoor area factor 30 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu15530.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	30	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.78E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.76E-01 to 8.83E-01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:38:17 AM
Site Name: Pathfinder
Description: Outdoor area factor 10 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu15510.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	10	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 8.78E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 8.76E-01 to 8.83E-01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:42:03 AM
Site Name: Pathfinder
Description: Outdoor area factor 3 square meters
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu1553.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	3	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 3.63E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 3.60E-01 to 3.65E-01 mrem/year

DandD Residential Scenario

DandD Version: 2.1.0
Run Date/Time: 10/27/2004 10:43:37 AM
Site Name: Pathfinder
Description: Outdoor area factor 1 square meter
FileName:C:\MyFiles\REDS\Pathfinder\RAIs\Area Factors\DandD runs\OAFEu1551.mcd

Options:

Implicit progeny doses NOT included with explicit parent doses
Nuclide concentrations are distributed among all progeny
Number of simulations: 100
Seed for Random Generation: 8718721
Averages used for behavioral type parameters

External Pathway is ON
Inhalation Pathway is ON
Secondary Ingestion Pathway is ON
Agricultural Pathway is ON
Drinking Water Pathway is ON
Irrigation Pathway is ON
Surface Water Pathway is ON

Initial Activities:

Nuclide	Area of Contamination (m^2)	Distribution
155Eu	1	CONSTANT(pCi/g)
Justification for concentration: calculate area factor		Value 1.00E+01

Site Specific Parameters:

General Parameters:

None

Element Dependant Parameters

None

Correlation Coefficients:

None

Summary Results:

90.00% of the 100 calculated TEDE values are < 1.21E-01 mrem/year .
The 95 % Confidence Interval for the 0.9 quantile value of TEDE is 1.20E-01 to 1.22E-01 mrem/year

Attachment A4

RESRAD Version 6.22 runs for Ag-108 area factors for 3 m^2 and 1 m^2

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ag-108m+D	2.830E-04	2.830E-04	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ag-108m+D	7.620E-06	7.620E-06	DCF3(1)
D-34	Food transfer factors:			
D-34	Ag-108m+D, plant/soil concentration ratio, dimensionless	1.500E-01	1.500E-01	RTF(1,1)
D-34	Ag-108m+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-03	3.000E-03	RTF(1,2)
D-34	Ag-108m+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.500E-02	2.500E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ag-108m+D, fish	5.000E+00	5.000E+00	BIOFAC(1,1)
D-5	Ag-108m+D, crustacea and mollusks	7.700E+02	7.700E+02	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ag-108m	2.730E+00	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Ag-108m	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ag-108m				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.790E-01	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Ag-108m	2.730E+00
Thickness:	2.00 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.063E+01	9.090E+00	2.267E+01	4.441E-01	6.779E-08	0.000E+00	0.000E+00	0.000E+00
M(t):	4.252E-01	3.636E-01	9.070E-01	1.777E-02	2.712E-09	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 2.499E+01 mrem/yr at t = 4.284 ± 0.009 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.284E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	3.562E-01	0.0143	1.189E-06	0.0000	0.000E+00	0.0000	6.712E-03	0.0003	5.786E-04	0.0000	5.524E-03	0.0002	1.369E-05	0.0000
Total	3.562E-01	0.0143	1.189E-06	0.0000	0.000E+00	0.0000	6.712E-03	0.0003	5.786E-04	0.0000	5.524E-03	0.0002	1.369E-05	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 4.284E+00 years

Water Dependent Pathways

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.445E+01	0.5784	1.019E-01	0.0041	0.000E+00	0.0000	1.150E+00	0.0460	4.617E-01	0.0185	8.455E+00	0.3383	2.499E+01	1.0000
Total	1.445E+01	0.5784	1.019E-01	0.0041	0.000E+00	0.0000	1.150E+00	0.0460	4.617E-01	0.0185	8.455E+00	0.3383	2.499E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.026E+01	0.9656	3.426E-05	0.0000	0.000E+00	0.0000	1.924E-01	0.0181	1.626E-02	0.0015	1.564E-01	0.0147	3.946E-04	0.0000
Total	1.026E+01	0.9656	3.426E-05	0.0000	0.000E+00	0.0000	1.924E-01	0.0181	1.626E-02	0.0015	1.564E-01	0.0147	3.946E-04	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.063E+01	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.063E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	4.684E+00	0.5153	1.564E-05	0.0000	0.000E+00	0.0000	8.827E-02	0.0097	7.609E-03	0.0008	7.265E-02	0.0080	1.801E-04	0.0000
Total	4.684E+00	0.5153	1.564E-05	0.0000	0.000E+00	0.0000	8.827E-02	0.0097	7.609E-03	0.0008	7.265E-02	0.0080	1.801E-04	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	2.618E+00	0.2880	1.771E-02	0.0019	0.000E+00	0.0000	1.939E-01	0.0213	5.625E-02	0.0062	1.351E+00	0.1486	9.090E+00	1.0000
Total	2.618E+00	0.2880	1.771E-02	0.0019	0.000E+00	0.0000	1.939E-01	0.0213	5.625E-02	0.0062	1.351E+00	0.1486	9.090E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	9.756E-01	0.0430	3.257E-06	0.0000	0.000E+00	0.0000	1.838E-02	0.0008	1.585E-03	0.0001	1.513E-02	0.0007	3.751E-05	0.0000
Total	9.756E-01	0.0430	3.257E-06	0.0000	0.000E+00	0.0000	1.838E-02	0.0008	1.585E-03	0.0001	1.513E-02	0.0007	3.751E-05	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.275E+01	0.5623	8.974E-02	0.0040	0.000E+00	0.0000	1.011E+00	0.0446	3.999E-01	0.0176	7.412E+00	0.3269	2.267E+01	1.0000
Total	1.275E+01	0.5623	8.974E-02	0.0040	0.000E+00	0.0000	1.011E+00	0.0446	3.999E-01	0.0176	7.412E+00	0.3269	2.267E+01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	4.022E-03	0.0091	1.343E-08	0.0000	0.000E+00	0.0000	7.579E-05	0.0002	6.533E-06	0.0000	6.237E-05	0.0001	1.546E-07	0.0000
Total	4.022E-03	0.0091	1.343E-08	0.0000	0.000E+00	0.0000	7.579E-05	0.0002	6.533E-06	0.0000	6.237E-05	0.0001	1.546E-07	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	2.535E-01	0.5708	1.813E-03	0.0041	0.000E+00	0.0000	2.065E-02	0.0465	9.136E-03	0.0206	1.549E-01	0.3486	4.441E-01	1.0000
Total	2.535E-01	0.5708	1.813E-03	0.0041	0.000E+00	0.0000	2.065E-02	0.0465	9.136E-03	0.0206	1.549E-01	0.3486	4.441E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	6.175E-10	0.0091	2.061E-15	0.0000	0.000E+00	0.0000	1.164E-11	0.0002	1.003E-12	0.0000	9.576E-12	0.0001	2.374E-14	0.0000
Total	6.175E-10	0.0091	2.061E-15	0.0000	0.000E+00	0.0000	1.164E-11	0.0002	1.003E-12	0.0000	9.576E-12	0.0001	2.374E-14	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	3.870E-08	0.5708	2.767E-10	0.0041	0.000E+00	0.0000	3.152E-09	0.0465	1.394E-09	0.0206	2.363E-08	0.3486	6.779E-08	1.0000
Total	3.870E-08	0.5708	2.767E-10	0.0041	0.000E+00	0.0000	3.152E-09	0.0465	1.394E-09	0.0206	2.363E-08	0.3486	6.779E-08	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	3.894E+00	3.330E+00	8.305E+00	1.627E-01	2.483E-08	3.447E-32	0.000E+00	0.000E+00

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	6.421E+00	7.508E+00	3.010E+00	1.537E+02	1.007E+09	*2.608E+13	*2.608E+13	*2.608E+13

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 4.284 ± 0.009 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ag-108m	2.730E+00	4.284 ± 0.009	9.154E+00	2.731E+00	9.154E+00	2.731E+00

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	1.063E+01	9.090E+00	2.267E+01	4.441E-01	6.779E-08	0.000E+00	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	2.730E+00	1.246E+00	2.595E-01	1.070E-03	1.642E-10	2.329E-34	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

RESCALC.EXE execution time = 1.33 seconds

Summary : Pathfinder Ag-108 1 square meter area factor
File : PathfinderAg108mlsqmeter.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ag-108m+D	2.830E-04	2.830E-04	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ag-108m+D	7.620E-06	7.620E-06	DCF3(1)
D-34	Food transfer factors:			
D-34	Ag-108m+D, plant/soil concentration ratio, dimensionless	1.500E-01	1.500E-01	RTF(1,1)
D-34	Ag-108m+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-03	3.000E-03	RTF(1,2)
D-34	Ag-108m+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.500E-02	2.500E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ag-108m+D, fish	5.000E+00	5.000E+00	BIOFAC(1,1)
D-5	Ag-108m+D, crustacea and mollusks	7.700E+02	7.700E+02	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ag-108m	2.730E+00	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Ag-108m	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ag-108m				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.790E-01	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E-03	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E-04	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E-04	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and molluśks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : Pathfinder Ag-108 1 square meter area factor
File : PathfinderAg108m1sqmeter.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	1.00 square meters	Ag-108m	2.730E+00
Thickness:	2.00 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	1.129E+00	5.175E-01	1.176E-01	6.456E-04	9.893E-11	0.000E+00	0.000E+00	0.000E+00
M(t):	4.518E-02	2.070E-02	4.702E-03	2.582E-05	3.957E-12	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 1.129E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.129E+00	0.9998	1.284E-05	0.0000	0.000E+00	0.0000	1.924E-04	0.0002	1.626E-06	0.0000	1.564E-05	0.0000	3.946E-07	0.0000
Total	1.129E+00	0.9998	1.284E-05	0.0000	0.000E+00	0.0000	1.924E-04	0.0002	1.626E-06	0.0000	1.564E-05	0.0000	3.946E-07	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.129E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.129E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	5.153E-01	0.9958	5.860E-06	0.0000	0.000E+00	0.0000	8.827E-05	0.0002	7.609E-07	0.0000	7.264E-06	0.0000	1.801E-07	0.0000
Total	5.153E-01	0.9958	5.860E-06	0.0000	0.000E+00	0.0000	8.827E-05	0.0002	7.609E-07	0.0000	7.264E-06	0.0000	1.801E-07	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	2.094E-03	0.0040	1.771E-06	0.0000	0.000E+00	0.0000	1.551E-07	0.0000	4.500E-09	0.0000	1.081E-07	0.0000	5.175E-01	1.0000
Total	2.094E-03	0.0040	1.771E-06	0.0000	0.000E+00	0.0000	1.551E-07	0.0000	4.500E-09	0.0000	1.081E-07	0.0000	5.175E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.073E-01	0.9130	1.220E-06	0.0000	0.000E+00	0.0000	1.838E-05	0.0002	1.585E-07	0.0000	1.513E-06	0.0000	3.751E-08	0.0000
Total	1.073E-01	0.9130	1.220E-06	0.0000	0.000E+00	0.0000	1.838E-05	0.0002	1.585E-07	0.0000	1.513E-06	0.0000	3.751E-08	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.020E-02	0.0868	8.974E-06	0.0001	0.000E+00	0.0000	8.088E-07	0.0000	3.199E-08	0.0000	5.930E-07	0.0000	1.176E-01	1.0000
Total	1.020E-02	0.0868	8.974E-06	0.0001	0.000E+00	0.0000	8.088E-07	0.0000	3.199E-08	0.0000	5.930E-07	0.0000	1.176E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	4.425E-04	0.6854	5.032E-09	0.0000	0.000E+00	0.0000	7.579E-08	0.0001	6.533E-10	0.0000	6.237E-09	0.0000	1.546E-10	0.0000
Total	4.425E-04	0.6854	5.032E-09	0.0000	0.000E+00	0.0000	7.579E-08	0.0001	6.533E-10	0.0000	6.237E-09	0.0000	1.546E-10	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	2.028E-04	0.3142	1.813E-07	0.0003	0.000E+00	0.0000	1.652E-08	0.0000	7.309E-10	0.0000	1.239E-08	0.0000	6.456E-04	1.0000
Total	2.028E-04	0.3142	1.813E-07	0.0003	0.000E+00	0.0000	1.652E-08	0.0000	7.309E-10	0.0000	1.239E-08	0.0000	6.456E-04	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	6.793E-11	0.6866	7.725E-16	0.0000	0.000E+00	0.0000	1.164E-14	0.0001	1.003E-16	0.0000	9.576E-16	0.0000	2.374E-17	0.000(
Total	6.793E-11	0.6866	7.725E-16	0.0000	0.000E+00	0.0000	1.164E-14	0.0001	1.003E-16	0.0000	9.576E-16	0.0000	2.374E-17	0.000(

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	3.096E-11	0.3129	2.767E-14	0.0003	0.000E+00	0.0000	2.522E-15	0.0000	1.116E-16	0.0000	1.891E-15	0.0000	9.893E-11	1.0000
Total	3.096E-11	0.3129	2.767E-14	0.0003	0.000E+00	0.0000	2.522E-15	0.0000	1.116E-16	0.0000	1.891E-15	0.0000	9.893E-11	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	4.137E-01	1.896E-01	4.306E-02	2.365E-04	3.624E-11	5.104E-35	0.000E+00	0.000E+00

*Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	6.043E+01	1.319E+02	5.806E+02	1.057E+05	6.899E+11	*2.608E+13	*2.608E+13	*2.608E+13

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ag-108m	2.730E+00	0.000E+00	4.137E-01	6.043E+01	4.137E-01	6.043E+01

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr							
		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	1.129E+00	5.175E-01	1.176E-01	6.456E-04	9.893E-11	0.000E+00	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g							
		t=	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	2.730E+00	1.246E+00	2.595E-01	1.070E-03	1.642E-10	2.329E-34	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

RESCALC.EXE execution time = 1.39 seconds

Summary : Pathfinder Ag-108 area factor 3 square meters
File : PathfinderAg108m3sqmeters.RAD

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary
File: FGR 13 Morbidity

Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ag-108m+D	2.830E-04	2.830E-04	DCF2(1)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ag-108m+D	7.620E-06	7.620E-06	DCF3(1)
D-34	Food transfer factors:			
D-34	Ag-108m+D, plant/soil concentration ratio, dimensionless	1.500E-01	1.500E-01	RTF(1,1)
D-34	Ag-108m+D, beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-03	3.000E-03	RTF(1,2)
D-34	Ag-108m+D, milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.500E-02	2.500E-02	RTF(1,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ag-108m+D, fish	5.000E+00	5.000E+00	BIOFAC(1,1)
D-5	Ag-108m+D, crustacea and mollusks	7.700E+02	7.700E+02	BIOFAC(1,2)

Site-Specific Parameter Summary

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	3.000E+00	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	2.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	2.500E+01	2.500E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	3.000E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	1.000E+02	1.000E+02	---	T(6)
R011	Times for calculations (yr)	3.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Ag-108m	2.730E+00	0.000E+00	---	S1(1)
R012	Concentration in groundwater (pCi/L): Ag-108m	not used	0.000E+00	---	W1(1)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone field capacity	2.000E-01	2.000E-01	---	FCCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ
R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Average annual wind speed (m/sec)	2.000E+00	2.000E+00	---	WIND
R013	Humidity in air (g/m**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	5.000E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.000E+00	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	2.000E-01	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone field capacity	2.000E-01	2.000E-01	---	FCSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, field capacity	2.000E-01	2.000E-01	---	FCUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Ag-108m				
R016	Contaminated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	0.000E+00	0.000E+00	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.790E-01	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	1.000E-04	1.000E-04	---	MLINH
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	>0 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)
R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	5.400E+00	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	9.000E-01	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	5.100E+02	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	1.000E+00	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	5.000E-01	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.150E-02	FPLANT
R018	Contamination fraction of meat	-1	-1	0.150E-03	FMEAT
R018	Contamination fraction of milk	-1	-1	0.150E-03	FMILK
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	1.000E+00	1.000E+00	---	FGWLW
R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
R19B	Wet weight crop yield for Non-Leafy (kg/m**2)	7.000E-01	7.000E-01	---	YV(1)
R19B	Wet weight crop yield for Leafy (kg/m**2)	1.500E+00	1.500E+00	---	YV(2)
R19B	Wet weight crop yield for Fodder (kg/m**2)	1.100E+00	1.100E+00	---	YV(3)
R19B	Growing Season for Non-Leafy (years)	1.700E-01	1.700E-01	---	TE(1)
R19B	Growing Season for Leafy (years)	2.500E-01	2.500E-01	---	TE(2)
R19B	Growing Season for Fodder (years)	8.000E-02	8.000E-02	---	TE(3)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R19B	Translocation Factor for Non-Leafy	1.000E-01	1.000E-01	---	TIV(1)
R19B	Translocation Factor for Leafy	1.000E+00	1.000E+00	---	TIV(2)
R19B	Translocation Factor for Fodder	1.000E+00	1.000E+00	---	TIV(3)
R19B	Dry Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RDRY(1)
R19B	Dry Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RDRY(2)
R19B	Dry Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RDRY(3)
R19B	Wet Foliar Interception Fraction for Non-Leafy	2.500E-01	2.500E-01	---	RWET(1)
R19B	Wet Foliar Interception Fraction for Leafy	2.500E-01	2.500E-01	---	RWET(2)
R19B	Wet Foliar Interception Fraction for Fodder	2.500E-01	2.500E-01	---	RWET(3)
R19B	Weathering Removal Constant for Vegetation	2.000E+01	2.000E+01	---	WLAM
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
C14	DCF correction factor for gaseous forms of C14	not used	8.894E+01	---	CO2F
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	7.000E+00	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	7.000E+00	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR1
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Site-Specific Parameter Summary (continued)

Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
TITL	Number of graphical time points	32	---	---	NPTS
TITL	Maximum number of integration points for dose	17	---	---	LYMAX
TITL	Maximum number of integration points for risk	257	---	---	KYMAX

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	active
7 -- drinking water	active
8 -- soil ingestion	active
9 -- radon	suppressed
Find peak pathway doses	active

Summary : Pathfinder Ag-108 area factor 3 square meters
File : PathfinderAg108m3sqmeters.RAD

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	3.00 square meters	Ag-108m	2.730E+00
Thickness:	2.00 meters		
Cover Depth:	0.00 meters		

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 2.500E+01 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
TDOSE(t):	2.480E+00	1.138E+00	2.663E-01	1.581E-03	2.422E-10	0.000E+00	0.000E+00	0.000E+00
M(t):	9.919E-02	4.552E-02	1.065E-02	6.324E-05	9.687E-12	0.000E+00	0.000E+00	0.000E+00

Maximum TDOSE(t): 2.480E+00 mrem/yr at t = 0.000E+00 years

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	2.479E+00	0.9997	1.448E-05	0.0000	0.000E+00	0.0000	5.771E-04	0.0002	4.877E-06	0.0000	4.691E-05	0.0000	1.184E-06	0.0000
Total	2.479E+00	0.9997	1.448E-05	0.0000	0.000E+00	0.0000	5.771E-04	0.0002	4.877E-06	0.0000	4.691E-05	0.0000	1.184E-06	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.480E+00	1.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.480E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.131E+00	0.9942	6.608E-06	0.0000	0.000E+00	0.0000	2.648E-04	0.0002	2.283E-06	0.0000	2.179E-05	0.0000	5.403E-07	0.0000
Total	1.131E+00	0.9942	6.608E-06	0.0000	0.000E+00	0.0000	2.648E-04	0.0002	2.283E-06	0.0000	2.179E-05	0.0000	5.403E-07	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	6.283E-03	0.0055	5.314E-06	0.0000	0.000E+00	0.0000	1.396E-06	0.0000	4.050E-08	0.0000	9.729E-07	0.0000	1.138E+00	1.0000
Total	6.283E-03	0.0055	5.314E-06	0.0000	0.000E+00	0.0000	1.396E-06	0.0000	4.050E-08	0.0000	9.729E-07	0.0000	1.138E+00	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	2.356E-01	0.8847	1.376E-06	0.0000	0.000E+00	0.0000	5.515E-05	0.0002	4.754E-07	0.0000	4.539E-06	0.0000	1.125E-07	0.0000
Total	2.356E-01	0.8847	1.376E-06	0.0000	0.000E+00	0.0000	5.515E-05	0.0002	4.754E-07	0.0000	4.539E-06	0.0000	1.125E-07	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	3.060E-02	0.1149	2.692E-05	0.0001	0.000E+00	0.0000	7.279E-06	0.0000	2.879E-07	0.0000	5.337E-06	0.0000	2.663E-01	1.0000
Total	3.060E-02	0.1149	2.692E-05	0.0001	0.000E+00	0.0000	7.279E-06	0.0000	2.879E-07	0.0000	5.337E-06	0.0000	2.663E-01	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	9.714E-04	0.6145	5.674E-09	0.0000	0.000E+00	0.0000	2.274E-07	0.0001	1.960E-09	0.0000	1.871E-08	0.0000	4.639E-10	0.0000
Total	9.714E-04	0.6145	5.674E-09	0.0000	0.000E+00	0.0000	2.274E-07	0.0001	1.960E-09	0.0000	1.871E-08	0.0000	4.639E-10	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	6.085E-04	0.3849	5.438E-07	0.0003	0.000E+00	0.0000	1.487E-07	0.0001	6.578E-09	0.0000	1.115E-07	0.0001	1.581E-03	1.0000
Total	6.085E-04	0.3849	5.438E-07	0.0003	0.000E+00	0.0000	1.487E-07	0.0001	6.578E-09	0.0000	1.115E-07	0.0001	1.581E-03	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	1.491E-10	0.6158	8.711E-16	0.0000	0.000E+00	0.0000	3.491E-14	0.0001	3.009E-16	0.0000	2.873E-15	0.0000	7.122E-17	0.0000
Total	1.491E-10	0.6158	8.711E-16	0.0000	0.000E+00	0.0000	3.491E-14	0.0001	3.009E-16	0.0000	2.873E-15	0.0000	7.122E-17	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+01 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	9.287E-11	0.3835	8.301E-14	0.0003	0.000E+00	0.0000	2.269E-14	0.0001	1.004E-15	0.0000	1.702E-14	0.0001	2.422E-10	1.0000
Total	9.287E-11	0.3835	8.301E-14	0.0003	0.000E+00	0.0000	2.269E-14	0.0001	1.004E-15	0.0000	1.702E-14	0.0001	2.422E-10	1.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+02 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Independent Pathways (Inhalation excludes radon)

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years

Water Dependent Pathways

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Ag-108m	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000

*Sum of all water independent and dependent pathways.

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

Parent (i)	Product (j)	Branch Fraction*	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	9.084E-01	4.169E-01	9.756E-02	5.791E-04	8.871E-11	1.248E-34	0.000E+00	0.000E+00

*Branch Fraction is the cumulative factor for the j't principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 30 days) daughters.

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 2.500E+01 mrem/yr

Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	2.752E+01	5.997E+01	2.562E+02	4.317E+04	2.818E+11	*2.608E+13	*2.608E+13	*2.608E+13

*At specific activity limit

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

Nuclide (i)	Initial (pCi/g)	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Ag-108m	2.730E+00	0.000E+00	9.084E-01	2.752E+01	9.084E-01	2.752E+01

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	2.480E+00	1.138E+00	2.663E-01	1.581E-03	2.422E-10	0.000E+00	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

Nuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	3.000E+01	1.000E+02	3.000E+02	1.000E+03
Ag-108m	Ag-108m	1.000E+00	2.730E+00	1.246E+00	2.595E-01	1.070E-03	1.642E-10	2.329E-34	0.000E+00	0.000E+00

BRF(i) is the branch fraction of the parent nuclide.

RESCALC.EXE execution time = 2.17 seconds

Pathfinder Decommissioning Plan

Appendix G

RESPONSES TO

NRC REQUEST FOR ADDITIONAL INFORMATION

General Comments

1. *Provide a statement in the Pathfinder Decommissioning Plan (DP) that provides a basis to conclude that Xcel Energy property outside the secured area has not been impacted by licensed operations. Page 2-3 of the DP states "Although Xcel Energy owns additional land that surrounds the Pathfinder location, the Pathfinder site as referred to herein, principally includes the secured area shown in Figures 2-1 and 2-2. The buildings and the areas enclosed within the secured area and the influent and effluent pathways to the Big Sioux River (e.g., settling ponds and diversion ditch) are the subjects of this decommissioning plan. Three of the existing buildings have been previously decommissioned and approved for unrestricted release."*

   Basis: 10 CFR 30.36(g)(4)(I). The proposed DP for the site or separate building or outdoor area must include a description of the conditions of the site or outdoor area sufficient to evaluate the acceptability of the plan. In addition, NUREG-1757, Vol. 1, Section 16.4, states that information provided by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive contamination as well as the extent of this contamination.

   Response

   The areas outside of the secured area of the Pathfinder have not been impacted by licensed operations at the Pathfinder facility. Section 2.1 of the Plan (p.3) has been revised to reflect the above statement. Please note that plant liquid effluent pathways, which were impacted by licensed operations and are included in the scope of the decommissioning plan, originate within the secured area but cross over the northern boundary of the secured area and terminate at the Big Sioux River.

2. *Describe any area of the site or property where a spill or burial of radioactive materials occurred. If any such area exists, provide the types, forms, activities and concentrations of the radioactive materials in the spill or burial, and a map/scaled drawing showing the location of the spill or burial. If no such spill or burial exists, please include a statement to that effect in the revised DP.*

   Basis: 10 CFR 30.36(g)(4)(I). The proposed DP for the site or separate building or outdoor area must include a description of the conditions of the site or outdoor area sufficient to evaluate the acceptability of the plan. In addition, NUREG-1757, Vol. 1, Section 16.4, states that information provided by the licensee should be sufficient to allow the staff to fully understand the types and activity of radioactive contamination as well as the extent of this contamination.

   Response

   Xcel Energy conducted a comprehensive historical site assessment of the Pathfinder Site. This included a search of the complete Pathfinder docket, interviews with persons that operated the atomic plant, and interviews with workers involved in the previous decommissioning. The interviews included the former Radiation Safety Officer. Workers were asked directly if they could recall any spills or burials of radioactive materials. None were identified. The entire Pathfinder docket was searched. No evidence or indications of radioactive spills or burials were found. There is also no indication of soil or water contamination from the extensive record of radiation surveys. There is also no indication of contaminated areas, other than

the areas identified in the Decommissioning Plan, with residual radioactivity in excess of natural background or fallout levels. On this basis, it is reasonable to conclude that no spills or burials of radioactive materials occurred at the Pathfinder site.

Section 2.2.3 of the Plan (p.7) has been revised to reflect the preceding statement.

3. *Identify the names of individuals responsible for all decommissioning project units on the organization chart. The Organizational Chart (DP Page 22, Figure 4.1), includes the names of individuals responsible for some decommissioning organizational units. However, it omits the identity of persons responsible for other decommissioning project units, such as the, Quality Assurance Manager, Radiation Safety Officer, etc.*

   Basis: 10 CFR 30.36(g)(4)(ii and iii). NUREG-1757, Vol. 1, Sect 17.2.1, Decommissioning Management Organization states that the information supplied by the licensee should be sufficient to allow the staff to fully understand the licensee's decommissioning project management organization and structure to determine if the decommissioning can be conducted safely and in accordance with NRC requirements.

   Response

   Herb Giorgio, CHP, is the Radiation Safety Officer at Pathfinder. Figure 4-1 of the Plan (p. 22) has been updated to reflect this change.

   Up to this point in time, the rest of the presently unnamed positions on the chart have been drawn from a pool of Xcel Energy or Nuclear Management Company (NMC) employees that are qualified to perform this type of work. In some instances, work such as project engineering has been done by the Project Manager or by contractors. The Decommissioning Plan was completed in February 2004. Since then the review cycle has reduced the workload, and many of the original project employees besides the named core team have gone on to work on other projects.

   Xcel Energy, through its own engineering staff and its NMC nuclear operating company, has significant and readily available resources to staff this project. Xcel Energy will be able to quickly fill the support positions for the Pathfinder project as the need warrants.

   Depending on the workload involved, some of the duties may be more efficiently performed by the Project Manager, the RSO, or by qualified contractors. Consequently, the names of the support positions will remain blank. The core team, which is already shown in Figure 4-1 and includes the RSO above, will stay the same for the duration of the project barring unforeseen circumstances such as job change, retirement, etc. Once remediation activities, which are scheduled for late 2005, begin, Xcel Energy will make reasonable efforts to keep the project team members together for the remaining duration of the decommissioning effort.

4. *Include a description or reference to the methods and procedures for planned decommissioning activities sufficient to allow the staff to assess if they can be performed safely and in accordance with NRC requirements, such that they may be incorporated in to the license. This information should include a summary of the procedures for which approval is being requested in the DP. The DP should also*

include a summary of any unique safety or other issues associated the remediation of a room or area. This includes a summary of methods and procedures for addressing any hazardous chemical materials (e.g., asbestos, or other hazardous materials) expected to be encountered during decommissioning.

Basis: 10 CFR 30.36 (g)(4)(ii). NUREG-1757 Section 17.1, Planned Decommissioning Activities also provides that the staff will ensure that the licensee and contractor are authorized to perform the decommissioning procedures described in the DP or that the licensee has described the decommissioning procedures sufficiently to allow the staff to incorporate them into the license.

Response

The proposed remediation activities are generally described in Section 3.4 of the Plan. These activities are small-scale remediation of relatively low levels of contamination. Many of the remediation activities involve general cleaning and crud removal. The floor drain piping and expansion joint and one small sump are expected to be cut, and then removed entirely. There are no significant operating equipment concerns for the existing plant since this portion of the plant has been inactive and retired since 2000.

The principal remediation methods expected for Pathfinder are as follows.

- Floor drains
  - Concrete sawing, jackhammer to access drain pipes, vacuuming, general cleaning
- Sumps, Condenser Hotwell, Mud Drums, Condenser Floor, Other
  - Needle guns to remove crud layers, vacuuming, general cleaning
  - Cutting and removal of expansion joint and possibly one small sump

In preparation of decommissioning an asbestos abatement program has been completed that has removed the asbestos from all planned remediation areas. At this time there are no known hazardous materials in the areas to be remediated.

Because this work is not unique of complex, a significant portion of the work can be accomplished using or slightly modifying existing processes and procedures. Xcel Energy routinely employs procedures in the operation and maintenance of its power plants, which include nuclear power plants. The proposed activities will involve standard and routine methods of removing contamination that experienced remediation contractors, such as Duratek, have existing procedures for and are very familiar with. Xcel Energy commits to perform all decommissioning activities using written and approved procedures as described below.

Prior to commencing remediation activities, procedures or work permits will be written or existing Xcel Energy or Duratek procedures will be modified as necessary by qualified and cognizant personnel to govern proper application of the remediation method, to minimize the spread of contamination, to provide for radwaste packaging, and to assure personnel safety. The procedures will be reviewed and approved in accordance with the Pathfinder Quality Assurance Plan. The planned development of work documents and procedures is currently scheduled for the last quarter of 2005. This documentation will be available onsite for NRC inspection. Work permits are described in Section 5.9 of the Plan.

Regarding safety, remediation of some areas will require a confined space entry. Xcel

Energy routinely makes entries into confined spaces for maintenance purposes at its power plants, including Pathfinder when it operated as a peaking plant. Xcel Energy has long-established procedures and training requirements for ensuring safety during work in confined spaces. These procedures were successfully employed for sampling during the characterization survey. The work involved oversight by a qualified Xcel Energy Safety Inspector. Safety inspectors will be involved in the coordination and oversight of work documents and remediation activities. In addition, certain areas may require respirators or dust masks. Similarly, Xcel Energy has established procedures and training for employees and contractors who use respirators or dust masks. These procedures are part of the Xcel Energy Safety Manual and will be available onsite for inspection by NRC representatives.

There are no known unique safety hazards that are expected to be encountered during the remediation activities. If unique hazards are identified, such as those not typically encountered during power plant operation and maintenance, Xcel Energy will stop remediation activities and contact the NRC prior to continuing remediation activities.

Section 3.4 of the Plan (p. 17) has been revised to cross-reference this question for additional information.

Specific Comments.

5. *For each radionuclide, provide the area factors for the Derived Concentration Guideline Levels for Elevated Measurement Comparison, $DCGL_{emc}$ values, for residual radioactivity remaining in building surfaces and surficial soil.*

Basis: Table 3-1 and Table 3-2 of Chapter 3 of the Pathfinder Decommissioning Plan list the DCGL, values for demonstrating compliance with the release criteria for building surfaces and surficial soil. The listed DCGL values assume a relatively uniform distribution of residual radioactivity within a survey unit. However, smaller areas of the survey unit with concentrations exceeding the DCGL values should also be tested to ensure that the release criteria will be met for these elevated areas of the site. According to NUREG-1757, Vol. I, Appendix B, elevated measurement comparison values, $DCGL_{emc}$ values, should be developed for each radionuclide over a range of smaller limited areas. In addition, area factors are needed to develop the maximum detectable concentration required by the scan procedure. Illustrative examples of area factors can be found in NUREG-1575, Multi-Agency Radiological Survey and Site Investigation Manual (MARSSIM), Revision I.

Response

Please note that surveys to date indicate that the probability of employing elevated measurement criteria at Pathfinder is low. A discussion of area factors and elevated measurement is provided below. Addendum A has been added to the Final Status Survey Plan (FSSP) to document how the area factors were derived. A pointer to Question 5 has been added to Section 3 (p. 13) of the Plan and Page 17 of the FSSP.

Measurements and sample analysis results from a given survey unit that exceed the criteria for release for unrestricted use specified in Tables 4-1 and 4-2 of the FSSP will require that the area be remediated or that the area from which the result was obtained be evaluated using the elevated measurement criteria. The elevated measurement criteria are size dependent. The criteria require that the size of the area associated with the measurement or sample result that exceeded the criteria for unrestricted use be determined.

The elevated measurement criteria require the use of radionuclide specific area factors,

AFs, derived for the size of the area that exceeded the criteria for release for unrestricted use. The AF is calculated as the ratio of the dose from a default area to the dose from the area that exceeded the criteria for release for unrestricted use.

$$AF = \frac{Dose\ from\ default\ area}{Dose\ from\ area\ that\ exceeded\ the\ criteria\ for\ release}$$

Addendum A to the FSSP, Area Factors and Elevated Measurement Criteria for Building Surfaces and Soils, contains the computer runs used to calculate AFs for both building surfaces and soils. Table A below contains the AFs for building surfaces.

Table A
Area Factors For Building Surfaces

Radionuclide	10 m^2	9 m^2	8 m^2	7 m^2	6 m^2	5 m^2	4 m^2	3 m^2	2 m^2	1 m^2
H-3	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Co-60	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Zn-65	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Ag-108m	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Cs-137	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Eu-152	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Eu-154	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00
Eu-155	1.00	1.11	1.25	1.43	1.67	2.00	2.50	3.33	5.00	10.00

Table B below contains the area factors for surface soils.

Table B
Area Factors For Soils

Radionuclide	100 m^2	30 m^2	10 m^2	3 m^2	1 m^2
H-3	1.00	1.00	1.00	2.45	7.33
Co-60	1.00	1.00	1.00	2.44	7.32
Zn-65	1.00	1.00	1.00	2.41	7.23
Ag-108m	1.00	1.00	1.00	2.40	7.2
Cs-137	1.00	1.00	1.00	2.45	7.36
Eu-152	1.00	1.00	1.00	2.40	7.20
Eu-154	1.00	1.00	1.00	2.40	7.22
Eu-155	1.00	1.00	1.00	2.42	7.26

The elevated measurement criteria, EMC, are the criteria for free release for unrestricted use multiplied by the appropriate area factor.

$$EMC = AF\,(Criteria\ for\ release)$$

The EMC will be used as appropriate to evaluate survey units from which measurements and sample analysis results are obtained that are elevated, i.e. exceed the criteria for release for unrestricted use specified in Tables 4.1 or 4.2 of the FSSP. If the following condition is satisfied, then the survey unit in question is acceptable for release for unrestricted use.

$$\frac{\delta}{\text{criteria for release}} + \frac{\text{average activity concentraion in the area of elevated activity} - \delta}{EMC} < 1.0$$

Where: δ = the average activity concentration in the remainder of the survey unit, pCi/g or dpm/100 cm^2

EMC = the elevated measurement criteria calculated as shown above using the area of elevated activity

6. *The licensee needs to acknowledge that the Pathfinder site meets all qualifications for using the screening approach for developing the DCGL values for building surfaces and soil.*

Basis: When using the screening approach for demonstrating compliance with the unrestricted release dose criteria in 10 CFR Part 20, Subpart E, licensees need to demonstrate that the site conditions, which includes physical and source-term conditions, meet the qualifications for screening. The qualifications for use of the screening analysis are described in Appendix H of NUREG-1757, Vol. 2.

Response

The Pathfinder site meets the qualifications for using the screening approach for developing the DCGL values for building surfaces and soil. This statement is further amplified below. Section 3 of the Plan (p. 13) has been revised to cross-reference this question for additional information.

When using the screening values for building surfaces the following conditions must be satisfied.

- The residual radioactivity will not have penetrated the surface to depths in excess of 10 mm.
- The removable fraction of the residual contamination will not be in excess of 10 percent.
- The screening criteria will not be applied to buried structures or equipment without adequate justification.

Since most of the residual contamination is fixed within the upper surfaces of metal structures and these structures will be cleaned or removed as part of the remediation, it is reasonable to assume that the residual radioactivity will not have penetrated the surface that will remain following the final status survey to depths in excess of 10 mm. There was an insignificant amount of removable contamination identified during the characterization survey. The final status surveys will demonstrate that the removable contamination does

not exceed 10 percent of the screening values. The only buried structures identified during the characterization survey were several embedded drainpipes in the basement of the Turbine Building. Given our present knowledge of the concrete depth in the basement and the floor drain design, the drainpipes are likely to be entirely encased within the concrete. There is no indication of leakage from these pipes, and it is anticipated that these pipes will be completely removed during remediation activities.

When using the screening values for soils including open land areas the following conditions must be satisfied

- The residual radioactivity must be contained in the top 15 cm of soil.
- The unsaturated zone and ground water are free of residual radioactivity.
- The vertical saturation hydrologic conductivity at the site is greater than the infiltration rate (there is no ponding or surface run-off).

There were no radionuclides attributable to licensed activities found in the soils or ground water associated with the Pathfinder site during the characterization survey. The vertical hydrologic conductivity at the site exceeds the infiltration rate as evidenced by the lack of ponding or surface run-off.

7. *The dose contribution from residual radioactivity from past decommissioning activities at the Pathfinder site should be provided and considered in determining the DCGL values. The licensee should provide supporting documentation for the derived dose contribution. The proposed DCGL values should be appropriately adjusted to account for the dose attributable to the residual radioactivity from past decommissioning activities.*

Basis: The development of the DCGL values that will be used to demonstrate compliance with the regulations for releasing the site for unrestricted use (10 CFR Part 20.1402) was provided. However, the dose contribution from past decommissioning activities was not considered in the development of the DCGLs. Specifically, the 25 mrem per year dose criterion is applicable to the entire Pathfinder site, including residual radioactivity from past decommissioning activities of the site.

Response

A bounding dose calculation was prepared to conservatively estimate the annual dose to a hypothetical individual exposed to residual contamination following the decommissioning of the Pathfinder Reactor Building. The calculation demonstrated that the dose is insignificant, 0.04 mrem/yr.

The screening values are inherently conservative, and the Pathfinder site will be remediated below the screening values. In addition, the most significant radionuclides of concern have short lives and the site has no current plans for other the industrial use as a simple cycle power plant. Consequently, the insignificant dose from the reactor building has no cumulative effect on the overall demonstration that the Pathfinder site meets the criteria for release for unrestricted use.

The calculation is attached to the end of this document. Calculations were not performed for the Fuel Handling Building or the Temporary Loading and Storage Building since

these buildings have been in use since the 1992 decommissioning effort and are included in the scope of the current decommissioning effort.

A statement will be added to Section 3 (p. 13) of Plan to cross-reference this question.

8. *Provide the following information relative to groundwater and surface water issues:*

A. *The licensee should provide groundwater potentiometric maps of the water-bearing units that have been or potentially may be impacted by site-generated radionuclides. The licensee should indicate groundwater flow directions on these maps and provide information on the hydraulic gradient. Additional potentiometric maps may need to be developed to represent seasonal changes in the water levels if these changes are significant.*

Note: The figures and tables referenced in the Question 8 responses are included at the end of Question 8E.

Response

Big Sioux Aquifer

The Big Sioux Aquifer has the greatest potential for impacts due to its proximity, shallow depth and permeable soils. The aquifer is primarily recharged by the direct infiltration of precipitation. Recharge by the Big Sioux River is minimal and is limited to the short periods when the river is at flood stage. Typically the Big Sioux River is the discharge zone (Pence 1997, Donkers 1999).

Figures 1and 2 illustrate typical groundwater elevations for the Big Sioux Aquifer near the Pathfinder Plant. Flow direction is consistently NE, and ground water gradients across the site ranges from 0.006 to 0.0108 ft/ft (Donkers 1999). Hydraulic conductivity for the aquifer's coarse sand is $1x10^{-2}$ cm/sec. Groundwater travel velocities calculated for the vicinity range from 400 ft/yr to 700 ft/yr (Donkers 1999). The time for a contaminant to travel from the Pathfinder plant to the Big Sioux River is estimated to be 1.7 to 3.1 years (Donkers 1999).

Vertical gradients within the Big Sioux Aquifer are thought to be negligible. The thin, unconfined saturated layer is composed of coarse aquifer material, which does not typically produce vertical gradients. Perms are high, 1x10-2cm/sec, and the typical saturated thickness on site is less than five feet.

Split Rock Creek Aquifer

Due to site geology and hydraulics, the Split Rock Creek aquifer is protected from plant impacts. For completeness, a brief characterization of the Split Rock Creek aquifer has been provided. Figures 3 through 5 (Appendix 1) illustrate potentiometric isopleths for 1989, 1992, and 1995. Flow direction and gradient depicted by these sample events represent wet and dry years. Flow direction is S

to SE and is perpendicular to the Big Sioux aquifer flow direction. The gradient in the potentiometric surface ranges from 0.0009 ft/ft to 0.0005 ft/ft. Pence (1997) reported an aquifer transmissivity and storativity of 5.7 ft^2/min and 0.00095 respectively. The Split Rock Creek aquifer is a confined aquifer, free flowing wells may be found in wells located in topographic low areas along the Big Sioux River.

A strong upward gradient exists between the Split Rock Creek and the Big Sioux Aquifer. On 10/12/04 a 7.92 ft difference in groundwater elevations was measured between P-5 (1289.11msl) and TW-2 (1297.03+msl). These elevations reflect an upward vertical gradient of 0.097 ft/ft (Figure 6).

B. *The licensee needs to provide additional justification why the Split Rock Creek Aquifer, the uppermost bedrock water-bearing unit, has not been contaminated by site-generated radionuclides.*

Please Note: The figures and tables referenced in the Question 8 responses are included at the end of Question 8E.

Response

Regional geology and hydraulics naturally protect the Split Rock Creek from site-generated contamination (Gary Haag, SD DENR, Personal Communication 10/12/04). The rationale for this protection is described below and a summary of the possible contaminant pathways is included in Table 1 below.

Physical Barrier

Onsite boring logs (Appendix 1) and regional geology maps provide direct evidence of a massive physical barrier between the Split Rock Creek aquifer and site generated sources. The water-yielding portion of the Split Rock Creek formation is found along the lower elevations of the formation. Sixty feet of overlying clays, siltstones and shales provide a natural barrier (Rothrock 1958, Pence 1996, Dames & Moore 1992). The thickness and formation anisotropy impede downward infiltration from the overlying Big Sioux Aquifer and favor horizontal flow. Due to the proximity of the Big Sioux River and high Big Sioux Aquifer permeability, a contaminant is more likely to discharge into the river than migrate into the Split Rock Creek aquifer.

Artesian Conditions

The low permeable materials (clays, siltstone, and shales) found in the Split Rock Creek formation also create confined aquifer conditions. Two free flowing wells, TW-1 and TW-2, were finished in the Split Rock Creek aquifer at the Pathfinder site (Rothrock 1958). Using TW-2 and well P-5, an upward gradient of 0.097 ft/ft was calculated for 10/12/04. This upward groundwater gradient would prevent downward migration of dissolved contaminants.

Recharge from Deeper Aquifer

Rothrock (1958) and Pence (1996), report the underlying Sioux Quartzite Formation recharges the Split Rock Creek aquifer. The Big Sioux Aquifer does not recharge it. Recharge to the Sioux Quartzite formation is limited to out crop areas; the nearest out crop is approximately 2 miles north of the Pathfinder plant.

Tritium and carbon dating of Split Rock Creek aquifer water (Pence 1996) support the hypothesis that the Split Rock Creek aquifer is recharged from an older aquifer. Tritium analysis reported less than detectable, suggesting the aquifer water was greater than 50 years old (Figure 7). Carbon dating (Figure 8) concluded that it was between 3,000 and 10,000 years since aquifer waters were exposed to above ground influences. The age of these waters suggest the aquifer is protected from human activities, which take place at the ground surface.

Table 1. Contaminant Pathway Evaluation Summary

Receptor	Pathway	Comments
BSA & BSR	Contaminant released from the plant via waste water or fugitive dust, subsequent dissolution and infiltration into the BSA	Viable Pathway • This pathway has been verified using non-attenuating parameters.
SRCA	Contaminant released from the plant via wastewater, percolation into the BSA and subsequent infiltration into the Split Rock Creek aquifer.	Not considered a viable pathway. • 60 ft of barrier materials (clays, siltstone, shales) would protect the deeper bedrock aquifer. • A strong upward gradient exists between Split Rock Creek and Big Sioux Aquifers. This upward gradient would restrict any surface release to the Big Sioux Aquifer water table. This gradient would protect deeper bedrock aquifers. • Due to fast ground water travel velocities and a short distance to the BSR, there is little time for deep aquifer infiltration. • SRCA is recharged from the underlying SQF and not from the BSA.
SRCA	Contaminant discharged to the Big Sioux Aquifer via a wastewater discharge and subsequent infiltration into the Split Rock Creek via impaired well casing or fracture line.	Not considered a viable pathway. • SRF not known for vertical fracturing. Pump tests show the SRCA and BSA are not hydraulically connected. • An upward gradient (0.097 ft/ft) is exhibited between Split Rock Creek & Big Sioux Aquifer. This gradient would negate possible deep aquifer contamination due impaired well casings. • Three onsite wells, screened in the SCRA, exhibit consistent water quality that is also distinctly different from the BSA. If one of these deep wells were acting as a conduit, it would reflect a general water quality that is inconsistent with the other deep wells.
SRCA	Airborne releases deposited in SQF recharge areas and subsequent discharge into SRCA.	Not considered a viable pathway. • Distance to SQF out crops is greater than 2 miles away. • No documented soil contamination.

SRCA = Split Rock Creek Aquifer, BSA = Big Sioux Aquifer, BSR = Big Sioux River, SQF = Sioux Quartzite formation

C. *The licensee's supplemental document on radionuclides in the groundwater entitled "Attachment 4 - Off Site Sample Analysis Results" from the 2003 Characterization Report needs additional clarification on the date that samples were collected and on the definition of the "Error" term. The licensee should provide additional analytical results of the potential radionuclides dissolved in the groundwater to evaluate the impact of seasonal fluctuations, or the licensee should justify why this is not necessary.*

Please Note: The figures and tables referenced in the Question 8 responses are included at the end of Question 8E.

Response

As part of the characterization survey groundwater samples were collected from the Pathfinder site on October 13, 2003. The radionuclide specific analysis results along with the total propagated uncertainty at the 95_{th} percent confidence level as reported by the analytical laboratory were reported in the Characterization Report. The propagated uncertainty includes uncertainties associated with counting errors, instrument calibration, and sample preparation within the laboratory. The characterization report referred to the total propagated uncertainty at the 95_{th} percent confidence level as reported by the analytical laboratory as simply the "error."

A second round of groundwater sampling was performed with the NRC on October 12, 2004. Xcel Energy and the NRC obtained samples at each sampling location. The radionuclide specific analysis results associated with the Xcel sample were forwarded to the NRC Region IV office.

Seasonal fluctuations are unlikely to impact the results as there have been no discharges from the atomic plant since 1970. All subsequent decommissioning and cleanup activities that have disturbed fixed contamination have been isolated, contained and removed as radwaste, and there have been no spills or burials of radioactive materials at the site. All groundwater contamination prior to 1970, if any, would have migrated offsite long ago. See response to question 8.D below. All groundwater sampling done since 1992, including that done for the Final Survey Report for the previous decommissioning effort, have not identified any groundwater contamination from licensed radioactive materials.

D. *The licensee should discuss whether site-generated radionuclides dissolved in the groundwater have moved offsite (i.e., reached the Big Sioux River), or the licensee should discuss the potential for site-generated radionuclides in the groundwater to move offsite. The fate and transport of the radionuclides in the groundwater should be evaluated and discussed. This discussion should include the hydraulic conductivity of the water-bearing units, the rates of groundwater transport, and an estimate of the time for radionuclides in the groundwater to travel offsite.*

Please Note: The figures and tables referenced in the Question 8 responses are included at the end of Question 8E.

Response

There groundwater at the Pathfinder site does not contain site-generated

radionuclides. The distinct absence of site-generated radionuclides in groundwater samples collected in 1992, 2003, and 2004 support this statement.

In addition, the potential for a hypothetical contaminant, released at the Pathfinder facility, to migrate offsite via groundwater transport is quite high. The groundwater transport pathway consists of a dissolved contaminant infiltrating 3 to 9 ft to the Big Sioux Aquifer and subsequent groundwater transport until it discharges into the Big Sioux River 700 to 1200 ft away. The time for infiltration is estimated to take less than one day. Assuming no attenuation, the travel time necessary for off site migration is estimated to range from 1.7 to 3.1 years for a release originating near the plant buildings and as short as 1 year if the release originated from the treatment ponds, Figure 9 (Donkers 1999).

The above-mentioned pathway, and speed for offsite migration has been confirmed using sulfate as a surrogate. The water treatment portion of the plant routinely releases Reverse Osmosis wastewater, which is high in sulfate. Donkers (1999 and 2003) identified the sulfate plume as originating near the south end of Pond #2 and flowing NE to the Big Sioux River where it discharges. This sulfate plume would mimic a release of radionuclides from a plant sump, treatment pond or interconnective piping. Fluctuations in groundwater sulfate concentrations correlate to changes in system operations, loading rates and/or discharge points. Response times from system changes support the maximum travel velocities calculated by Donkers (1999). This case study supports the hypothesis that offsite migration of a non-attenuating contaminant will likely occur within eighteen months of its release.

E. *The impact of climatic conditions, land use near the site, stream flow and/or stage of the Big Sioux River, and groundwater recharge on the water-bearing units at this site should be discussed pertaining to the fate and transport of the potential site-generated radionuclides.*

Basis: The extent of site-generated radionuclides in the groundwater and surface water needs to be adequately characterized to understand the potential dose that these radionuclides may produce. The hydrogeologic features at this site that impact the ability of radionuclides in the groundwater and surface water to migrate should also be characterized.

Please Note: The figures and tables referenced in the Question 8 responses are included at the end of Question 8E.

Climate: Precipitation influences

Both the Big Sioux and Split Rock Creek aquifers are responsive to wet and dry precipitation years (Goodman 1995, Pence 1997). The Big Sioux Aquifer response is direct; it is reflected by changes in saturated thickness. The Split Rock Creek's response is indirect and is indicated by the transference of head pressure from the Sioux quartzite formation to the Split Rock Creek aquifer. The Split Rock Creek response is not due to the immediate recruitment of new water.

Contaminant fate and transport is not significantly affected by climate variations. Although both aquifers respond to precipitation in terms of saturated thickness or head pressure, neither aquifer responds by a change in groundwater flow direction or gradients. The range in calculated gradients (Figures 1 through 5) reflect both wet and dry periods.

Climate: River Stage influences

Precipitation and river stage are closely correlated. The Big Sioux River is generally a gaining stream, which receives water from the Big Sioux Aquifer. During times of flooding, river elevations may be greater than groundwater elevations. During these brief periods, the river would lose water and recharge the Big Sioux Aquifer. The duration for these events is very brief. Figure 10 shows the relationship between precipitation events and river stage.

Donkers (1999) collected hourly groundwater elevations for wells nearest the river. Groundwater flow direction was calculated for each day using daily average groundwater elevations. No flow reversal was documented for this period even though there were several rain events, which would have resulted in flood conditions. No measured response is reasonable considering the short duration of these episodic floods.

Land Use: High Capacity Pumping wells

There are no large capacity pumping wells within 1 mile of the site and finished in the Big Sioux Aquifer. Dames & Moore (1992) concluded that flow directions, within the Big Sioux Aquifer and at the Pathfinder site, are not effected by off site pumping wells.

Flow direction in the Split Rock Creek Aquifer may be effected by high capacity wells. Rothrock (1958) estimated the cone of influence for Pathfinders Deep Well A to be 6,900 ft when pumped at a rate of 673 gpm. Rothrock (1958) noted pumping influences were restricted to the Split Rock Creek aquifer; no impacts were observed in the overlying Big Sioux Aquifer. On 10/12/04, free flowing well conditions were observed in TW-2, at this time Xcel Energy's "Domestic Well B" had been pumping continuously for 24 hours. This observation suggest the operation of plant wells does not negate the upward gradient observed between P-5 and TW-2, thus preserving Split Rock Creek aquifer protective forces.

Question 8 Response References:

Donkers, Chuck. "Northern States Power Company, Pathfinder Plant Decommissioning, Hydrogeologic Evaluation and Ground Water Monitoring". June 1992.

Donkers, Chuck. "Pathfinder Remedial Investigation," September 1999.

Donkers, Chuck. " Managing Sulfate Concentrations Via Discharge Modifications." American Institute of Professional Geologists AIPG presentation discussing the Xcel Energy Pathfinder Facility October 2003

Dames & Moore, "Hydrogeologic Investigation, Pathfinder Site, Sioux Falls SD" March 1992.

Dienhart A.V. "Pathfinder Steam Plant, EA366, Geology of Plant Site, Preliminary Report." April 1, 1958.

Fetter, C.W., "Applied Hydrogeology," Merrill Publishing 1988

Goodman, James A. "Report on Water Permit Application No. 5861-3 for Northern States Power Company". May 24, 1995.

Haag, Gary. Hydrologist with South Dakota Dept of Environment and Natural Resources, Personal communication 10/12/04,

Northern States Power Company. "Ground Water Discharge Plan Application for Proposed Combustion Turbine Generating Facility Pathfinder Site, Minnehaha County, South Dakota" March 31, 1992.

Pence, Stan F. "Hydrology and recharge of the Split Rock Creek Aquifer, SE South Dakota," A Master's Thesis – University of North Dakota, Grand Forks ND, December 1996.

Pence, Stan F. "Summary of the Split Rock Creek Aquifer Study," Open File Report 87-UR, 1997

Rothrock E.P. " Geology and Water Supplies in the Vicinity of the Pathfinder Steam Plant Project," July 1, 1958.

Xcel Energy. "Pathfinder Decommissioning Plan, Environmental Information Addendum," February 17, 2004.

Table 2.
Determination of Ground Water Flow
Based Upon 3 Random Well Locatons

Well ID	$P\text{-}3_{p1}$	$P\text{-}4_{p2}$	$P\text{-}9_{p3}$
East Coordinate (X)	2978824	2979348	2978643
North Coordinate (Y)	485731	485632	485340
Aquifer Porisity	0.25		
Aquifer Permeability	1.60E-02	cm/sec	

m-det 0.000005 <— used in column X & Y det calculations

Time	GW Elev $P\text{-}3_{z1}$	$P\text{-}4_{z2}$	$P\text{-}9_{z3}$	Direction: Degrees from N	Gradient	$V_t = \frac{K \cdot I}{p}$ cm/sec	ft/day
4/14/99 3:03 PM	1295.25	1294.75	1296.04	32.8	0.002494	1.60E-04	4.52E-01
4/15/99 12:03 AM	1295.26	1294.72	1296.08	33.6	0.002597	1.66E-04	4.71E-01
4/16/99 12:03 AM	1295.48	1294.87	1296.20	38.5	0.002449	1.57E-04	4.44E-01
4/17/99 12:03 AM	1295.41	1294.82	1296.29	33.9	0.002809	1.80E-04	5.10E-01
4/18/99 12:03 AM	1295.14	1294.56	1296.40	27.7	0.003723	2.38E-04	6.75E-01
4/19/99 12:03 AM	1294.84	1294.28	1296.48	23.7	0.004684	3.00E-04	8.50E-01
4/20/99 12:03 AM	1294.58	1294.00	1296.53	22.1	0.005502	3.52E-04	9.98E-01
4/21/99 12:03 AM	1294.34	1293.75	1296.59	20.9	0.006264	4.01E-04	1.14E+00
4/22/99 12:03 AM	1294.14	1293.56	1296.63	19.8	0.006893	4.41E-04	1.25E+00
4/23/99 12:03 AM	1294.01	1293.40	1296.64	19.7	0.007281	4.66E-04	1.32E+00
4/24/99 12:03 AM	1293.86	1293.26	1296.68	19.0	0.007754	4.96E-04	1.41E+00
4/25/99 12:03 AM	1293.63	1293.05	1296.72	18.1	0.008443	5.40E-04	1.53E+00
4/26/99 12:03 AM	1293.33	1292.77	1296.72	17.2	0.009212	5.90E-04	1.67E+00
4/27/99 12:03 AM	1293.45	1292.80	1296.75	18.4	0.009051	5.79E-04	1.64E+00
4/28/99 12:03 AM	1293.58	1292.88	1296.78	19.3	0.008809	5.64E-04	1.60E+00
4/29/99 12:03 AM	1293.6	1292.90	1296.82	19.2	0.008876	5.68E-04	1.61E+00
4/30/99 12:03 AM	1293.56	1292.88	1296.85	18.8	0.009026	5.78E-04	1.64E+00
5/1/99 12:03 AM	1293.53	1292.85	1296.88	18.7	0.009195	5.88E-04	1.67E+00
5/2/99 12:03 AM	1293.4	1292.74	1296.88	18.2	0.009519	6.09E-04	1.73E+00
5/3/99 12:03 AM	1293.24	1292.60	1296.89	17.6	0.009938	6.36E-04	1.80E+00
5/4/99 12:03 AM	1293.09	1292.47	1296.89	17.2	0.010329	6.61E-04	1.87E+00
5/5/99 12:03 AM	1293.07	1292.42	1296.92	17.4	0.010477	6.71E-04	1.90E+00
5/6/99 12:03 AM	1293.3	1292.58	1296.93	18.5	0.009941	6.36E-04	1.80E+00
5/7/99 12:03 AM	1294.09	1293.25	1296.96	22.0	0.008059	5.16E-04	1.46E+00
5/8/99 12:03 AM	1293.81	1293.16	1296.98	18.5	0.008686	5.56E-04	1.58E+00
5/9/99 12:03 AM	1293.75	1293.13	1297.00	18.2	0.008895	5.69E-04	1.61E+00
5/10/99 12:03 AM	1293.73	1293.12	1297.00	18.1	0.008925	5.71E-04	1.62E+00
5/11/99 12:03 AM	1293.73	1293.09	1297.00	18.4	0.008945	5.73E-04	1.62E+00
5/12/99 12:03 AM	1293.84	1293.27	1297.08	17.7	0.008822	5.65E-04	1.60E+00
5/13/99 12:03 AM	1293.89	1293.29	1297.12	18.0	0.008832	5.65E-04	1.60E+00
5/14/99 12:03 AM	1293.69	1293.14	1297.13	17.0	0.009336	5.97E-04	1.69E+00
5/15/99 12:03 AM	1293.55	1292.98	1297.15	17.0	0.009774	6.26E-04	1.77E+00
5/16/99 12:03 AM	1293.34	1292.77	1297.15	16.6	0.010323	6.61E-04	1.87E+00
5/17/99 12:03 AM	1293.25	1292.65	1297.16	16.8	0.010606	6.79E-04	1.92E+00
5/18/99 12:03 AM	1293.07	1292.44	1297.15	16.8	0.011051	7.07E-04	2.00E+00
5/19/99 12:03 AM	1292.91	1292.28	1297.14	16.6	0.011453	7.33E-04	2.08E+00
5/20/99 12:03 AM	1292.83	1292.15	1297.11	17.0	0.011619	7.44E-04	2.11E+00
5/21/99 12:03 AM	1293.59	1292.75	1297.16	19.9	0.009887	6.33E-04	1.79E+00
5/22/99 12:03 AM	1293.31	1292.66	1297.20	17.3	0.010573	6.77E-04	1.92E+00
5/23/99 12:03 AM	1293.17	1292.52	1297.21	17.1	0.010983	7.03E-04	1.99E+00
5/24/99 12:03 AM	1292.96	1292.32	1297.21	16.7	0.01151	7.37E-04	2.09E+00
5/25/99 12:03 AM	1292.86	1292.17	1297.18	17.0	0.01173	7.51E-04	2.13E+00
5/26/99 12:03 AM	1292.75	1292.05	1297.15	17.0	0.011932	7.64E-04	2.16E+00
5/27/99 12:03 AM	1292.63	1291.91	1297.09	17.1	0.012123	7.76E-04	2.20E+00
5/28/99 12:03 AM	1292.5	1291.77	1297.05	17.1	0.012349	7.90E-04	2.24E+00
5/29/99 12:03 AM	1292.38	1291.63	1297.00	17.1	0.012555	8.04E-04	2.28E+00
5/30/99 12:03 AM	1292.25	1291.47	1296.96	17.3	0.012794	8.19E-04	2.32E+00
5/31/99 12:03 AM	1292.41	1291.61	1296.96	17.7	0.01239	7.93E-04	2.25E+00
6/1/99 12:03 AM	1292.13	1291.34	1296.96	17.2	0.01313	8.40E-04	2.38E+00

Note: Shaded Fields Are Calculated Fields

vector1.xls

Table 2. (continued)
Determination of Ground Water Flow
Based Upon 3 Random Well Locatons

Well ID	$P\text{-}3_{pz1}$	$P\text{-}4_{pz2}$	$P\text{-}9_{pz3}$
East Coordinate (X)	2978824	2979348	2978843
North Coordinate (Y)	485731	485632	485340
Aquifer Porisity	0.25		
Aquifer Permeability	1.60E-02	cm/sec	

m-det 0.000005 <— used in column X & Y det calculations

	GW Elev						$V_t = \frac{k \times i}{p}$
Time	$P\text{-}3_{z1}$	$P\text{-}4_{z2}$	$P\text{-}9_{z3}$	Direction: Degrees from N	Gradient	cm/sec	ft/day
6/2/99 12:03 AM	1292.32	1291.54	1296.95	17.4	0.012596	8.06E-04	2.29E+00
6/3/99 12:03 AM	1292.2	1291.45	1296.91	17.0	0.012798	8.19E-04	2.32E+00
6/4/99 12:03 AM	1292.07	1291.31	1296.87	17.0	0.013024	8.34E-04	2.36E+00
6/5/99 12:03 AM	1291.97	1291.22	1296.82	16.8	0.013158	8.42E-04	2.39E+00
6/6/99 12:03 AM	1291.88	1291.16	1296.80	16.5	0.013314	8.52E-04	2.42E+00
6/7/99 12:03 AM	1291.79	1291.19	1296.77	15.5	0.013386	8.57E-04	2.43E+00
6/8/99 12:03 AM	1291.73	1291.23	1296.74	14.7	0.013408	8.58E-04	2.43E+00
6/9/99 12:03 AM	1291.73	1291.22	1296.72	14.8	0.013382	8.56E-04	2.43E+00
6/10/99 12:03 AM	1292.08	1291.33	1296.72	17.1	0.012599	8.06E-04	2.29E+00
6/11/99 12:03 AM	1292.03	1291.32	1296.72	16.7	0.012704	8.13E-04	2.30E+00
6/12/99 12:03 AM	1292.05	1291.36	1296.72	16.6	0.012639	8.09E-04	2.29E+00
6/13/99 12:03 AM	1292.34	1291.64	1296.70	17.1	0.011828	7.57E-04	2.15E+00
6/14/99 12:03 AM	1292.5	1291.81	1296.66	17.3	0.011315	7.24E-04	2.05E+00
6/15/99 12:03 AM	1292.47	1291.79	1296.62	17.2	0.011257	7.21E-04	2.04E+00
6/16/99 12:03 AM	1292.38	1291.72	1296.62	16.9	0.011489	7.35E-04	2.08E+00
6/17/99 12:03 AM	1292.17	1291.48	1296.59	16.9	0.011981	7.67E-04	2.17E+00
6/18/99 12:03 AM	1292.01	1291.33	1296.53	16.7	0.012241	7.83E-04	2.22E+00
6/19/99 12:03 AM	1291.89	1291.23	1296.49	16.4	0.012453	7.97E-04	2.26E+00
6/20/99 12:03 AM	1291.87	1291.21	1296.45	16.4	0.012398	7.93E-04	2.25E+00
6/21/99 12:03 AM	1291.87	1291.22	1296.41	16.4	0.012271	7.85E-04	2.23E+00
6/22/99 12:03 AM	1291.85	1291.21	1296.35	16.4	0.012166	7.79E-04	2.21E+00
6/23/99 12:03 AM	1291.85	1291.21	1296.35	16.4	0.012166	7.79E-04	2.21E+00
6/24/99 12:03 AM	1291.8	1291.18	1296.33	16.2	0.012224	7.82E-04	2.22E+00
6/25/99 12:03 AM	1291.74	1291.16	1296.32	15.8	0.012327	7.89E-04	2.24E+00
6/26/99 12:03 AM	1291.68	1291.21	1296.27	14.8	0.012311	7.88E-04	2.23E+00
6/27/99 12:03 AM	1291.66	1291.21	1296.26	14.6	0.012323	7.89E-04	2.24E+00
6/28/99 12:03 AM	1291.72	1291.19	1296.29	15.3	0.012273	7.85E-04	2.23E+00
6/29/99 12:03 AM	1291.72	1291.21	1296.25	15.2	0.012156	7.78E-04	2.21E+00
6/30/99 12:03 AM	1291.75	1291.19	1296.20	15.7	0.011988	7.67E-04	2.17E+00
7/1/99 12:03 AM	1291.7	1291.19	1296.15	15.3	0.011952	7.65E-04	2.17E+00
7/2/99 12:03 AM	1291.65	1291.21	1296.13	14.6	0.011982	7.67E-04	2.17E+00
7/3/99 12:03 AM	1291.77	1291.18	1296.14	16.1	0.011786	7.54E-04	2.14E+00
7/4/99 12:03 AM	1291.77	1291.17	1296.11	16.2	0.011732	7.51E-04	2.13E+00
7/5/99 12:03 AM	1291.79	1291.18	1296.07	16.4	0.011566	7.40E-04	2.10E+00
7/6/99 12:03 AM	1291.85	1291.23	1296.04	16.6	0.01134	7.26E-04	2.06E+00
7/7/99 12:03 AM	1291.8	1291.21	1296.02	16.3	0.011407	7.30E-04	2.07E+00
7/8/99 12:03 AM	1291.73	1291.18	1295.98	15.9	0.011445	7.32E-04	2.08E+00
7/9/99 12:03 AM	1291.66	1291.16	1295.96	15.3	0.011566	7.40E-04	2.10E+00
7/10/99 12:03 AM	1291.65	1291.19	1295.93	15.0	0.011493	7.36E-04	2.09E+00
7/11/99 12:03 AM	1291.65	1291.19	1295.91	15.0	0.01142	7.31E-04	2.07E+00
7/12/99 12:03 AM	1291.65	1291.19	1295.85	15.1	0.011268	7.21E-04	2.04E+00
7/12/99 11:03 PM	1291.65	1291.16	1295.70	15.5	0.010898	6.97E-04	1.98E+00
							ft/yr
min	1291.65	1291.16	1293.49	11.71	0.002	0.00	0.44	160.2
max	1295.51	1294.92	1297.23	38.54	0.014	0.00	2.45	895.9
mean	1292.77	1292.15	1296.65	17.80	0.011	0.00	1.91	698.5
std	1.01	1.01	0.42	3.71	0.002	0.00	0.45	164.2

Note: Shaded Fields Are Calculated Fields

vector1.xls

Figure 1

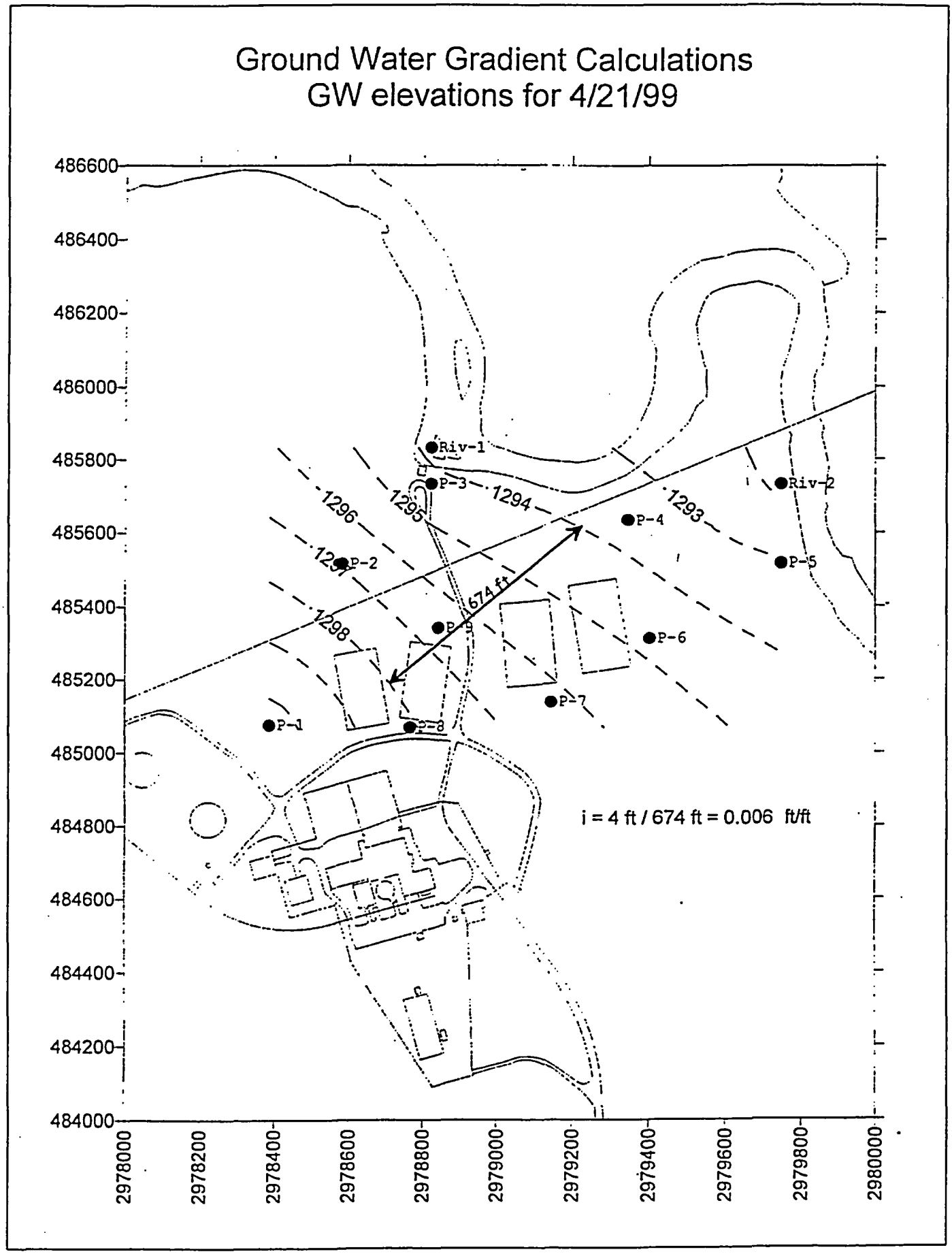

Ground Water Gradient Calculations
GW elevations for 4/21/99
486600
486400
486200
486000
485800
485600
485400
485200
485000
484800
484600
484400
484200
484000
2978000
2978200
2978400
2978600
2978800
2979000
2979200
2979400
2979600
2979800
2980000
Riv-1
P-3
Riv-2
P-4
P-5
P-2
P-6
P-7
P-1
P-8
1296
1295
1294
1293
1297
1298
674 ft
i = 4 ft / 674 ft = 0.006 ft/ft

Figure 2

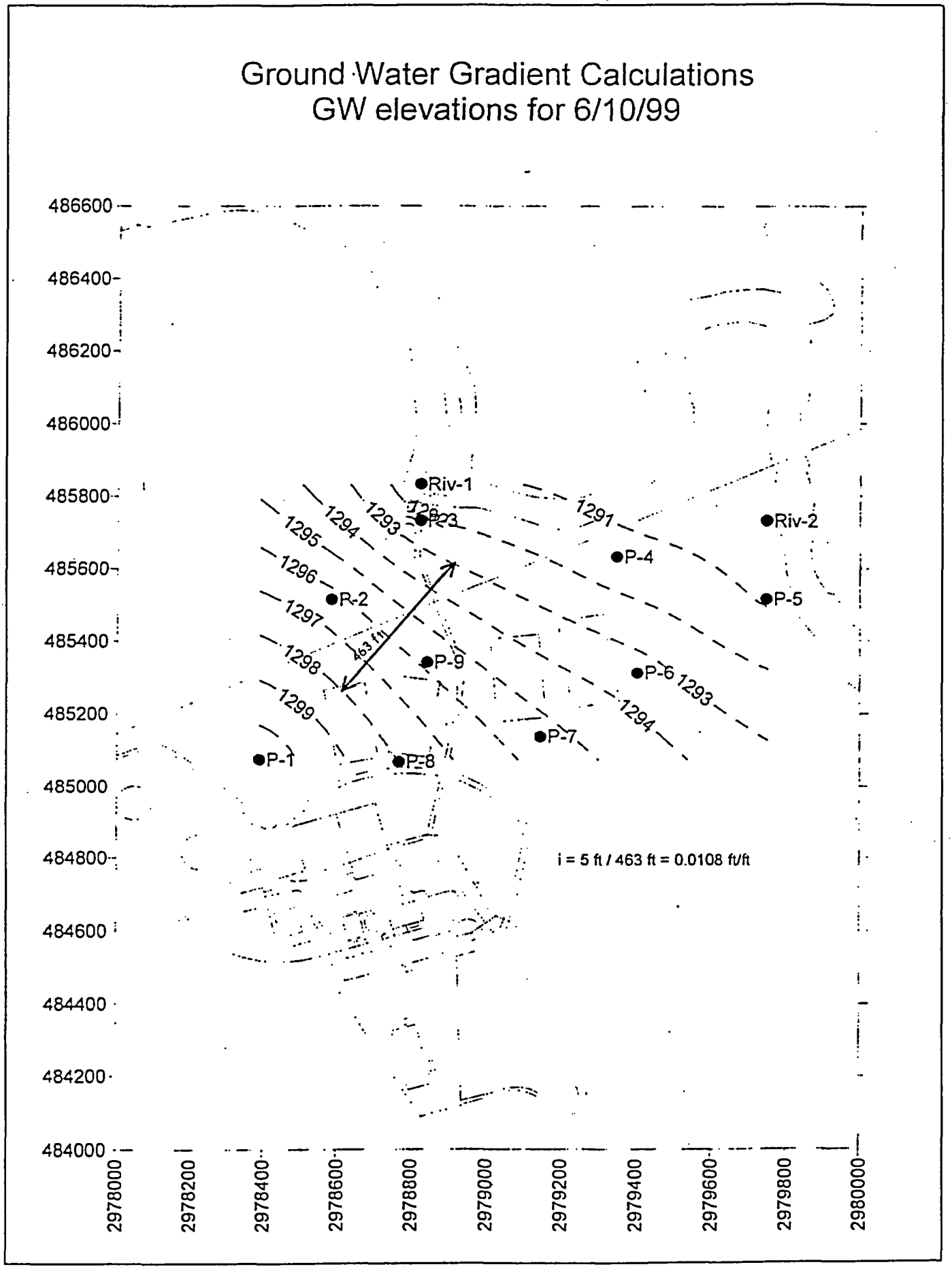

Ground Water Gradient Calculations
GW elevations for 6/10/99
486600
486400
486200
486000
485800
485600
485400
485200
485000
484800
484600
484400
484200
484000
2978000
2978200
2978400
2978600
2978800
2979000
2979200
2979400
2979600
2979800
2980000
Riv-1
P-3
Riv-2
P-4
P-5
R-2
P-9
P-6
P-7
P-1
P-8
1291
1293
1294
1295
1296
1297
1298
1299
463 ft
i = 5 ft / 463 ft = 0.0108 ft/ft

Figure 3 Potentiometric surface of the Split Rock aquifer on March 10, 1989 (Pence 1996)

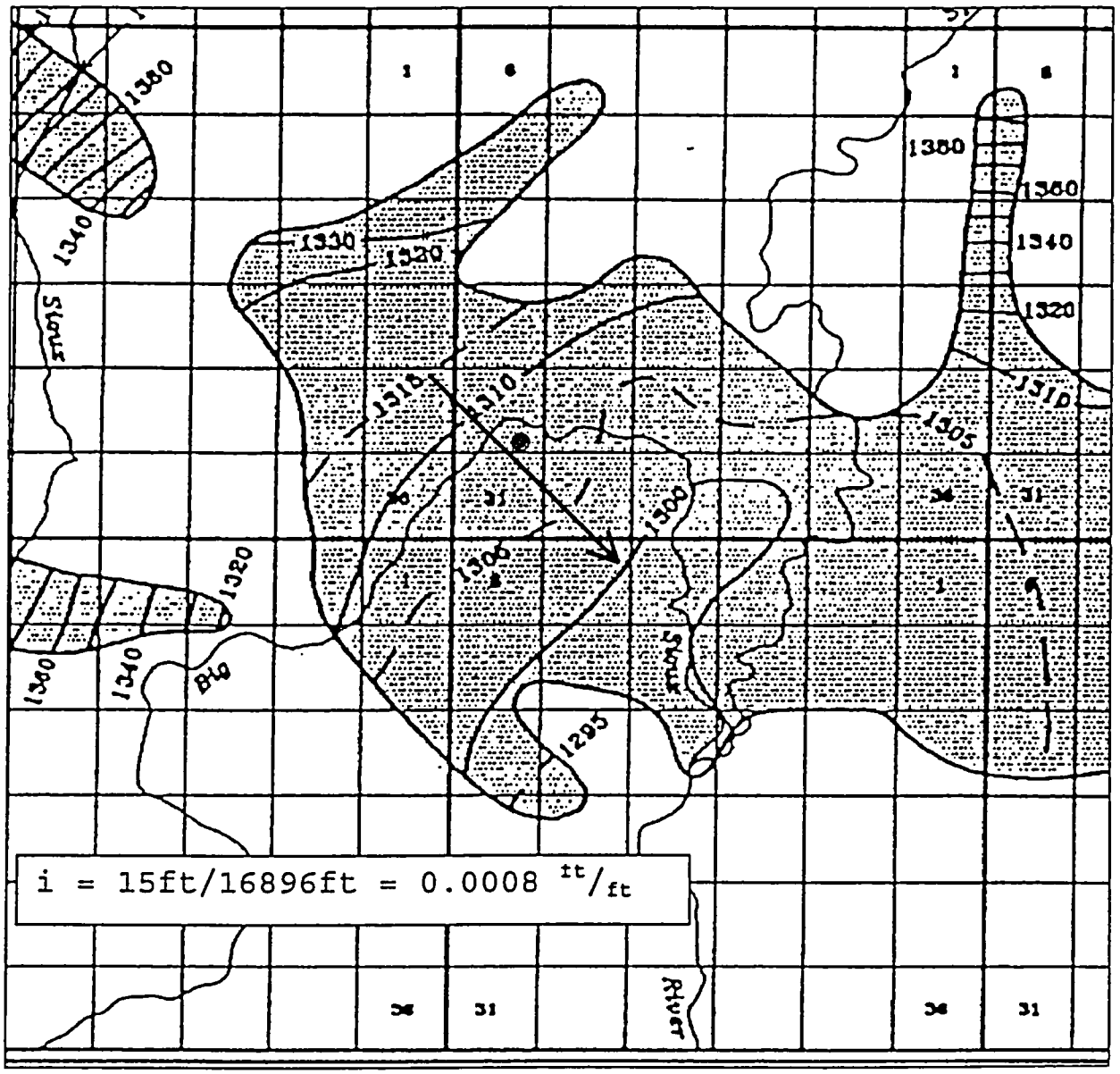


Figure 4: Potentiometric surface of the Split Rock aquifer on January 6, 1992 (Pence 1996)

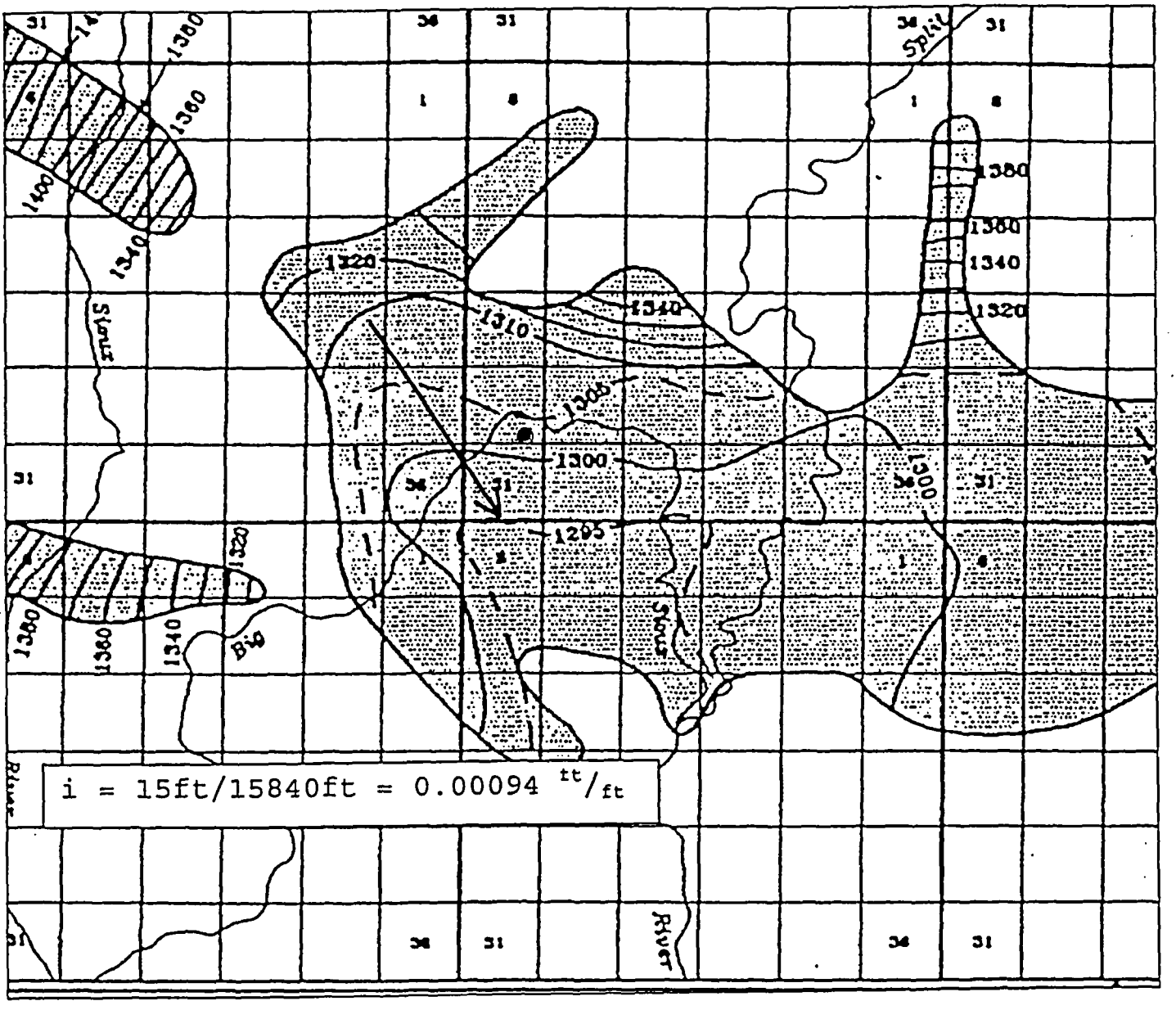


Figure 5: Potentiometric surface of the Split Rock aquifer on July 31, 1995 (Pence 1996)

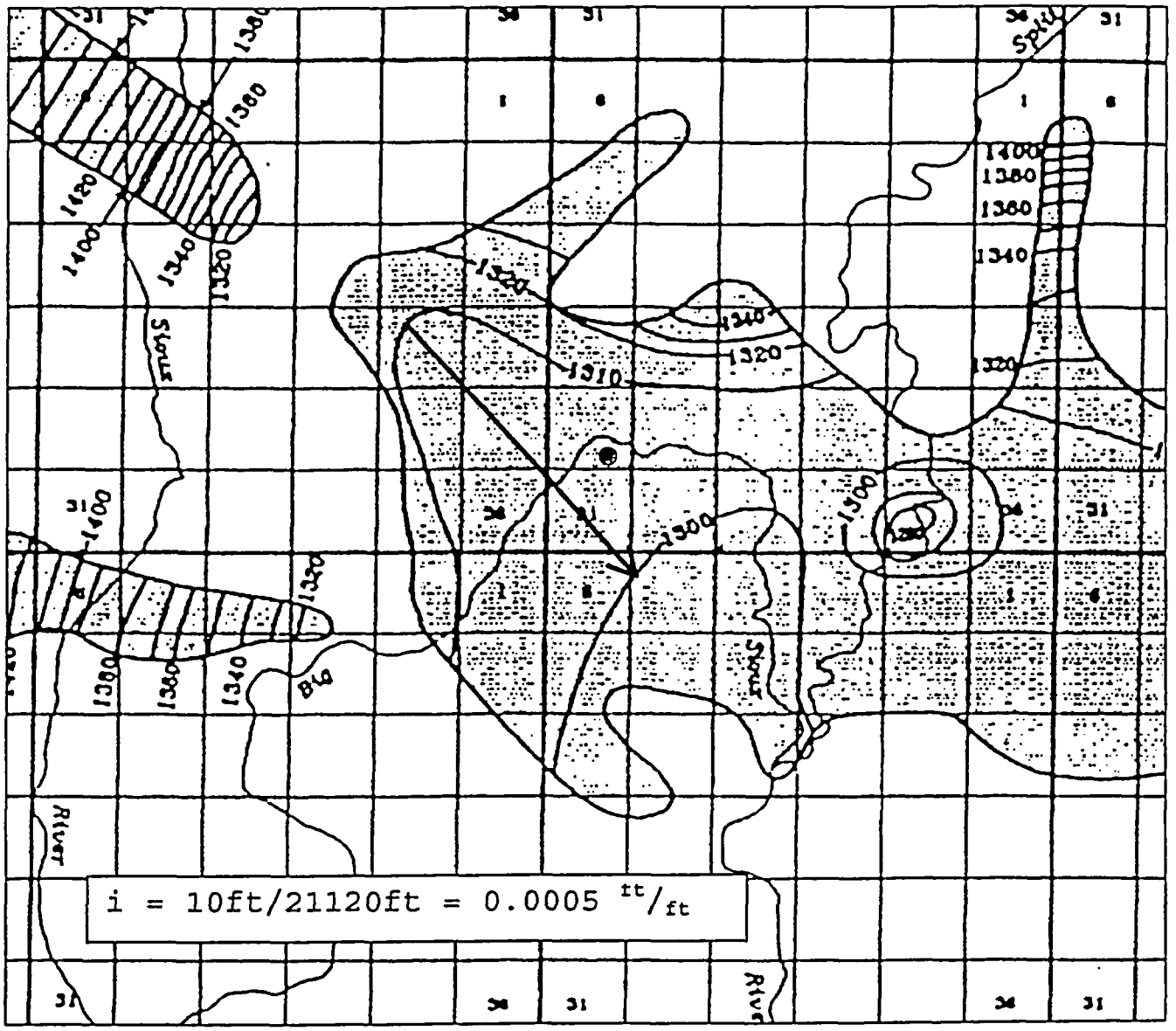


Figure 6: Vertical Gradient between the Split Rock Creek and Big Sioux Aquifers for 10/12/04

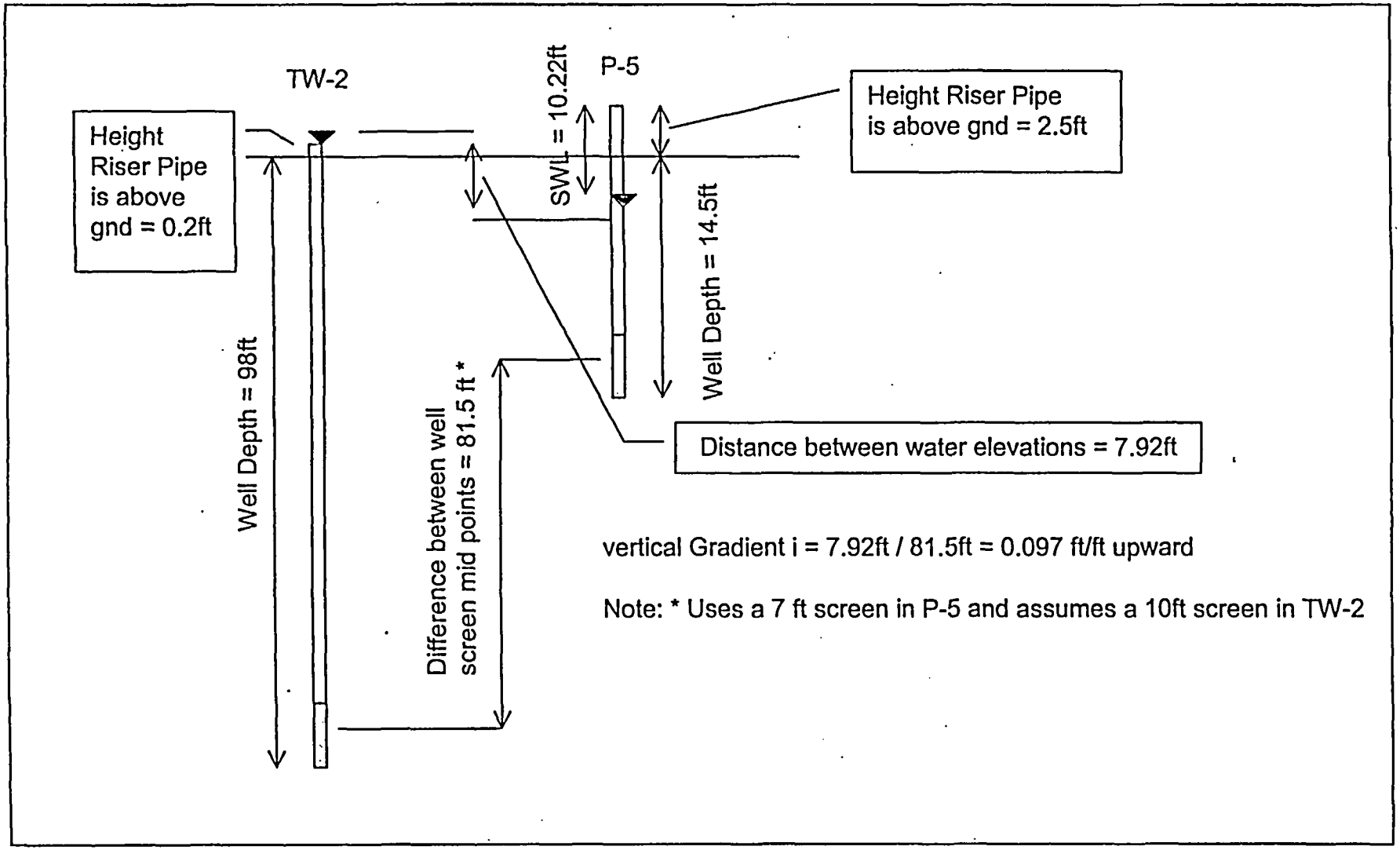


Figure 7: Age of Split Rock Creek Aquifer Water (Pence 1996)

Table 8. Laboratory Results of Tritium Analyses.

Well ID	Date Sampled	TU
NSP-3 PW	04/27/88	0 ± 0.10
Renner PW	02/13/89	0 ± 0.09
Renner PW	02/14/89	0 ± 0.09
Brandon PW	06/28/89	0 ± 0.09
Watrec PW	11/15/89	0 ± 0.09

Duplicate samples were not run by the laboratory.

These results show no tritium present in the ground-water samples collected from this aquifer.

Figure 8: Age of Split Rock Creek Aquifer Water (Pence 1996)

Table 9. Laboratory Results of Radiocarbon Analyses and Calculated Ages.

Well ID	Date Sampled	PMC	$\delta^{13}C$	Calculated Age
NSP-3 PW	04/27/88	28.2 ± 0.4	-9.90 ± 0.1‰	3,400
Renner PW	02/14/89	12.0 ± 0.2	-10.31 ± 0.1‰	10,600
Brandon PW	06/28/89	20.2 ± 0.2	-10.97 ± 0.1‰	6,900
Watrec PW	11/15/89	15.7 ± 0.3	-11.35 ± 0.1‰	9,200

Duplicate samples were not run; and analyses of standards were not reported.

The results of radiocarbon dating show the aquifer water ranging from approximately 3,000 years to 10,000 years old.

Figure 9: Big Sioux Aquifer, Ground Water Travel Velocity (Donkers 1999)

Pathfinder Travel Velocity Calculations

Sample depth	D_{10}	K_h	ln	Geometric Mean K_h
10	0.138	1.5E-02	-4.184147	
13	0.2336	4.4E-02	-3.131434	
10	0.0909	6.6E-03	-5.019134	
	geo-metric mean		-4.111571	1.6E-02 cm/sec

Source: TCT letter Report 1/14/92 for Pathfinder

Velocity Calculations

K_h	I	p	velocity ft/yr
1.60E-02	0.0108	0.25	715
1.60E-02	0.006	0.25	397

Source: Pathfinder GW elev for 4/21//99 & 6/10/99

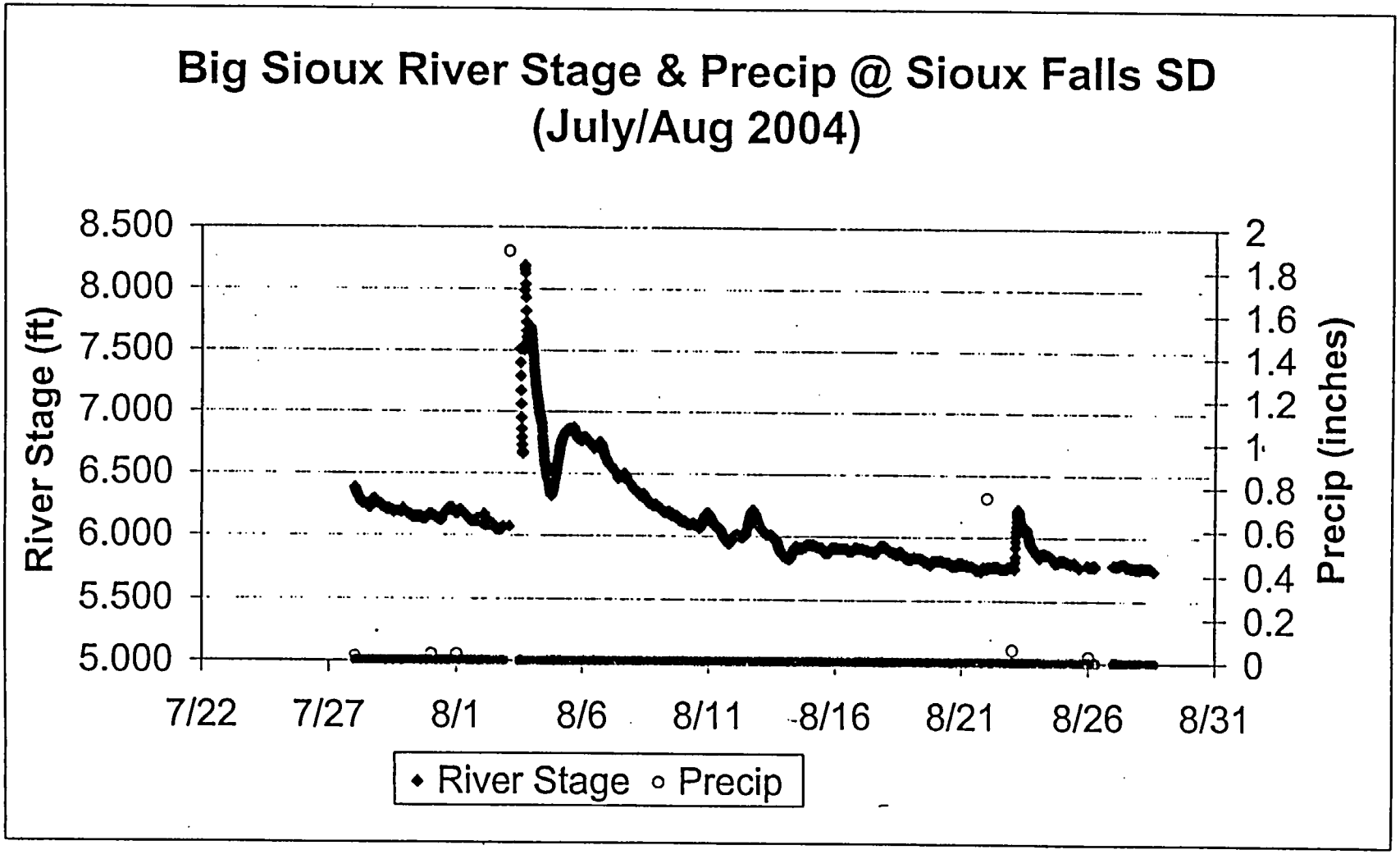
Source to Receptor Distances

Source	P3	P4
plant	1225	1225
pond	700	875

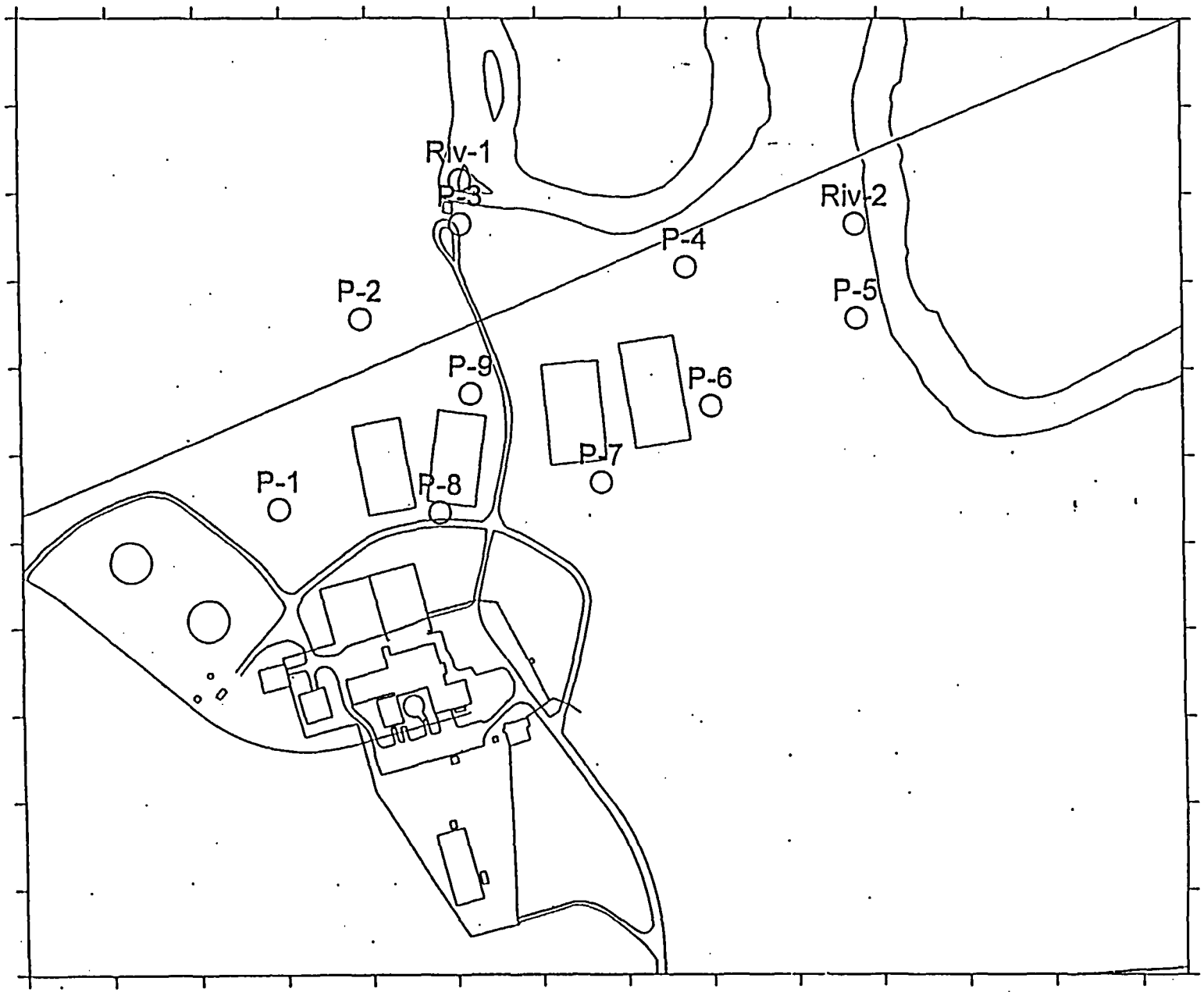
Travel Time in Years

	Receptor	
Source	P3	P4
plant	1.7 to 3.1	1.7 to 3.1
pond	1.0 to 1.7	1.2 to 2.2

Figure 10: Climate Influences: Precipitation & River Stage



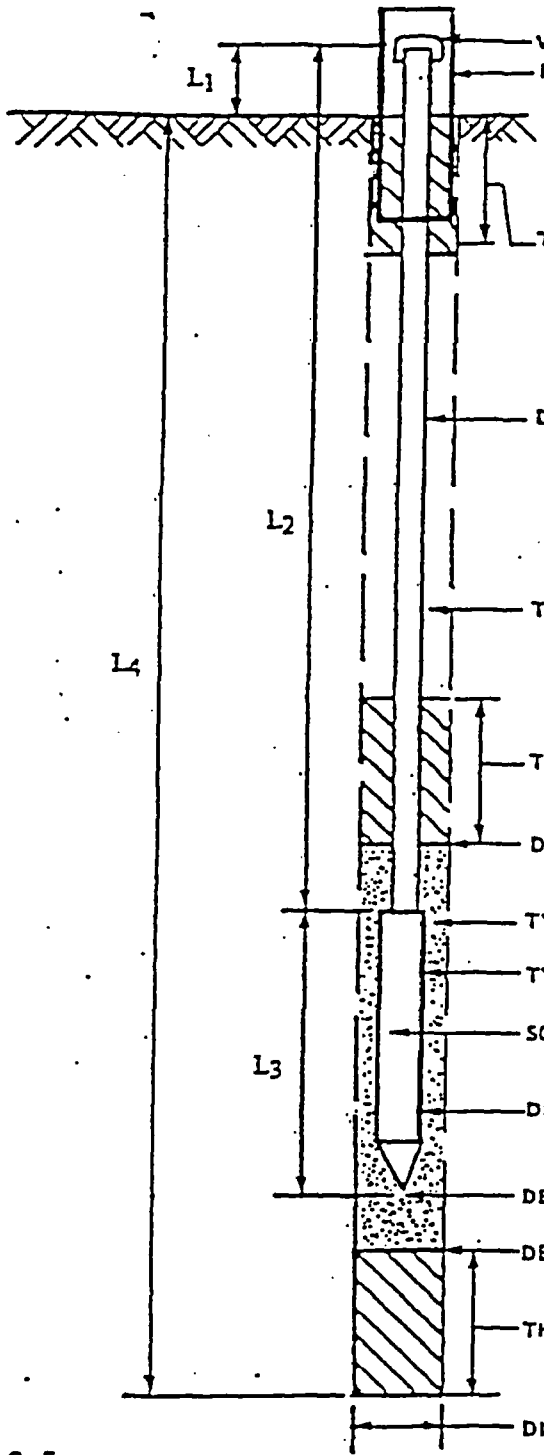
Monitoring Locations



Pathfinder Soil Borings
&
Well Construction Diagrams

JOB NO. 4220 92-1127 MONITORING WELL NO. P-1

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP

PROTECTIVE CASING
- Diameter and Type: 4" Steel
- Total Length: 5'
- Length Above Ground: 2.5'

THICKNESS AND TYPE OF SEAL: Neat Cement Grout

DIAMETER AND TYPE OF RISER PIPE: 2" PVC

TYPE OF BACKFILL AROUND RISER: Neat Cement Grout

THICKNESS AND TYPE OF SEAL: 5.0' - 6.5' Bentonite Pellets

DEPTH TO TOP OF FILTER SAND: 6.5'

TYPE OF FILTER AROUND SCREEN: #55/65 Silica Sand

TYPE OF MONITORING WELL: P.V.C.

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.): #10 Slot

DIAMETER AND LENGTH OF SCREEN: 2" X 7.5'

DEPTH TO BOTTOM OF MONITORING WELL: 15.4'

DEPTH TO BOTTOM OF FILTER SAND: 15.4'

THICKNESS AND TYPE OF SEAL: None

DIAMETER OF BOREHOLE: 8"

L_1= 2.5 FT

L_2= 10.4 FT

L_3= 7.5 FT

L_4= 15.4 FT

INSTALLATION COMPLETED: Date 11-19-91 Time 5:00

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

LOG OF TEST BORING

JOB NO. 4220 92-1127 VERTICAL SCALE 1" = 5' BORING NO. P-1

PROJECT NSP PATHFINDER PLANT-SIOUX FALLS, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	CLASSIFICATION SYMBOL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	Qu or ROD
	LEAN CLAY, black	CL	Topsoil			1	HSA					
2.0	LEAN CLAY W/SAND, dark brown to brown, very soft	CL	Fine Alluvium	4		2	SB					
5.5	SAND W/SILT AND GRAVEL, a few cobbles, medium grained, grayish brown, moist, medium dense to very dense	SP-SM TO GP-GM	Coarse Alluvium	12		3	SB					
				53		4	SB					
9.5	WEATHERED TO HARD BLACK ROCK, moist to wet		Blackrock Member of Pathfinder Formatiion	50/.4	▼	5	SB					
				50/.4		6	SB					
14.8				50/.3		7	SB					
	End of Boring											
	Note: Boring backfilled to the surface with tremied neat cement grout.											
	Note: Monitoring well installed in separate borehole within 10' of this boring											

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
11-18	3:40	14'	12'	12.5'		11.5'
11-18	3:50	16.5'	None	14.5'		13.5'

START 11-18-91 COMPLETE 11-18-91 @ 3:50

METHOD 3-1/4" HSA 0'-14.5'

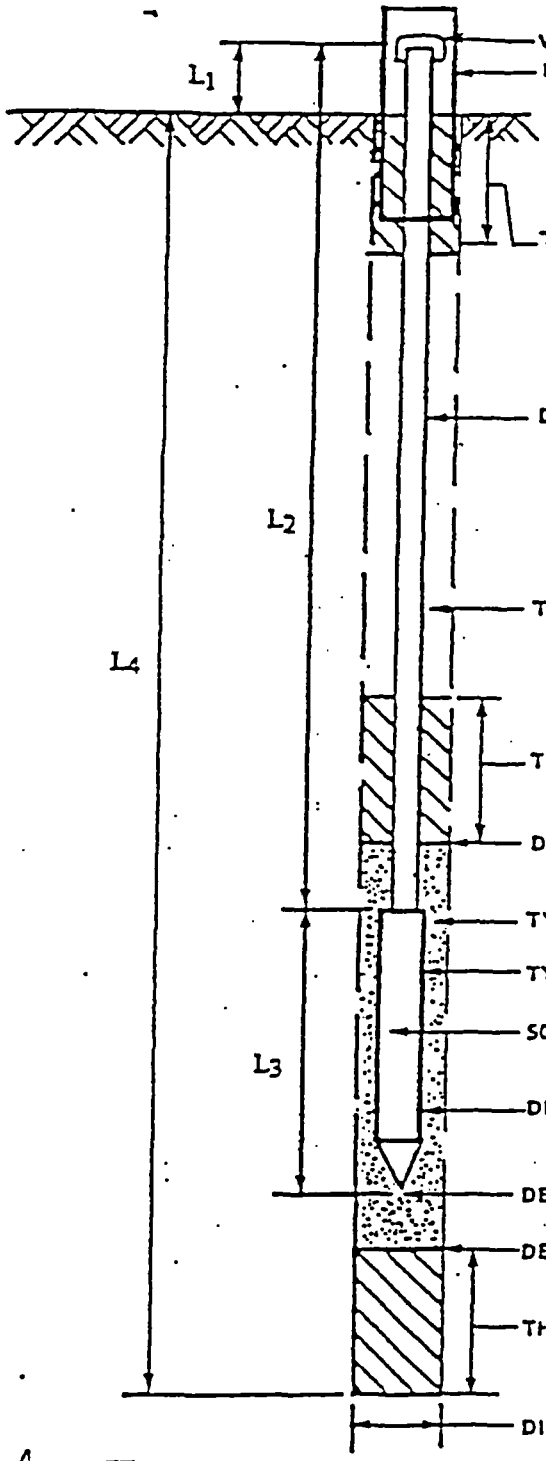
NORTH: EAST:

CREW CHIEF M. Crotty

twin city testing corporation

JOB NO. 4220 92 1127 MONITORING WELL NO. P-2

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" Steel
Total Length	5'
Length Above Ground	2.6'
THICKNESS AND TYPE OF SEAL	Neat Cement Grout
DIAMETER AND TYPE OF RISER PIPE	2" P.V.C.
TYPE OF BACKFILL AROUND RISER	Neat Cement Grout
THICKNESS AND TYPE OF SEAL	6.5' - 8' Bentonite Pellets
DEPTH TO TOP OF FILTER SAND	8'
TYPE OF FILTER AROUND SCREEN	#55/65 Silica Sand
TYPE OF MONITORING WELL	P.V.C.
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 8'
DEPTH TO BOTTOM OF MONITORING WELL	17.3'
DEPTH TO BOTTOM OF FILTER SAND	17.3'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	8"

L_1= 2.4 FT

L_2= 11.7 FT

L_3= 8.0 FT

L_4= 17.3 FT

INSTALLATION COMPLETED:
Date 11-20-91 Time 10:15

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

LOG OF TEST BORING

JOB NO. 4220 92-1127 VERTICAL SCALE 1" = 5' BORING NO. P-2

PROJECT NSP PATHFINDER PLANT-SIOUX FALLS, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL — SURFACE ELEVATION	CLASSIFICATION SYMBOL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	Qu or RQD
	LEAN CLAY, black	CL	Topsoil			1	HSA					
2.0	LEAN CLAY, dark brown to brown, soft	CL	Fine - Alluvium	7		2	SB					
4.5	LEAN CLAY W/SAND, brown, soft	CL		6		3	SB					
8.0	SAND W/SILT AND A LITTLE GRAVEL, medium grained, brown, moist, medium dense	SP-SM	Coarse Alluvium	12		4	SB					
10.0	SAND W/GRAVEL, a few cobbles, medium grained, grayish brown, moist to 12' then waterbearing, very dense	SP-SM		57	▼	5	SB					
13.0	WEATHERED TO HARD ROCK, black, wet		Blackrock Member*	60		6	SB					
14.9	End of Boring		*of Pathfinder Formation	50/.4		7	SB					

Note: Boring backfilled to the surface with tremied neat cement grout.
Note: Monitoring well installed in separate borehole within 10' of this boring.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
18	2:30	15'	14.5'	15'		14.5'
11-20	8:00	16.5'	None	13'		12'

START 11-18-91 COMPLETE 11-18-91 @ 2:30

METHOD 3-1/4" HSA 0'-14.5'

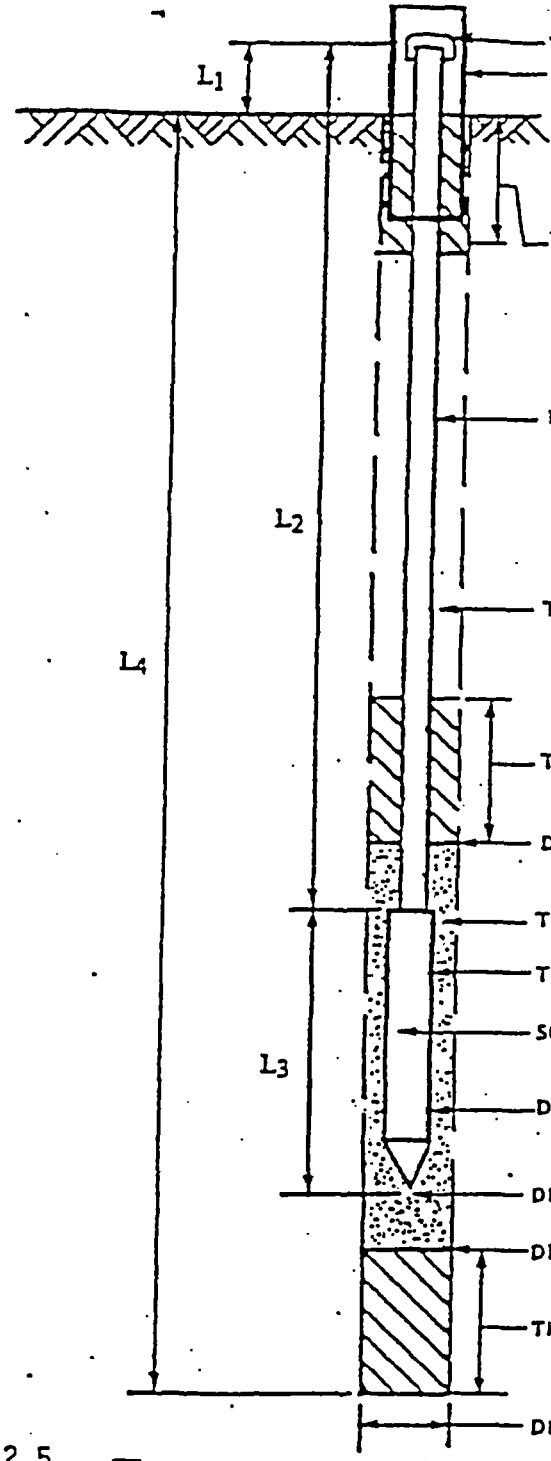
NORTH: EAST:

CREW CHIEF M. Crotty

twin city testing corporation

JOB NO. 4220 92 1127 MONITORING WELL NO. P-3

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP

PROTECTIVE CASING
- Diameter and Type: 4" Steel
- Total Length: 5'
- Length Above Ground: 2.7'

THICKNESS AND TYPE OF SEAL: Neat Cement Grout

DIAMETER AND TYPE OF RISER PIPE: 2" P.V.C.

TYPE OF BACKFILL AROUND RISER: Neat Cement Grout

THICKNESS AND TYPE OF SEAL: 7.0' - 8.5' Bentonite Pellets

DEPTH TO TOP OF FILTER SAND: 8.5'

TYPE OF FILTER AROUND SCREEN: #55/65 Silica Sand

TYPE OF MONITORING WELL: P.V.C.

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.): #10 Slot

DIAMETER AND LENGTH OF SCREEN: 2" X 8'

DEPTH TO BOTTOM OF MONITORING WELL: 18'

DEPTH TO BOTTOM OF FILTER SAND: 18'

THICKNESS AND TYPE OF SEAL: None

DIAMETER OF BOREHOLE: 8"

L_1= 2.5 FT

L_2= 12.5 FT

L_3= 8.0 FT

L_4= 18.0 FT

INSTALLATION COMPLETED:
Date 11-20-91 Time 4:10

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

LOG OF TEST BORING

JOB NO. 4220 92-1127 VERTICAL SCALE 1" = 5' BORING NO. P-3

JECT NSP PATHFINDER PLANT-SIOUX FALLS, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	CLASSIFICATION SYMBOL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	Qu or RQD
	CLAYEY SAND W/A LITTLE GRAVEL, black to dark brown	SC	Topsoil			1	HSA					
2.0												
	LEAN CLAY, brown, very soft	CL	Fine Alluvium	2		2	SB					
4.5												
	SILTY CLAY, brown, very soft	CL-ML		4		3	SB					
7.0												
	LEAN CLAY, a few cobbles below about 10-1/2, dark brown to brown, very soft	CL		3		4	SB					
				1/0.5		5	SB					
11.0												
	WEATHERED BLACK ROCK, brown and dark brown, moist, very dense	GM	Probably Weathered Blackrock Member*	50/.2		6	SB					
14.5												
	WEATHERED TO HARD BLACK ROCK, dark brown to black, moist to wet		Blackrock Member*	82	▼	7	SB					
17.3				75/.3		8	SB					
	End of Boring											
			*of Pathfinder Formation									
	Note: Boring backfilled to the surface with tremied neat cement grout.											
	Note: Monitoring well installed in separate borehole within 10' of this boring.											

WATER LEVEL MEASUREMENTS

ATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
11-18	12:10	16.5'	14.5'	15.5'		15'

START 11-18-91 COMPLETE 11-18-91 @ 12:30

METHOD 3-1/4" HSA 0'-17'

NORTH: EAST:

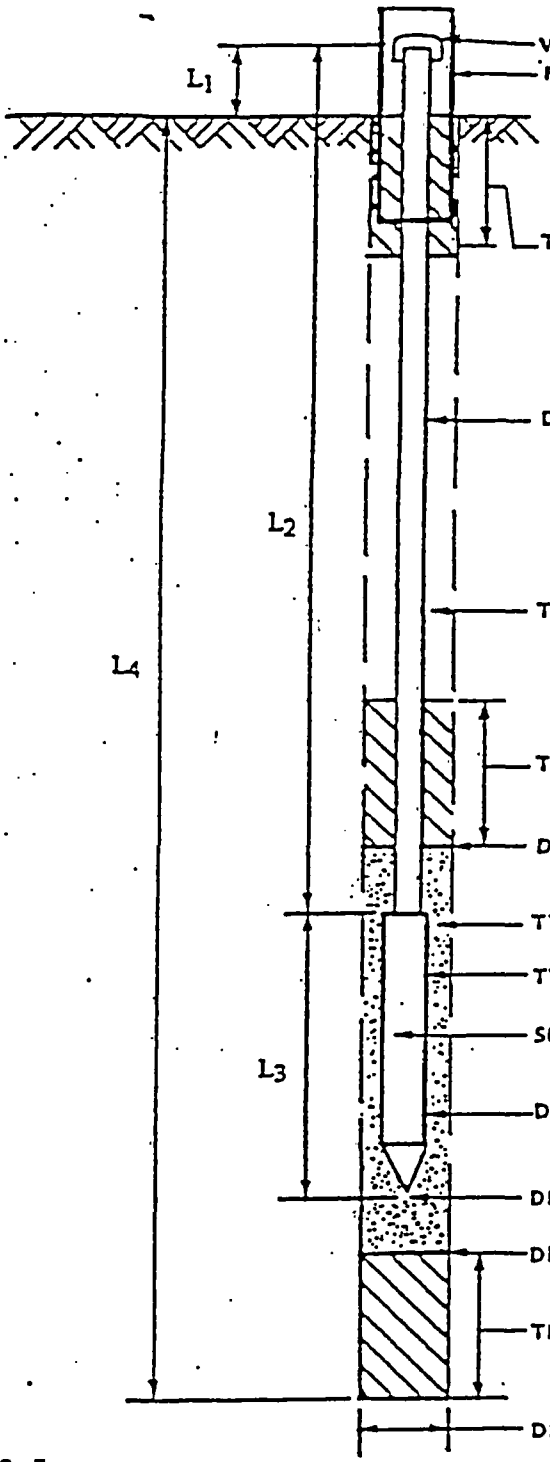
CREW CHIEF M. Crotty

twin city testing corporation

INSTALLATION OF MONITORING WELL

JOB NO. 4220 92 1127 MONITORING WELL NO. P-4

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION _____ (with cap removed)



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" Steel
Total Length	5'
Length Above Ground	2.7'
THICKNESS AND TYPE OF SEAL	Neat Cement Grout
DIAMETER AND TYPE OF RISER PIPE	2" P.V.C.
TYPE OF BACKFILL AROUND RISER	Neat Cement Grout
THICKNESS AND TYPE OF SEAL	5.5' - 7' Bentonite Pellets
DEPTH TO TOP OF FILTER SAND	7'
TYPE OF FILTER AROUND SCREEN	#55/65 Silica Sand
TYPE OF MONITORING WELL	P.V.C.
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 7.5'
DEPTH TO BOTTOM OF MONITORING WELL	15.8'
DEPTH TO BOTTOM OF FILTER SAND	15.8'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	8"

L_1= 2.5 FT

L_2= 10.8 FT

L_3= 7.5 FT

L_4= 15.8 FT

INSTALLATION COMPLETED:
Date 11-19-91 Time 1:30

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

LOG OF TEST BORING

JOB NO. 4220 92-1127 VERTICAL SCALE 1" = 5' BORING NO. P-4

PROJECT NSP PATHFINDER PLANT-SIOUX FALLS, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL — SURFACE ELEVATION	CLASSIFICATION SYMBOL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	Qu or RQD
	CLAYEY SAND, black	SC	Topsoil			1	HSA					
2.0	CLAYEY SAND, gray, firm	SC	Mixed Alluvium	11		2	SB					
5.0	SAND W/SILT, fine grained, gray, moist, loose	SP-SM	Coarse Alluvium	8		3	SB					
7.0	LEAN CLAY, dark brown, soft, a few laminations of silt	CL/OL	Fine Alluvium	2		4	SB					
				2	▼	5	SB					
12.0	SAND W/SILT AND A LITTLE GRAVEL, fine to medium grained, brown, waterbearing, loose	SP-SM	Coarse Alluvium	5		6	SB					
15.0												
15.8	WEATHERED TO HARD BLACK ROCK, wet		Blackrock Member* *of Pathfinder Formation	100/0.8		7	SB					
	End of Boring											

Note: Boring backfilled to the surface with tremied neat cement grout.

Note: Monitoring well installed in separate borehole within 10' of this boring.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
11-18	10:10	11.5'	9.5'	11.5'		11'
11-18	10:30	16.5'	14.5'	15'		11'

START 11-18-91 COMPLETE 11-18-91 @ 10:30

METHOD 3-1/4" HSA 0'-14.5'

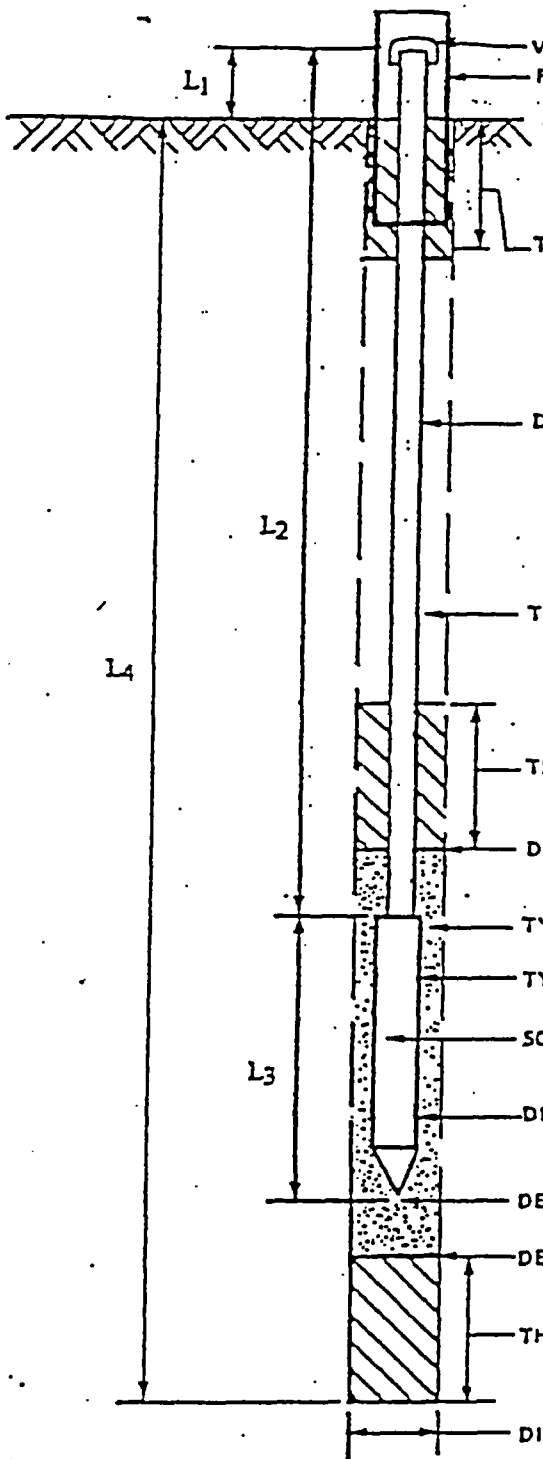
NORTH: EAST:

CREW CHIEF M. Crotty

twin city testing corporation

JOB NO. 4220 92 1127 MONITORING WELL NO. P-5

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION _____
(with cap removed)



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" Steel
Total Length	5'
Length Above Ground	2.7'
THICKNESS AND TYPE OF SEAL	Neat Cement Grout
DIAMETER AND TYPE OF RISER PIPE	2" P.V.C.
TYPE OF BACKFILL AROUND RISER	Neat Cement Grout
THICKNESS AND TYPE OF SEAL	4.0' - 6.5' Bentonite Pellets
DEPTH TO TOP OF FILTER SAND	6.5'
TYPE OF FILTER AROUND SCREEN	#55/65 Silica Sand
TYPE OF MONITORING WELL	P.V.C.
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 7'
DEPTH TO BOTTOM OF MONITORING WELL	14.5'
DEPTH TO BOTTOM OF FILTER SAND	14.5'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	8"

L_1= 2.5 FT

L_2= 10.0 FT

L_3= 7.0 FT

L_4= 14.5 FT

INSTALLATION COMPLETED:
Date 11-19-91 Time 11:30

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

LOG OF TEST BORING

JOB NO. 4220 92-1127 VERTICAL SCALE 1" = 5' BORING NO. P-5

PROJECT NSP PATHFINDER PLANT-SIOUX FALLS, SOUTH DAKOTA

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	CLASSIFICATION SYMBOL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	D	LL	PL	Qu or ROD
	LEAN CLAY, black	CL	Topsoil			1	HSA					
2.0												
	LEAN CLAY, dark grayish brown, very soft	CL	Fine Alluvium	2		2	SB					
4.0												
	LEAN CLAY, gray, very soft, a few lenses of silt and sand	CL		2		3	SB					
				1-1/2		4	SB					
10.0					▼							
	SAND W/SILT AND GRAVEL, medium to coarse grained, gray, waterbearing, loose	SP-SM	Coarse Alluvium	8		5	SB					
12.5												
13.1	WEATHERED TO HARD BLACK ROCK, wet		Blackmock Member* *of Pathfinder Formation	100/.6		6	SB					
	End of Boring											

Note: Boring backfilled to the surface with tremied neat cement grout.

Note: Monitoring well installed in separate borehole within 10' of this boring.

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
11-[illegible]	8:50	11.5'	9.5'	10'		9.5'
11-18	9:20	14'	12'	13'		9.5'

START 11-18-91 COMPLETE 11-18-91 @ 9:20

METHOD 3-1/4" HSA 0'-12'

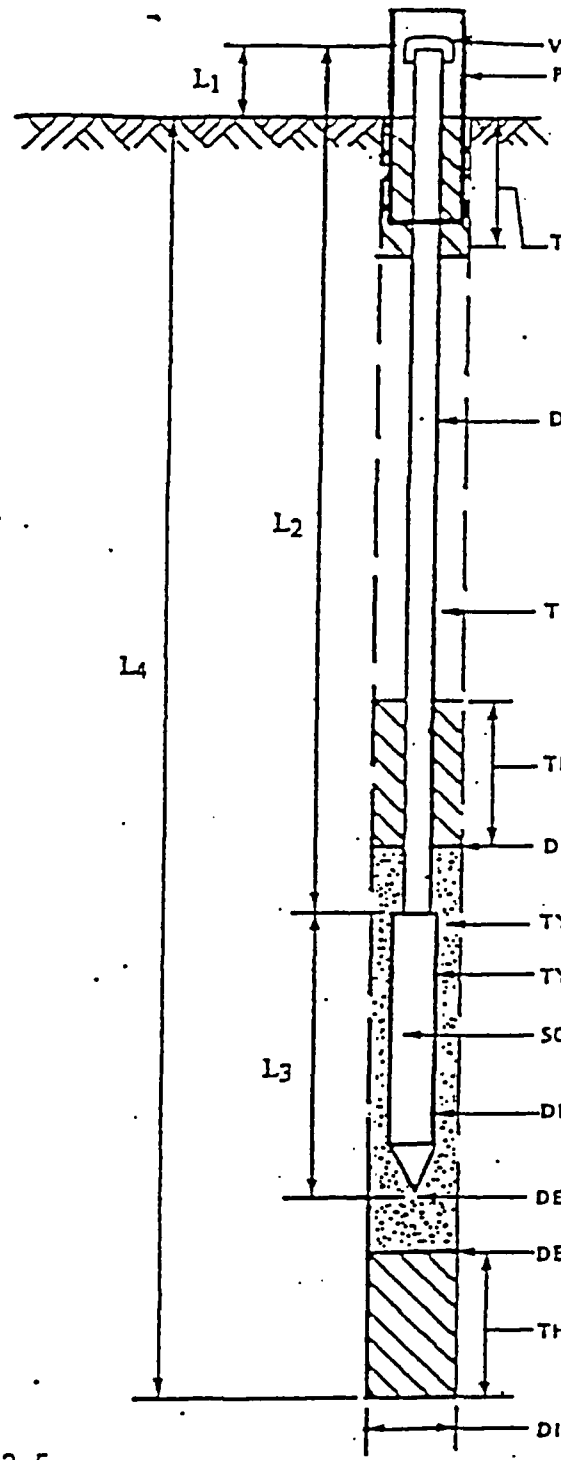
NORTH: EAST:

CREW CHIEF M. Crotty

twin city testing corporation

JOB NO. 4220 92 1127 MONITORING WELL NO. P-6

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION (with cap removed) _____



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" Steel
Total Length	5'
Length Above Ground	2.7'
THICKNESS AND TYPE OF SEAL	Neat Cement Grout
DIAMETER AND TYPE OF RISER PIPE	2" P.V.C.
TYPE OF BACKFILL AROUND RISER	Neat Cement Grout
THICKNESS AND TYPE OF SEAL	6.9' - 8.4' Bentonite Pellets
DEPTH TO TOP OF FILTER SAND	8.4'
TYPE OF FILTER AROUND SCREEN	#55/65 Silica Sand
TYPE OF MONITORING WELL	P.V.C.
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	#10 Slot
DIAMETER AND LENGTH OF SCREEN	2" X 9'
DEPTH TO BOTTOM OF MONITORING WELL	18.8'
DEPTH TO BOTTOM OF FILTER SAND	18.8'
THICKNESS AND TYPE OF SEAL	None
DIAMETER OF BOREHOLE	8"

L_1= 2.5 FT

L_2= 12.3 FT

L_3= 9.0 FT

L_4= 18.8 FT

INSTALLATION COMPLETED:
Date 11-20 Time 1:40

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL (1)

(1) DEPTH BELOW TOP OF RISER PIPE

LOG OF TEST BORING

JOB NO. 4220 92-1127 VERTICAL SCALE 1" = 5' BORING NO. P-6

PROJECT NSP PATHFINDER PLANT-SIOUX FALLS, SOUTH DAKOTA

FEET	DESCRIPTION OF MATERIAL — SURFACE ELEVATION	CLASSIFICATION SYMBOL	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	qu or RQD
2.0	FILL, MOSTLY LEAN CLAY W/A LITTLE GRAVEL, black	FILL	Fill			1	HSA					
4.5	FILL, MOSTLY SANDY LEAN CLAY W/A LITTLE GRAVEL, brown	FILL		4		2	SB					
6.5	LEAN CLAY, black, soft	CL	Topsoil	6		3	SB					
9.5	SANDY LEAN CLAY, dark brown, soft, a few lenses of sand	CL	Mixed Alluvium	6		4	SB					
15.5	SAND W/SILT AND A LITTLE GRAVEL, a few cobbles,, medium grained, brown to light brown, moist, medium dense to loose	SP-SM	Coarse Alluvium	21		5	SB					
				9		6	SB					
				38		7	SB					
	WEATHERED TO HARD BLACK ROCK, water in rock below about 17'		Blackrock Member ofPathfinder Formation	50/.3	▼	8	SB					
				50/.3		9	SB					
	End of Boring Note: Boring backfilled to the surface with tremied neat cement grout. Note: Monitoring well installed in separate borehole within 10' of this boring.											

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1	4:50	19'	17'	17.5'		17'

START 11-18-91 COMPLETE 11-18-91 @ 5:30

METHOD 3-1/4" HSA 0'-19.5'

NORTH: EAST:

CREW CHIEF M. Crotty

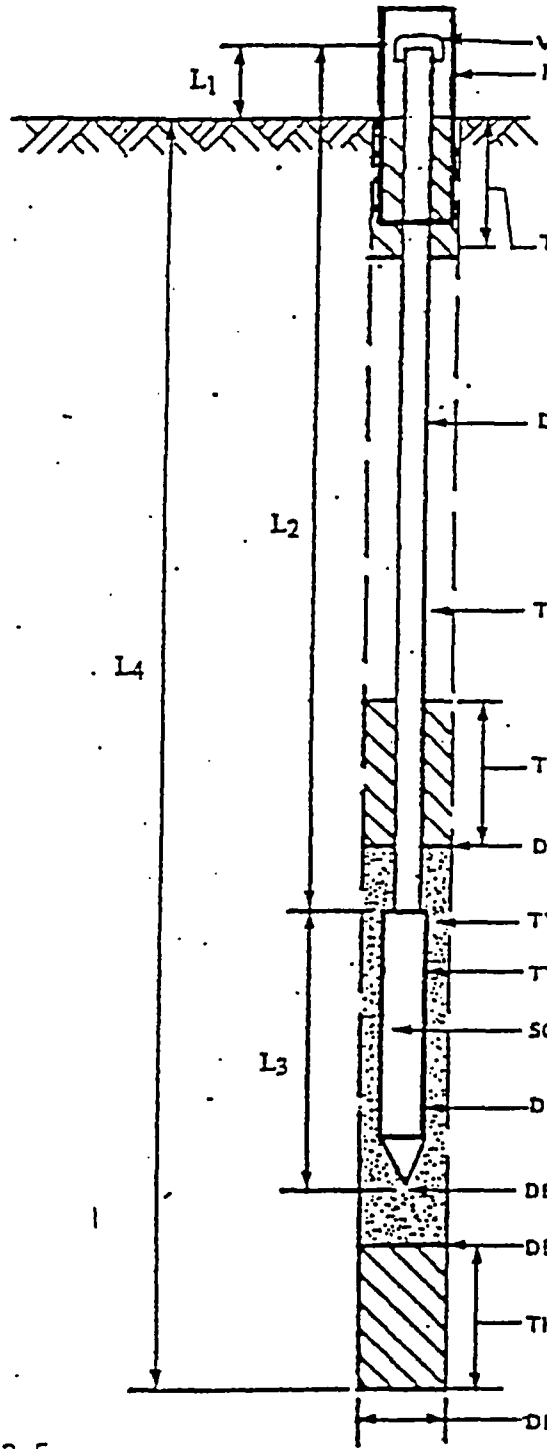
twin city testing corporation

INSTALLATION OF MONITORING WELL

JOB NO. 99-04729 MONITORING WELL NO. P-7

Angus Anson Generating Plant

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION _____ (with cap removed)



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel
Total Length	4'
Length Above Ground	2.5'
THICKNESS AND TYPE OF SEAL	6' concrete
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	Concrete
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	8'
TYPE OF FILTER AROUND SCREEN	BB2 silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" x 7'
DEPTH TO BOTTOM OF MONITORING WELL	17'
DEPTH TO BOTTOM OF FILTER SAND	17'
THICKNESS AND TYPE OF SEAL	—
DIAMETER OF BOREHOLE	7 1/4"

L_1= 2.5 FT

L_2= 12.5 FT

L_3= 7.0 FT

L_4= 17.0 FT

INSTALLATION COMPLETED:
Date 3/26/99 Time 1:30

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
3/26/99	12:15	—	14.3

* DEPTH BELOW TOP OF RISER PIPE

MAXIM

)G OF TEST BORING

JOB NO. 99-04729 VERTICAL SCALE 1" = 3' BORING NO. P-7

PROJECT CONTRACT DRILLING, ANGUS ANSON GENERATING PLANT, SIOUX FALLS, S.D.

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	D	LL	PL	Qu or ROD
	LEAN CLAY, black (CL-OL)	TOPSOIL	3		1	SB					
2.0	CLAYEY SAND, fine to medium grained, with a little gravel, brown, moist, loose to medium dense (SC)	MIXED ALLUVIUM	4		2	SB					
			10		3	SB					
5.0	LEAN CLAY, brown, soft (CL)	FINE ALLUVIUM	3		4	SB					
7.0	CLAYEY SAND, fine to medium grained, brown, moist, very loose (SC)	MIXED ALLUVIUM	2		5	SB					
9.0	GRAVEL WITH SAND, brown, moist to 11.8' then waterbearing, dense to medium dense (GP)	COARSE ALLUVIUM	18		6	SB					
			15	▽	7	SB					
12.0	SAND, medium to coarse grained, with gravel, brown, waterbearing, dense (SP)		22		8	SB					
14.0					9	SB					
	WEATHERED SHALE, (textural classification: Fat Clay, dark gray mottled, stiff to very stiff, a layer of silty clay at 15' (CH))	SPLITROCK CREEK FORMATION	29		10	SB					
16.0			44 / .3'		11	SB					
	SILTSTONE, black, very stiff		80		12	SB					
18.0	END OF BORING										

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
-26	12:15	13.5'	12'	13.5'		11.8'

START 3-26-99 COMPLETE 3-26-99 @ 12:48

METHOD 3 1/4" HSA 0-17'

CREW CHIEF P. OLLERICH

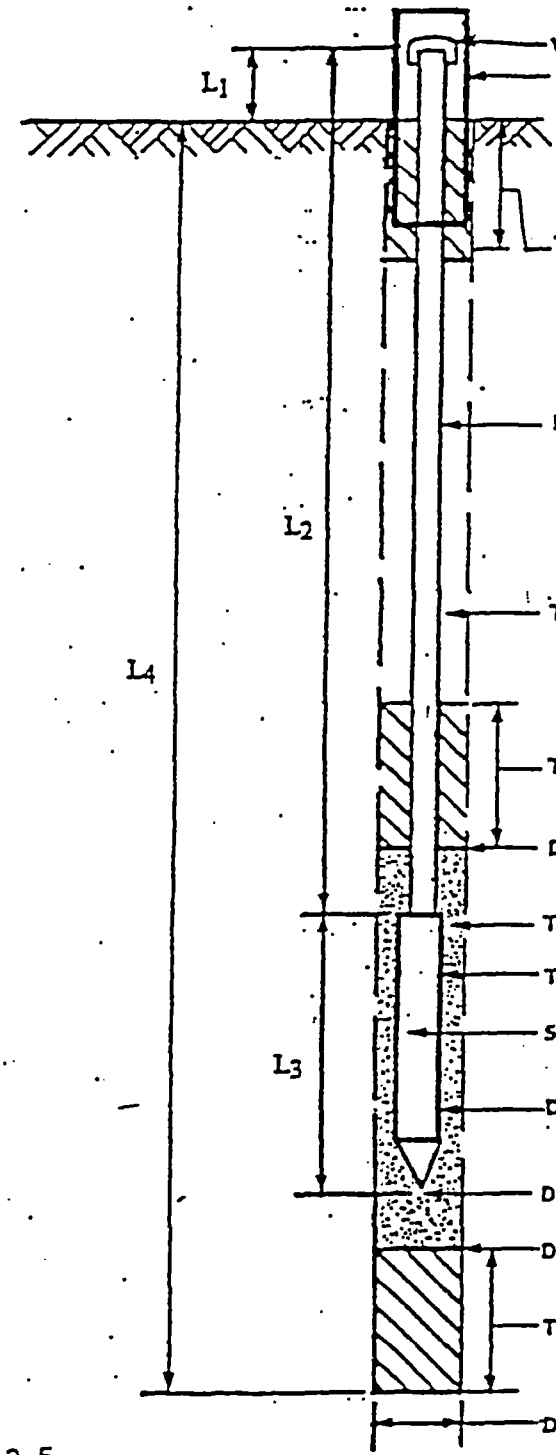
MAXIM

INSTALLATION OF MONITORING WELL

JOB NO. 99-04729 MONITORING WELL NO. P-8

Angus Anson Generating Plant

GROUND SURFACE ELEVATION _____ TOP OF RISER PIPE ELEVATION _____ (with cap removed)



VENTED CAP	
PROTECTIVE CASING	
Diameter and Type	4" steel
Total Length	4'
Length Above Ground	2.5'
THICKNESS AND TYPE OF SEAL	6' concrete
DIAMETER AND TYPE OF RISER PIPE	2" PVC
TYPE OF BACKFILL AROUND RISER	Concrete
THICKNESS AND TYPE OF SEAL	2' bentonite
DEPTH TO TOP OF FILTER SAND	8'
TYPE OF FILTER AROUND SCREEN	BB2 silica sand
TYPE OF MONITORING WELL	PVC
SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.)	0.010"
DIAMETER AND LENGTH OF SCREEN	2" x 8'
DEPTH TO BOTTOM OF MONITORING WELL	17'
DEPTH TO BOTTOM OF FILTER SAND	17'
THICKNESS AND TYPE OF SEAL	—
DIAMETER OF BOREHOLE	7 1/4"

L_1= 2.5 FT

L_2= 11.5 FT

L_3= 8.0 FT

L_4= 17.0 FT

INSTALLATION COMPLETED:
Date 3/26/99 Time 11:15

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	BAILED DEPTHS	WATER LEVEL *
3/26/99	9:42	—	13.3

* DEPTH BELOW TOP OF RISER PIPE

)G OF TEST BORING

JOB NO. 99-04729 VERTICAL SCALE 1" = 3' BORING NO. P-8

PROJECT CONTRACT DRILLING, ANGUS ANSON GENERATING PLANT, SIOUX FALLS, S.D.

DEPTH IN FEET	DESCRIPTION OF MATERIAL — SURFACE ELEVATION ____	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LABORATORY TESTS W	D	LL	PL	qu or RQD
	FILL, mixture of ORGANIC LEAN CLAY and FAT CLAY, black and dark brown	FILL	6		1	SB					
			7		2	SB					
			10		3	SB					
			2		4	SB					
7.0	LEAN CLAY, brown, soft, cobbles (CL)	FINE ALLUVIUM	4		5	SB					
9.0	GRAVEL WITH SAND, brown, wet to 10.8' then waterbearing, dense to very dense (GP)	COARSE ALLUVIUM	18		6	SB					
			20	▽	7	SB					
			24		8	SB					
			44		9	SB					
15.0	SILTSTONE, gray and black, very stiff	SPLITROCK CREEK FORMATION	94		10	SB					
17.4	END OF BORING		109/.4'		11	SB					

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
3-26	9:42	13.5'	12'	13.5'		10.8'

START 3-26-99 COMPLETE 3-26-99 @ 10:30

METHOD 3 1/4" HSA 0-17.4'

CREW CHIEF P. OLLERICH

MAXIM

)G OF TEST BORING

JOB NO. 99-04729 VERTICAL SCALE 1" = 3' BORING NO. P-9

PROJECT CONTRACT DRILLING, ANGUS ANSON GENERATING PLANT, SIOUX FALLS, S.D.

DEPTH IN FEET	DESCRIPTION OF MATERIAL (SURFACE ELEVATION ____)	GEOLOGIC ORIGIN	N or CR	WL	SAMPLE NO.	SAMPLE TYPE	LAB TESTS W	D	LL	PL	Qu or RQD
	FILL, mixture of ORGANIC LEAN CLAY and LEAN CLAY, black and dark brown	FILL	5		1	SB					
			11		2	SB					
2.0	LEAN CLAY, dark brown, rather stiff (CL/CH)	FINE ALLUVIUM	9		3	SB					
3.5	SANDY LEAN CLAY, brown, medium to soft to rather stiff (CL/CH)	MIXED ALLUVIUM	5		4	SB					
			4		5	SB					
			11		6	SB					
7.0	CLAYEY SAND, medium grained, with a little gravel, wet to 8.1' then waterbearing, loose (SC)		7	▽	7	SB					
8.5	SAND, medium to coarse, with gravel, brown, waterbearing, very dense, a lens of sandy lean clay at 9 1/2' (SP)	COARSE ALLUVIUM	31		8	SB					
10.0	SILTSTONE, brownish gray and black	SPEARFISH-CROW CREEK FORMATION	45/.4'		9	SB					
			25/.2'		10	SB					
13.0	END OF BORING										

WATER LEVEL MEASUREMENTS

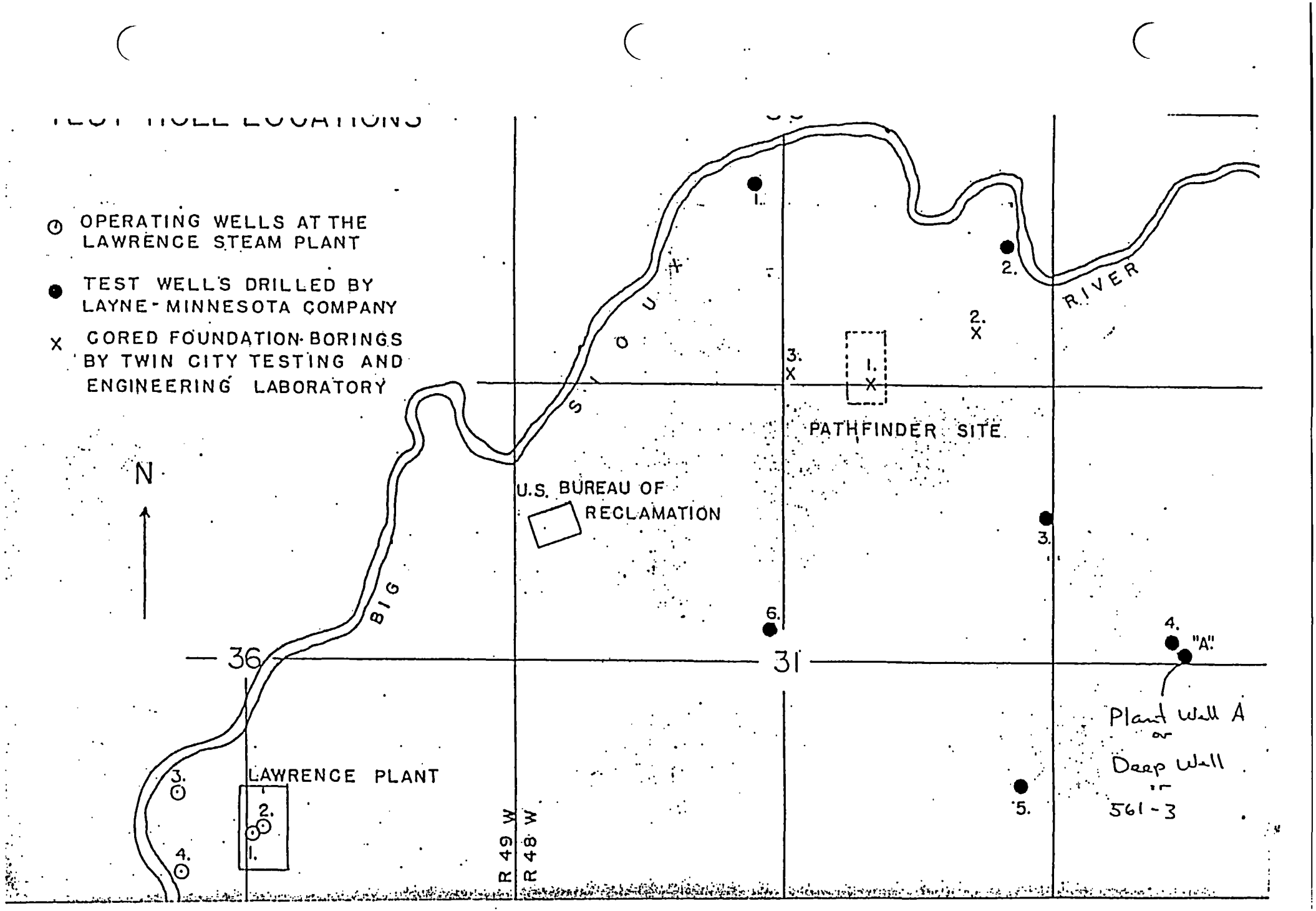
DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
3-26	2:20	10'	8'	10'		8.1'

START 3-26-99 COMPLETE 3-26-99 @ 2:35

METHOD 3 1/4" HSA 0-13'

CREW CHIEF P. OLLERICH

MAXIM


TEST HOLE LOCATIONS
OPERATING WELLS AT THE LAWRENCE STEAM PLANT
TEST WELLS DRILLED BY LAYNE-MINNESOTA COMPANY
CORED FOUNDATION BORINGS BY TWIN CITY TESTING AND ENGINEERING LABORATORY
N
SOUTH
SOUTH
RIVER
BIG
PATHFINDER SITE
U.S. BUREAU OF RECLAMATION
LAWRENCE PLANT
36
31
R 49 W
R 48 W
1.
2.
3.
4.
5.
6.
"A"
Plant Well A
or
Deep Well
561-3

Location Information

Legal Location: NE SE NE SW SEC.30,T. 102 N.,R. 48 W.
Location: 102N-48W-30CADA
County: MINNEHAHA
Basin: BIG SIOUX
Latitude: 43 deg 36 min 26 sec
Hydrologic Unit Code:10170203
Longitude: 96 deg 38 min 33 sec
Land Owner: NSP
Ground Surface Elevation (ft.): 1295 T

Project Information

Project: PATHFINDER TEST HOLES
Geologist:
Drill Date: 01/01/1957
Geologist's Log:
Company: LAYNE MINNESOTA COMPANY
Driller:
Drilling Method: ROTARY
Driller's Log: X
Test Hole Number:
Total Drill Hole Depth(ft.): 68.2
Samples:

Geophysical Information

Spontaneous Potential:
Single Point Resistivity:
Natural Gamma:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 1.

Elevation (ft.)	Depth (ft.)	Description
1295.00 - 1290.00	0.0 - 5.0	TOPSOIL AND CLAY, SANDY
1290.00 - 1272.50	5.0 - 22.5	SAND AND GRAVEL
1272.50 - 1250.00	22.5 - 45.0	SILTSTONE, BLACK (SPLIT ROCK CREEK FORMATION)
1250.00 - 1240.50	45.0 - 54.5	CLAY (SPLIT ROCK CREEK FORMATION)
1240.50 - 1233.30	54.5 - 61.7	SAND; STARTED TO FLOW (SPLIT ROCK CREEK FORMATION)
1233.30 - 1230.80	61.7 - 64.2	SILTSTONE, BLACK (SPLIT ROCK CREEK FORMATION)
1230.80 - 1226.80	64.2 - 68.2	QUARTZITE (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: SW SE NE SE SEC.30,T. 102 N.,R. 48 W.
Location: 102N-48W-30DADC
County: MINNEHAHA
Basin: BIG SIOUX
Latitude: 43 deg 36 min 21 sec
Hydrologic Unit Code:10170203
Longitude: 96 deg 37 min 59 sec
Land Owner: NSP
Ground Surface Elevation (ft.): 1291 T

Project Information

Project: PATHFINDER TEST HOLES
Geologist:
Drill Date: 01/01/1957
Geologist's Log:
Company: LAYNE MINNESOTA COMPANY
Driller:
Drilling Method: ROTARY
Driller's Log: X
Test Hole Number:
Total Drill Hole Depth(ft.): 97.8
Samples:

Geophysical Information

Spontaneous Potential:
Single Point Resistivity:
Natural Gamma:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 2.

Elevation (ft.)	Depth (ft.)	Description
1291.00 - 1284.00	0.0 - 7.0	TOPSOIL AND CLAY, SANDY
1284.00 - 1279.00	7.0 - 12.0	SAND AND GRAVEL; SOME BLACK SILTSTONE

1279.00 - 1241.20	12.0 - 49.8	SILTSTONE, BLACK (SPLIT ROCK CREEK FORMATION)
1241.20 - 1231.00	49.8 - 60.0	CLAY, DARK (SPLIT ROCK CREEK FORMATION)
1231.00 - 1225.00	60.0 - 66.0	CLAY, LIGHT (SPLIT ROCK CREEK FORMATION)
1225.00 - 1219.50	66.0 - 71.5	CLAY, SANDY (SPLIT ROCK CREEK FORMATION)
1219.50 - 1204.50	71.5 - 86.5	SAND; SOME CLAY AND SILTSTONE STREAKS (SPLIT ROCK CREEK FORMATION)
1204.50 - 1200.00	86.5 - 91.0	SILTSTONE, WHITE; SOME CLAY STREAKS (SPLIT ROCK CREEK FORMATION)
1200.00 - 1196.00	91.0 - 95.0	SILTSTONE, RED AND WHITE; WITH CLAY STREAKS (SPLIT ROCK CREEK FORMATION)
1196.00 - 1193.20	95.0 - 97.8	QUARTZITE (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: SW SW SW SE SEC.30,T. 102 N.,R. 48 W.
Location: 102N-48W-30DCCC
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 36 min 07 sec
Longitude: 96 deg 38 min 28 sec
Ground Surface Elevation (ft.): 1330 T

Project Information

Project: PATHFINDER CORES
Drill Date: 09/14/1957
Company: TWIN CITY TESTING
Drilling Method:
Test Hole Number:
Samples:
Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 92.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:
Single Point Resistivity:
Extra:

TWIN CITY TESTING TESTHOLE NO. 3.

Elevation (ft.)	Depth (ft.)	Description
1330.00 - 1328.00	0.0 - 2.0	LOAM, BLACK, CLAYEY; SOFT
1328.00 - 1324.00	2.0 - 6.0	LOAM, GRAY, CLAYEY; SOFT TO MEDIUM
1324.00 - 1318.00	6.0 - 12.0	CLAY, GRAY MOTTLED WITH YELLOW; STIFF TO MEDIUM
1318.00 - 1309.10	12.0 - 20.9	SHALE, GRAY MOTTLED WITH YELLOW; RATHER STIFF TO VERY STIFF (SPLIT ROCK CREEK FORMATION)
1309.10 - 1241.30	20.9 - 88.7	SILTSTONE, DARK-GRAY TO BLACK; WITH LAYERS OF SHALE (SPLIT ROCK CREEK FORMATION)
1241.30 - 1238.00	88.7 - 92.0	QUARTZITE, PINK (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: SW SE SW SE SEC.30,T. 102 N.,R. 48 W.
Location: 102N-48W-30DCDC
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 36 min 07 sec
Longitude: 96 deg 38 min 17 sec
Ground Surface Elevation (ft.): 1340 T

Project Information

Project: PATHFINDER CORES
Drill Date: 08/28/1957
Company: TWIN CITY TESTING
Geologist:
Geologist's Log:
Driller:

Drilling Method:
Test Hole Number:
Samples:

Driller's Log: X
Total Drill Hole Depth(ft.): 136.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:

Single Point Resistivity:
Extra:

TWIN CITY TESTING TESTHOLE NO. 1.

Elevation (ft.)	Depth (ft.)	Description
1340.00 - 1339.50	0.0 - 0.5	LOAM, BLACK, SILTY; MOIST
1339.50 - 1336.00	0.5 - 4.0	LOAM, BROWN, SANDY; MOIST
1336.00 - 1335.00	4.0 - 5.0	LOAM, BROWN, CLAYEY
1335.00 - 1320.50	5.0 - 19.5	SAND, BROWN, COARSE; SOME GRAVEL, MOIST
1320.50 - 1316.00	19.5 - 24.0	CLAY, LIGHT-BROWN; MOTTLED, MEDIUM
1316.00 - 1284.80	24.0 - 55.2	SHALE, DARK-GRAY; STIFF TO HARD (SPLIT ROCK CREEK FORMATION)
1284.80 - 1219.50	55.2 - 120.5	SILTSTONE, DARK-GRAY TO BLACK; SOME SHALE LAYERS (SPLIT ROCK CREEK FORMATION)
1219.50 - 1213.50	120.5 - 126.5	SANDSTONE; UNCEMENTED, NO RECOVERY (SPLIT ROCK CREEK FORMATION)
1213.50 - 1210.00	126.5 - 130.0	SANDSTONE, PINK; CEMENTED, 70 PERCENT RECOVERY (SPLIT ROCK CREEK FORMATION)
1210.00 - 1204.00	130.0 - 136.0	QUARTZITE, PINK (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: NE SW SE SE SEC.30,T. 102 N.,R. 48 W.
Location: 102N-48W-30DDCA
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 36 min 13 sec
Longitude: 96 deg 38 min 03 sec
Ground Surface Elevation (ft.): 1320 T

Project Information

Project: PATHFINDER CORES
Drill Date: 09/06/1957
Company: TWIN CITY TESTING
Drilling Method:
Test Hole Number:
Samples:

Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 122.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:

Single Point Resistivity:
Extra:

TWIN CITY TESTING TESTHOLE NO. 2.

Elevation (ft.)	Depth (ft.)	Description
1320.00 - 1319.00	0.0 - 1.0	LOAM, BLACK, SILTY, CLAYEY; MEDIUM HARD
1319.00 - 1315.00	1.0 - 5.0	LOAM, BROWN, SANDY, CLAYEY; RATHER STIFF
1315.00 - 1308.00	5.0 - 12.0	SHALE, GRAY WITH SOME MOTTLED YELLOW; RATHER STIFF TO STIFF (SPLIT ROCK CREEK FORMATION)
1308.00 - 1295.00	12.0 - 25.0	SHALE, DARK-GRAY; VERY STIFF (SPLIT ROCK CREEK FORMATION)
1295.00 - 1222.00	25.0 - 98.0	SILTSTONE, DARK-GRAY TO BLACK; WITH LAYERS OF SHALE (SPLIT ROCK CREEK FORMATION)
1222.00 - 1200.00	98.0 - 120.0	SANDSTONE, PINK TO BLACK; UNCEMENTED (SPLIT ROCK CREEK FORMATION)
1200.00 - 1198.00	120.0 - 122.0	QUARTZITE, PINK (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: SE SE NE NE SEC.31,T. 102 N.,R. 48 W.
Location: 102N-48W-31AADD
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 35 min 54 sec
Longitude: 96 deg 37 min 55 sec
Ground Surface Elevation (ft.): 1360 T

Project Information

Project: PATHFINDER TEST HOLES
Drill Date: 01/01/1957
Company: LAYNE MINNESOTA COMPANY
Drilling Method: ROTARY
Test Hole Number:
Samples:
Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 186.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:
Single Point Resistivity:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 3.

Elevation (ft.)	Depth (ft.)	Description
1360.00 - 1353.00	0.0 - 7.0	CLAY
1353.00 - 1351.50	7.0 - 8.5	SAND AND GRAVEL
1351.50 - 1344.50	8.5 - 15.5	SILTSTONE; SOFT, SOME CLAY (SPLIT ROCK CREEK FORMATION?)
1344.50 - 1336.00	15.5 - 24.0	SILTSTONE; HARD, SOME CLAY (SPLIT ROCK CREEK FORMATION?)
1336.00 - 1326.00	24.0 - 34.0	SILTSTONE; SOME SAND AND CLAY (SPLIT ROCK CREEK FORMATION?)
1326.00 - 1292.00	34.0 - 68.0	CLAY (SPLIT ROCK CREEK FORMATION?)
1292.00 - 1240.00	68.0 - 120.0	SILTSTONE, BLACK; SOME CLAY SEAMS (SPLIT ROCK CREEK FORMATION)
1240.00 - 1220.50	120.0 - 139.5	CLAY (SPLIT ROCK CREEK FORMATION)
1220.50 - 1183.00	139.5 - 177.0	SAND; DIRTY IN SPOTS, SOME CLAY FROM 166 TO 174 FEET (SPLIT ROCK CREEK FORMATION)
1183.00 - 1174.00	177.0 - 186.0	SILTSTONE, BLACK; SOME CLAY, BECOMES HARD AT 180 FEET (SPLIT ROCK CREEK FORMATION)

* * * *

Location Information

Legal Location: NE SE SE NW SEC.31,T. 102 N.,R. 48 W.
Location: 102N-48W-31BDDA
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 35 min 44 sec
Longitude: 96 deg 38 min 30 sec
Ground Surface Elevation (ft.): 1370 T

Project Information

Project: PATHFINDER TEST HOLES
Drill Date: 01/01/1957
Company: LAYNE MINNESOTA COMPANY
Drilling Method: ROTARY
Test Hole Number:
Samples:
Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 162.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:
Single Point Resistivity:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 6.

Elevation (ft.)	Depth (ft.)	Description
1370.00 - 1348.00	0.0 - 22.0	CLAY, YELLOW (TILL)
1348.00 - 1341.50	22.0 - 28.5	CLAY, DARK; ROCK (TILL)
1341.50 - 1340.50	28.5 - 29.5	SAND
1340.50 - 1336.40	29.5 - 33.6	ROCK; HARD
1336.40 - 1335.00	33.6 - 35.0	SAND
1335.00 - 1316.00	35.0 - 54.0	CLAY
1316.00 - 1312.00	54.0 - 58.0	SAND, RUSTY
1312.00 - 1303.00	58.0 - 67.0	CLAY, YELLOW
1303.00 - 1295.50	67.0 - 74.5	CLAY, DARK
1295.50 - 1244.00	74.5 - 126.0	SILTSTONE, BLACK (SPLIT ROCK CREEK FORMATION)
1244.00 - 1223.00	126.0 - 147.0	CLAY, BLACK (SPLIT ROCK CREEK FORMATION)
1223.00 - 1220.00	147.0 - 150.0	CLAY, SANDY (SPLIT ROCK CREEK FORMATION)
1220.00 - 1210.50	150.0 - 159.5	SAND; DIRTY, CLEAN AT 155 FEET (SPLIT ROCK CREEK FORMATION)
1210.50 - 1209.30	159.5 - 160.7	SILTSTONE, BLACK; SOME CLAY STREAKS (SPLIT ROCK CREEK FORMATION)
1209.30 - 1208.00	160.7 - 162.0	QUARTZITE, PINK (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: SE SE NE SE SEC.31,T. 102 N.,R. 48 W.
Location: 102N-48W-31DADD
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 35 min 28 sec
Longitude: 96 deg 37 min 56 sec
Ground Surface Elevation (ft.): 1405 T

Project Information

Project: PATHFINDER TEST HOLES
Drill Date: 01/01/1957
Company: LAYNE MINNESOTA COMPANY
Drilling Method: ROTARY
Test Hole Number:
Samples:
Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 231.3

Geophysical Information

Spontaneous Potential:
Natural Gamma:
Single Point Resistivity:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 5.

Elevation (ft.)	Depth (ft.)	Description
1405.00 - 1365.00	0.0 - 40.0	CLAY, YELLOW (TILL)
1365.00 - 1325.00	40.0 - 80.0	CLAY, DARK (TILL)
1325.00 - 1320.00	80.0 - 85.0	SAND; DIRTY
1320.00 - 1284.50	85.0 - 120.5	CLAY
1284.50 - 1230.00	120.5 - 175.0	SILTSTONE, BLACK (SPLIT ROCK CREEK FORMATION)
1230.00 - 1210.00	175.0 - 195.0	CLAY, DARK (SPLIT ROCK CREEK FORMATION)
1210.00 - 1184.50	195.0 - 220.5	SAND; DIRTY, SOME CLAY (SPLIT ROCK CREEK FORMATION)
1184.50 - 1174.00	220.5 - 231.0	CLAY (SPLIT ROCK CREEK FORMATION)
1174.00 - 1173.70	231.0 - 231.3	QUARTZITE (SIOUX QUARTZITE)

* * * *

Location Information

Legal Location: SE SE SW NW SEC.32, T. 102 N., R. 48 W.
Location: 102N-48W-32BCDD

County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP

Latitude: 43 deg 35 min 43 sec
Longitude: 96 deg 37 min 39 sec
Ground Surface Elevation (ft.): 1368 T

Project Information

Project: PATHFINDER TEST HOLES
Drill Date: 01/01/1957
Company: LAYNE MINNESOTA COMPANY
Drilling Method: ROTARY
Test Hole Number:
Samples:

Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 226.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:

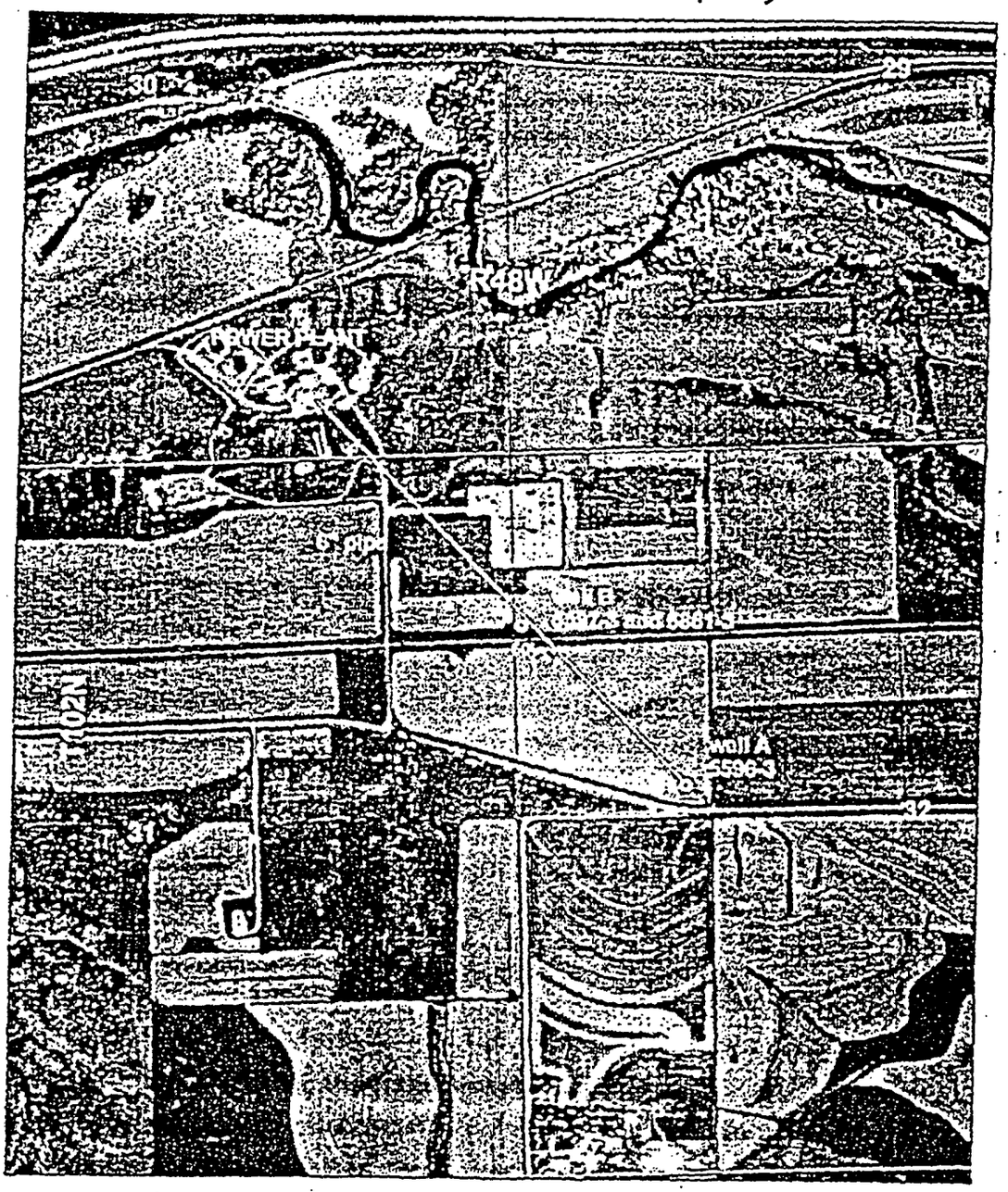
Single Point Resistivity:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 4.

Elevation (ft.)	Depth (ft.)	Description
1368.00 - 1365.00	0.0 - 3.0	TOPSOIL
1365.00 - 1359.50	3.0 - 8.5	CLAY, YELLOW; SOFT
1359.50 - 1337.00	8.5 - 31.0	SAND AND GRAVEL
1337.00 - 1333.00	31.0 - 35.0	SAND; WITH SOFT BLACK SILTSTONE
1333.00 - 1328.00	35.0 - 40.0	CLAY, FINE, SANDY
1328.00 - 1323.00	40.0 - 45.0	CLAY, BLUE; SOME SAND
1323.00 - 1318.00	45.0 - 50.0	CLAY, BLACK (SPLIT ROCK CREEK FORMATION)
1318.00 - 1308.00	50.0 - 60.0	CLAY, BLACK, SANDY; SOME BLACK SILTSTONE (SPLIT ROCK CREEK FORMATION)
1308.00 - 1303.00	60.0 - 65.0	CLAY, BLUE; HARD (SPLIT ROCK CREEK FORMATION)
1303.00 - 1298.00	65.0 - 70.0	CLAY; HARD (SPLIT ROCK CREEK FORMATION)
1298.00 - 1293.00	70.0 - 75.0	CLAY, GREEN; HARD (SPLIT ROCK CREEK FORMATION)
1293.00 - 1291.00	75.0 - 77.0	CLAY, SANDY (SPLIT ROCK CREEK FORMATION)
1291.00 - 1228.00	77.0 - 140.0	SILTSTONE, BLACK; SOME CLAY AND SHALE (SPLIT ROCK CREEK FORMATION)
1228.00 - 1218.00	140.0 - 150.0	SILTSTONE, BLACK; SOME SANDSTONE (SPLIT ROCK CREEK FORMATION)
1218.00 - 1213.00	150.0 - 155.0	CLAY, SANDY; DIRTY (SPLIT ROCK CREEK FORMATION)
1213.00 - 1148.00	155.0 - 220.0	SAND, FINE; CLEAN FROM 165 TO 177 FEET, CLAY STREAKS FROM 177 TO 180 FEET (SPLIT ROCK CREEK FORMATION)
1148.00 - 1142.30	220.0 - 225.7	CLAY; WITH SHALE AND SILTSTONE LAYERS (SPLIT ROCK CREEK FORMATION)
1142.30 - 1142.00	225.7 - 226.0	QUARTZITE (SIOUX QUARTZITE)

* * * *

Water Right No. 5597-3 and 5861-3
Northern States Power Company



Lynn Beck
Natural Resources Engineering Specialist
DENR, Water Rights Program
November 7, 2003

South Dakota GIS

5861-3

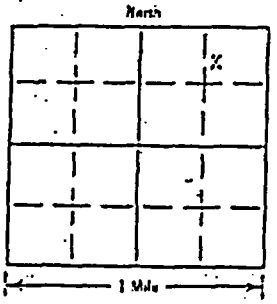
SOUTH DAKOTA WATER WELL COMPLETION REPORT

07-92

Location NW¼ NE¼ Sec 36 Twp 102 Rge 49 W

County Minnehaha

Please mark well location with an "X"



Well Completion Date 9-30-97

Well Owner: Northern States Power Company

Business Name:

Address: 414 Nicollet Mall
Minneapolis MN 55401

WELL LOG:

FORMATION	DEPTH FROM	DEPTH TO
top soil	0	5
yellow clay gravel	5	20
yellow clay	20	40
blue	40	70
hard coal	70	120
blue clay	120	140
sand	140	177

LOCATION:

Distance from nearest potential pollution source (septic tank, abandoned well, lead lot, etc)? 2500 ft. from Septic (identify source).

PROPOSED USE:

☐ Domestic/Stock ☒ Municipal ☐ Business ☐ Test Hole
☐ Irrigation ☐ Industrial ☐ Institutional ☐ Monitoring well

METHOD OF DRILLING:

Rotary

CASING DATA:

☒ Steel ☐ Plastic ☐ Other

If other describe: stainless steel screen

PIPE WEIGHT	DIAMETER	FROM	TO	HOLE DIAMETER
49.56 LB/FT	12 IN	0 FT	147 FT	26 IN
30# LB/FT	12 IN	147 FT	177 FT	26 IN
LB/FT	IN	FT	FT	IN

GROUTING DATA

Grout Type	No. of Sacks	Grout Weight	From	To
Portland	200	lb/gal	0 ft	100 ft
		lb/gal	ft	ft

Describe grouting procedure: Tremie pipe

SCREEN: ☐ Perforated pipe ☒ Manufactured

Diameter 12 IN Length 30 FEET

Material: stainless steel

Set Slot 60 Set From 147 Feet to 177 Feet

Other information:

WAS A PACKER OR SEAL USED? ☒ YES ☐ NO

If so, what material? Bentonite

Describe packer(s) and location? 100 – 120'

DISINFECTION:

Was well disinfected upon completion? X YES, How MTH

NO, Why Not?

Laboratory sent to for water quality analysis: Pierre, SD

STATIC WATER LEVEL 60 Feet

If flowing closed in pressure PSI

GPM flow through inch pipe

Controlled by ☐ Valve ☐ Reducers ☐ Other

Reduced Flow to GPM

Can well be completely shut in?

WELL TEST DATA:

☒ Pumped Describe: line shaft turbine
☐ Bailed
☐ Other

Pumping Level Below Land Surface
135 ft. After 12 Hrs. pumped 400 GPM
ft. After Hrs. pumped GPM

If pump installed, pump rate GPM

REMARKS

OCT 1997
WATER RIGHTS
PROGRAM
Pierre, SD

This well was drilled under license # 94

And this report is true and accurate.

Drilling firm: Huron Drilling Inc.

Signature of License Representative:

Signature of Well Owner or Equitable Property Holder:

Date: 9-30-97

Domestic Well = Well B = Water Rights Permit 742-3

9. (Continued)

III. Well Specifications

(a) Hole and casing

Size of drill hole or excavation 25" diameter, Depth 222'-0"

Type of casing Standard steel (wood, concrete, steel, etc.)

Size of casing 12", Thickness of casing 3/8"

Length of casing 180'-0" If collection gallery, length, size and depth of gallery

(b) Screens

Type of perforated screen Stainless steel (Layne shutter)

Size of perforated screen 12" (diameter) 40'-0" (length)

Thickness of gravel pack 12", length of gravel pack 60'-0"

(c) Water Bearing Materials

Distance to water 60'. Character of water bearing materials Sand formation

Thickness of water bearing material 65'

(d) Pump and Motor future - (to be determined at a later date)

Type of pump (centrifugal, propeller, mixed flow, etc.)

Name of pump , size

Kind of motor (gasoline, electric, diesel, etc.)

Horsepower , Name of Motor

(e) Complete well

Capacity 800 GPM at drawdown of . Estimated cost

(f) Owner of land upon which well is located Northern States Power Company (Name)

(Address)

(g) Distance to nearest existing wells

On same owner's property rods. On property owned by others 100 rods east to (see attached) a domestic well which does not penetrate the caprock

Well A

Layne Test Well #4 – Adjacent to NSP Deep Well

pathfinder_logs.txt

Location Information

Legal Location: SE SE SW NW SEC.32, T. 102 N., R. 48 W.
Location: 102N-48W-32BCDD
County: MINNEHAHA
Basin: BIG SIOUX
Hydrologic Unit Code:10170203
Land Owner: NSP
Latitude: 43 deg 35 min 43 sec
Longitude: 96 deg 37 min 39 sec
Ground Surface Elevation-(ft.): 1368 T

Project Information

Project: PATHFINDER TEST HOLES
Drill Date: 01/01/1957
Company: LAYNE MINNESOTA COMPANY
Drilling Method: ROTARY
Test Hole Number:
Samples:
Geologist:
Geologist's Log:
Driller:
Driller's Log: X
Total Drill Hole Depth(ft.): 226.0

Geophysical Information

Spontaneous Potential:
Natural Gamma:
Single Point Resistivity:
Extra:

LAYNE MINNESOTA COMPANY TESTHOLE NO. 4.

Elevation (ft.)	Depth (ft.)	Description
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1318.00 - 1308.00	50.0 - 60.0	CLAY, BLACK, SANDY; SOME BLACK SILTSTONE (SPLIT ROCK CREEK FORMATION)
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1148.00 - 1142.30	220.0 - 225.7	CLAY; WITH SHALE AND SILTSTONE LAYERS (SPLIT ROCK CREEK FORMATION)
1142.30 - 1142.00	225.7 - 226.0	QUARTZITE (SIOUX QUARTZITE)

* * * *

9. *Final Status Survey Plan (FSSP) Page 4. Describe how floor joints and cracks will be surveyed to determine contamination and assessed to ensure there is no contamination under buildings.*

Basis: NUREG-1757, Vol. 2, Appendix E.4 Sampling.

Response

The guidelines of NUREG-1757, Vol. 2, Appendix E.4 Sampling, will be adhered to if floor joints and cracks are encountered. Page 4 of the FSSP has been revised to reflect this statement.

As appropriate, systems will be opened and floor joints and cracks scraped and expanded if necessary to facilitate the surveys. A walk down of the contaminated areas of the turbine floor did not reveal any floor cracks. There are no sub floors in the presently known contaminated areas.

Large area gas flow proportional detectors will typically be used to obtain measurements of total beta activity. However if the surfaces to be surveyed are smaller than the effective area of the detector, smaller area GM detectors will be used. The Ludlum Model 2350 Data Logger will be used in combination with a wide variety of detectors. The data logger is a portable microprocessor computer based counting instrument. The data logger is designed to operate with a wide variety of detectors and record the measurement results for subsequent downloading using proprietary software. Sodium iodide detectors will be used to obtain relative exposure rate measurements. These measurements will not be corrected to account for the energy dependent response of the sodium iodide detectors, i.e. the response of the sodium iodide measurements will not be corrected using pressurized ion chamber measurements.

10. *FSSP Page 15, Section 5.5. Describe how background radioactivity levels will be determined.*

Basis: NUREG-1757, Vol.-1, Section 16.4 and Vol. 2, Appendix A.3.1, Need for Background Reference Areas.

Response

Xcel Energy will follow the guidance provided in NUREG-1757, Vol.-1, Section 16.4 and Vol. 2, Appendix A.3.1, Need for Background Reference Areas, when determining background levels at Pathfinder.

Typically a background study is performed to determine the background contribution to total beta activity measurements due to natural radioactivity in various building materials and due to the activity concentrations of specific radionuclides in soils. Since the characterization survey did not identify any radionuclides attributable to licensed activities in the soils associated with the Pathfinder Site, only the contribution to total beta activity measurements due to natural radioactivity in various building materials will be determined.

Buildings, or areas within buildings, known to be unaffected by licensed activities will be surveyed to determine the contribution to total beta activity measurements due to natural

radioactivity in various building material. The surveys will be performed using the same instrumentation that will be used for performing the final status surveys of building materials. For each type of building material to be evaluated a minimum of 30 total beta activity measurements will be required. Building materials expected to have a minimal impact on the total beta activity measurements will likely not be evaluated. At present the only building material of interest is concrete. There are several possibilities for a reference area. It is anticipated that the screen house on the Pathfinder Site or a non-impacted and suitably shielded Administration Building interior area will be used for determining the contribution to total beta activity measurements due to concrete. (The previous decommissioning effort used a local school building.) Prior to performing background measurements within these areas, it will be shown that no radionuclides attributable to licensed activities are present.

Section 5.5 of the FSSP (p. 15) has been revised to cross-reference this question.

11. *FSSP Page 17, Section 5. Provide a discussion on "As Low As is Reasonably Achievable" (ALARA) and the cost benefits for performing the decontamination. On DP Page 16, provide a discussion of ALARA programs based on DCGLs and expected final dose.*

Basis: NUREG-1757 Vol. 1, Section 16.1.1 and Vol. 2, Appendix N, ALARA Analyses.

Response

Appendix N of NUREG 1757, Vol. 2 specifies that "In light of the conservatism in the building surface and surface soil generic screening levels developed by NRC staff, the NRC staff presumes, absent information to the contrary, that licensees who remediate building surfaces or soil to the generic screening levels do not need to provide analyses to demonstrate that theses screening levels are ALARA."

Given the above, Xcel Energy's decision to remediate to unrestricted use criteria using the conservative dose modeling assumptions associated with the screening values in NUREG 1757 Volume 1 Appendix B will result in meeting the ALARA criteria for these radionuclides. Since the average surface activity due to residual contamination remaining following decommissioning is expected to be significantly less that the screening values, the dose to a hypothetical individual exposed to the residual contamination will be less than the 25 mrem/yr criteria predicted using the conservative screening values.

Although the screening values are based on residential scenarios, the current and planned uses of the Pathfinder Site precludes residential uses in the foreseeable future. Given the radionuclides of interest the potential doses from any residual contamination remaining following decommissioning will decrease with a half-life of between 5 and 15 years. This is not expected to present a threat to the public health and safety.

For the area with Ag-108m, a generic screening level was not available and was derived using the RESRAD BUILD model. To date, the only area this radionuclide was found was in a small sump that will be removed. Using the Appendix N NUREG 1757 Vol.2 methodology, this effort becomes cost effective at approximately $2500 (for discussion purposes). Xcel Energy does not expect to leave any significant amount of contamination

from Ag-108m at Pathfinder, and the other radionuclides will all be reduced well below the generic screening levels, which are considered ALARA as discussed above.

To further ensure the ALARA criteria are met, areas that are easily decontaminated with simple techniques such as vacuuming and wiping and do not generate a significant volume of radioactive waste are being remediated even though they are likely to meet the criteria for unrestricted use in their present condition.

Xcel Energy is not seeking any remediation relief on an ALARA cost benefit basis and does not expect to present a justification for not taking an ALARA action. For the relatively higher contaminated areas, the remediation activities involve the entire removal of the building surfaces such as sumps or drain pipes, which is inherently ALARA. The remaining remediation efforts, principally the cleaning of the accessible areas of the condenser, condenser floor, and the mud drums, represent ALARA good practices that reduce radiation levels below the generic screening values.

Section 3.4 of the Plan (p. 17) and Section 4.0 of the FSSP (p. 9) have been revised to cross-reference this question.

12. *FSSP Page 18, Section 6.1. Describe (a) protocols for surveying for alpha radiation both fixed and loose surface; (b) protocols for using the Ludlum Model 2350 for gamma exposure rates and how the exposure rates or the protocols relate to the release criteria (determination of contamination at depth); and c) efficiencies and bases (ISO-7503) for various surfaces: metal, rough concrete and others expected to be encountered.*

Basis: NUREG-1757 Vol.2, Appendix E, Measurements for Facility Radiation Surveys

Response

a) Alpha

As shown in Table 3.2 of the FSSP no alpha emitting radionuclides attributable to licensed activities were identified during the characterization survey. To date no alpha emitting radionuclides or other radionuclides that would be considered as non-detectable or hard to detect, with the exception of H-3, have been identified. Therefore total alpha activity measurements are not anticipated to be required as part of the final status survey. If alpha emitting radionuclides are identified prior to or during the final status survey, the survey protocols will be adjusted to require total alpha activity measurements or the alpha emitting radionuclides may be considered as non-detectable or hard to detect radionuclides in accordance with Equation 4.1 in Section 4.4 of the FSSP.

To help ensure that alpha emitting radionuclides attributable to licensed activities are identified if present, all smears collected for accessing removable contamination will be analyzed for both alpha and beta activity after allowing sufficient time for the short lived naturally occurring radionuclides attributable to the thorium and uranium decay chains to decay.

The Ludlum Model 2350 in combination with 1 inch by 1 inch or 2 inch by 2 inch sodium iodide detectors will be used to perform gamma scans of open land areas as discussed in Section 6.6.1 of the FSSP. Although the characterization survey did not identify any licensed radioactivity in the

open land areas associated with the Pathfinder site, for the purposes of designing the survey protocols to be used during the FSSP it will be assumed that if present it would be uniformly distributed in the top six inches of soil.

b) Gamma Scans

The following methodology will be used for determining the MDA for gamma scans assuming a small volume of elevated activity attributable to a specific radionuclide or radionuclide mix is to be identified.

First the $MDCR_{surveyor}$ is calculated is calculated using the following equation

$$MDCR_{surveyor} = \frac{(d')(\sqrt{b_i})\left(\frac{60}{i}\right)}{\sqrt{p}}$$

Where:

$MDCR_{surveyor}$	=	The minimum detectable count rate, cpm
d'	=	Decision error taken from Table 6.5 the MARSSIM
b_i	=	Background count per observation interval
i	=	Observation interval, equal to the diameter of the assumed volume of elevated activity divided by the scan rate, sec
p	=	surveyor efficiency

Next the exposure rate due to the small volume of activity attributable to the specific radionuclide or radionuclide mix is estimated using a code such as Microshield in order to derive a conversion factor in terms of pC/g per uR/hr .

A second conversion factor that relates an exposure rate to a count rate for the instrumentation used to perform the scan in terms of uR/hr per cpm is also required.

The MDA is given as

$$MDA = MDCR_{surveyor}(cpm)\left(\frac{uR/hr}{cpm}\right)\left(\frac{pCi/g}{uR/hr}\right)$$

c) Efficiencies

Section 6.1 of the FSSP states that "...if appropriate, the efficiencies of the field instrumentation will be adjusted to account for lower counting efficiencies typically observed when making field measurements due to self attenuation and self absorption in accordance with the guidance in NUREG-1507." The guidance in NUREG 1507 mimics the guidance contained in ISO 7503-1.

If appropriate, the efficiencies of the field instrumentation will be adjusted to account for lower counting efficiencies typically observed when making field measurements due to self attenuation and self absorption. Since the instrumentation to be used during the final status survey will be calibrated using NIST traceable sources and their stated 4 Π emission rates, the efficiency for these instruments, for beta emitters with end point beta energies less than 0.4 MeV, will be reduced by a factor of 0.5.

Section 6.1 of the FSSP (p. 19) has been revised to cross-reference this question.

13. *FSSP Page 18, Section 6. Provide the Minimum Detectable Concentration (MDC) and the Minimum Detectable Count Rate (MDCR) and demonstrate how the instrumentation will meet MARSSIM guidance.*

Basis: NUREG-1757 Vol. 2, Appendix E, Measurements for Facility Radiation Surveys.

Response

See the response to Question 12 above in addition to the following.

The MDA for direct beta measurements will be less than 1000 dpm/100 cm^2. The MDA for removable beta activity will be less than 1,000 dpm/100 cm^2. The MDA for beta scans will be approximately 5,000 dpm/100 cm^2. The MDAs specified in Section 6.2 of the FSSP for direct beta measurements, removable beta measurements, and beta scans, are equal to or less than the criteria provided in Tables 4.1 and 4.3 of the FSSP.

For off site analyses, the radionuclide specific MDAs to be achieved will be in accordance with Table 6.2 of the FSSP. The MDA for the analysis of Co-60, Cs-137, and Ag-108m is 0.1 pCi/g. The MDA for H-3 is 10 pCi/g. The MDAs specified in Table 6.2 are less than the criteria provided in Table 4.2 of the FSSP

According to MARSSIM, it is generally considered a good practice to select instrumentation that will provide an MDA of between 10 and 50 percent of the criteria for release for unrestricted use. MARSSIM notes that this may not be achievable based on site-specific conditions. In most cases the MDA is considered acceptable if it is less than 75 percent of the criteria for release for unrestricted use. If it is conservatively assumed that the radionuclide of interest is Co-60, the criteria for release for building surfaces is 7,100 dpm/100 cm^2 and the criteria for release for soils is 3.8 pCi/g. The MDAs that have been specified are well below these criteria for release for unrestricted use. It is expected that the actual MDAs to be achieved will be below the specified MDAs, especially the MDA for removable beta activity

A statement has been added to the Section 6.2 of the FSSP (p. 20) that the MDAs specified are considerably less than the release criteria per MARSSIM guidance.

14. *FSSP Page 28, Section 7.9. Describe the Survey Quality Control process to ensure that field measurements were performed in accordance with procedures and survey unit release criteria have been met.*

Basis: NUREG-1757 Vol. 1, Section 17.6, DP: Quality Control Program.

Response

With specific regard to this question, the applicable quality requirements for procedures and acceptance criteria are contained in Sections 4.B, 7.B, and 7.1 of the Pathfinder Quality Assurance Project Plan (contained in Appendix E of the Plan). These sections provide the requirements to assure that field measurements will be performed in accordance with procedures and that survey unit release criteria will be included.

15. *FSSP Page 5, Table 3.2. The characterization data below needs to be included in the FSSP radiological information or justification for not including the data needs to be provided. The Pathfinder Characterization Report, Package #2, Turbine Deck Ventilation Duct Internals, direct beta reading are (disintegrations per minute/100cm2): Mean 4128, Standard deviation 6444, Maximum 18915. The loose surface contamination survey does not state whether the areas surveyed are on the interior or exterior of the ducts. The Turbine Building Deck Ventilation Duct has measurements in excess of the preliminary DCGL.*

Basis: NUREG-1757 Vol. 1, Section 16.4, DP Radiological Status of Facility

Response

The justification for not including the data is as follows. The characterization survey report, both in Table 8.2 and in Attachment 1, provides direct beta measurement results associated with the survey of the ventilation duct internals. An initial survey revealed potential contamination on the filters. The filters were bagged and set aside. A subsequent survey of the filters revealed a significant and large reduction in the measurement results. It was concluded that short-lived naturally occurring radionuclides were responsible for the initial measurement results. It is also important to note that given the history of surveys at the plant and the recent characterization survey results; there are no contaminated areas on or near the turbine deck where this duct takes its suction.

16. *DP Page 17. Identify the methods used for surveying and sampling the soils, if encountered, after floor drains have been removed.*

Basis: NUREG-1757 Vol. 1, Section 16.4.4 and Vol. 2, Appendix G.2.1, Subsurface Residual Radioactivity.

Response

In general, soils that may be encountered following removal of the floor drains will be sampled in a manner similar to the soils in the open land areas associated with the Pathfinder site. The excavated area will be designated as a Class 1 survey unit. Specific survey instructions for this survey unit will be contained in a detailed survey package.

It is expected that the area will be scanned and areas of potential contamination investigated by collecting biased soil samples. Both surface (0-6 inches) and subsurface (6-12 inches) soil samples will be collected at each biased soil sampling location. If contamination in excess of the criteria for release for unrestricted use is encountered the area will be remediated and the process repeated. Following the scan and resulting investigation, if required, systematic surface soil samples will be collected along the length of the excavation. Sampling locations will be marked on a map or drawing of the area. It is anticipated that a minimum of 20 systematic surface soil samples will be collected from each survey unit. Each sample should consist of approximately 2 liters of soil, if available.

Section 3.4 (p. 17) of the Plan has been revised to cross-reference this question.

17. *DP Page 9, FSSP Page 5. Describe how hard-to-detect (HID) radionuclides (Ni-63) are being addressed. Page 11, Section 4.3, clarify (HTD) radionuclides. If deemed justifiable, suggest referencing Characterization Study data to eliminate HTDs.*

Basis: NUREG-1757 Vol. 1, Section 16.4.1, Contaminated Structures.

Response

Please see the response to Question 12 and the following.

No alpha emitting radionuclides or other radionuclides that would be considered as non-detectable or hard to detect, with the exception of H-3, were identified during the site characterization survey. If radionuclides that would be considered as non-detectable or hard to detect are identified prior to or during the final status survey they will be addressed using equation 4.1 of Section 4.4 of the FSSP.

18. *DP Page 40. Clarify MARSSIM classification of the following survey units:*
- The Condenser basement floor is a Class 1 area. Identify the classification for the walls and ceilings.
- FSSP, Page 22-23, Table 6.4. Identify the classification of Temporary Loading and Storage Building (e.g., Class 2 area).

Basis: NUREG-1757 Vol. 2, Appendix A.1, Classification of Areas by Residual Radioactivity Levels.

Response

For the turbine building hot side where the condenser basement is located (impacted area 1 in Table 6.4), the walls and ceilings above 2 meters will be classified as a Class 2 survey unit.

Our characterization survey did not indicate any residual contamination in the Temporary Loading and Storage Building. This building received extensive

surveying after the 1992 decommissioning effort. The current classification of this building is a Class 3 area. In light of the reasonableness of the above approach to the turbine building hot side and the need to be conservative with regard to the past use of the Temporary Loading and Storage Building, this building has been reclassified as a Class 2 area. The walls and ceilings above 2 meters will be classified as a Class 3 area. The first floor of the boiler building will also be classified in the same manner.

Table 6.4 of the FSSP (p. 22 and 23) has been revised to reflect these changes.

19. *Clarification recommendations:*
- *FSSP Page 6, recommend referring to pipes as being "embedded" instead of encased.*

Response

Page 6 has been revised to replace the term "encased" with "embedded."

- *FSSP Page 11 Section 4.3, will the non-permanent structures be removed or is the Reg. Guide 1.86 criteria to be used for all items allowed to remain on site?*

Response

Section 4.3 of the FSSP applies to all non-permanent structures remaining at the time of the final status survey. Section 5.11 of the Plan refers to the release of items from radiological areas. Non-permanent structures that are released from a radiologically controlled area will be released in accordance with the requirements of Section 5.11.

It should be noted, that at present, there are no readily accessible radiologically controlled areas at the Pathfinder site. However it is expected that radiologically controlled areas will be established for certain remediation activities. Once a radiologically controlled area has been established, all items to be released from the area, such as tools, debris, and cleaning equipment, will be released in accordance with Section 5.11 of the decommissioning plan or will remain and be surveyed as part of the final status survey. There are currently no plans for demolition at the Pathfinder site. The presently contaminated areas are unlikely to be disturbed following decommissioning for the foreseeable future.

- *FSSP Page 13, Section 4.5, correct typo, "unrestricted."*

Response

Page 13 has been revised to correct "unrestrictec" to "unrestricted."

- *FSSP Page 14, most reactor sites use the Sign Test versus the Wilcoxon Rank Sum Test due to background considerations.*

Response

The Wilcoxon information was principally included for completeness. Section 5.5 of the FSSP (p. 15) has been revised to allow the use of the Sign Test or the Wilcoxon Rank Sum Test.

- *FSSP Page 27, Section 7.1, what qualification standard will HP technicians and supervision meet, ASTM, ANSI 1.8, RG 3.1?*

Response

Section 7.1 of the FSSP (p. 27) has been revised to include the following information.

The Certified Health Physicist, supervisory personnel, and the Senior Health Physics Technicians will meet or exceed the requirements of Sections 4.3.3, 4.4.6 and 4.5.3.2 of ANSI/ANS-3.1-1993, (Selection, Qualification, and Training of Personnel for Nuclear Power Plants) respectively, with the exception of the requirements for on-site experience at the Pathfinder site.

- *DP Page 31, Section 5.10, should-Table 5.3 be in Section 5.5 or 5.6?*

Response

Both sections are appropriate. A cross-reference to Table 5.3 has been added to Section 5.5 (p. 27) and Section 5.6 (p. 28).

- *DP Page 29, Section 5.8, does instrumentation include air sampling equipment?*

Response

Yes, Section 5.8 applies to air sampling equipment also.

BOUNDING DOSE ESTIMATE TO A HYPOTHETICAL INDIVIDUAL EXPOSED TO RESIDUAL CONTAMINATION FOLLOWING THE DECOMMISSIONING OF THE PATHFINDER REACTOR BUILDING

Revision 0

November 2004

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TABLE OF CONTENTS

1.0 INTRODUCTION

In order to demonstrate that the Pathfinder Site meets the criteria for release for unrestricted use specified in 10 CFR 20 Subpart E, the annual dose to a hypothetical individual exposed to residual contamination following the decommissioning of the Pathfinder Reactor Building must be determined. Although the Reactor Building was decommissioned in 1992, the dose from residual contamination that may be present in the remaining portion of the Reactor Building must be accounted for now that the remainder of the Pathfinder Site is being decommissioned. The criteria for release for unrestricted use specified in 10 CFR 20 is an annual dose of 25 mrem. The annual dose from residual contamination that may be present in the remaining portion of the Reactor Building will be calculated, and if significant subtracted from the 25 mrem criteria. If necessary the resulting dose will then be used to derive secondary criteria in terms of dpm/100 cm^2 for building surfaces or pCi/g for soils that will be used to demonstrate that the remainder of the Pathfinder Site meets the criteria for release for unrestricted use.

Although the 1992 decommissioning included the Reactor Building, the Fuel Handling Building and the Temporary Loading and Storage Building only the dose from the Reactor Building need to be considered in deriving the secondary criteria for demonstrating the criteria for release for unrestricted use. Following the 1992 decommissioning the above grade portion of the Reactor Building was removed and the below grade portion backfilled and capped with cement. The remaining two buildings remained virtually intact and continued to be used to support on going site activities associated with non nuclear power generation. Since the remaining two buildings continued to be used and had the potential for storing radioactively contaminated components they are being included in the scope of the current decommissioning.

2.0 SOURCE TERM

For the purposes of determining the source term for this calculation it will be assumed that at the time of the 1992 decommissioning that the internal surfaces of the Reactor Building were uniformly contaminated with an activity concentration of 2,500 dpm/100 cm^2. This conservative assumption is supported by the data presented in Table 6-7 of Reference 6.1 and the statements made on page 8 of Reference 6.2:

The radionuclides of concern on the concrete at the time of the 1992 decommissioning and their average activity concentrations, which were obtained from Table 5-1 of Reference 6.1, are provided in Table 1.

Table 1
Average Radionuclide Activity Concentrations In Concrete

Radionuclide	Half-life (yr)	Average Act Conc (pCi/g)	Relative Fraction
Co-60	5.271	46.75	.7219
Cs-134	2.06	0.12	.0019
Cs-137	30.17	17.8	.2748
Eu-152	13.6	0.07	.0011
Eu-154	8.8	0.023	.0004
	Total	64.763	1.00

As Table 1 demonstrates the two radionuclides of concern are Co-60 and Cs-137. Assuming an initial activity concentration of 2,500 dpm/100 cm^2 in 1992, the activity concentration of these two radionuclides in 2005 are given by the following equations.

Co-60

$$A_{Co\text{-}60} = (2{,}500\ dpm/100\ cm^2)(.7219)e^{\frac{-.693(13)}{5.271}} = 327\ dpm/100\ cm^2$$

Cs-137

$$A_{Cs\text{-}137} = (2{,}500\ dpm/100\ cm^2)(.2748)e^{\frac{-.693(13)}{5.271}} = 510\ dpm/100\ cm^2$$

In order to estimate the residual activity present within the remaining portion of the Reactor Building the Reactor Building is modeled as an open toped cylinder with a height of 36 feet and a diameter of 80 feet.

The area of a cylinder is given by the following equation

$$A_{cyl} = \Pi(D)(H)$$

$$A_{cyl} = \Pi(36\ ft)(80\ ft) = 9{,}048\ ft^2$$

The area of a circle is given by the following equation

$$A_{cir} = \Pi\left(\frac{D}{2}\right)^2$$

$$A_{cir} = \Pi\left(\frac{80}{2}\right)^2 = 5{,}027\ ft^2$$

To account for building structures and miscellaneous equipment that may have been left within the Reactor Building the area of the opened top cylinder is multiplied by a factor of 1.5. The surface area associate with the remaiñing portion of the Reactor Building including any for building structures and miscellaneous equipment that may have been left within the Reactor Building is given by the following equation.

$$A_{Rx} = (1.5)(9{,}048\ ft^2 + 5{,}027\ ft^2)\left(\frac{12\ in}{ft}\right)^2\left(\frac{2.54\ cm}{in}\right)^2 = 1.961E7\ cm^2$$

The Co-60 source term associated remaining portion of the Reactor Building is given by the following equation

$$Act_{Co\text{-}60} = (1.961E7)\left(\frac{327\ d}{m\ 100\ cm^2}\right)\left(\frac{m}{60\ s}\right)\left(\frac{s\ Ci}{3.7E10\ d}\right) = 2.889E-5\ Ci$$

The Cs-137 source term associated remaining portion of the Reactor Building is given by the following equation

$$Act_{Cs\text{-}137} = (1.961E7)\left(\frac{510\ d}{m\ 100\ cm^2}\right)\left(\frac{m}{60\ s}\right)\left(\frac{s\ Ci}{3.7E10\ d}\right) = 4.505E-5\ Ci$$

3.0 GEOMETRY

To calculate the annual dose to a hypothetical individual exposed to the residual contamination remaining following the decommissioning in 1992 it is assumed that the activity is distributed in a thin disc with a diameter equal to the Reactor Buildings. A 1-foot thick concrete cap above the remaining portion of the Reactor Building provides shielding and limits access. The hypothetical individual is assumed to spend 1000 hours per year above the center of the disc. The dose is calculated at a distance of three feet above the center of the disc.

The assumed geometry is considered to be conservative since the residual activity is expected to be adhered to the Reactor Building surfaces, some of which are significantly below grade, and the Reactor Building was backfilled with gravel which would provide significant shielding. The exposure time of 1000 hours per year is also considered to be conservative and is based on an industrial exposure scenario. It was assumed that the hypothetical individual would be exposed to residual contamination due to the Reactor Building Decommissioning for half the year and to residual contamination resulting from

the planned decommissioning of the Pathfinder Site for half the year. This assumption relied on the fact that the exposed individual could not be in two places at one time.

4.0 CALCULATION METHODOLOGY

The annual dose to a hypothetical individual exposed to residual contamination following the decommissioning of the Pathfinder Reactor Building was calculated using Microshield Version 5.05. Attachment 1 contains a copy of the Microshield run.

As shown in Attachment 1 the exposure rate to a hypothetical individual positioned three feet above the center of the concrete cap covering the remaining portion of the Reactor Building is estimated to be 3.918E-5 mR/hr

Given an exposure rate of 3.055E-5 mR/hr the annual dose to a hypothetical individual spending 1000 hours per year above the cap over the remaining portion of the Reactor Building is given by the following equation.

$$D = \left(3.918E-5 \frac{mR}{hr}\right)\left(\frac{mrem}{mR}\right)(1000\,hr) = 0.039\,mrem$$

5.0 RESULTS

The annual dose to a hypothetical individual exposed to residual contamination following the decommissioning of the Pathfinder Reactor Building is estimated to be 0.039 mrem. Compared to the criteria for release for unrestricted use of 25 mrem per year specified in 10 CFR 20 Subpart E the dose from residual contamination following the decommissioning of the Pathfinder Reactor Building is insignificant. Subtracting the dose associated with residual contamination following the decommissioning of the Pathfinder Reactor Building from annual dose limit associated with the criteria for release for unrestricted use of 25 mrem per year results in annual dose of 24. 961 mrem. When rounded to 2 or 3 significant figures 24.961 mrem and 25.0 mrem are equivalent.

Since the dose associated with residual contamination following the decommissioning of the Pathfinder Reactor Building is insignificant when compared to the criteria for release for unrestricted use, it will have no affect on the criteria for release for unrestricted uses that will be applied to the planned decommissioning of the Pathfinder Site

6.0 REFERENCES

6.1 Final Survey Report For The Pathfinder Atomic Plant, May 1992

6.2 Confirmatory Radiological Survey Of Portions Of The Pathfinder Generating Station Sioux Falls, South Dakota, November 1992

Attachment 1 - Microshield run

MicroShield v5.05 (5.05-00013)
GTS Duratek

Page : 1
DOS File: Case1
Run Date: November 1, 2004
Run Time: 2:49:54 PM
Duration: 00:00:00

File Ref: _____
Date: _____
By: _____
Checked: _____

Case Title: Pathfinder
Description: Bounding Dose Calculation For Reactor Building
Geometry: 3 - Disk

Source Dimensions

Radius	2.4e+3 cm	80 ft	0.0 in

Dose Points

	X	Y	Z
# 1	121.92 cm	0 cm	0 cm
	4 ft	0.0 in	0.0 in

Shields

Shield Name	Dimension	Material	Density
Shield 1	1.0 ft	Concrete	2.3
Air Gap		Air	0.00122

Source Input
Grouping Method : Actual Photon Energies

Nuclide	curies	becquerels	µCi/cm²	Bq/cm²
Ba-137m	4.2617e-005	1.5768e+006	2.2815e-006	8.4417e-002
Co-60	2.8890e-005	1.0689e+006	1.5466e-006	5.7225e-002
Cs-137	4.5050e-005	1.6669e+006	2.4118e-006	8.9235e-002

Buildup
The material reference is : Shield 1

Integration Parameters

Radial	50
Circumferential	50

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.0318	3.265e+04	5.148e-37	1.591e-30	4.288e-39	1.326e-32
0.0322	6.023e+04	7.520e-36	3.051e-30	6.052e-38	2.456e-32
0.0364	2.192e+04	1.426e-28	4.512e-28	8.104e-31	2.563e-30
0.6616	1.419e+06	1.755e-05	2.569e-04	3.402e-08	4.980e-07
0.6938	1.744e+02	2.584e-09	3.577e-08	4.990e-12	6.906e-11
1.1732	1.069e+06	1.085e-04	8.246e-04	1.939e-07	1.474e-06
1.3325	1.069e+06	1.686e-04	1.122e-03	2.925e-07	1.946e-06
TOTALS:	3.672e+06	2.947e-04	2.203e-03	5.204e-07	3.918e-06