DOE/EIS-0247

Construction and Operation of the Spallation Neutron Source Facility

Final Environmental Impact Statement

Volume II

U.S. Department of Energy
Office of Science

April 1999

APPENDIX A

PUBLIC COMMENTS AND DOE RESPONSES

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A. PUBLIC COMMENTS AND DOE RESPONSES

The Department of Energy (DOE) received 206 public review comments on the Spallation Neutron Source (SNS) draft Environmental Impact Statement (DEIS). These comments and the DOE responses to them are presented in this appendix.

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CONTENTS

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Chapter 1
Introduction

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CHAPTER 1

INTRODUCTION

DOE issued the *Draft Environmental Impact Statement: Construction and Operation of the Spallation Neutron Source* in December 1998. This document was made available for review by federal agencies; tribal governments; the states of Tennessee, New Mexico, Illinois, and New York; local governments; and the general public. DOE invited comments on the accuracy and adequacy of the DEIS and any other matters pertaining to environmental review of the document. The formal review and comment period extended from December 24, 1998 until February 8, 1999. DOE considered all comments submitted after the review and comment period.

DOE provided several different ways for reviewers to submit comments on the DEIS. These included public hearings, mail or courier service, telephone calls, facsimile, and electronic mail. DOE received a total of 206 public review comments.

This appendix to the Final Environmental Impact Statement (FEIS) contains the 206 comments received and the DOE responses to these comments. It consists of four chapters. Chapter 1 provides an introduction to the contents of this appendix and discusses the general methodology DOE used for documenting, considering, and responding to the review comments on the DEIS. Chapter 2 summarizes the principal issues of public concern collectively reflected by the comments and presents DOE's responses to these issues. The full texts of the comments on the DEIS are presented in Chapter 3. Chapter 4 contains DOE's written responses to these comments and the locations of textual changes in the FEIS that were made in response to the comments.

1.1. METHODOLOGY

Comments on the DEIS were recorded in comment messages, hearing transcripts, and hearing transcript attachments. The written comments were recorded in the comment messages, which include formal letters sent by U.S. mail or courier services, facsimiles, e-mail messages, and completed comment forms. DOE supplied the blank comment forms to persons attending the public hearings. The transcripts of telephone messages containing comments have also been included in the comment message category. The oral comments presented at the public hearings were recorded by court reporters, who produced verbatim transcripts of the proceedings. Comments are also contained in hearing transcript attachments, which are documents officially entered into the record of the public hearings. The full texts of these documents and the comments they contain are provided in Chapter 3 of this volume.

The texts of the comment messages, hearing transcripts, and hearing transcript attachments were reviewed to identify discrete comments and their topics. Most of these documents were found to contain multiple comments dealing with several topics of concern to reviewers of the DEIS. For tracking and response purposes, each of these comments was assigned an alphanumeric comment code (refer to Section 3.2).

DOE considered all comments to evaluate the accuracy and adequacy of the DEIS and to determine whether or not draft text needed to be revised. During these considerations, DOE gave equal weight to oral comments, written comments, comments received in public hearings, and comments received in other ways. The comments were reviewed exclusively for their content and relevance to the environmental analysis contained in the DEIS.

A formal DOE response to each comment on the DEIS is included in Chapter 4 of this appendix. If revisions of the DEIS text have occurred in response to a comment, the affected sections of the text are indicated beneath the response.

Some commenters submitted comments that are not pertinent to the content, accuracy, or adequacy of the DEIS. DOE has responded by attempting to answer the questions and concerns voiced in these comments, but the text of the DEIS was not revised as a result of these comments. Some comments indicated simple agreement or disagreement with the proposed action or particular aspects of the environmental analysis in the DEIS. DOE acknowledged these comments in its responses, but these comments did not result in changes to the text of the DEIS.

Chapter 2
Principal Issues of Public Concern

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CHAPTER 2

PRINCIPAL ISSUES OF PUBLIC CONCERN

The texts of the 206 comments on the draft Environmental Impact Statement (DEIS) for the Spallation Neutron Source (SNS) were collectively analyzed to identify principal issues of concern to the public. As a result of this analysis, four major issues were identified. These issues are radioactive contamination of groundwater, selection of the proposed SNS site on the Oak Ridge Reservation (ORR), effects of the proposed action on research projects in the Walker Branch Watershed, and the need for a Mitigation Action Plan.

Each of the following sections in this chapter is devoted to one of the four issues of public concern. In each section, the issue is stated in the first paragraph, and it is followed by the formal DOE response.

2.1 RADIOACTIVE CONTAMINATION OF GROUNDWATER

Operation of the proposed SNS has the potential for neutron activation of soils in the shielding berm surrounding the linear accelerator and accumulator rings. This would result in the contamination of berm soils by radionuclides. A principal issue of concern to stakeholders is the potential for water infiltrating the berm soils to transport radionuclide contamination to saturated groundwater zones, especially those that are sources of potable water.

The key design element for shielding the linear accelerator and accumulator rings in the proposed SNS is an earthen berm. This berm would be designed to isolate the activation products generated by the SNS particle beam and to provide radiation protection for outside areas around the beam and ring tunnels. The berm would be constructed of compacted native soils and would be engineered to isolate activation products by minimizing the amount of water infiltrating the berm. The design incorporates a groundwater interceptor system to collect any water that might get through the engineered berm. This water would be sampled and analyzed for radionuclides. If any are found to be present, the water would be managed as low-level radioactive waste. Otherwise, the water would be released to the retention basin.

The FEIS analysis of radionuclide transport in berm soil is based on very conservative assumptions concerning dilution, groundwater travel times, and levels of radionuclides in the berm. Such conservatism was necessitated by uncertainties in the amounts of soil activation products in the berms and uncertainties about the groundwater at each of the proposed SNS sites. The results of this analysis present a bounding estimate of potential effects from the proposed action. This bounding estimate becomes the maximum design limit of the proposed SNS. If the need for additional groundwater protection is identified during design of the facility, an alternative berm design that would provide equal or better protection than is presented in the FEIS.

2.2 SELECTION OF THE PROPOSED SNS SITE ON THE OAK RIDGE RESERVATION

The DOE-Oak Ridge Operations Office has actively sought public input on the future use of ORR land. An Oak Ridge citizens advisory organization, the End Use Working Group, has recommended a set of final land use guidelines to DOE-ORO. One of these guidelines recommends the siting of additional

DOE facilities on brownfield sites instead of greenfield sites. Brownfield sites are previously contaminated and/or developed areas, whereas greenfield sites are natural, undeveloped areas. The proposed SNS site at ORNL is a 110-acre (45-ha) tract of undeveloped forest land near the top of Chestnut Ridge. Selection of this greenfield site instead of a brownfield site for the proposed SNS is an issue of concern among stakeholders in the Oak Ridge area.

The proposed SNS site at ORNL was chosen through a formal site-selection process. This process is described in a document entitled *Spallation Neutron Source, Oak Ridge National Laboratory Site Selection Report*. The entire text of this report is included in Appendix B of the FEIS.

The process of selecting the preferred site for construction of the SNS on the Oak Ridge Reservation was a two-phase process. In the first phase, the entire reservation was screened to eliminate areas that were not suitable for construction of the SNS. Brownfield and greenfield areas of the reservation were both included. One of the screening criteria was identification of areas of land within the ORR with waste area groupings, environmental restoration projects, or waste management areas. These areas were eliminated from consideration because they would require cleanup, with some attendant uncertainty on the extent of cleanup required, prior to excavation for the SNS foundations. This activity could increase worker exposure to radioactive and nonradioactive contaminants, and would require the disposal of material removed during cleanup in a licensed landfill. This could affect both the budget and schedule of the project. Working in a contaminated area could increase labor costs and disposal costs of the contaminated materials. Coordinating with the Environmental Management program for the cleanup of these areas may resolve the budget issue; however, long schedule delays may result. Coordination of this construction effort with the requirement of RCRA or CERCLA for cleanup of these areas could add a year or more to the construction schedule of the SNS. Siting the SNS in a waste management area could require cleanup of the area with its associated cost increases and schedule delays, and possibly the relocation of waste management activities. The result of this first phase was the identification of four candidate sites; however, none of these were brownfield sites.

The second phase consisted of a comparative evaluation of the candidate sites using specific site-evaluation criteria. One of the functional criteria was the avoidance of contaminated soils. One of the health and safety criteria was avoiding existing hazardous materials areas and waste areas (i.e., Waste Area Groups and RCRA sites). Again, these criteria were included to avoid the increased risk to construction workers and the increased costs and schedule delays associated with placing a large-scale construction project at a site with contaminated soils or hazardous materials.

2.3 EFFECTS ON RESEARCH PROJECTS IN THE WALKER BRANCH WATERSHED

The Walker Branch Watershed is an important research area located approximately 0.75 mi (1.2 km) east of the proposed SNS site at ORNL. It is one of the few sites in the world characterized by long-term, intensive environmental studies. Environmental monitoring and ecological research projects in the area are being conducted by the National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) and the ORNL Environmental Sciences Division (ESD). The proposed SNS site is located within a buffer zone designed to protect research in the watershed. During construction and operation of the proposed SNS, CO_2 emissions from vehicles and small sources may adversely affect this research. During SNS operations, CO_2 emissions from natural gas boilers would affect such research. Operational emissions of water vapor from the SNS cooling towers may also affect this research. The principal effects would be loss of data quality and comparability over time. These potential effects on research in the Walker Branch Watershed are a principal issue of concern to stakeholders in the Oak Ridge area.

If the site at ORNL is selected for the SNS in the Record of Decision, DOE would investigate appropriate measures to mitigate the potential effects of the proposed action on environmental monitoring and ecological research in the Walker Branch Watershed. Two measures that would be evaluated for mitigation of the effects from CO_2 emissions would be the use of heat pumps or heat recovery from the cooling towers instead of natural gas boilers to heat the SNS. The use of electric or ultra-low-emission vehicles to shuttle workers from remote parking lots to the SNS would also be evaluated. Another potential mitigation measure for the effects of CO_2 and water vapor emissions could be moving the existing NOAA/ATDD meteorological monitoring tower to a new location less susceptible to emissions from SNS activities or building a new monitoring tower at this new location. The evaluation and selection of appropriate mitigation measures will be documented in a Mitigation Action Plan.

2.4 MITIGATION ACTION PLAN

Several commenters expressed concern about mitigation measures to minimize potential impacts of the SNS on research activities in the Walker Branch Watershed on the Oak Ridge Reservation. One commenter suggested specific mitigation measures.

If the decision in the ROD is to construct the SNS, DOE would prepare a MAP for the selected site. The MAP would present details concerning the planning, implementation, and monitoring of the mitigation measures designed to minimize potential impacts associated with construction and operation of the SNS. DOE would complete the MAP prior to the start of construction, and the document would be made available to the public for review and comment.

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Chapter 3
Public Comments

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CHAPTER 3

PUBLIC COMMENTS

The Notice of Availability (NOA) (63 FR 71285) for the DEIS was published in the *Federal Register* on December 24, 1998. This initiated a 45-day public review and comment period that ended on February 8, 1999. During the review and comment period, DOE held public hearings on the DEIS in the vicinity of each proposed site for the SNS. Hearings were held at the following locations on these dates: Oak Ridge, Tennessee (January 28, 1999); Los Alamos, New Mexico (January 19, 1999); Argonne, Illinois (January 25, 1999); and Upton, New York (January 21, 1999). At each hearing, attendees were given an opportunity to submit oral or written comments to DOE. Transcripts of the proceedings at these hearings were prepared by experienced court reporters.

Throughout the review and comment period, reviewers were given the option of submitting comments to DOE by U.S. mail or courier service, toll-free telephone, facsimile, or electronic mail. To accommodate as many commenters as possible, comments were accepted after closure of the formal review and comment period. The last comment was received on April 6, 1999. DOE considered all late comments.

3.1 COMMENT CATEGORIES

The complete texts of the original comment messages received by DOE are presented in this chapter. They are printed two original letter-size sheets per page and are presented by source category. The source categories and their order of presentation are shown in Section 3.2.

Complete transcripts of the public hearings and written attachments to the transcripts follow the comment messages. A typical transcript attachment would be a set of notes used by a respondent in making oral comments at the hearings. These attachments do not include the DOE comment forms distributed at the public hearings because respondents had the option of mailing the completed forms to DOE sometime after the hearings or turning them in at the hearings. All of these completed forms are treated as comment messages in this chapter.

3.2 COMMENT CODE

The comment messages, hearing transcripts, and hearing transcript attachments are coded to indicate major comment source categories, individual commenters, and their discrete comments. The primary purpose of these comment codes is to relate the DOE comment responses in Chapter 4 back to the precise locations where these comments were made in the texts of the comment messages, hearing transcripts, and hearing transcript attachments. This section describes the system used to code the comments.

The comment coding system is described at this point in the appendix because certain elements of the system relate to the organization, layout, and labeling of the comment messages, hearing transcripts, and hearing transcript attachments presented in this chapter. This system also describes how the many separate comments in the texts of these documents are marked and numbered for individual identification and tracking. Although the complete comment codes are not used in this chapter, they are used extensively in Chapter 4.

Each comment code consists of an initial capital letter followed by two numbers. All capital letters and numbers are separated by hyphens. An example comment code would be F-1-5.

The initial capital letter in the comment code designates the comment source category. The following is a list of the capital letters used and their corresponding comment source categories:

F Federal Agency
S State Government
M Municipal and Local Government
O Organization
P Private Citizen
H Public Hearing

The first code number after the initial capital letter designates a specific comment message, hearing transcript, or hearing transcript attachment. These sequentially assigned numbers are often repeated among the comment source categories. However, they function as effective discriminators by working in tandem with the capital letters.

The last number in the comment code designates a specific comment within the text of each comment message, hearing transcript, or hearing transcript attachment. In this chapter, vertical side bars along the left margins of comment document pages are used to indicate discrete comments. Each vertical bar is accompanied by the appropriate last number in the comment code.

The following are examples of how the comment code works:

- Comment Code F-1-5 refers to a Federal agency source, Comment Message 1, fifth separate comment in the message.
- Comment Code H-3-7 refers to a public hearing source, the hearing transcript designated with Code Number 3, seventh separate comment in the transcript.
- Comment Code H-9-3 refers to a public hearing source, the hearing transcript attachment designated with Code Number 9, third separate comment in the attachment.

3.3 LIST OF COMMENTERS AT THE PUBLIC HEARINGS

This section contains a list of the persons who provided oral comments at the public hearings on the DEIS. If a commenter was representing a government agency, company, or organization, the name of this entity is listed with the person's name. Commenters who did not wish to reveal their identities are listed as "anonymous."

The following people provided oral comments at the public hearings:

Oak Ridge Morning Session

Walt Brown, Mayor of Oak Ridge
Wolf Naegeli, Foundation for Global Sustainability

Oak Ridge Afternoon Session

Barbara Walton
Daniel Axelrod
Fred Maienschein
Lorraine Sigal
Josh Johnson
Susan Gawarecki, Local Oversight Committee
Anonymous

Los Alamos Morning Session

No public comments

Los Alamos Afternoon Session

Tom Switlik

Argonne Afternoon Session

No public comments

Argonne Evening Session

Russell Zizek

Brookhaven Afternoon and Evening Sessions

No public comments

3.4 PUBLIC COMMENTS ON THE DEIS

This section contains an index of comments on the DEIS and the original texts of the comments as they appear in the comment messages, hearing transcripts, and hearing transcript attachments received by DOE.

3.4.1 Index of Comments

An index of the oral and written comments on the DEIS is presented in this section. It is designed to facilitate use of the comment text in Section 3.4.2. The index is organized according to the comment source categories already discussed in Section 3.2. In the index, commenters from government agencies, companies, and organizations are identified by affiliation rather than the individual names of the commenters. However, their names are present on the comment documents presented in Section 3.4.2. Private citizens who submitted written comments or public hearing attachments are identified by name. Each index listing is accompanied by a page number indicating the location of the comment text in Section 3.4.2.

Comment Source
Category/Code
Number/Commenter **Appendix A Page Number**

Federal Agencies

State Government

Municipal & Local Government

Organizations

Private Citizens

Hearing Transcripts and Attachments

3.4.2 Comment Messages, Hearing Transcripts, and Hearing Transcript Attachments

The subsequent pages contain the texts of the comment messages, hearing transcripts, and hearing transcript attachments received by DOE. The order of presentation is the same as that indicated by the index in Section 3.4.1. As previously indicated in Section 3.2, the specific comments on the DEIS are shown with numbered vertical bars along the left margins of each comment document page.

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Comment Messages

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Comment Messages

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

FEB 12 1999

ASSISTANT ADMINISTRATOR
FOR ENFORCEMENT AND
COMPLIANCE ASSURANCE

Ms. Carol M. Borgstrom, Director
Office of NEPA Policy and Assistance (EH-42)
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Ms. Borgstrom:

The Environmental Protection Agency has reviewed the Draft Environmental Impact Statement (DEIS) for the proposed Department of Energy's Construction and Operation of the Spallation Neutron Source (SNS). The proposed SNS facility will provide a next-generation accelerator-based neutron scattering facility that would support the needs of the scientific community. EPA is providing comment in accordance with Section 309 of the Clean Air Act, as amended (42 U.S.C., PL 91-604 12(a), 84 Stat. 1709), and the National Environmental Policy Act (NEPA).

The DEIS evaluates and compares four proposed alternative locations for the SNS. DOE's preferred alternative site is Oakridge National Laboratory (ORNL) in Oak Ridge, TN. The remaining alternative sites outlined in the DEIS, and the order of selection are the Los Alamos National Laboratory (LANL), located in Los Alamos, NM; Argonne National Laboratory (ANL), located in Argonne, ILL; and Brookhaven National Laboratory (BNL), located in Upton, NY. In addition to the "No Action" alternative, three other alternative methods were considered, but were later found to be technically inferior and therefore were eliminated by DOE.

The proposed action will involve the construction and operation of a short-pulse spallation neutron source comprising an ion source, a linear accelerator, a proton accumulator ring, a liquid mercury ring, a liquid mercury target, and a set of neutron scattering instrumentation. This facility would be designed to operate at a proton beam power of one Mega Watts (MW) and could be upgraded in the future to four MW. The one MW SNS would occupy real property approximately 110 acres. Supporting

Recycled/Recyclable

facilities would be located in 15 structures occupying an additional six acres. An increase in the power level to four MW would expand the footprint size of the SNS by approximately 15 acres.

EPA's general and regional specific comments are attached. Our overarching comments fall into two basic categories. These categories are programmatic authorities under the Clean Air Act, Radionuclide National Emission Standards for Hazardous Air Pollutants (Radionuclide NESHAPS), and the approval of accepted methodologies for calculating the effective dose equivalent (ede) exposures for members of the public.

EPA has rated this document EC-2 (Environmental Concerns-Insufficient Information). For additional information concerning our rating system, please refer to the attached rating summary. This rating reflects EPA's environmental concerns based on insufficient information described in our attached comments. Information requested includes a more detailed analysis of the preferred alternative, more detailed analysis of one of the non-preferred alternatives, additional mitigations for wetlands impacted areas, and the exposure dose factors used by DOE.

Please contact me (202-564-7148) or Marguerite Duffy of my staff (at 202-564-7148) if you have questions regarding these comments.

Sincerely,

Richard E. Sanderson,
Director
Office of Federal Activities

Enclosure

SUMMARY OF RATING DEFINITIONS AND FOLLOW-UP ACTION

Environmental Impact of the Action

LO--Lack of Objections
The EPA review has not identified any potential impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC--Environmental Concerns
The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

EO--Environmental Objections
The EPA review has identified significant environmental impacts that must be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU--Environmentally Unsatisfactory
The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the CEQ.

Adequacy of the Impact Statement

Category 1--Adequate
EPA believes that draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2--Insufficient Information
The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

Category 3--Inadequate
EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

USEPA Comments on the Draft Environmental Impact Statement Spallation Neutron Source

Site Specific Information

1 We recommend that the final document include more site specific information relating to water resources, ecological resources, cultural resources, human health, support facilities and infrastructure, long-term productivity of the environment, and lastly, cumulative impacts resulting from construction and operation. The DEIS assesses these impacts at a general level. We recommend including site specific NEPA analysis or information so that each of the identified potential impacts for each facility are fully assessed.

Radiation

The DEIS is unclear on the programmatic authorities under the Clean Air Act, Radionuclide National Emission Standards for Hazardous Air Pollutants (Radionuclide NESHAPs), and the approval of accepted methodologies for calculating the effective dose equivalent (ede) exposures for members of the public.

Radionuclide Methodology

2 We were unable to find anywhere in the DEIS a request for an alternate methodology for demonstration of compliance with the Radionuclide NESHAPs. It is unclear whether DOE intends to seek such approval for the values provided within the DEIS. The values DOE has provided for ede, with the pathways of exposure chosen, are presented as having to meet the 10 millirem per year ede dose standard for all public exposures. Prior US EPA approval must be obtained for any alteration of Clean Air Act Assessment Package 1988 (CAPP88-PC). This includes other radionuclides of concern. If this prior approval is not sought and obtained, the calculated ede exposures cannot be accepted as being adequately protective of public health and safety. We recommend that if this is not the case, then that the request, along with the approval letter be provided in the EIS.

Radionuclide State Delegation

3 We recommend that DOE clarify the state authorities for each alternate site. For example, the State of Illinois Environmental Protection Agency has no authorities delegated to it with regards to the Radionuclide NESHAPs, or radiation in any form. Radiation issues for the State of Illinois is dealt with by the Illinois Department of Nuclear Safety, which also has no delegated authority for the Radionuclide NESHAPs. All enforcement authority resides with the United States Environmental Protection Agency, Region 5 office for Radionuclide NESHAPs issues. The DEIS needs to be changed to reflect this confusion.

NESHAP Reports

4 The DEIS should address how operation of the facility would contribute to radionuclide emissions in the atmosphere and how it would contribute to the existing NESHAP reports.

Air Quality

5 While the EIS contains tables which provide monitoring data for all of the criteria pollutants for 1996, it does not state whether or not ANL and BNL are in areas classified as non-attainment or maintenance of the National Ambient Air Quality Standards (NAAQS). If they are in non-attainment or maintenance status they would be subject to the general conformity rules (40 CFR Part 93: "Determining Conformity of General Federal Actions to State or Federal Implementation Plans"). The final EIS should address both the status of all of the alternatives and the applicability of the general conformity rule.

Groundwater

6 The DEIS states that the Till formation at Argonne is classified as having low permeability which renders this formation unusable. EPA believes this groundwater information is inaccurate. It has been well documented that the Wadsworth Till formation possess extensively high yielding sand and gravel scams. Although several municipalities in the Chicago land area have recently switched to using Lake Michigan water as a potable source, several private residences in northeastern Illinois are still dependent on shallow groundwater as a potable supply source. EPA recommends that further consideration must be given to potential impacts to shallow ground water resources in the area.

DOE Preferred Alternative, ORNL Site Specific

Contaminated Site

7 The document references several conflicts surrounding the siting of the SNS at the preferred alternative, ORNL. As noted, an Oak Ridge citizens advisory organization, the End-Use Working Group, has drafted land use guidelines and recommendations for the DOE - Oak Ridge Operations. One of the draft guidelines

7 recommends the siting of additional DOE facilities at ORNL on brownfield sites instead of greenfield sites (Page S-17). EPA has an initiative - the Brownfields Economic Redevelopment Initiative - designed to empower stakeholders in economic redevelopment of abandoned industrial areas to clean up and reuse brownfields. We note that DOE is currently participating in the Interagency Working Group on Brownfield development [DOE contacts are Martha Crosland 202-568-5793 and Chris Camillo 202-401-3819, April 1997 data]. We recommend that the Final EIS examine the potential for using brownfield sites for the SNS project. Instead of committing 110 acres of hardwood and pine forest habitat for this project, EPA Region IV supports the examination of brownfield sites within ORNL to determine what sites might serve DOE's needs in this regard.

Conflicts With Existing Land Use

8 A potential conflict at the ORNL site stems from on-going environmental monitoring and ecological research projects in the proposed project area (Page S-17) being conducted by National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ADD). The proposed site is situated within a buffer zone designed to protect an ecological monitoring project from carbon dioxide and other pollutant emissions. The Final EIS needs to include: a) how long the NOAA/ADD monitoring project are expected to continue; b) what is the projected building schedule of the SNS project, including the proposed upgrade to peak operation to the proposed build-out to 4 MW beam; and c) indicate if there are any of the NOAA/ADD ecological monitoring projects that can be completed prior to addition to the atmosphere of combustion products from the natural gas-fired boilers at the proposed SNS site.

Wetlands

9 EPA requests that the final EIS includes discussion on avoidance and reduction of wetland impact, as well as, mitigation necessary to offset unavoidable wetland impacts.

Other Alternatives

10 Our limited review indicates that based upon population, health impacts, and groundwater issues, that the best site for the facility would be LANL. We would suggest that additional information be provided explaining why Oak Ridge is the preferred alternative.

Illinois Department of Agriculture

Bureau of Land and Water Resources • State Fairgrounds • P.O. Box 19281 • Springfield, IL 62794-9281
217/782-6297 • TDD 217/524-6858 • Fax 217/524-4882

January 7, 1999

Mr. David Wilfert
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/SNS
Oak Ridge, TN 37831

Re: Proposed Spallation Neutron Source Project
Draft Environmental Impact Statement
DOE/EIS-0247

Dear Mr. Wilfert:

The Illinois Department of Agriculture (IDOA) has reviewed the Draft Environmental Impact Statement (DEIS) prepared for the proposed Spallation Neutron Source (SNS) project. We submit the following comments.

The primary site chosen for the SNS is Oak Ridge, Tennessee. Three other sites considered include Argonne National Laboratory in Illinois; Las Alamos, New Mexico; and Upton (Brookhaven), New York.

1 The Illinois site has no significant agricultural impacts since it is located on the grounds of the Argonne National Laboratory. The site consists of support service buildings, open space, and undeveloped ecological plots. If any agricultural land remains on the site, its viability for long-term agricultural use would be very low given the development that has occurred around it. Land use plans designate the area for nonagricultural uses. The IDOA would have no objection to the project if the Argonne National Laboratory was eventually chosen for the site of the SNS.

The IDOA would have two other comments to make on the DEIS.

2 1. It is the responsibility of the USDA Natural Resources Conservation Service (NRCS) to determine whether a site is subject to the provisions of the federal Farmland Protection Policy Act. Section 4.3.1.3 (Soils), page 4-117 of the DEIS indicates that the preparer of the DEIS has made this decision rather than the NRCS.

3 2. Numerous references to "open space" were made in the DEIS. The term need to be defined in the glossary. If the term includes farmland, then farmland needs to be broken out and assessed separately. Farmland is a natural resource and a land use just like wetlands, woodlands, and prairies, etc. Impacts to this natural resource must be properly evaluated in NEPA documents.

Mr. Wilfert
Page 2
January 7, 1999

If you have any questions concerning our review, please contact me.

Sincerely,

James R. Hartwig, Supervisor
Office of Farmland Protection and Mined Land Reclamation

JRH:drs

cc: Robert L. McLeese, NRCS
Kane-DuPage County SWCD

TENNESSEE HISTORICAL COMMISSION
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
2941 LEBANON ROAD
NASHVILLE, TN 37243-0442
(615) 532-1550

January 11, 1999

Mr. A. Lee Watkins
Oak Ridge Operations
Post Office Box 2001
Oak Ridge, Tennessee 37831-8218

RE: DOE, ENVIRONMENTAL IMPACT STATEMENT, SPALLATION NEUTRON SOURCE/ORNL, OAK RIDGE, ANDERSON COUNTY

Dear Mr. Watkins:

1 At your request, our office has reviewed the above-referenced document in accordance with regulations codified at 36 CFR 800 (51 FR 31115, September 2, 1986). Considering the information provided, we find that the area of potential effect for this undertaking contains no cultural resources eligible for listing in the National Register of Historic Places. You should notify interested persons and make the documentation associated with this finding available to the public.

2 If your agency proposes any modifications in current project plans or discovers any archaeological remains during the ground disturbance or construction phase, please contact this office to determine what further action, if any, will be necessary to comply with Section 106 of the National Historic Preservation Act.

This office appreciates your cooperation.

Sincerely,

Herbert L. Harper
Executive Director and
Deputy State Historic
Preservation Officer

HLH/jyg

Illinois Historic Preservation Agency

1 Old State Capitol Plaza • Springfield, Illinois 62701-1507 • (217) 782-4836 • TTY (217) 524-7128

DuPage County
Argonne National Laboratory
DOE-Spallation Neutron Source Project; Draft Environmental Impact Statement; 800 Area
DOE/EIS-0247; IHPA Log #01122198

January 11, 1999

David Wilfert
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/SNS
Oak Ridge, TN 37831

Dear Mr. Wilfert:

Thank you for requesting comments from our office concerning the possible effects of your project on cultural resources. Our comments are required by Section 106 of the National Historic Preservation Act of 1966, as amended, and its implementing regulations, 36 CFR 800: "Protection of Historic Properties".

1 Our staff has reviewed the "Draft Environmental Impact Statement for the Construction and Operation of the Spallation Neutron Source" dated December 1998. We understand from the draft EIS that the proposed location for the project is the 800 Area at Argonne Naitonal Laboratory-East. Recently Building 829 was determined as not eligible for listing on the National Register of Historic Places. At this time, our office is not sure if there are any other buildings located in the 800 Area. Even though these buildings may be less than fifty years old, if they are located in the 800 Area they should be assessed for National Register eligibility.

2 The process set forth in Table S 1.5.2-1 (page S-36) of the EIS for addressing possible impacts to prehistoric site 11DU207, if Argonne National Laboratory were selected for construction of the Spallation Neutron Source, is acceptable to our office. If you have any further questions, please contact Tracey A. Sculle, Cultural Resource Manager, at 217/785-3977 or Joseph S. Phillippe, Staff Archaeologist, at 217/785-1279.

Sincerely,

Anne E. Haaker
Deputy State Historic
Preservation Officer

AEH:TAS

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

524 South Second Street, Springfield 62701-1787

Brent Manning, Director

January 29, 1999

David Wilfert
US Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/SNS
Oak Ridge, Tennessee 37831

Re: Spallation Neutron Source EIS
Argonne National Laboratory, DuPage County

Dear Mr. Wilfert:

Thank you for contacting the Illinois Department of Natural Resources for comments on the Draft EIS for the proposed Spallation Neutron Source (SNS). The Argonne National Laboratory (ANL) study was distributed to appropriate Department staff for review. The following need to be addressed if ANL is chosen to house the SNS:

1 • Threatened and Endangered Species. While no listed species are known to occur on the exact site for the SNS, several have been observed within the limits of ANL and the adjacent Waterfall Glen Forest Preserve. Surveys for the Kirtland's snake, red-shouldered hawk, and their respective habitats should be performed if ANL is chosen for the SNS.

2 • Waterfall Glen Forest Preserve District. The DuPage County Forest Preserve District should be consulted for impacts to Waterfall Glen, one of the county's largest preserves.

3 • Stream Resources. While the Department does not have authority over the floodways on the two small tributaries on the ANL site (because they both drain less than one square mile), a permit may be needed from the Department's Office of Water Resources if an impoundment is proposed. Additionally, any proposal to alter the streams on site should have a thorough macroinvertebrate and fish survey.

4 • Wetlands. Before a permit is sought from the Department of Environmental Concerns and the US Army Corps of Engineers to fill or alter any wetland, a thorough floristic survey should be performed to determine appropriate mitigation strategies.

(printed on recycled and recyclable paper)

Page 2 January 29, 1999

Please contact me if the ANL alternative is selected for the SNS. The Department can then provide further guidance and more detailed comments regarding the anticipated impacts. If you have any questions or need additional information, please do not hesitate to contact me at (217) 785-5500.

Sincerely,

Kim M. Roman

Kim M. Roman
Project Manager
Endangered Species Consultation Program

cc: Bob Rung, IDNR
Bill Boyd, IDNR
JoEllen Siddens, DuPage Co. FPD

STATE OF TENNESSEE

DON SUNDQUIST
GOVERNOR

February 8, 1999

Mr. David Wilfert, EIS Document Manager
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/FEDC
Oak Ridge, TN 37831

Dear Mr. Wilfert:

As the Governor's Lead Contact for State of Tennessee National Environmental Policy Act (NEPA) reviews, I am providing comments in response to the **Draft Environmental Impact Statement (DEIS) for the Construction and Operation of the Spallation Neutron Source, (SNS) DOE/EIS-0247.** The attached comments from state agencies represent the complete and official response of the State of Tennessee. These comments are limited to the scope of study appropriate for the aforementioned document. Please give these comments your full consideration.

A spallation neutron source as proposed shall provide opportunities for scientific inquiry that may result in significant advances in human knowledge. This state-of-the-art facility will certainly produce improvements in education, engineering, technology, and both basic and applied research. The State of Tennessee fully supports such intellectual activity and firmly believes that Oak Ridge is best suited to host the facility

Because of its size and complexity, the project presents issues that warrant further evaluation. The State has identified some of these in the attached comments. None of these comments appear to present difficulties which cannot be satisfactorily resolved and none justify any halt of progress on the project. In general, the State requests a more complete explanation of the operating and safety systems of the proposed facility.

State Capitol, Nashville, Tennessee 37243-0001
Telephone No. (615) 741-2001

Mr. Wilfert
Page 2
February 8, 1998

The State of Tennessee welcomes the Spallation Neutron Source at Oak Ridge. We appreciate the opportunity to comment and will be pleased to consult with DOE on any concerns. If you have any questions, please contact me or our staff policy analyst at 615/532-4968 (fax 615/532-0740).

Sincerely,

Justin P. Wilson
Deputy Governor for Policy

JPW/emw

cc: Mr. Milton H. Hamilton, Jr., Commissioner
NEPA coordination file/Mr. Dodd Galbreath
State NEPA Contacts

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY ROAD
OAK RIDGE, TENNESSEE 37830-7072

February 1, 1999

David Wilfert, EIS Document Manager
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/FEDC
Oak Ridge, TN 37831

Dear Mr. Wilfert

DOCUMENT REVIEW: Draft Environmental Impact Statement (DEIS) for the Construction and Operations of the Spallation Neutron Source, (SNS) DOE/EIS-0247, December 1998

The Tennessee Department of Environment and Conservation, DOE Oversight Division (TDEC/DOE-O) has reviewed the subject DEIS in accordance with the requirements of the National Environmental Policy Act (NEPA) and associative regulations of 40 CFR 1500-1508 and 10 CFR 1021 as implemented and offers the attached comments for consideration.

The State of Tennessee supports the overall mission of the Oak Ridge National Laboratory and the construction of the Spallation Neutron Source. The DEIS has addressed most of the information requested in our letter of August 29, 1997. It did not provided sufficient information on (1) **the design life and decontamination and decommissioning (D&D) plans for the facility** and (2) **health and safety, including radiologically activated and contaminated materials.** [1] [2]

3 It is the State of Tennessee's understanding that the SNS will be designed, constructed, and operated in a manner that is compliant with applicable laws, regulations and DOE Orders. The DEIS needs additional information to clearly demonstrate groundwater protection requirements, radioactive wastewater treatment capacity to support ORNL's active waste management, environmental restoration waste and SNS waste needs.

4 The State will expect best available technology in design and construction for pollution prevention, emission controls, and monitoring. It will also expect adequate funding for compliant treatment, storage and disposal of waste.

David Wilfert, EIS Document Manager
February 1, 1999
Page Two

If you have any questions regarding the Division's comments, please contact John Owsley or me at (423) 481-0995.

Sincerely

Earl C. Leming
Director

xc: Justin Wilson – Govenor's Policy Office
Mike Mobley – TDEC
Elgan Usrey - TEMA
Dodd Galbreath – TDEC, Environmental Policy Office

EI451.99

GENERAL COMMENTS

5 Several environmental health and safety issues, including radiologically activated and/or contaminated materials, need to be addressed. Possible release of radiological materials to the environment during future upgrades to the facility should be addressed in the Final EIS. According to page A-15 of the Draft EIS, it may be ten years after initial operation before the power is upgraded to 4 megawatts. Significant radioactivity levels may have been reached in various facility locations and equipment by that time subjecting the public and environment to undue risks unless proper precautions are taken. 6 In addition, a more thorough examination of transport of radiological components through the soil and groundwater is required. Design criteria should include protection of groundwater from any contamination including leaching of radionuclides from neutron activated soil.

7 The Department commented on the SNS Notice of Intent by a letter from Mr. Earl C. Leming to Mr. David Wilfert dated August 29, 1997. It was requested in those comments that selection of a "green field" site over a "brown-field" site be addressed and justified in the EIS. It appears this has been done; however, the information is scattered over several sections of the document. Please consolidate the "green field" versus "brown-field" site information under a specific section and list some of the Oak Ridge brownfield sites that were initially considered and explain why those sites were rejected.

8 From a groundwater perspective, if this facility were located in Melton Valley over the relatively tight clastic formations such as the Pumpkin Shale, rather than over the Knox Aquifer (the Knox Aquifer is the best source of usable groundwater in E. Tennessee), there would be less risk of groundwater contamination. Further the relatively tight shales under Melton Valley, would offer an advantage from a standpoint of contaminant travel times, absorption, and matrix diffusion compared to the conduit flow that exists beneath Chestnut Ridge.

9 If Chestnut Ridge remains the preferred site, every effort should be made to reduce impact to the area.
In addition, DOE should respond to citizens' concerns about loss of data quality for the long-term
10 ORNL ecological research projects at Walker Branch Watershed by exploring mitigation opportunities.

11 The draft EIS does not acknowledge that there is currently no outlet for Oak Ridge Reservation Low Level Waste.

12 Several topics that were not covered in the Draft EIS should be included in the final document. These include disposal of Cooling Tower Basin Sludge, handling and disposal of the sediments in the Retention Basin, and processing of activated cooling water from the target areas. Also discuss the expected residence lifetime (in the system) of the cooling water.

13 Include detailed facility maps in the final document. These maps should show expected locations of the facility, retention basins, cooling towers, etc.

SPECIFIC COMMENTS
Volume 1

14 **Page S-53, Table S 1.5.2-1. Comparison of impacts among alternatives, ORNL Alternative, Low-Level Radioactive Wastes**
Although "contracts are in place", there is currently (Jan. 19, 1999) no outlet for Oak Ridge Reservation Low level Waste.

15 **Page 3-47, Table 3.5-1, Comparison of impacts among alternatives, ORNL Alternatives**
What does "(4%) in radionuclide flux over White Oak Dam" mean? Describe this in terms of an increase in radiological activity in addition to a percentage increase.

16 **Page 4-1, Section 4.1.1. Geology and Soils**
This section of the Draft EIS does not discuss the transport of radiological contamination through the soils. Page 9-3 of the Conceptual Design Report NSNS/CDR-2/V2 states in the third paragraph: "A study of soil groundwater transport and migration of various radionuclides at the preferred NSNS (SNS) site must be performed as part of the EIS in order to determine if the indicated soil concentrations are capable of imparting a radiologically significant component to the groundwater." Please include this study in the Final SNS EIS.

17 **Page 4-7, Section 4.1.1.4, Site Stability**
The discussion of soils states that the soils "are not susceptible to liquefaction or mass movement." This section does not discuss karst sinkhole development which is an active process on Chestnut Ridge. There is a small depression within the footprint of the facility. Please discuss the implications on groundwater, surface water and structural stability following the discovery of karst landforms and how will karst be dealt with during design, construction, and operation of the facility.

18 **Page 5-17, 5.2.1.1, Site Stability**
Consideration should be made to the active doline formation encountered in the two barrow areas that exits along strike with the proposed SNS site. The two barrow areas suggest that anthropogenic factors can drastically increase the rate of sinkhole formation on Chestnut Ridge. Please discuss the implications of the above in the final document.

19 **Page 5-18, Section 5.2.1.2, Seismic Risk, 5.2.1.2-1 Seismic design criteria for ORR**
The discussion says Table 5.2.1.2-1 will present "estimated peak ground acceleration (PGA) at locations with greater than 30 ft (10m) of soil cover..," but the table presents "soil >10 ft (3m)."

20 **Page 5-22 Section 5.2.2.3.1 Resources**
Describe the "appropriate measures" if a karst formation is encountered during site characterization at the location of the retention pond.

21 **Page 5-22 through 5-245.2.2.3, Groundwater**
There is a closed depression shown on the S-19-A Oak Ridge Area Map, located within the map south and east area shown as the footprint of the proposed SNS facility. There is also a closed depression shown on the above referenced map to the east of the proposed facility. In all

21 probability these closed depressions represent dolines. The East End barrow area, opened up with numerous swallets, suggests that the West End barrow area may have similar sinkhole development. These two areas are on strike with the proposed SNS facility. This suggests that the Knox Group beneath the site is an active karst aquifer with conduit flow. Dye traces conducted by TDEC demonstrates travel times in the order of 2 cm/sec, not the 2.9 m/yr. ground water velocity provided in this document.

22 A large karst spring SS-5 emerges at the base of Chestnut Ridge just to the map north of the proposed SNS site SS-5 is one of a series of large karst springs located in similar geologic situations at the base of Chestnut Ridge. A tracer study to determine travel times from this site utilizing potential karst features on or near the site to various receptors cross strike (SS-5) and along strike should be referenced in the final EIS.

23 **Page 5-24, Table 5.2.2.3.2-1 Estimates of radionuclide concentrations in soils and water surrounding the proposed SNS**
Please explain how the list of radionuclides and the quantities in this table were generated. Free release criteria should apply when there are uncontrolled releases to the environment. The quantities shown exceed the NRC Limits.

24 **Page 5-24, Section 5.2.2.3.2, Contamination, Last Paragraph**
The concept of a barrier to isolate the soil below the tunnel should be added to the design as a matter of course. This will help mitigate most chances of groundwater being affected by percolating surface water. A rainwater cover or protection of some type over all or selected portions merit consideration.

25 **Page 5-31, Section 5.2.5.3, Aquatic Resources**
Large volumes of water containing biocides and antiscaling agents are to be discharged from the retention basin into a relatively small creek. There should be further consideration of the effects of the chemicals and flow increase to White Oak Creek. Alternatives should be evaluated.

26 **Page 5-207, Section 5.9, Short-Term Use and Long-Term Productivity**
The Draft EIS mentions design life and decontamination and decommissioning (D&D) plans for the facility but contains insufficient detail. The EIS should also include the estimated costs associated with D&D and a plan for accumulating the finances required for D&D purposes.

27 **Page 6-1 through 6-18, Chapter 6, Permits and Consultations**
The Permitting and licensing requirements' section of the Draft EIS does not mention the Nuclear Regulatory Commission (NRC). The EIS should discuss the possibility of a NRC or State of Tennessee radiological permit/license being required for facility startup and /or operation.

28 **Page 6-3, Section 6.1.1, AIR QUALITY**
Tennessee has jurisdiction over radiological NESHAPS. Please correct the statement and Table 6.1-1.

Volume II

29 **<u>Page D-11, Table 2-1, Protected vertebrate species with potential habitat on the NSNS site, their preferred habitats, and federal or state protection status.</u>**
The first and fourth entries under the "Preferred Habitat" column are incomplete.

30 **<u>Page D-12, Figure 2-1, Potential habitat areas for T & E animal species within the proposed NSNS site.</u>**
The map would be more useful with the inclusion of the approximate locations of pools and sinkholes where threatened and endangered species and species in need of management might occur.

31 **<u>Page D-25, Section 3.4.2, Functional Assessment, Wildlife Diversity</u>**
There is no mention of fish being a possible inhabitant of wetlands on this site.

32 **<u>Page D-26, Section 4.0, Summary</u>**
The second paragraph states "...no habitat suitable for any fish species that have been previously documented on the ORR..." Should this read "Threatened and Endangered fish species" instead?

STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DOE OVERSIGHT DIVISION
761 EMORY VALLEY ROAD
OAK RIDGE, TENNESSEE 37830-7072

March 10, 1999

Mr. David Wilfert, EIS Document Manager
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/FEDC
Oak Ridge, TN 37831

Dear Mr. Wilfert:

DOE's response to Tennessee Department of Environment and Conservation, DOE-Oversight Division's (TDEC/DOE-O) comments on the *Draft Environmental Impact Statement (EIS), Construction and Operation of the Spallation Neutron Source (SNS)*, DOE/EIS-0247

We have further reviewed the responses, both written an oral, to the State's comment letter of February 9, 1999. The DOE provided these responses at the meeting on February 24, 1999, at the DOE-Oversight office. The following are the Division's comments on the DOE responses.

33 As addressed in our original comment letter, the current draft EIS fails to provide specific information on health and safety issues, potential radiological releases, proposed mitigation for protection of groundwater, and the location or occurrence of protected and endangered species within the proposed sites. In addition, specific locations of structures including roads, retention basins, cooling towers and the facility are not provided.

DOE has responded that requested information will be provided in studies and other documents after the Record of Decision (ROD) is issued. Because these items are necessary to fully evaluate the Environmental Impact of this project, we agree, after concurrence with your office, that it would be appropriate for DOE to issue a supplemental EIS in order to reference those studies and documents. This would formalize the commitments the DOE has made in their responses to comments on the Draft EIS. A supplemental EIS should be issued after the ROD but before construction is begun on the SNS project. The supplemental EIS should also include other appropriate environmental information that will not be available until that time.

The Division also offers the following specific comments for your consideration.

David Wilfert
March 10, 1999
Page Two

Comment Code S-5-1

34 Although the scope of the EIS is construction and operation of the SNS, decommissioning is an inevitable end result. It would seem prudent to have some type of funding assurance for D&D after the project life has been exceeded.

Comment Code S-5-9 & S-5-12

35 Based upon our current understanding of the processes associated with the SNS, it is highly unlikely that all radiological waste generated by operation of the Facility can be treated or disposed on site. What commitment will the Department make with regard to management of waste which will not meet an Oak Ridge Waste Acceptance Criteria or will in fact be characterized Special Case Waste (meaning it has no disposition alternative)?

It should be noted that commercial Low-Level Waste disposal contracts are for very low concentrations of radionuclides and certainly could not be utilized for disposition of all LLW generated by this proposed facility.

If you have questions regarding the Division's comments, please contact Bill Childres or me at (423) 481-0995.

Sincerely,

Earl C. Leming
Director

xc: Justin Wilson – Governor's Policy Office
Mike Mobley – TDEC
Elgan Usrey - TEMA
Dodd Galbreath – TDEC, Environmental Policy Office

el453 99

TENNESSEE COMMISSION OF INDIAN AFFAIRS
7th Floor, L & C Annex, 401 Church Street
Nashville, Tennessee 37243-0459
(615) 532-0745

February 9, 1999

David Wilfert
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/SNS
Oak Ridge, TN 37831

Dear Mr. Wilfert:

Thank you for giving me the opportunity to comment on the Draft EIS for the Spallation Neutron Source (DOE/EIS-0247). I reviewed the Draft EIS when I received it, and I originally intended to make no comments.

1 However, I believe that I may have misunderstood statements in the document pertaining to avoidance of cultural resources in areas on the ORNL site that had not been surveyed yet (page 4-38 and page 5-37, for example). I took these statements to mean that all cultural resources identified during the survey would be avoided, but in reviewing the Draft EIS again, I am not sure I understood this correctly.

2 My specific concern is with the site identified as 40RE488, a multicomponent site located in an area that will be affected by road improvements. I understand that the survey does not indicate that this site is eligible for listing on the National Register of Historic Places, even though prehistoric artifacts were found. My concern is that 10 shovel tests in an area covering 262 feet by 67 feet could have missed Native American graves in this area.

If site 40RE488 will not be avoided during road construction, I would request that more extensive tests be done to determine if burials are present in this area. I realize that DOE has fulfilled the requirement to determine if this site contains resources eligible for the NRHP, but I feel that under the circumstances, more tests are warranted. If Indian burials were found before construction began, it would be easier to avoid them, thus saving time and money.

State of New Mexico
ENVIRONMENT DEPARTMENT
Harold Runnels Building
1190 St. Francis Drive, P.O. Box 26110
Santa Fe, New Mexico 87502-6110
Telephone (505) 827-2855
Fax: (505) 827-2836

GARY E. JOHNSON
Governor

PETER MAGGIORE
Secretary

February 5, 1999

David Wilfert
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/SNS
Oak Ridge, Tennessee 37831

Dear Mr. Wilfert :

RE: CONSTRUCTION AND OPERATION OF SPALLATION NEUTRON SOURCE PROJECT DRAFT ENVIRONMENTAL IMPACT STATEMENT, DOE/EIS-0247; U.S. DEPARTMENT OF ENERGY, OFFICE OF SCIENCE; DECEMBER 1998

This transmits New Mexico Environment Department (NMED) staff comments concerning the above-referenced Draft Environmental Impact Statement (DEIS).

A. BACKGROUND:

The U.S. Department of Energy (DOE) has proposed siting, constructing and operating a new Spallation Neutron Source (SNS) at one of four DOE facilities. Design will begin in 1999, construction is planned to begin in 2000, and operation will begin at the end of 2005. Los Alamos National Laboratory (LANL) in New Mexico is one of the potential candidates. Oak Ridge National Laboratory (ORNL) in Tennessee is the preferred site. This DEIS addresses the consequences of the SNS at each facility and a no action alternative.

The DOE selection criteria for the SNS required an area approximately 1,100 ft by 4000 ft. The proposed site at LANL is located in its southwest portion, at Technical Area-70 (TA-70). The area is on an undeveloped mesa top, flanked by Ancho Canyon to the southwest and a small unnamed canyon to the northeast. Other primary selection requirements by DOE were: a one mile buffer zone to insulate the public from accidents, proximity to a 62 to 90 MW power source, and presence of existing facilities and programs using neutron scattering techniques.

B. GENERAL COMMENTS:

1 1. LANL has the rights to approximately 1.8 billion gallons of water per year. They currently use 0.5 billion gallons, the surrounding communities use approximately 0.9 billion gallons, and the proposed SNS could use up to 0.7 billion gallons of water per year. Ground

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2 Please let me know if it will be possible for more tests to be done on 40RE488, and please keep me informed of the progress of the SNS project. Thank you for your time.

Sincerely,

Toye Heape
Executive Director

David Wilfert
February 5, 1999
Page 2

1 water pumping may lower the water table in nearby wells, reduce long term main aquifer productivity, and directly compete with surrounding communities for water. The DEIS did not describe measures to mitigate this impact.

2 2. The proposed site at TA-70 is an undeveloped area at LANL within 1 to 2 miles of Bandelier National Monument. Large scale development would eliminate existing public use, be highly visible during the day and night, and increase traffic congestion. Over 330,000 people visit the Monument each year. We expect a greater negative impact to monument visitors and local residents than described.

3 3. White Rock was described to be 3 miles from the SNS. Pajarito Acres is a subdivision of White Rock and appears to be within 1.5 miles of the facility. If the Maximum Exposed Individual (MEI) is based on exposure to individuals in White Rock, we expect it to be greater for
2 residents of Pajarito Acres. We also expect noise levels and traffic congestion to be greater than described.

4 4. Siting the SNS at TA-70 would require development of extensive utility infrastructures, such as a 60 to 90 MW power source, natural gas lines, steam lines, a water delivery system and access to sanitary waste facilities. The DEIS did not adequately describe the expense or environmental impacts that would occur from these actions.

5 5. This document described cooling-tower blowdown discharge of 250 to 350 gpm into TA-70 drainage. It also stated that the water would infiltrate before reaching the Rio Grande. We believe the shallow alluvium, the short distance to the Rio Grande, and existence of Ancho Spring make it possible for water to flow to the Rio Grande. Surface water flows should meet New Mexico Cold Water Fishery Standards.

6 6. This document states that waste management facilities at LANL have sufficient capacity to handle the waste volume projected for the period 1996-2030. Therefore, construction and operation of the SNS would have a minimal contribution to cumulative impacts on waste management facilities. However, it also concludes that the existing treatment facilities do not have the capacity to treat all of the Low Level Waste (LLW) from the proposed SNS. It correctly states that the LLW (with accelerator-produced tritium) would not meet the waste acceptance criteria for the existing treatment facility at TA-50. Therefore, additional facilities that will accept these wastes are required. A new facility at TA-53 is under construction and expansion at TA-54 would be required. These expansions would be for treatment of waste with accelerator-produced tritium and LLW disposal. They do not appear to be minimal impacts.

7 7. **Air Quality:** a) The project is in an area that is currently in attainment for all National Ambient Air Quality Standards (NAAQS). (Incidentally, the reference on Page 5-69 to Table 5.2.3.2-1 should probably be changed to Table 5.3.3.2-1.) Should LANL be chosen as the preferred site, LANL personnel should meet with the Department's Air Quality Bureau permitting personnel prior to construction of the proposed project to determine the appropriate level of air quality permitting for it.

8 b) The DEIS states that the MEI would receive a radiation dose from this project of approximately 2.9 mrem/year. The DEIS does not provide the location of this individual. Currently, LANSCE (a linear accelerator) at LANL provides between 2.9 and 5.0 mrem per year

David Wilfert
February 5, 1999
Page 3

8 to the current MEI. The report does not state whether the contributions from LANSCE have been considered in the 2.9 mrem present in this report. Communication with LANL personnel indicates that none of the staff responsible for the calculation of dose from airborne radiation were consulted in the development of the report. LANL is a very unique site due to its topography and climate (as opposed to Oak Ridge). If these considerations were not taken into account, the number reported in the DEIS could be significantly off. Concern about this possibility increases when noting the statement in the DEIS that the MEI reported in 1997 by LANL personnel is too large and should be reduced.

9 c) The DEIS does not address the Tribal Authority Rule (TAR) which is a vague EPA document that may empower the tribes to receive regulatory authority over LANL instead of the state. The new Neutron Source may place the MEI on tribal land, which would give the tribe excellent leverage to receive authority. However, since the location of the MEI was not adequately described nor were data provided showing that proper meteorological and topographical considerations were taken into account, it is not possible to reach any specific conclusion.

10 8. If the SNS is located at LANL, locations other than TA-70 should be considered. For example, there is an existing accelerator facility at TA-53. This location appears to have many of the features described as necessary for the SNS.

C. SPECIFIC COMMENTS

11 1. **4.2 Los Alamos National LANL, Page 4-63, paragraph 1, line 11**
The Rio Grande is the only permanently flowing river near the project area.

This statement is incorrect. Ancho Canyon contains a perennial reach, which is supplied by Ancho Spring, that normally extends to the Rio Grande from a position about 0.5 miles southeast of the proposed SNS facility site.

2. **4.2.2.1 Surface Water, Page 4-70, paragraph 2, line 1**
There are no permanent surface water resources within 0.25 miles (0.44 km) of the proposed SNS facility site.

The statement is true; however, the document should note that approximately 0.5 miles downstream of the proposed facility, a perennial reach exists in Ancho Canyon.

12 3. **4.2.2.1 Surface Water, Page 4-72, paragraph 2, line 13**
Los Alamos, Water, and Pajarito canyons/streams originate upstream of LANL facilities.

This statement is not entirely correct. Several perennial streams exist onsite, and they include: 1) a 2-3 mile reach in Sandia Canyon exists as a result of the discharge of treated sanitary-sewage effluent, and heads at Technical Area 3, 2) a 1.5-2.0 mile reach in Canon de Valle that heads at Technical Area 16, and 3) 2-3 mile reach in Pajarito Canyon that heads near Technical Area 22 (Dale, 1996). A more accurate description of the hydrologic setting should be incorporated into the document.

4. **4.2.2.1 Surface Water, Page 4-72, paragraph 2, line 15**

David Wilfert
February 5, 1999
Page 4

12

Perennial streams in the lower portions of Ancho and Chaquehui Canyons extend to the Rio Grande without being depleted by recharge to the ground.

A more accurate description of the flow conditions in the referenced canyons should be included in the document. Field observations and documentation during 1995, 1997 and 1998 showed that perennial flow in Chaquehui Canyon extended for approximately 300 ft from Spring 9A, and did not reach the Rio Grande. On September 29, 1998, field observations showed that perennial flow Ancho Canyon extended from Ancho Spring to within about 600 ft of the Rio Grande. In other words, these perennial reaches do not always reach the Rio Grande.

13

5. 4.2.2.2. Flood Potential, Page 4-72, paragraph 1, line 10
The overall flood risk to LANL and facilities at TA-70 is small because of the position of this site on a mesa top.

We agree that the flood risk on the mesa top is minimal. However, the flood risk downstream in Ancho Canyon and the unnamed canyon may be increased due to the additional outfall and runoff from parking lots, roofs, etc., at the site. The increase in runoff may affect the physical conditions and biological communities downstream from the proposed facility.

14

6. 4.2.2.3 Groundwater, Page 4-73, paragraph 2, line 9
Depth to groundwater, 840 ft (256 m), at TA-70 is inferred from a monitoring well adjacent to the site.

To the best of our knowledge there is no regional monitoring well adjacent to the TA-70. DT-9 is the closest well, and it is located approximately 4 miles northwest of the proposed SNS site.

7.. 4.2.2.3 Groundwater, Page 4-73, paragraph 2, line 11
The depth to groundwater at the bottom of Ancho Canyon along the southern edge of TA-70 is 600 ft.

This statement may not be correct considering the fact that Ancho Spring discharges within the canyon bottom.

15

8. 4.2.2.3 Groundwater, Page 4-75, paragraph 4, line 14
Background concentrations of radionuclides and trace metals are shown in the Ancho Spring results.

o The text should explain what "background concentrations" were used. To the best of our knowledge, background concentrations for ground water at LANL have not been agreed upon.

o It should be noted that in 1995, the high explosive compounds HMX (4.9 ppb), RDX (23 ppb) and 2,4-DNT (0.18 ppb) were detected in Ancho Spring waters (data from LANL Report: Environmental Surveillance at Los Alamos during 1995), which may indicate that Ancho Spring is not an appropriate background station.

o Contaminants were also found in Ancho Spring at earlier times. From 1951 through 1955 some contaminants were found: nitrate as nitrate (NO3), 0.2 to 30.0 ppm;

David Wilfert
February 5, 1999
Page 5

15

phosphate (NO3), 3.0 to 30 ppm; chloride (Cl), 2.8 to 93 ppm; and Fluoride (F), 0.2 to 3.2 ppm (data from Weir, et al., 1963, USGS report titled "The hydrology and the chemical and radiochemical quality of surface and ground water at Los Alamos, New Mexico, 1949-55").

16

9. 4.2.2.3 Groundwater, Page 4-75, paragraph 5, line 1
Long-term trends of the water quality in the main aquifer beneath LANL have shown little impact resulting from operations (LANL, 1997d).

The regional-aquifer monitoring system at LANL is probably inadequate to monitor long-term trends (e.g., long-screened intervals, spacing, casing degradation, possible borehole leakage, etc.). Recent data show that the regional aquifer beneath several historical release sites has been impacted by LANL activities.

17

10. 4.2.5.3 Aquatic Resources, Page 4-85, paragraph 1, line 2
These habitats currently receive NPDES-permitted wastewater discharges from LANL.

This statement is incorrect. A total of three perennial reaches or aquatic habitats at LANL do not receive wastewater effluent: 1) lower Ancho Canyon, 2) Canon de Valle near TA-16, and 3) Pajarito Canyon from TA-9/22 to approximately the mouth of Two-mile Canyon.

18

11. 4.2.9.1.2 Water, Page 4-108, paragraph 1, line 21
Surface and runoff water results from Ancho Canyon (TA-70) indicate all radionuclides well below the DOE DCGs for public dose, with many reported values below analytical detection limits (Table 4.2.9.1.2-1).

Surface-water data should be compared to more applicable standards such as New Mexico Water Quality Act or the federal Clean Water Act.

We appreciate the opportunity to comment on this DEIS. Please let us know if you have any questions.

Sincerely,

Gedi Cibas, Ph.D.
Environmental Impact Review Coordinator

NMED File No. 1229ER

New York State Department of Environmental Conservation
Division of Solid & Hazardous Materials, Room 488
50 Wolf Road, Albany, New York 12233-7250
Phone: (518) 457-6934 **FAX:** (518) 457-0629
Website: www.dec.state.ny.us

John P. Cahill
Commissioner

MAR 2 5 1999

Mr. David Wilfert
U. S. Department of Energy
Oak Ridge Operations Office
200 Administration Road
146/SNS
Oak Ridge, TN 37831

Dear Mr. Wilfert:

The New York State Department of Environmental Conservation has reviewed the Draft Environmental Impact Statement (DEIS) for the construction and operation of the Spallation Neutron Source (DOE/EIS-0247). The Department is not commenting on the preferred alternative, siting the Spallation Neutron Source at the Oak Ridge National Laboratory, because this is outside of New York State. Since Brookhaven National Laboratory is an alternative site, our comments will focus on the impacts of this alternative. Enclosed are the Division of Solid and Hazardous Materials' comments on the DEIS.

Thank you for the opportunity to comment on this document. If you have any questions, please contact Dr. Paul Merges, of my staff, at (518) 457-9253.

Sincerely,

Stephen Hammond, P.E.
Director
Division of Solid & Hazardous Materials

Enclosure

Division of Solid & Hazardous Materials
Department of Environmental Conservation
Comments on the Spallation Neutron Source
Draft Environmental Impact Statement (DOE/EIS-0247)

March 1999

1 In general, the Division of Solid & Hazardous Materials found the Draft Environmental Impact Statement (DEIS) to be technically rigorous, thoroughly researched, and conscientiously presented. There are no subjects related to the radioactivity involved that we believe should be addressed in greater detail, and we were pleased to see the level of attention paid to radioactive emissions, their environmental impacts, and potential accident scenarios involving radioactive materials.

2 A comparison using Table S 1.5.2-1 starting on page S-27 shows several reasons why Brookhaven National Laboratory (BNL) should not be the preferred alternative. The BNL alternative has the highest potential for increasing the radionuclide concentrations in groundwater due to soil activation by the linear accelerator (linac). The estimated radiation dose to the maximally exposed individual (page S-45) and the estimated latent cancer fatalities (page S-46) due to the presented accidents scenarios are greater than those for the Oak Ridge National Laboratory (ORNL) and Los Alamos National Laboratory (LANL) alternatives. This leads to the conclusion on page S-62 of Table S1.5.2-1 that the BNL alternative has the "potential for adverse radiological impacts on human health from normal BNL and SNS operations." In addition, the projected annual amount of low-level radioactive wastes (page S-53) generated by the SNS (16,400 m^3/yr) exceeds BNL's total annual capacity (300 m^3/yr), which would require additional low-level waste treatment capacity be provided. For all of these reasons, we agree that BNL should not be the preferred alternative.

3 Section 5.8.4 on page 5-205 lists the unavoidable adverse environmental impacts, should the SNS be constructed and operated at BNL. The first impact listed, neutron activation of soils in the berm used to shield the linac tunnel, is our primary concern. Activation of the soil berm, which is approximately 20 feet above the groundwater table, and the high permeability of the soils in which the SNS would be built, will lead to the rapid contamination of groundwater in much greater concentrations than will be experienced at ORNL or LANL. The intentional contamination of groundwater in the Upper Glacial Aquifer on Long Island without any mitigating measures is unacceptable.

4 Under the measures described to mitigate the adverse environmental impacts within section 5.11.4 on page 5-217, the only measure that BNL has not committed to implementing is a multi-layer shielding design to minimize the activation of the berm soils and the subsequent spread of contamination through subsurface soils and groundwater. If the SNS were to be constructed at BNL, the Department of Environmental Conservation would expect BNL's commitment to construction of the additional shielding, or some equivalent measures, in order to offer the greatest protection of the Upper Glacial Aquifer. Without such measures, this Department opposes the siting of the SNS at BNL.

CITY OF
OAK RIDGE

ENVIRONMENTAL QUALITY ADVISORY BOARD

POST OFFICE BOX 1 • OAK RIDGE, TENNESSEE 37831-0001

February 5, 1999

Mr. David Wilfert, EIS Document Manager
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/FEDC
Oak Ridge, TN 37831

RE: DRAFT ENVIRONMENTAL IMPACT STATEMENT, CONSTRUCTION AND OPERATION OF THE SPALLATION NEUTRON SOURCE, DOE/EIS-0247

Dear Mr. Wilfert:

The City of Oak Ridge Environmental Quality Advisory Board (EQAB) appreciates the opportunity provided to the public to review and comment on the Draft EIS on Construction and Operation of the Spallation Neutron Source (SNS).

The Oak Ridge City Council has passed a resolution expressing the City's support for the SNS project. The enclosed comments by EQAB are intended to assist DOE in assuring the quality and accuracy of the final EIS.

Sincerely,
For the Board

Ellen D. Smith by [initials]

Ellen D. Smith, Chairperson

cc: Mayor and Members, Oak Ridge City Council

Oak Ridge EQAB Comments on SNS Draft EIS

1 1. **Site maps.** Different maps in the EIS show different shapes and boundaries for the proposed facility site on the Oak Ridge Reservation (for example, compare the figures on pages 4-20 and 4-27). This is confusing. Please give an explanation for the different site configurations shown on the different maps.

2 2. **Section 4.1:** There is a puzzling absence of reference citations in some subsections of this chapter. For example, the discussions of the bedrock geology and geologic structure of the Oak Ridge Reservation (pages 4-1 to 4-6) surely are not original to this EIS, but there are no citations to the actual source or sources. Among the other sections where supporting references are absent or incomplete are Section 4.1.2.2 (pages 4-12 to 4-13), which cites no references; Section 4.1.5 (pages 4-18 to 4-27), which directs the reader to "the references compiled for this section" for more detail, but cites only two references that are related to only two of the several topics covered; and the discussion of the End-Use Working Group recommendations (page 4-56), which describes the Working Group's draft recommendations but does not include a reference citation.

In other instances, sources are identified informally, without full citations. For example, the discussion of emissions from non-DOE facilities (beginning at the bottom right on page 4-57) states that information about airborne emissions was "supplied by the facilities," but it does not name the facilities, give the dates for which the supplied information was valid, give the dates of the communications by which this information was supplied, nor identify the basis or source for the conclusion about the effective cumulative annual dose equivalent from these facilities. Similarly, Section 4.1.5.3 (page 4-18) names "the Forest Compartment Maps for the ORR" as a source, but gives no citation.

In these cited locations and throughout the EIS, please make sure that the final EIS identifies the sources of information relied upon, both to give appropriate credit to the sources and to help readers investigate the various subjects further, if they wish to do so.

3 3. **Page 4-7, last paragraph in first column.** It appears that the second sentence should say "The soils tested ranged from clayey sandy silt *with* gravel-sized chert (Unified Soil Classification System-"GC") to ..." (emphasis added to show insertion).

4 4. Page 4-30, Table 4.1.6.1-2. The entry for "Lenoir" should be "Lenoir City."

5 5. Page 4-31, Section 4.1.6.3.1. No source is identified for the information in the second paragraph of this section. However, data from the State Department of Education at http://www.k-12.state.tn.us/arc/fa_asr/table19.htm (essentially the same source that is cited elsewhere in the Education section) disagree with the numbers presented here. The lowest local funding percentage (30%) is in Loudon County (not Roane County) and the highest local funding percentage is in Oak Ridge (55%), not Knox County. State funding ranges from 38% in Oak Ridge (lower than Knox County's 43% figure) to 62% in Loudon (not Roane) County.

6 6. Page 4-32, Table 4.1.6.3.1-1. This table of public school statistics sometimes omits city-operated school systems and sometimes lumps them in with the counties. Cities in the region that operate separate school systems are Oak Ridge, Clinton, Harriman, and Lenoir City. Based on

6 comparison with the cited source (which gives data for the city and county systems separately), it appears that the table includes data for Oak Ridge and Clinton in some of the measures for Anderson County (e.g., the number of schools) but not others (e.g., student enrollment and per-pupil expenditures), while data for Lenoir City and Harriman seem to be completely missing. Please revise this table to include data for the city school systems. It is misleading to combine the data for city and county systems, since measures such as per-pupil expenditures can differ significantly between different systems in the same county (for example, Oak Ridge spent $6,794 per pupil, while Anderson County spent $4,900). Also, please check all the figures in the table for accuracy (some of them do not match any of the data in the source).

7 7. Page 4-32, first paragraph. The City of Oak Ridge Fire Department does serve the Oak Ridge community, but it is not the primary source of fire protection for ORNL. ORNL operates its own separate fire department, although there is a mutual aid agreement with the City. Please obtain the correct information from ORNL or from DOE Oak Ridge Operations and revise this passage accordingly.

8 8. Pages 4-35 to 4-40, Section 4.1.7. This Cultural Resources section mentions several properties on the Oak Ridge Reservation as being "eligible" for National Register listing, but does not mention the properties that are listed on the National Register of Historic Places, nor indicate that the Oak Ridge Graphite Reactor is a National Historic Landmark. Please include this information.

9 9. Page 4-41, first paragraph in second column. The north corner of the original reservation was never "politically separated from the reservation and incorporated as the City of Oak Ridge." From the City's inception, the corporate boundaries of the City of Oak Ridge have included the entire reservation area.

10 10. Page 5-22, Section 5.2.2.3.1. Regional construction experience indicates that infiltration from retention basins built over the Knox Group can sometimes accelerate karst processes and lead to formation of sinkholes, even when no preexisting sinkhole features have been identified. Therefore, DOE should consider constructing the retention basin in a manner that prevents or minimizes infiltration of collected runoff.

11 11. Page 5-22, last paragraph. It is not conservative to assume that the hydraulic conductivity of the vadose zone is equal to the saturated hydraulic conductivity of the soil matrix in the saturated zone. There is an extensive body of evidence (including research observations on the Walker Branch Watershed, published in ORNL reports and the open literature by researchers including Robert Luxmoore, Glenn Wilson, and Philip Jardine) demonstrating that most vadose zone flow is in "macropores," including fractures and root channels, not in the soil matrix. As a result, transit time through a 10-m distance in the vadose zone could be measured in minutes or hours, not years. Please use Walker Branch research results as a basis for revising the analysis of groundwater contamination impacts to include a more realistic assessment of radionuclide transport in the vadose zone.

12 12. B-34, Table. This table indicates that the Clinch River Breeder Reactor Site is currently used for waste management. As we understand it, the site is vacant and available for industrial

12 development. Please check the information and correct the table.

CITY OF
OAK RIDGE

OFFICE OF THE MAYOR

POST OFFICE BOX 1 • OAK RIDGE, TENNESSEE 37831-0001

February 5, 1999

(DISTRIBUTION AS INDICATED IN ATTACHED RESOLUTION)

You may recall that in April of 1997, you received a copy of a resolution adopted by the Oak Ridge City Council (Resolution No. 4-61-97) supporting and endorsing the National Spallation Neutron Source (SNS) and the companion Joint Institute for Neutron Science (JINS). The resolution was accompanied by a letter enlisting your support for these projects. I am once again enlisting your support as a fellow Tennessean.

Enclosed is a copy of Resolution No. 2-14-99 which was unanimously adopted by the Oak Ridge City Council during its regular meeting on Monday, February 1, 1999. This resolution reinforces our strong support for the Spallation Neutron Source (SNS) and urges its construction and operation at the preferred site in Oak Ridge. As explained in the resolution, the Department of Energy (DOE) has identified four alternative sites for the SNS: Oak Ridge National Laboratory (ORNL), Argonne National Laboratory in Illinois, Brookhaven National Laboratory in New York, and Los Alamos National Laboratory in New Mexico. We want to ensure that this project which will benefit not only Oak Ridge but our entire state, both economically and prestigiously, is located on the ORNL site. I am enclosing a publication titled, "Spallation Neutron Source, the Next-Generation Neutron Scattering Facility for the United States," that I believe you will find helpful in understanding the scope of this project and the opportunities it offers for future scientific and industrial research and development.

1

Any action you may take at this time to demonstrate your support for the location of the SNS at ORNL will be helpful. I cannot state too strongly that the completion of this project, and the companion JINS, will be in the long-term best interests of our state and our country. Please feel free to call me if you have questions or would like additional information about these projects.

Sincerely yours,

Walter K. Brown
Mayor

Enclosures

NUMBER 2-14-99

RESOLUTION

WHEREAS, the U.S. needs a neutron source to provide the scientific and industrial research communities with a much more intense source than is currently available, and to assure the availability of a state-of-the-art facility in the decades ahead; and

WHEREAS, this next-generation neutron source would create new scientific and engineering opportunities, and would help replace the capacity that will be lost by the eventual shutdown of existing sources as they reach the end of their useful operating lives; and

WHEREAS, the U.S Department of Energy (DOE) has worked with the scientific community since the early 1970s to provide a new neutron source; and

WHEREAS, the DOE has proposed to construct and operate a state-of-the-art, short-pulsed spallation neutron source (SNS) facility comprised of an ion source, a linear accelerator, a proton accumulator ring, and an experiment building containing a liquid mercury target and a suite of neutron scattering instrumentation; and

WHEREAS, the DOE has used a systematic process to select suitable alternative sites for the proposed facility that included criteria such as availability of land, adequacy of electric power source, presence of existing neutron science expertise and experience to meet mission goals, and existence of major facilities and programs using neutron scattering techniques; and

WHEREAS, the DOE has identified four siting alternatives for the proposed SNS: Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory in New Mexico, Argonne National Laboratory in Illinois, and Brookhaven National Laboratory in New York; and

WHEREAS, the DOE has prepared an Environmental Impact Statement (EIS) to examine the potential impacts associated with construction and operation of the proposed SNS at the four sites, and which names the ORNL location as the DOE preferred alternative; and

WHEREAS, the EIS describes the beneficial economic impacts of the proposed project on the Region of Impact (ROI), which includes Anderson, Knox, Loudon, and Roane Counties and the City of Oak Ridge; and

WHEREAS, the EIS states that economic benefits to the ROI in the form of jobs, wages, business taxes, and income would begin to accrue during the first year of the project in FY 1999, and would increase as construction and other associated project activities increase; and

WHEREAS, the DOE estimates that design and construction employment would be highest in FY 2002, and there would be an estimated 1,499 total (direct, indirect, and induced) new jobs created at ORNL; and

WHEREAS, the DOE further estimates that facility operation would continue to support up to 1,704 direct, indirect, and induced jobs for the first year of full operation (FY 2006), and for each of the following years of operation; and

WHEREAS, the DOE further estimates the economic benefits of annual operation, which would accrue to the ROI, to be: $ 68.7 million in local wages, $ 7.5 million in business taxes, $ 75.9 million in personal income; and $ 176.3 million in total output; and

WHEREAS, the preferred alternative for the SNS is located at the Oak Ridge National Laboratory, which is within the corporate limits of the City of Oak Ridge; and

WHEREAS, the City of Oak Ridge strongly supports the Department of Energy's objectives to ensure the vitality of the national scientific community by providing a neutron source that would satisfy current and future demand for research neutrons, lead to new scientific and technological discoveries, and meet international technological and economic challenges in an environmentally sound and safe facility; and

WHEREAS, the City of Oak Ridge commends the DOE Oak Ridge Operations office and the Oak Ridge National Laboratory for organizing a collaborative effort to achieve these objectives with Argonne, Brookhaven, Berkeley, and Los Alamos National Labs, and other U.S. industrial firms and universities that will be involved as the project matures; and

WHEREAS, the City of Oak Ridge commends the State of Tennessee for committing $ 8 million for ORNL and the University of Tennessee to construct a Joint Institute for Neutron Science (JINS), which will enhance the utility of the SNS by providing support facilities to scientists and engineers from universities, industries, and the international community; and

WHEREAS, an overwhelming majority of Oak Ridge citizens responding to a recent community survey stated strong support for the construction and operation of the proposed SNS at the preferred site at ORNL; and

WHEREAS, construction and operation of the SNS at the preferred site at ORNL will greatly assist the City of Oak Ridge as it continues to address the negative social and economic impacts associated with DOE downsizing.

NOW, THEREFORE, BE IT RESOLVED BY THE MAYOR AND COUNCILMEN OF THE CITY OF OAK RIDGE, TENNESSEE:

That the City of Oak Ridge supports and endorses the Department of Energy's preferred alternative to construct and operate the Spallation Neutron Source at the Oak Ridge National Laboratory.

BE IT FURTHER RESOLVED that this resolution shall be sent to the Secretary of Energy, the Governor of the State of Tennessee, the Tennessee Congressional Delegation, the City's representatives in the Tennessee General Assembly, the Tennessee Municipal League, and the Mayors of the cities throughout Tennessee urging their continued support for the SNS and JINS projects.

This the 1st day of February 1999.

APPROVED AS TO FORM AND LEGALITY:

City Attorney

Walter K Brown
Mayor

Jacquelyn J. Bernard
City Clerk

LOC INC
Oak Ridge Reservation
Local Oversight Committee

February 10, 1999

Mr. David Wilfert,
EIS Document Manager
U.S. Department of Energy
Oak Ridge Operations
200 Administration Road, 146/FEDC
Oak Ridge, TN 37830

Fax 576-4542

Subject: *Comments on the Draft Environmental Impact Statement for Construction and Operation of the Spallation Neutron Source (DOE/EIS-0247, December 1998)*

Dear Mr. Wilfert:

The Citizens' Advisory Panel (CAP) of the Oak Ridge Reservation (ORR) Local Oversight Committee, Inc. (LOC) has unanimously endorsed the following comments on the Draft Environmental Impact Statement (EIS) for Construction and Operation of the Spallation Neutron Source (SNS) (DOE/EIS-0247, December 1998). The LOC Board has not had the opportunity to review and approve the comments, and thus these comments should be considered submitted by the CAP only.

The LOC is a non-profit regional organization funded by the State of Tennessee and established to provide local government and citizen input into the environmental management and operation of the DOE ORR. The Board of Directors of the LOC is composed of the County Executives of Anderson, Knox, Loudon, Meigs, Morgan, Rhea, and Roane Counties; the Mayor of the City of Oak Ridge; and the Chairs of the Roane County Environmental Review Board, the City of Oak Ridge Environmental Quality Review Board, and the LOC CAP. The CAP has up to 20 volunteer members with diverse backgrounds who represent the greater ORR region.

1 The CAP strongly supports the selection of the Preferred Alternative to locate the SNS in Oak Ridge and have it be operated by ORNL. We recognize the importance of the research enabled by the SNS. The following comments are given for the purpose of strengthening the document and support for SNS.

2 The draft EIS documents most of the concerns and issues raised at the scoping meeting except for one--the lack of public involvement in selecting the actual, physical site. The draft EIS and associated public meetings are the first opportunity to comment on the proposed physical site. Allowing public involvement earlier in the site screening process for the ORR would have been desirable.

Anderson • Meigs • Rhea • Roane • City of Oak Ridge • Knox • Loudon • Morgan

136 S. Illinois Ave., Suite 208 • Oak Ridge, TN 37830 • Phone (423) 483-1333 • Fax (423) 482-6572 • E-mail: locinc@aol.com

D. Wilfert
February 10, 1999
Page 2

The Draft EIS does not consider all of the potential environmental impacts. Two such potential impacts are:

3 1. The site plan shown on page 3-12 and elsewhere does not show the retention basin for site runoff, sediment settling, and cooling tower blowdown. This basin is discussed on pages 5-20, 5-21, 5-30, and elsewhere, but its size and location are never given. The retention basin could significantly increase the footprint of the SNS on the ridgetop.

4 2. Page 5-37, last paragraph mentions construction or improvement of utility corridors and a southwest access road not assessed at the time of the Draft EIS. Mitigation measures should be planned and implemented for impacts in addition to those on cultural resources, for example if any of the corridors run through the buffer zone for Walker Branch watershed.

5 The Draft EIS does not effectively show the intrusion of the SNS into environmentally sensitive areas. In contrast, the CERCLA Waste Disposal RI/FS (DOE/OR/02-1637&D2 in Figures 7.2, 7.3 and 7.4) shows in detail the sensitive areas. The CAP referred to these figures in studying the proposed SNS site, as they better show the sensitive areas' proximity to the SNS preferred location. For example, a copy of Figure 7.4 is enclosed; the inclusion of a similar figure in Section 4.1.5 or 5.2.5.4 along with the figure found on page B-43 is recommended. 6 In addition, an outline of the SNS footprint should be shown on Figures 4.1.5.4-1 and 4.1.5.4-2. 7 Figures 4.1.8.3-1 and 4.1.8.3-2, found on pages 4-54 and 4-55 respectively, are not readable; these maps would be improved by expanding the view of the affected area and choosing lighter shading patterns.

8 The Draft EIS does a good job of stating the potential impact of the Chestnut Ridge SNS site on the climatic research being done in the Walker Branch watershed in support of the Nations Global Change Program. If this proves to be the chosen site, the CAP would like to see a commitment to mitigation measures before construction begins. Mitigation of the SNS impact on this research is extremely important to protect the value of 30 years of climate data. In addition to replacement of natural gas boilers with electric heat pumps (page 5-41), use of an electric shuttle bus to transport people to the site during the operations period is another potential mitigation mechanism. An electric shuttle would not only reduce carbon dioxide emissions from conventional vehicles but would also reduce runoff by eliminating the need for large parking lots, consequently allowing reduction of the volume of the retention basin and of the overall footprint of the SNS complex.

9 A better decommissioning plan is needed. Page 5-43 (second paragraph) states: "Current plans call for in-situ decommissioning of the SNS when its operational life cycle is completed." This is unacceptable to the CAP. Such approaches typically have resulted in excessive releases of contaminants to the environment as well as disproportionate surveillance and maintenance costs. 10 Additionally, 30-years of continuous operations (page 5-19) seems unrealistically short for this type of facility with the likely strong demand for linac time by neutron researchers. In practice, even "temporary" buildings on the ORR are still in use more than 50 years after construction.

D. Wilfert
February 10, 1999
Page 3

Errors found in the document are listed below:

11 1. On page 4-5 the figure is mislabeled; it should be 4.1.1.1-3 (as referenced on page 4-7). In addition, the four borings discussed should be identified.

12 2. Page 4-19 (second paragraph of second column) states that one wetland area near Bear Creek south tributary 4 (BCST4) will be affected. However Table 4.1.5.2-1 and Figure 4.1.5.2-1 show BCST2.

13 3. On page 5-38 in the first column, 40RE488 is discussed in both the prehistoric and historic resource section, it is not clear whether there are two components to this location or if this is an error.

14 4. On page 5-48 in the second paragraph of the second column the figures for annual dose to members of the public appear to be reversed for inside and outside the controlled area.

15 5. Table 2.1 in Appendix B should be inverted, currently much of the information is upside down.

16 6. Figures 1 and 2, respectively on pages B-27 and B-29, are unreadable.

1 The CAP reiterates its strong support for locating the SNS at the Oak Ridge Reservation. We also appreciate the two-day extension of the comment period, enabling consideration of these comments by the full CAP at its regular meeting of February 9, 1999. The CAP believes that with proper mitigation measures, the facility can be sited in the proposed physical site and not cause a detrimental impact on research within the Walker Branch watershed. If you have any questions regarding these comments, please call me at 483-1333.

Sincerely,

Susan L. Gawarecki, Ph.D., P.G.
Executive Director

Enclosure

cc: LOC Citizens' Advisory Panel
LOC Board of Directors
Bill Pardue, Chair, ORREMSSAB
Jeff How, SNS Program Manager, DOE ER-10
Earl Leming, Director, TDEC DOE-O
Steve Richardson, Acting Manager DOE ORO

County of Loudon

GEORGE M. MILLER — COUNTY EXECUTIVE

100 RIVER RD. #106 LOUDON, TENNESSEE 37774 PH. 458-4664

February 8, 1999

Mr. David Wilfert, EIS Document Manager
United States Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146 FEDC
Oak Ridge, TN 37831

Dear Mr. Wilfert:

As the Loudon County Executive, I want to express my support for the Spallation Neutron Source Because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

1

Yours truly,

George M. Miller,
Loudon County Executive

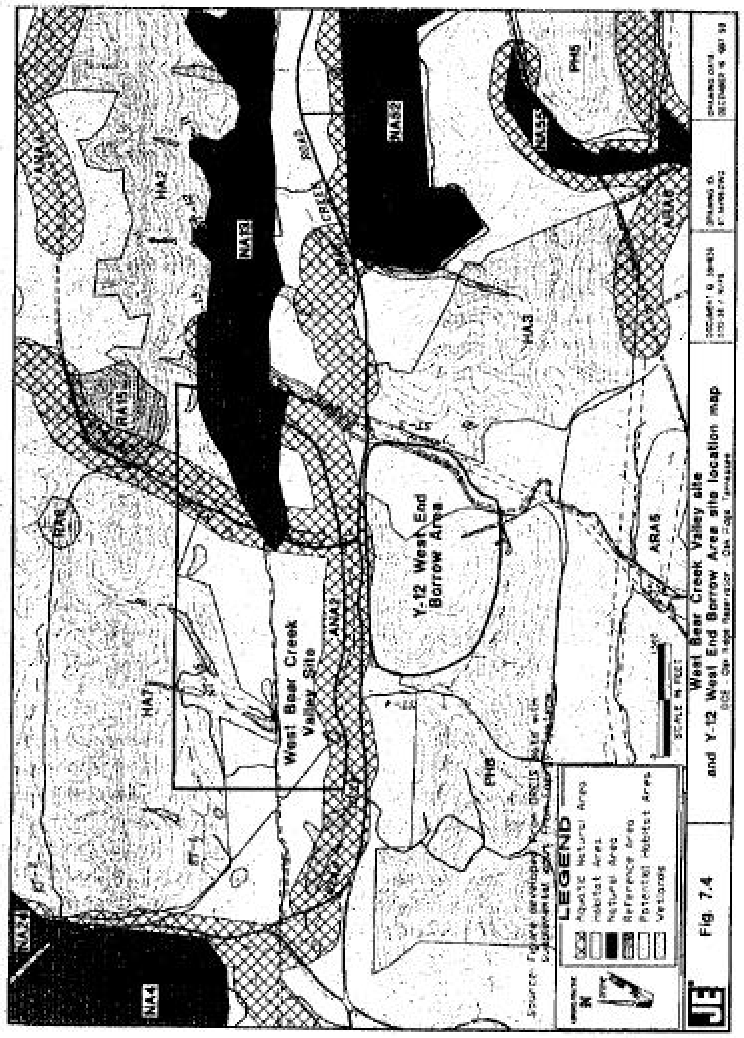

Fig. 7.4 West Bear Creek Valley site and Y-12 West End Borrow Area site location map

7-12

5

County Executive
Thomas Schumpert

Knox County

February 8, 1999

Mr. David Wilfert, EIS Document Manager
United States Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146 FEDC
Oak Ridge, Tennessee 37831

Dear Mr. Wilfert:

1

As Knox County Executive, I am pleased to take this opportunity to express my support for the Spallation Neutron Source. It will have a positive impact in our region, and more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

Sincerely,

Tom Schumpert
Knox County Executive

Room 615 • City-County Building • 400 Main Street • Knoxville, TN 37902-2405 • (423) 215-2005 • Fax (423) 215-2002

THE CITY OF KNOXVILLE, TENNESSEE
VICTOR ASHE
MAYOR

February 8, 1999

Mr. David Wilfert
EIS Document Manager
Department of Energy
200 Administration Road, 146 FEDC
Oak Ridge, TN 37831

Dear Mr. Wilfert:

1

As Mayor of Knoxville, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

Sincerely yours,

Victor Ashe

OFFICE OF THE MAYOR • 400 MAIN STREET • P.O. BOX 1631 • KNOXVILLE, TENNESSEE 37901
PHONE 423-215-2040 • FAX 423-215-2085 •

Executive Offices
376-5578
FAX (423) 376-4318

Accounting Department
376-5551

Office of the County Executive
Roane County Courthouse
Kingston, Tennessee 37763

FAXED
2-8-99 @ 2:45 pm

February 8, 1999

Mr. David Wilfert, EIS Document Manager
United States Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146 FEDC
Oak Ridge TN 37831

Dear Mr. Wilfert:

1 As the Roane County Executive, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

Yours truly,

Ken Yager
Roane County Executive

KY:sl

---

341 Court Street
Maryville, TN 37804-5906
Phone (423) 982-1302
Fax (423) 977-1276

BLOUNT COUNTY GOVERNMENT
William A. Crisp
County Executive

February 8, 1999

Mr. David Eilfert, EIS Document Manager
United States Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146 FEDC
Oak Ridge, TN 37831

Dear Mr. Eilfert:

1 As the Blount County Executive, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importaantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

1 It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

Sincerely,

Bill

William A. Crisp
Blount County Executive

WAC/tjp

Spallation Neutron Source Program

Comment Form

The U.S. Department of Energy is interested in your comments on the *Construction and Operation of the Spallation Neutron Source Facility: Draft Environmental Impact Statement.*

There are several ways to provide comments on this document, and these include:

- Attending public meetings and giving your comments directly to DOE officials.
- Returning this comment form to the registration desk at the public meetings.
- Returning this comment form or other written comments to the address on the back of this form.
- Faxing your comments to (423) 576-4542.
- Calling toll-free (1-800-927-9964) and leaving your comments via voice mail.
- Commenting via electronic mail to this address: nsseis@ornl.gov.

Comments:

1 I tully support the SNS at the Oak Ridge Reservation.

2 1. I disagree with the decision to select the site without public involvement. The preferred site may actually be the best one, but the location being in the buffer area of Walker Branch does raise some questions. This long term research area will be impacted.

3 2. Better maps are required in the Final EIS. Figure S 1.3.1-1 showing the proposed SNS site on the ORR is cursory to say the least. A similar overview is fine, but a more detailed map of the site showing Walker Branch, the buffer area, relationship to EM areas in Bear Creek Valley, and any other ORR features (roads, utilities,etc.)is necessary.

4 3. The sense of the noun mitigation is "to act in such a way as to cause an offense to seem less serious." It is used in monitoring, (continued)

Thank you for your input. Please use additional sheets if necessary and attach them to this form.

Name NORMAN A. MULVENON (optional)
Organization CAP/LOC
Address 118 CONCORD RD (optional)
City OAK RIDGE State TN Zip 37830-7126 (optional)
Phone number 423.482.3153 (optional)
E-mail address mulvenon@juno.com (optional)

☑ Please add my name to the SNS EIS mailing list.
☐ Please take my name off the SNS EIS mailing list.

SNS Spallation Neutron Source

Spallation Neutron Source Program
U.S. Department of Energy • Oak Ridge Operations Office
200 Administration Road, 146 SNS Building • Oak Ridge, TN 37831 • (800) 927-9964 • Fax (423) 576-4542

Comment Form — Continuation Sheet

(continued from page 1)

4 wetlands, and maybe other places. As Ms. Barbara Walton pointed out, there is no commitment to mitigation measures. Please consider this very seriously. We do not want the more colloquial definition to be used: "If the good lord is willing and the creeks dont't rise."

5 4. I listened very carefully to the explanation of why the retention pond (s) is not shown on the site plan (Figure 3.2.1.5-1), but I suggest you make an educated guess. I think we deserve to know how the footprint will be affected.

6 I would also be surprised if a heated discussion did not take place over increased flow to WOC to White Oak Lake to White Oak Dam along with the attendant subjects of velocity, erosion, sediment transport, etc., and increase in radionuclide releases. In 5.2.2.1.2 it is stated in the last paragraph that "actual flow over White Oak Dam would be lost in the noise of monthly...." and "Accordingly, the effect of the proposed SNS on radionuclide releases from ORNL is considered minimal." One does not necessarily follow the other/and more precise language is in order.

7 The remainder of the Draft EIS is acceptable, but I will wait for the Final version.

Norman A. Mulvenon [signature]

Name NORMAN A. MULVENON
Organization CAP/LOC
Address 118 CONCORD RD
City OAK RIDGE State TN Zip 37830-7126

SNS Spallation Neutron Source

Spallation Neutron Source Program

Comment Form

The U.S. Department of Energy is interested in your comments on the *Construction and Operation of the Spallation Neutron Source Facility: Draft Environmental Impact Statement.*

There are several ways to provide comments on this document, and these include:

- Attending public meetings and giving your comments directly to DOE officials.
- Returning this comment form to the registration desk at the public meetings.
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- Faxing your comments to (423) 576-4542.
- Calling toll-free (1-800-927-9964) and leaving your comments via voice mail.
- Commenting via electronic mail to this address: snseis@ornl.gov.

Comments:

1 On page 4-111, Vol. II, there is a minor mistake on the map (Fig. 4.7.10.1-1). The 4-lane highway between Santa Fe & Espanola is listed incorrectly. Signage shows an Interstate Icon with 285 inside. Road is US-84/US-285. Signage should show a simple [icon] instead of [icon] the Interstate symbol.

2 Otherwise, the draft E.I.S. looks good.

Thank you for your input. Please use additional sheets if necessary and attach them to this form.

Name: Tom Switlik (optional)
Organization: Rio Arriba Env. Health Partnership
Address: P.O. Box 4449 (optional)
City: Fairview State: NM Zip: 87533
Phone number: 505-747-9079 (optional)
E-mail address: acequia@gte.net (optional)

☒ Please add my name to the SNS EIS mailing list.
☐ Please take my name off the SNS EIS mailing list.

SNS Spallation Neutron Source

Spallation Neutron Source Program
U.S. Department of Energy • Oak Ridge Operations Office
200 Administration Road, 146 SNS Building • Oak Ridge, TN 37831 • (800) 927-9964 Fax (423) 576-4542

KNOXVILLE AREA CHAMBER PARTNERSHIP

CHAMBER OF COMMERCE
THE DEVELOPMENT CORPORATION OF KNOX COUNTY
KNOX COUNTY TOURIST COMMISSION
CENTRAL BUSINESS IMPROVEMENT DISTRICT
TENNESSEE SMALL BUSINESS DEVELOPMENT CENTER
U.S. DEPARTMENT OF COMMERCE EXPORT ASSISTANCE CENTER

February 8, 1999

Mr. David Wilfert, EIS Document Manager
United States Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146 FEDC
Oak Ridge, Tennessee 37831

Dear Mr. Wilfert,

1 As Chairman of the Knoxville Area Chamber Partnership, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

Sincerely,

Sharon J. Miller

Sharon J. Miller, Chairman
Knoxville Area Chamber Partnership

601 W. SUMMIT HILL DRIVE, SUITE 300
KNOXVILLE, TN 37902-2011
TELEPHONE: 423 637 4550
FACSIMILE: 423 523 2071
E-MAIL: PARTNERSHIP@KACP.COM
WEBSITE: WWW.KNOXVILLE.ORG

Chamber of Commerce
Blount Partnership

201 S. Washington St., Maryville, TN 37804-5728
423-983-2241 • Fax: 423-984-1386
http://chamber.blount.tn.us
E-Mail Address: chamb@chamber.blount.tn.us

February 8, 1999

Mr. David Wilfert, EIS Document Manager
United States Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146 FEDC
Oak Ridge, TN 37831

RE: Spallation Neutron Source

Dear Mr. Wilfert:

1 As Chairman of the Blount County Chamber of Commerce, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

Sincerely,

George Williams
Chairman, Blount County Chamber of Commerce

GW/bsf

Blount Partnership

Tom Wood
PO Box 3069
Littleton, CO 80161

January 5, 1999

Mr. David Wilfert
USDOE, ORO
200 Administration Road
146/SNS
Oak Ridge, TN 37831

NSNSEIS@ornl.gov

Subject: Comments on the Draft EIS for the Spallation Neutron Source Facility

David:

I appreciate the opportunity to review the SNS EIS draft documents. As a recently relocated Oak Ridger, I enjoy keeping up with the events in town.

Comments:

I am very much in favor of the Oak Ridge site for the SNS. It is clearly the preferred alternative. However, there are some issues that might be considered in specific site selection decisions within the Oak Ridge Reservation.

1 On page S-39, Table S 1.5.2-1 there is a discussion of land use impacts and a statement that "… no brownfield sites … are available." This implies that no suitable sites were considered within the immediate area. I would like to suggest that at least one brownfield site, and perhaps others, are indeed available in the Oak Ridge Reservation and should be considered for the SNS site.

1 As discussed in the section on land use impacts, Section 5.7.1.8, page 5-168, the White Wing Scrap Yard site is being considered as a CERCLA disposal area. This site might also be an ideal "brownfield" site for the SNS.

1 The site is adjacent to ED-1 and a positive land use interaction of this "brownfield" site would be the added development for ED-1 in terms of a future hotel and potential private "spinoff" development at ED-1 that is supported by scientific work at the SNS. This location also makes the SNS more accessible to the private sector. Siting the SNS at this location can help to improve or accelerate the economic redevelopment of the City of Oak Ridge and the surrounding four county region.

1 Other benefits would include easier road way access and a reduction in the cost of remediation for the site, as it can be left as a "brownfield' with more relaxed cleanup or

130 Clemson Drive
Oak Ridge, Tennessee 37830-7664
E-mail: mosesa@aol.com
January 31, 1999

Mr. David Wilfert
SNS EIS Manager
U.S. Department of Energy
Oak Ridge Operations Office
200 Administration Road, 146/SNS
Oak Ridge, TN 37831
E-Mail: NSNSEIS@ornl.gov

Dear Mr. Wilfert:

Comments and Recommendations on the Draft Environmental Impact Statement (EIS) for the Spallation Neutron Source (SNS)

The following comments and recommendations are submitted based on my review of copies of the Draft EIS for the SNS (DOE/EIS-0247 Draft, December 1998) and related sections of the SNS Conceptual Design Report (CDR) (NSNS/CDR-1 and NSNS/CDR-2, May 1997) as they appear in electronic files on the Internet. I note that each comment is rather long while each recommendation is very short and to the point. The length of each comment is unfortunately necessitated by the importance and complexity of the issue involved coupled with the shortcoming of the draft EIS in failing either to address the issue at all or to address the issue in a direct and understandable fashion.

1 Before documenting my comments, I want to make it clear that I fully support the mission of the SNS and its siting in Oak Ridge. My comments are made not to disparage or negate the importance of the SNS to the future of neutron-based research in the U.S. or at Oak Ridge but to assure that all-important issues potentially affecting public welfare are adequately and sufficiently addressed. The issues raised in the comments and recommendations that are provided below are just as valid for public consideration and for DOE or other official resolution no matter where the SNS is sited. I strongly recommend that Oak Ridge be the selected site for SNS.

1. **<u>Radioactive Waste Classification and Management:</u>**

2 <u>Comment</u>: SNS EIS Sects. 6.1.3, 6.1.4, 6.1.10, and 6.1.11 and SNS CDR Sects. 8.8 and 9.1 fail to define the legal bases for how the SNS radioactive wastes are to be classified and regulated for disposal. Both sets of cited sections fail to indicate under which statutes or laws and under which regulatory authorities the SNS radioactive wastes are to be regulated, and both sets use terminology (specifically, "mixed waste") without further clarifying why the statutory definition of the term does not apply to SNS-generated radioactive wastes. Lack of clarity and specificity is unacceptable because the disposal of radioactive wastes from the SNS involves complex and conflicting statutory and regulatory matters that have not been resolved by the government

1

1 risk assessment criteria. This is clearly a better land use for this location than as a future disposal site.

2 Another area of concern that is not clearly addressed in the EIS is the topic of karst formations associated with the siting of the SNS.

2 The region is noted for its karst formations, which have the potential to dramatically impact the construction of new facilities. The Copper Ridge area has been known to contain sink-holes and caves. Perhaps the White Wing Scrap Yard site is better suited from a karst standpoint and is less likely to have these impacts.

Again, I appreciate the opportunity to comment on this draft EIS. Please feel free to contact me at the above address if any clarification or additional comments are needed.

Sincerely,

Thomas R. Wood

T. R. Wood

2

previously (see U.S. Nuclear Regulatory Commission, NRC, documents NUREG-1310 and SECY-92-325). If DOE at this juncture does not properly address this situation, there is confusion as to who is the legally empowered regulator for such wastes and what are the proper regulatory requirements. The fact is that the replaceable metallic components in the SNS target will under proton-neutron irradiation become as highly radioactive as any power reactor component irradiated in the core where such reactor-irradiated material would be classified as Greater-than-Class-C Low-Level Radioactive Waste (GTCC LLRW) under NRC regulations at 10 CFR Part 61 and would require ultimate permanent disposal in a geologic repository unless the NRC approves an alternative disposal. In the DOE system, however, appropriate regulatory requirements for disposal of these wastes have never been defined. The authors of both the EIS and the CDR do the public a disservice by failing to present this problem in a clear and straightforward manner. Although SNS EIS Sect. 6.1.2 alludes to one key aspect of the problem in the context of radioactive materials affecting water quality in site effluents, the issue is never detailed in the context of radioactive waste management and classification.

The reason that an issue exists is because SNS-generated radioactive materials do no meet the statutory definitions of source material, special nuclear material (SNM), or by-product material as defined in the *Atomic Energy Act of 1954* (AEA), as amended, and codified at 42 *U.S.C.* 2014. Thus, in a strict legal sense, SNS-generated radioactive wastes appear to fall solely under the *Resource Conservation and Recovery Act* (RCRA) as meeting the definition for "solid waste" codified at 42 *U.S.C.* 6903(27), are tehreby excluded both from the definition of "mixed waste" codified at 42 *U.S.C.* 6903(41) and from the DOE mixed waste reporting requirements at 42 *U.S.C.* 6939c, and should be regulated only as "hazardous waste" under the definition at 42 *U.S.C.* 6903(5) by the Environmental Protection Agency (EPA) and by the states under the *Federal Facilities Compliance Act* (FFCA). Therefore, SNS-generated highly radio-toxic or high-hazard radioactive wastes are subject to listing as hazardous waste under 42 *U.S.C.* 6921 and subject to all the standards and permitting requirements at 42 *U.S.C.* 6922, 6924, and 6925. Since EPA and the states (except perhaps for Illinois) have not promulgated land disposal restrictions previously for this type waste, it is expected that new EPA and/or state rulemaking, additional Federal EISs, and public meetings are required to bring closure by defining proper statute-based regulatory controls for the handling and disposal of SNS radioactive wastes. The draft EIS addresses none of this. There is no mention in the draft EIS that the SNS radioactive wastes fall into a category of wastes that NRC indicates in NUREG-1310 that Congress refers to as "orphan wastes," that DOE has itself called "unregulated wastes" (*Federal Register, 60*, pp. 13424-13425, March 13, 1995), and for which EPA has failed to take regulatory ownership in spite of the law.

DOE has previously acknowledged EPA authority over accelerator-generated (non-by-product) radioactive materials. This previous DOE acknowledgment of EPA authority has been (1) implicit both in 10 CFR Part 962 and in Definitions 3.a and 27 of DOE 5820.2A that respectively delineate the demarcation of authority between the AEA and RCRA and (2) explicit in Chapter IV of DOE 5820.2A that specifies that accelerator-generated radioactive materials are to be regulated under RCRA and/or as "residual radioactive material" under 40 CFR Part 192, where the latter EPA regulation is not really applicable. It is noted that the recent draft DOE O435.1 attempts to redefine DOE authority under the AEA-based oversight of radioactive wastes to include accelerator-generated radioactive wastes, but I have noted to DOE in separate

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correspondence that this proposed revision to DOE 5820.2A requirements is not advisable because (1) there is an absence of clear statutory authority and (2) DOE needs to issue regulations not directives to manage radioactive wastes in an acceptable and enforceable manner. Thus, notwithstanding the broad regulatory authority granted both DOE and NRC at 42 *U.S.C.* 2201(i)(3) and (p) and with due consideration to the DOE General Counsel's interpretation of this authority with regard to the regulation of radiological hazards (Sect. B.1, *Federal Register, 61*, pp. 4209-4910, February 5, 1996), the AEA and RCRA appear to be very clear when considered in combination that the types of waste to be generated in SNS are not subject to DOE regulatory authority. It is also noted that DOE has used the terms "unregulated waste" and "special case waste" (*Federal Register, 60*, pp. 13424-13425, March 13, 1995) to refer to certain types of non-AEA radioactive wastes, that is, "unregulated" wastes that pose the same hazards as GTCC LLRW are to be treated as "special cases" under Sect. III.3.i(4) of DOE 5820.2A. However, DOE is understood to be dropping the "special case waste" terminology. This change in terminology is presumably due to the criticism stemming from the multiple findings of DOE activities involving the production or storage of special case waste with no clear path forward to disposal. These findings are documented in the DOE report, "Complex-Wide Review of DOE's Low-Level Waste Management ES&H Vulnerabilities," May 1996, submitted in response to Defense Nuclear Facilities Safety Board Recommendation 94-2. Finally, in the context of possibly considering DOE regulatory oversight of radioactive wastes, it is noted that DOE's issuance of regulations to implement the *Price-Anderson Amendments Act of 1988* is way behind schedule, is in abeyance, and has never proposed nor attempted to implement consistent rulemaking for radioactive waste classification and management analogous with and equivalent to that of the NRC regulations at 10 CFR Parts 60 and 61 for AEA-regulated materials. Thus DOE appears to have neither the statutory authority nor the regulatory track record to provide the regulatory structure needed to control the classification, treatment and disposal of SNS hazardous radioactive wastes.

It is noted that the statutory issue could be resolved if Congress would amend the definition of by-product material as it appears in 42 *U.S.C.* 2014(e)(1) from reading "any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material" to read instead "any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing *atomic energy or* special nuclear material." This wording change would adapt the intent of the words used in 42 *U.S.C.* 2013(c) regarding the purpose of the AEA and make by-product material consistent with the definitions both of "atomic energy" in 42 *U.S.C.* 2014(c) as being "all forms of energy released in the course of nuclear fission or nuclear transformation" and of "utilization facility" in 42 *U.S.C.* 2014(cc)(1) as being "any equipment or device, except an atomic weapon, determined by rule of the Commission to be...peculiarly adapted for making use of atomic energy in such quantity as to be of significance to the common defense and security, or in such manner as to affect the health and safety of the public." The recommended amendment would permit radioactive materials produced by particle accelerators and nuclear fusion devices to be classified as by-product material and thus subject to regulation by DOE and NRC but would exclude naturally-occurring radioactive materials except those covered under 42 *U.S.C.* 2014(e)(2). This change would permit NRC to license the use of such materials under 42 *U.S.C.* 2111 and thereby obviate the NRC's reluctance to assert licensing and regulatory authority, including waste classification,

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over this type of radioactive waste by meeting the "consistent with existing law" provisions at 42 *U.S.C.* 2021b(9)(B) and 10101(12)(B) and (16)(B). Therefore, if this amendment were enacted, the regulation of the radio-toxicity of SNS-generated radioactive wastes and the safe disposal of these wastes would fall under the statutory provisions of the AEA, the *Nuclear Waste Policy Act* and the *Low-Level Radioactive Waste Policy Act* as opposed to RCRA only as is the case without the amendment. However, the proposed amendment would place the production and use of all radioactive medical therapy and diagnostic isotopes that are produced in small accelerators in hospitals under NRC regulations, but this control would in most cases simply be delegated back to the states, which already regulate such isotopes by default, by the NRC under 42 U.S.C. 2021(b)(1). The states would thus have enhanced authority under Federal law since litigation of contested violations could be referred to Federal courts if needed.

Finally, SNS EIS Sect. 6.1.11 states: "The Toxic Substances Control Act (TSCA) regulates the manufacture, use, treatment, storage, and disposal of certain toxic substances not regulated by RCRA or other statutes." While this statement is true with respect to the AEA as provided at 15 *U.S.C.* 2602(2)(B)(iv), this statement implies incorrectly that the treatment, storage, and disposal of certain hazardous materials are not subject to RCRA. Please note that the treatment, storage, and disposal of all hazardous materials except AEA-defined materials are covered under RCRA; that TSCA provides the statutory basis for implementing by regulation additional treatment, storage, and disposal requirements as may be appropriate for certain toxic substances generated for commercial purposes and regulated under TSCA; but that, as provided at 15 *U.S.C.* 2608(b) and 42 *U.S.C.* 6905(b), TSCA and RCRA are fully coordinated as the statutory bases for regulating the treatment, storage, and disposal of hazardous materials including toxic substances regulated under TSCA. Obviously, if this were not the case, TSCA regulations at 40 CFR Subchapter R would contain treatment, storage, and disposal requirements that are instead given in 40 CFR Subchapter I. It is also noted in this regard that the NRC has taken the position in SECY-92-325 that accelerator-generated radioactive materials that are produced for commercial purposes without using source material, special nuclear material, or by-product material are not subject to the AEA but are subject to regulation by the states and by the EPA under TSCA. This basis for the NRC's position applies to any radionuclides produced for commercial purposes in the SNS. This will not change unless Congress changes the AEA such as by redefining by-product material as noted above or makes some other set of changes to TSCA.

<u>Recommendations</u>:

1-1 The above-cited sections in the SNS EIS and CDR should be revised to indicate that all SNS radioactive wastes are subject to regulation by EPA and the state of siting under RCRA and FFCA. The inapplicability of the AEA to the regulation of SNS radioactive wastes should be clarified and explained. The use of the term "mixed wastes" should be deleted. The planned path forward should be outlined as to how DOE intends to obtain EPA and state rulemaking to define appropriate land disposal restrictions for SNS radioactive wastes.

1-2 The SNS EIS should clarify that any radionuclides produced for commercial purposes in SNS without using source material, special nuclear material, or by-product material will be regulated by the state of siting or by the EPA under

4

2

TSCA and that disposal of such commercial products when no longer used will be in accordance with TSCA/RCRA regulations or appropriate state regulations. The SNS EIS should commit that DOE will obtain TSCA permits for the production of any radionuclides in SNS for commercial purposes consistent with the NRC's position given in SECY-92-325.

1-3 SNS EIS Sect. 6.1.11 should be revised to correct the implication that TSCA and RCRA are not coordinated laws.

1-4 As an alternative to Recommendations 1-1 and 1-2 above, the SNS EIS could indicate the steps planned (1) to obtain an amendment to the AEA by Congress that will redefine by-product material to include SNS-generated radioactive materials and (2) for DOE and NRC to work together with the NRC agreement states to implement appropriate regulations under the amended AEA and related legislation.

2. <u>Environmental and Public Health Hazards from Accidents</u>:

3

<u>Comment</u>: In reviewing the draft EIS and the CDR, I have attempted to understand the bounding or worst case accidents so as to understand the degree of need for active prevention and mitigation features and the reliance if any that can be placed on inherent and passive features to prevent accidents and to mitigate the consequences of accidents. Although Sect. 3.1.2 of Appendix A to the draft EIS acknowledges the importance of the beam trip, I find that the "structured" process for defining the accident source terms, as given in Appendix A to the draft EIS, obscures key assumptions about the human factors in the assumed operability of safety systems and the high dependence of success paths both upon a safety culture that is yet to be created and upon institutional controls that have yet to be defined or specified. This situation is also obscured in CDR Chapters 7 and 8 so that safety-system top-level requirements are never well defined.

I do readily acknowledge that the total radioactive source term in SNS is very, very small in comparison to a large research or power reactor and that, during normal operation, the thermal margins in terms of temperature appear quite substantial to conditions that would fail the target vessel and the vessel confinement. However, unlike an NRC-licensed nuclear research reactor that would be designed and regulated under 10 CFR Part 50 Appendix A to meet NRC General Design Criterion (GDC) 11, "Reactor inherent protection," the SNS accelerator and target apparently lack any inherent protective or mitigative feedback mechanism to control the rate at which thermal energy is deposited in the target mercury by the proton beam. The singular importance of this fact is significant but has not been emphasized in the limited safety analysis presented in the EIS.

Thus, in SNS, the control of target heating during normal operation or upset conditions relies totally upon either the human operator or automatic detection and actuation systems that are designed, fabricated, constructed, configured, maintained, and tested by humans. The structures around the target provide the only inherent features that can passively prevent or mitigate a release of radioactive materials in the event of a worst case accident in which the target is

5

3 vaporized. However, the functional integrity of the confinement structures to prevent or mitigate a release of radioactive materials will be maintained and not bypassed only if conditions in the confinement, including the effects of an untripped beam, do not present a serious challenge to the confinement structure and particularly to the less massive barriers that would be in place if active mitigation features fail to operate during an upset to secure experimental access to the target as needed during operations to extract the neutron beams.

The fragility of relying solely on human operators and automatic prevention and mitigation systems, which can be bypassed by human operators, in a nuclear system that lacks inherent protective or mitigative feedbacks was illustrated most dramatically and notoriously in the accident at Chernobyl Unit 4. While the possible consequences and therefore the risk of a worst case accident in SNS is in no way comparable to what happened at Chernobyl, it must be remembered that the SNS mercury target is not merely a jar of radioactive liquid sitting in a hot cell where the standard practice is not to load hot cells containing radioactive materials with large quantities of highly flammable or explosive materials nor to place the jar in the path of an explosive or incendiary projectile. Instead the SNS target might better be characterized as an actively-cooled jar of radioactive liquid sitting in a hot cell with access ports more similar to those of a glove box and where the jar is heated by a device that is technically similar to the directed energy weapons regulated in international trade by the U.S. Department of State on the United States Munitions List at 22 CFR 121.1, Article XIII(h). An extended failure to trip the beam in an accident that is initiated by target under-cooling can lead to the vaporization of the target and adjacent target structures and potentially lead to energetic interactions with confinement structures and barriers contributing to loss of confinement integrity. The presence of cooling water systems nearby the target could lead to steam explosion or confinement over-pressurization.

The SNS accelerator beam may also be potentially classifiable as the energizing or effecting mechanism in a large "utilization facility" that effects "nuclear transformations" and satisfies the portion of the definition for utilization facility in the AEA at 42 *U.S.C.* 2014(cc)(1) as being "any equipment or device, except an atomic weapon, determined by rule of the Commission to be...peculiarly adapted for making use of atomic energy...in such manner as to affect the health and safety of the public." Although NRC has elected to classify even the smallest nuclear reactor as a utilization facility subject to a "minimum" set of health and safety regulations at 10 CFR Part 50, no such equivalent determination has ever been made by the NRC with respect to the utilization of atomic energy through the nuclear transformations that are induced by the accelerator beam in the target of an accelerator facility. Perhaps this is because the radioactive materials produced in an accelerator target are not AEA-regulated materials or perhaps because to date most commercial particle accelerators have been very small and with very low-power beams compared to what is envisioned for SNS. The historical safety and health physics performance of small accelerators is summarized only in the DOE report SLAC-327, *Health Physics Manual of Good Practices for Accelerator Facilities*, April 1988. In Sect. 2.6, "Beam Containment," pp. 28-30 of this report, examples are given of how failures to control the beam in small accelerators can lead to melting or vaporization of that portion of the target or other structures exposed to the uncontrolled beam. The substantial radiation hazard posed by the irradiated non-fissionable, heavy-metal targets in the larger DOE accelerators is also a matter of record (See Occurrence Report Number ALO-LA-LANL-RADCHEM-1996-0010, "Unposted

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3 High Radiation Area on the Rooftop above TA-49-1 Hot Cells," 10/11/1996).

As implied in Sect. 3.1.2 of Appendix A to the EIS, the bounding accident for the SNS would be the failure of target cooling with simultaneous failure to trip the beam for an extended period of time. However, Sect. 3.17 Table 3.7 and Exhibit F Table F.1 of Appendix A to the draft SNS EIS indicate that one of the two bounding "beyond design basis accidents" analyzed in the draft EIS is the failure of target cooling with the failure of two out of three beam trip mechanisms such that there is a slightly delayed beam trip but the delay causes beam window failure leading to a mercury spill. The so-called bounding accident addressed in the draft EIS assumes that both the Target Protection System (TPS) and the Beam Permit (BP) fail but that the Personnel Protection System (PPS) operates quickly either automatically or in response to an operator action. This accident is indicated in the EIS to be beyond design basis because the estimated combined frequencies of component failures produces an event sequence frequency that is greater than 10^{-6} /year but less than 10^{-6} /year. The assumption of a simultaneous failure of the PPS is indicated in a footnote in Table 3.7 of Appendix A to have a frequency of occurrence that is less than 10^{-6} /year.

However, the accident failure frequencies used in the draft EIS are, according to Sect. 1.2 (P. A-14) of Appendix A, "based on experience and on engineering judgement considerations." In other words at this stage of the conceptualization of an as yet unbuilt and non-prototyped facility, the failure frequencies are based on unreviewed and non-validated guesses. It is highly likely that these guesses were developed by nuclear engineers with the tacit assumption that the typical regulated institutional controls of NRC-licensed nuclear systems will apply to SNS (that is, a continuously updated safety analysis report, technical specifications, a quality assurance program, configuration management and the associated procedural controls that are regulated by NRC against commitments made in the safety analysis report).

Although I am a proponent of the usefulness of risk-based regulation for nuclear systems when used as a guide to better understand the margins and conservatism in deterministic accident analyses and to address risk cliffs that may lurk beyond the design basis, it is noted that SNS lacks a key defense-in-depth component available in nuclear reactors by not meeting NRC GDC 11 and that there is no guarantee that SNS will be subject to equivalent institutional controls since, historically within DOE, accelerator facilities have received a much reduced level of regulation and external oversight compared to reactors. In general, copies of the safety assessment documents for DOE accelerators are not available to persons outside the facility and are not maintained available for outside review either by the public or by DOE safety oversight organizations.

Thus, I find fault with the underlying assumptions of the risk assessment in the EIS at this early stage of SNS design and with the failure to address a deterministic worst case scenario for assessing defense-in-depth. One cannot rely on hand-waving risk analyses for non-existent systems for which there is no data base for making integral estimates of system reliability that account for as-built configurations and the impacts of institutional controls. In this case, you must be deterministic and bounding in any accident or heatlh-risk analysis.

Consistent with the NRC's requirements for deterministic safety analyses of anticipated

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transients without scram (ATWS) for reactors, which have inherent feedbacks to mitigate such accidents, and consistent with NRC's treatment of operator actions wherein it is typically assumed that the operator takes no action or the wrong action for the first 10 minutes of a transient, it would appear to be more prudent and bounding if the SNS EIS addressed loss of target cooling with failure to trip the beam for a period of time up to 10 minutes. Since water-cooled systems are nearby, the potential for steam explosion or over-pressurization of the confinement should also be assessed under the worst case assumptions. More simply, it may be best to assume that all radioactive materials in the target environs are vaporized and released to the atmosphere similar to the conservative and bounding assumptions in NRC report NUREG-0396 that was used to establish the bases for 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities." It should be sufficient to determine for the most adverse weather conditions the boundaries of the zone around the SNS site where such an accident would lead to doses that exceed the EPA minimum guidelines for sheltering and evacuation (that is, 1 Rem whole body and 5 Rem thyroid). Beyond that boundary, which would hopefully be shown not to pass beyond the one-mile exclusion zone for the site, the SNS can be considered to be passively safe no matter what mistakes the operators might make. This is analogous to the approach proposed for the Modular High-Temperature Gas-Cooled Reactor that was being designed to incorporate numerous diverse and redundant, inherent and passive safety features that have no equivalent in the SNS.

Since my home in Oak Ridge is located on a hill about 10 miles Northeast of the proposed site for SNS, as a professional nuclear engineer, I am most interested in knowing the results of such a bounding accident analysis in which no optimistic assumptions are made about the performance of systems and operators. I prefer knowing that no matter what mistakes are made by the operators on site I have no need to be concerned off-site; I assume that my fellow residents of Oak Ridge and surrounding areas feel the same way. Of course, my requirements stem from treating SNS as a nuclear facility. Since the radio-toxic substances in the SNS target are not AEA-regulated materials, other bounding accident scenarios may be posed more analogous to the types of accident and emergency response situations that can occur in industries regulated by EPA and the states. However, whether one draws upon historical worst-case precedents at Chernobyl or Bhopal, the fragility of relying on the human operator and the importance of institutional controls must be addressed in setting the bounding case for public risk. My assumption is that it can be shown that no substantive risk exists; I expect that the final EIS will provide the substantive documentation to validate this assumption and not confuse the issue with hand-waving discussions about reliabilities for untried and nonexistent systems, operators, and procedural controls. While this approach will establish the hazard or bounding consequences for public health off-site, a similar approach is recommended for establishing the hazard or bounding consequences for both occupational safety and health and environmental insult on-site. It appears that the SNS approach used to date to evaluate hazards under DOE 5480.23 and DOE-STD-1027-92 always gets shortcut by the assumption that the target is never vaporized so the assumed release fractions for non-volatile radioactive materials are always much less than 1.0. Thus the strict requirements of Sect. 8.c of DOE 5480.23 and Sects. 3.1.2 and 4.1.1 of DOE-STD-1027-92 seem to be violated by the fatal logic flaw of assuming that which you want to prove.. Such logic may unfortunately be taken as further proof by some persons that DOE is inherently incapable of honest self-regulation. I hope that this is not the case.

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Recommendations:

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1-1 The SNS draft EIS and CDR should be revised to indicate that equipment relied upon to perform safety functions will be classified as safety-related and that DOE is committed to assuring that all safety-related equipment is subject to both technical safety requirements and configuration management controls as required for the DOE research reactors. This includes the TPS, BP and PPS.

2-2 The accident scenario for the beyond-design-basis event to be provided in the final EIS should address the consequences of the untripped beam (up to 10 minutes) as it affects the target and confinement. Consistent with NRC's treatment of ATWS, the failure to trip the beam should be applied to all events in which cooling is lost to the target both loss of coolant and loss of flow. The treatment of the accident upon which emergency planning is to be based should be as conservative as the NRC assumption underlying 10 CFR Part 50, Appendix E (namely, total loss of target integrity and total loss of confinement integrity).

3. Recommendations based on Other Considerations:

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Comment: Sect. 1.2 (p. 1-7) of the draft SNS EIS indicates that the construction of SNS is a "global concern" from the standpoint of filling a "neutron gap" in research capabilities. The SNS is proposed to be a U.S. research facility, but it is inferred that SNS will be open to international research collaborations. The significance of SNS in the context of international collaborations and the sharing of its technology advances and advantages is not addressed in the draft EIS.

In particular, an issue that is not addressed in the SNS draft EIS is that which is addressed briefly in Sect. 1.6, "Nonproliferation," of DOE/EIS-0270D, December 1997, which is the draft EIS for locating the Accelerator Production of Tritium (APT) at the Savannah River Site. Sect. 1.6 of DOE/EIS-0270D asserts that "accelerator technology has been in use for more than 75 years," that "the possibility of producing special nuclear material (i.e., plutonium) using an accelerator was recognized several decades ago," and that the "APT is the first known accelerator proposed for a mission to produce weapons materials in a sustained production operating mode." The latter statement is simply not true since the formerly-classified Materials Test Accelerator pursued by the Atomic Energy Commission in the late 1940s and early 1950s was a project dedicated to developing an accelerator-driven system to produce weapons plutonium as an alternative to constructing large production reactors. Sect. 1.6 of DOE/EIS-0270D also indicates that using "an accelerator to produce special nuclear materials in quantities which could be a proliferation concern requires a particle beam power of approximately 1 megawatt or greater" and that "research accelerators with beam powers in the 1 megawatt range have been viable for at least 20 years." As noted in the SNS draft EIS, SNS is to use a 1 MW beam initially and upgraded to 4 MW later.

Article III of the *Treaty on the Non-Proliferation of Nuclear Weapons* stipulates that "Each State Party to the Treaty undertakes not to provide:...(b) equipment...especially designed or prepared for the...production of special fissionable material, to any non-nuclear-weapon State for peaceful

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purposes, unless the source or special fissionable material shall be subject to the safeguards required by this Article." However, there are currently no U.S. safeguards requirements or export controls placed on particle accelerators that DOE/EIS-0270D acknowledges are a potential proliferation risk at the beam power levels of the SNS. It is noted that the U.S. is a member of an international body called the Nuclear Suppliers Group (NSG) composed of signatories of the Nonproliferation Treaty. The guidance formulated by the NSG on issues of export controls includes the "Trigger List," which triggers safeguards, and the "Dual Use List." Based on an earlier international agreement on safeguards, the Trigger Lists starts with export controls for reactor equipment for a facility that can produce as little as 100 grams of plutonium annually. This international standard has implications for accelerators operating with beam powers much, much less than 1 megawatt. These agreements, guidelines and lists are published in the International Atomic Energy Agency (IAEA) Information Circulars. A logical question that arises is that, in the absence of clear controls to prevent the diversion of accelerator technologies for purposes of nuclear weapons proliferation, how can one be sure that any international collaboration on SNS will not lead to the uncontrolled transfer of technology that can be used to promote the illegal production of special nuclear materials for nuclear explosive purposes. What pro-active measures does DOE intend to take to prevent or mitigate the risk of nuclear proliferation arising from the construction and operation of SNS? Sect. 1.6 of DOE/EIS-0270D indicates only that DOE is considering changes to its regulations at 10 CFR Part 810 that implement its authority under 42 *U.S.C.* 2077(b) although it is now one year since these words were published for public consumption and no such rulemaking has been proposed to the public. However, how does DOE intend to coordinate its actions on SNS effectively with the NRC and the Department of Commerce that have the primary responsibility for nuclear-related export controls under 42 *U.S.C.* 2139 and 2139a? How does DOE intend to coordinate its activities on SNS effectively with the Department of Commerce under its authority provided in Sect. 3(d) of Presidential Executive Order 12938 of November 14, 1994, "Proliferation of Weapons of Mass Destruction," "to regulate the activities of United States persons in order to prevent their participation in activities that could contribute to the proliferation of weapons of mass destruction?"

Also, 22 CFR 121.1(a) stipulates that "The following articles, services and related technical data are designated as defense articles and defense services pursuant to sections 38 and 47(7) of the Arms Export Control Act (22 U.S.C. 2778 and 2794(7))." Further, 22 CFR 121.1, Article XIII(h) lists "Devices embodying particle beam and electromagnetic pulse technology and associated components and subassemblies (e.g., ion beam current injectors, particle accelerators for neutral or charged particles, beam handling and projection equipment, beam steering, fire control, and pointing equipment, test and diagnostic instruments, and targets) which are specifically designed or modified for directed energy weapon applications." While the SNS accelerator is not "specifically designed or modified for directed energy weapon applications," how can one be sure that any international collaboration on SNS will not be used to promote the illegal transfer of "services and related technical data" that could be diverted for purposes of developing directed energy weapon applications? What pro-active measures does DOE intend to take to prevent or mitigate the risk of the proliferation of enabling technology for directed energy weapon applications arising from the construction and operation of SNS? How does DOE intend to coordinate its activities on SNS effectively with the Department of State to preclude inadvertently violating the intent of the *Arms Control Export Act* by allowing the export of

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enabling technology?

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Notably, high-energy particles such as those used in the beam of SNS release secondary energetic particles and radiations from collisions with target atoms through the process of nuclear spallation, which is a form of "nuclear transformation." Energy released from the process of nuclear transformation is defined at 42 *U.S.C.* 2014(c) to be "atomic energy." Per 42 *U.S.C.* 2014(d): "The term 'atomic weapon' means any device utilizing atomic energy, exclusive of the means for transporting or propelling the device (where such means is a separable and divisible part of the device), the principal purpose of which is for use as, or for development of, a weapon, a weapon prototype, or a weapon test device." Thus, any directed energy weapon utilizing a particle beam energetic enough to induce nuclear transformation by effecting spallations in the target materials may apparently be inferred legally to be an atomic weapon if not a "weapon of mass destruction." None of the existing regulations specifically address this notable aspect of SNS-related technologies. Does DOE intend to address this aspect of SNS and its implications on how SNS technologies are to be regulated in international collaboration?

<u>Recommendations</u>:

3-1 DOE needs to revise the SNS EIS (1) to assess the risks posed by SNS to the proliferation of the capability to produce special nuclear material without safeguards and thereby to produce weapons of mass destruction and (2) to specify the active measures to be taken by DOE in coordination with the NRC, the Department of Commerce, and the NSG to prevent or mitigate such risks. In particular, DOE might indicate when the previously-indicated rulemaking for 10 CFR Part 810 can be expected.

3-2 DOE needs to revise the SNS EIS to assess the risks posed by SNS to the proliferation of directed energy weapons and to specify the active measures to be taken by DOE in coordination with the Department of State to prevent or mitigate such risks arising from international collaborations that might lead to the export of SNS technologies. DOE also needs to explain why directed energy weapons using beam energies comparable to SNS and incorporating technologies very similar to that used in SNS do not need to be regulated as atomic weapons.

Sincerely and respectfully submitted,

/submitted electronically via e-mail at mosesa@aol.com/
David L. Moses, Ph.D., P.E.
Nuclear Engineer

cc: Earl Leming, TDEC-DOE Oversight
Stanley Lichtman, DOE/EH-42
Michael H. Mobley, TDEC-Radiation Health
Mary Ann Sullivan, DOE General Counsel

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February 5, 1999

To: David Wilfert, USDOE OROO,
200 Administration Rd, 146/SNS
Oak Ridge, TN 37831

From: Barbara Walton
85 Claymore Ln,
Oak Ridge, TN 37830

Subject: SNS Draft EIS (DOE/EIS-0247, December 1998)

1 I support the selection of the Preferred Alternative; locate the SNS in Oak Ridge to be operated by the ORNL. I recognize the importance of the research the SNS enables.

2 The draft EIS does a good job of documenting the concerns and issues raised at the scoping meeting -- except for one -- the lack of public involvement in selecting the actual, physical site. The draft EIS and associated public meetings are the first such opportunity since then. An informal, interactive work session earlier in the process would have been desirable. Unfortunately it may now be too late in the process to affect the outcome for actual adjustment of the site.

3 The document does NOT give all the environmental impacts. The site plan shown on page 3-12 and elsewhere does not show the retention basin. This basin is discussed on pages 5-20,21,30 and elsewhere but its size and location are never given. The impact of a retention basin on the top of a ridge can be very large; it could increase the footprint of the SNS. 4 Page 5-37, last paragraph mentions construction or improvement of utility corridors and a southwest access road not assessed at the time of the draft EIS; these should be included in the final EIS and not just for cultural resources.

5 The EIS does not do a good job of showing the intrusion of the SNS into environmentally sensitive areas in a way the public can easily see. In contrast, for example, the CERCLA Waste Disposal RI/FS (DOE/OR/02-1637&D2 in figures 7.2, 7.3 and 7.4) show in detail, the sensitive areas and the proximity to the candidate sites. I have used these in studying the SNS site. The inclusion of a figure similar to Figure 7.4 in section 4.1.5 or 5.2.5.4, along with the figure found on page B43 of this document, is recommended. 6 In addition, an outline of the SNS footprint should be shown on Figures 4.1.5.4-1 and 4.1.5.4-2. 7 Figures 4.1.8.3-1 and 4.1.8.3-2, found on pages 4-54 and 4-55 are not readable; an expanded view of the affected area would be an improvement.

8 The Draft EIS also does a good job of stating the impact of the SNS on the research being done in the Walker Branch Watershed. The work being done here is very important to the Nations Global Change Program. It is extremely important to mitigate such impacts. For example, in addition to the potential replacement of natural gas boilers with electric heat pumps mentioned on page 5-41, the use of an electric shuttle bus to transport people to the site during the operations period would reduce both runoff by eliminating the need for parking lots as well reducing carbon dioxide emissions from conventional vehicles.

9 There needs to be a COMMITMENT to mitigation measures BEFORE construction begins!

10 A better decommissioning plan is needed. Page 5-43 (2nd paragraph) states: "Current plans call for in-situ decommissioning of the SNS when its operational life cycle is completed." This is unacceptable. Is a 30 year operational life (page 5-19) realistic?

Other comments and errors found in the document:

11 1. Page 4-19 (3rd paragraph) states that one wetland area in the area of BCV south tributary 4 will be affected. However Table 4.1.5.2-1 and Figure 4.1.5.2-1 show BCST2.

12 2. On page 5-48 in the 2nd paragraph of the 2nd column the annual dose to members of the public, inside and outside the controlled area appear to be reversed.

13 3. On page 5-38 in the 1st column, 40RE488 is discussed in both prehistoric and historic resource section, there appears to be an error.

14 4. On page 4-5 the figure is mislabeled, it should be 4.1.1.1-3 (as referenced on page 4-7). In addition, the four borings discussed should be identified.

15 5. Figures 1 and 2 in Appendix B are unreadable.

Barbara A. Walton

Spallation Neutron Source Program

Comment Form

The U.S. Department of Energy is interested in your comments on the *Construction and Operation of the Spallation Neutron Source Facility: Draft Environmental Impact Statement.*

There are several ways to provide comments on this document, and these include:

1. Attending public meetings and giving your comments directly to DOE officials.
2. Returning this comment form to the registration desk at the public meetings.
3. Returning this comment form or other written comments to the address on the back of this form.
4. Faxing your comments to (423) 576-4542.
5. Calling toll-free (1-800-927-9964) and leaving your comments via voice mail.
6. Commenting via electronic mail to this address: nsnseis@ornl.gov.

Comments:

A couple of corrections:

1 page 5-45 (Table S1.5.2-1) 9b. BNL Alternative
I believe 3.4mrem is 34% of limit (not 3.4%).

2 page 1-3 1st ¶ – it states that cold n°s are slower than thermal n°; yet, the energies listed state otherwise. Units correct?

Thank you for your input. Please use additional sheets if necessary and attach them to this form.

Name Vickie G. Davis (optional)
Organization None
Address 155 Schotzer Drive (optional)
City Sweetwater State TN Zip 37874
Phone number (423) 337-2742 (optional)
E-mail address (optional)

☐ Please add my name to the SNS EIS mailing list.
☐ Please take my name off the SNS EIS mailing list.

SNS SPALLATION NEUTRON SOURCE

Spallation Neutron Source Program
U.S. Department of Energy • Oak Ridge Operations Office
200 Administration Road, 146 SNS Building • Oak Ridge, TN 37831 • (800) 927-9964 Fax (423) 576-4542

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Public Hearing Transcript – Comment Number H-2
Oak Ridge – Evening Session

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Public Hearing Transcript Attachment 1
Comment Number H-3
Oak Ridge - Evening Session

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NUMBER 2-14-99

RESOLUTION

WHEREAS, the U.S. needs a neutron source to provide the scientific and industrial research communities with a much more intense source than is currently available, and to assure the availability of a state-of-the-art facility in the decades ahead; and

WHEREAS, this next-generation neutron source would create new scientific and engineering opportunities, and would help replace the capacity that will be lost by the eventual shutdown of existing sources as they reach the end of their useful operating lives; and

WHEREAS, the U.S Department of Energy (DOE) has worked with the scientific community since the early 1970s to provide a new neutron source; and

WHEREAS, the DOE has proposed to construct and operate a state-of-the-art, short-pulsed spallation neutron source (SNS) facility comprised of an ion source, a linear accelerator, a proton accumulator ring, and an experiment building containing a liquid mercury target and a suite of neutron scattering instrumentation; and

WHEREAS, the DOE has used a systematic process to select suitable alternative sites for the proposed facility that included criteria such as availability of land, adequacy of electric power source, presence of existing neutron science expertise and experience to meet mission goals, and existence of major facilities and programs using neutron scattering techniques; and

WHEREAS, the DOE has identified four siting alternatives for the proposed SNS: Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory in New Mexico, Argonne National Laboratory in Illinois, and Brookhaven National Laboratory in New York; and

WHEREAS, the DOE has prepared an Environmental Impact Statement (EIS) to examine the potential impacts associated with construction and operation of the proposed SNS at the four sites, and which names the ORNL location as the DOE preferred alternative; and

WHEREAS, the EIS describes the beneficial economic impacts of the proposed project on the Region of Impact (ROI), which includes Anderson, Knox, Loudon, and Roane Counties and the City of Oak Ridge; and

WHEREAS, the EIS states that economic benefits to the ROI in the form of jobs, wages, business taxes, and income would begin to accrue during the first year of the project in FY 1999, and would increase as construction and other associated project activities increase; and

WHEREAS, the DOE estimates that design and construction employment would be highest in FY 2002, and there would be an estimated 1,499 total (direct, indirect, and induced) new jobs created at ORNL; and

WHEREAS, the DOE further estimates that facility operation would continue to support up to 1,704 direct, indirect, and induced jobs for the first year of full operation (FY 2006), and for each of the following years of operation; and

WHEREAS, the DOE further estimates the economic benefits of annual operation, which would accrue to the ROI, to be: $ 68.7 million in local wages, $ 7.5 million in business taxes, $ 75.9 million in personal income; and $ 176.3 million in total output; and

WHEREAS, the preferred alternative for the SNS is located at the Oak Ridge National Laboratory, which is within the corporate limits of the City of Oak Ridge; and

WHEREAS, the City of Oak Ridge strongly supports the Department of Energy's objectives to ensure the vitality of the national scientific community by providing a neutron source that would satisfy current and future demand for research neutrons, lead to new scientific and technological discoveries and meet international technological and economic challenges in an environmentally sound and safe facility; and

WHEREAS, the City of Oak Ridge commends the DOE Oak Ridge Operations office and the Oak Ridge National Laboratory for organizing a collaborative effort to achieve these objectives with Argonne, Brookhaven, Berkeley, and Los Alamos National Labs, and other U.S. industrial firms and universities that will be involved as the project matures; and

WHEREAS, the City of Oak Ridge commends the State of Tennessee for committing $ 8 million for ORNL and the University of Tennessee to construct a Joint Institute for Neutron Science (JINS), which will enhance the utility of the SNS by providing support facilities to scientists and engineers from universities, industries, and the international community; and

WHEREAS, an overwhelming majority of Oak Ridge citizens responding to a recent community survey stated strong support for the construction and operation of the proposed SNS at the preferred site at ORNL; and

WHEREAS, construction and operation of the SNS at the preferred site at ORNL will greatly assist the City of Oak Ridge as it continues to address the negative social and economic impacts associated with DOE downsizing.

NOW, THEREFORE, BE IT RESOLVED BY THE MAYOR AND COUNCILMEN OF THE CITY OF OAK RIDGE, TENNESSEE:

That the City of Oak Ridge supports and endorses the Department of Energy's preferred alternative to construct and operate the Spallation Neutron Source at the Oak Ridge National Laboratory.

BE IT FURTHER RESOLVED that this resolution shall be sent to the Secretary of Energy, the Governor of the State of Tennessee, the Tennessee Congressional Delegation, the City's representatives in the Tennessee General Assembly, the Tennessee Municipal League, and the Mayors of the cities throughout Tennessee urging their continued support for the SNS and JINS projects.

This the 1st day of February 1999.

APPROVED AS TO FORM AND LEGALITY:

City Attorney

Walter K Brown
Mayor

Jacquelyn J. Bernard
City Clerk

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Public Hearing Transcript – Comment Number H-4
Los Alamos – Afternoon Session

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Public Hearing Transcript – Comment Number H-5
Los Alamos – Evening Session

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U.S. DEPARTMENT OF ENERGY

OFFICE OF SCIENCE

PUBLIC REVIEW MEETING TO RECEIVE
COMMENTS ON THE DRAFT SPALLATION
NEUTRON SOURCE ENVIRONMENTAL
IMPACT STATEMENT

PUBLIC REVIEW MEETING

Tuesday, January 19, 1999

6:30 to 9:00 p.m.

Los Alamos Area Office - Main Conference Room

528 35th Street

Los Alamos, New Mexico 87544

REPORTED BY: EDITH ARNOLD FLORES, NM CCR #208
Cumbre Court Reporting
2019 Galisteo Street - Suite A-1
Santa Fe, New Mexico 87505

ORIGINAL

CUMBRE COURT REPORTING (505) 984-2244

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MODERATOR:

JOHN HAAS, Associate Professor and
Head, Department of Speech Communication
University of Tennessee

SUMMARY COMMENTS:

DAVID WILFERT
EIS Document Manager
Oak Ridge Operations Office
U.S. Department of Energy

JEFF HOY, SNS Program Manager
Office of Basic Energy Research
U.S. Department of Energy

CUMBRE COURT REPORTING (505) 984-2244

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P R O C E E D I N G S

MR. HAAS: Good evening. Welcome to the public review meeting concerning the Draft Environmental Impact Statement for the Spallation Neutron Source.

My name is John Haas. I'm Associate Professor and head of the Department of Speech Communication at the University of Tennessee, and I have been asked to serve as moderator for the meeting.

The goal of the meeting today is to solicit comment on the Draft Environmental Impact Statement concerning the Spallation Neutron Source.

Translators are available for those needing translation services, so during the course of the meeting, if anyone needs those, they are readily available, and seating has been reserved for those individuals.

In addition to providing comments today at the public meeting, there are other mechanisms by which comment can be provided for the draft report. Those comments can be mailed to the following address and that is available on a form that is at the information table outside of the meeting room. Those information packets can be directed toward Mr. David Wilfert at the U.S. Department of Energy, Post Office Box 2001, Oak

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Ridge, Tennessee 37831. And again that information is available out in the lobby area.

In addition, comment can be provided via a toll free number. That number is also available on the form for written comments. The number is 1-800-927-9964.

There is also a fax number available for those wishing to provide comments via fax. That number is also available on the comment form that is on the information table outside of the meeting room. That fax number is (423) 576-4542.

In addition, there is an E-Mail address by which comment can be provided. That is at NSNSEIS@ORNL.gov. That E-mail address is also on the information form that is available outside the meeting room.

There is also a page on the Worldwide Web where information can be obtained from the draft report, and that can be found at the DOE NEPA home page.

This evening any member of the audience wishing to provide comment on the Draft Environmental Impact Statement will be given the opportunity to make such comment. Each individual will be allotted five minutes, and as long as time permits, individuals will

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be able to provide additional comments if they so wish.

We ask for those who wish to make comment to register at the table outside the meeting room, and during the course of their comments, if they would please introduce themselves so that we will have something for the record.

To begin the meeting this evening, we have two individuals who wish to make some comments concerning the spallation neutron source, one of which is Mr. Jeff Hoy who is the Program Manager for the spallation neutron source in the Office of Basic Energy Sciences, Department of Energy Headquarters. He will be speaking concerning the purpose and need for the spallation neutron source.

Also with us tonight is David Wilfert who is wearing two hats. He is the Deputy Project Manager for the spallation neutron source as well as the Environmental Impact Statement Document Manager. He will be discussing with us tonight the Environmental Impact Statement process.

Following these two presentations, we will then open up the meeting to any public comment.

So let me introduce then Mr. Jeff Hoy.

SUMMARY COMMENTS BY MR. JEFF HOY

MR. HOY: Thanks, John.

I just want to spend a few brief minutes with you describing the programmatic context of the proposed spallation neutron source project. I am with the Office of Science in Germantown, Maryland.

The advancement of the frontiers of science and basic research is one of the major mission components of the Department of Energy. We're one of the top five federal agencies in the nation for funding basic and applied research across the board, and we're the number one sponsor of research and development facilities in the nation.

The purpose of this research, as you can see, is aimed at determining what are affordable and clean energy sources for the future and understanding the impacts on our populace and the environment generated in using this energy.

We also do a lot of basic research in understanding the building blocks of matter. We have a system of national laboratories that host a number of research facilities that are used by researchers across the country as tools for expanding our knowledge of basic science, and we're very proud of our reputation for sponsoring world class research.

DOE has sponsored some 71 Nobel Prizes and over 450 R&D One Hundred Awards since we began work in this business, and that's more than any other entity in the country, and it's more than twice as many as any other federal agency.

Within the Office of Science, the Office of Basic Energy Sciences is charged actually by public law with responsibility for planning, constructing and operating major scientific user facilities, and these facilities are used by researchers from a wide range of institutions, universities, national laboratories, and also industrial laboratories.

The range of disciplines you can see along here on the bottom range from materials to geo and biosciences to engineering sciences.

To give you some sense as to the scope of these user facilities, if you include the proposed spallation neutron source, we'll have a total of 18 scientific user facilities in the country that are used by approximately 6,000 researchers a year, doing about 1,400 research projects with participants from roughly 200 institutions.

I would make note of the fact that the Los Alamos Neutron Science Center is located right here at Los Alamos National Laboratory, and it is one of four operating -- with SNS included, five -- high flux neutron sources that are used as probes to explore the

inner structure and dynamics of materials.

The Department has been in the business of sponsoring neutron science since its inception as a scientific discipline at Oak Ridge National Laboratory using facilities there in the 1940s, and this has been an ever-expanding field of scientific research with a number of very impressive scientific accomplishments.

The spinoffs of this work we see in our every-day lives in the form of various lightweight, strong, durable materials for a variety of uses, nondestructive testing, development of super conducting magnets, semiconductors for electronics and so forth.

The Department relies to a large extent on the advice of external advisory groups, and we have received a number of recommendations over the past several years for enhancing our stable of user facilities for neutron science and in particular for neutron sources with higher beam intensity and more instrumentation, so the proposed SNS is intended to address that need.

Now I'll turn the floor over to my colleague Dave Wilfert from the Oak Ridge Operations Office.

SUMMARY REMARKS BY DAVID WILFERT

MR. WILFERT: Thank you. Again, I am David Wilfert. I am wearing the two hats for a specific reason. The benefit of having responsibilities both on the project and on the document is that I have a close hand on the technology of the machine in terms of how it's going to influence the environment, and, secondarily, I am able to influence the construction or the evolution of this document to be sure it incorporates that information. Also, as the impacts are defined, I can assure that as the design of the facility evolves, it remains within the bounds of the scope of the document that we're preparing.

The document we have been preparing, the Draft Environmental Impact Statement for the Spallation Neutron Source, is a part of the National Environmental Policy Act process. That process for this project began back in February of '95 when Martha Krebbs, the director of the then called Office of Energy Research and now the Office of Science, made the determination that we would in fact prepare an EIS on this document.

We then proceeded to completion of a conceptual design report that came out in May of '97 and immediately followed in June of '97 with a Notice of Intent of preparing this document. We needed that conceptual design report to form the basis, the technology basis for writing the report and evaluating the impacts of the facility.

We held public scoping meetings back in '97 to collect public input on the scope of the document, what should we cover with this document. We have then been in the process for over a year actually preparing the analysis and the results and the conclusions of the impacts of this facility and issued the draft EIS this past December just prior to Christmas.

We are currently in a comment period again, and the reason we're here tonight is to collect your input on the analysis done, whether we covered the right topics, whether we got enough analysis, whether we may have made any errors in the analysis, any comments that you may have that would help the Department create a document that is the best decision-making document with regards to this facility. Now, I'll come back to that decision in just a moment.

We will then take all of the comment that we get during this period. We will create a Final Environmental Impact Statement targeting for April of this year, and following that, the Record of Decision.

For this facility, there is a decision that has to be made. The decision official will be the Secretary of Energy. This document will be the basis for that decision, and it's basically on whether or not we build this facility and where we build this facility. And I'll get to those alternatives in just a moment. Well, I'll get to them right now.

The proposed action, the jargon within the NEPA process, the proposed action is to construct and operate a state-of-the-art, short-pulsed neutron research facility that will have an initial power of 1 megawatt on target but then it would have the ability to be economically upgraded to 4 megawatts as technology and additional funding are available at a later time.

The alternatives considered for this project first began with facilities. We went through a screening process and defined the four locations. The facility is proposed for location in Oak Ridge, Tennessee, but alternates, Argonne National Laboratory in Illinois, Brookhaven in New York, and Los Alamos in New Mexico, are also being evaluated to compare these locations to see if there are any significant environmental consequence differentials between those locations.

The no-action alternative is also evaluated, that is, don't build the facility, and we were also in the process of evaluating technology alternatives, though it turned out that there is really only one technology that we are proposing for this facility that

meets all of the proposed action requirements.

That facility conceptually at this stage consists of a linear accelerator that accelerates protons to approximately 80 percent of the speed of light, and an accumulator ring where we gather large numbers of these high energy protons and store them until we are prepared for a one microsecond release of all of those protons onto a target, the target being liquid mercury, a high Z material which has a large number of neutrons to proton ratio in the nuclei.

The impact of these high energy particles releases, boils off, spallates, hence the name of the facility, neutrons that have been thermalized to lower energies and then delivered to the research stations.

This is a collaborative project. There are many laboratories involved in this effort. Lawrence Berkeley is involved in the ion source, Los Alamos here is responsible for the Linac, Brookhaven National Laboratory for the ring, Oak Ridge for the target, a combination of Oak Ridge and Argonne for the actual instruments, with Oak Ridge responsible for the overall project coordination.

For the siting of this facility, just for your information, here at Los Alamos, this is a map of the LANL reservation, and the proposed location on the

13

reservation is out on one of the mesas just to the southwest of White Rock.

The document itself, as I said earlier or mentioned earlier, is based on the conceptual design report which gave us a consistent basis for evaluation. There has been a continuing evolution of the design, but we used that conceptual design report as a fixed basis so we could get on with the analysis.

There was a siting alternative process that we went through initially where we looked at the 34 DOE reservation locations. Through a set of screening criteria, we were able to define four candidate sites, the four that I mentioned, that met all of those criteria. Then within each of those four candidate locations, we did a specific site selection process to identify the best place on that reservation which would have availability of utilities, power, least potential impacts on environment, those kinds of things.

We then developed a comparable data base for all four sites. It turns out there is an enormous variation in terms of the kinds and quality of environmental data amongst those four laboratory locations, so we had to develop an apples and apples comparative base again for the Secretary and his decision on this project based upon the analysis that

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14

we did.

We then performed the analysis to try and define what are the environmental consequences of placing this facility at each of the four sites as well as what is the no-action alternative for the site, and in this process we attempted to the absolute extent possible to be conservative, i.e., whatever the conceptual design report identified as emission sources, source terms, whatever, we increased those numbers by some small amount, by some factor to be certain that if there were errors in the conceptual design, that we were within the bounds of that error.

But at the same time we tried to be realistic. We didn't arbitrarily increase emissions or numbers beyond the realm of reasonable variation. So the document again has basically this conservative but realistic approach in its evaluation.

What we found, the principal findings from the document, accelerator facilities generally have shown by their reputation, because this is not the first accelerator facility we built, they are not very obtrusive in terms of environmental impact. What you find is the major impacts being the fact that it occupies space, it sits on a footprint, and whatever is on that footprint gets moved off or destroyed or

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15

whatever, so there is an impact of placing the facility there.

There's the impact of how it affects surrounding activities. There may be research activites, there may be production activities, there may be commercial activities, whatever, and we have found that that's one of the major impacts that you find for this facility.

The second has to do with the emissions and soil activation, both in air and water, it's creation, it's migration, where the receptors are, both in normal operation and under accident scenarios for the facility, again trying to define the bound of how bad could it be in terms of the impact on the environment.

Thirdly is waste. Almost any industrial facility complex will generate some kind of waste, and we have to be able to define what we're going to do with that waste, how we are going to treat it, how we're going to store it, how we're going to dispose of it. And for each of the locations, there are some variations, and we have evaluated all of those, and they are contained in the document.

So these are the three areas that we have found as the primary impacts on the environment of this facility.

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16

We solicit your input on the evaluations contained in the draft document, and thank you for coming.

MR. HAAS: Thank you.

A copy of the draft report is available on the information table in the area outside the meeting room. In addition, there are copies that are available at each one of the sites. Here at the Los Alamos National Lab, it is available at the Public Outreach and Reading Room.

We move now to the phase of the meeting where public comment is offered. No one has signed up to make any comment, so let me ask members of the audience, is there anyone here wishing to make comment on the Draft Environmental Impact Statement?

If not, we will adjourn in just a moment.

Let me take this opportunity, however, to make you aware that during the course of your adjournment, if you wish to speak to some of the representatives here this evening about the impact statement or the spallation neutron source, they encourage you to do so.

A number of folks including Mr. Jeff Hoy and Mr. David Wilfert can talk to you about the overall project, its outline and the NEPA process.

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17

Dave Bean and Bill Fleming can talk to you about the Environmental Impact Statement document itself. Frank Karnegie --

MR. WILFERT: Dan Hartline will be covering that activity this evening.

MR. HAAS: So those individuals will be happy to answer any technical questions that might arise during the course of the informal discussions. I would encourage you to meet with those folks and ask whatever questions you have.

Again, if no one has any comment, we will adjourn until such time as someone has a comment to make. We stand adjourned.

(The hearing adjourned from 7:25 p.m. to 9:00 p.m.)

MR. HAAS: The meeting will come to order. Let the record show that it is nine p.m.

Is there anyone present wishing to make comments on the Draft Environmental Statement for the Spallation Neutron Source?

There being no one present wishing to make comment, I adjourn the meeting.

(The meeting adjourned at 9:01 p.m.)

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18

STATE OF NEW MEXICO)
) ss.
COUNTY OF SANTA FE)

REPORTER'S CERTIFICATE

I, EDITH ARNOLD FLORES, New Mexico Certified Court Reporter No. 208, and Notary Public within and for the State of New Mexico, DO HEREBY CERTIFY that I stenographically recorded the proceedings in the above-entitled hearing, and that the foregoing is a true and correct transcript of the proceedings had to the best of my ability.

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Public Hearing Transcripts - Comment Numbers H-6 & H-7
Argonne - Afternoon and Evening Sessions

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ORIGINAL

UNITED STATES
DEPARTMENT OF ENERGY

ENVIRONMENT IMPACT STATEMENT
FOR SITING, CONSTRUCTION, AND OPERATION
OF THE NATIONAL SPALLATION NEUTRON SOURCE

ARGONNE AREA PUBLIC SCOPING MEETING

Monday, January 25, 1999
1:30 p.m. - 4:00 p.m. and
7:00 p.m. - 9:00 p.m.
Argonne National Laboratory
Building 401- Advanced Photon Source
Room A1100
9700 South Cass Avenue
Argonne, IL 60439

PANEL:

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2

PROCEEDINGS

MODERATOR HAAS: Good afternoon. Welcome to the Public Review Meeting concerning the Draft Environmental Impact Statement for the Spallation Neutron Source. Translator services are available. And for those requesting translator services, a row of seats have been reserved at the front of the meeting room. Those are immediately to my right.

My name is John Haas. I am Associate Professor and head of the Department of Speech Communication at the University of Tennessee, and I have been asked to serve as Moderator for today's meeting. The goal of today's meeting is to solicit comment on the Draft Environmental Impact Statement for the Spallation Neutron Source.

In addition to providing public comment, there are other methods of commenting on the draft report for this Environmental Impact Statement for the Spallation Neutron Source. Comment forms are available at the information desk outside the meeting room. In addition, comments can be provided by mail to Mr. David Wilfert, U.S. Department of Energy, Post Office Box 2001, Oak Ridge, Tennessee, 37831; by phone at 1/800/927-9964; by fax at 423/576-4542; by electronic mail at nsnseis@ornl.gov. All of that information concerning

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addresses and phone numbers and electronic mail addresses are available on the comment forms outside of the meeting room.

Copies of the Draft Environmental Impact Statement are available in local and Department of Energy Headquarter public reading rooms. For the Argonne National Lab, the Draft Environmental Impact Statement is available at the Documents Department at the University Library, University of Illinois at Chicago. In addition, that information is also available at the DOE NEPA home page.

I want to briefly review the procedures we'll follow for today's meeting. Each individual wishing to speak on the Environmental Impact Statement for the Spallation Neutron Source will be allotted five minutes to make his or her presentation. And we ask that each individual sign in prior to making that presentation. If time allows, individuals will be allowed additional time to speak.

The meeting will open with a presentation from Mr. David Wilfert. Mr. Wilfert will be speaking to us today on the need and purpose of the Spallation Neutron Source, as well as discussing the EIS process. Mr. Wilfert wears two hats involving this project. He is the

Deputy Project Manager for the Spallation Neutron Source, and he is also the EIS Document Manager. So, I'll now turn the meeting over to David Wilfert.

MR. WILFERT: Thank you for your attendance, interest in this meeting, this process and in this project. As John said, my name is David Wilfert. I am both the Deputy Project Manager for the Spallation Neutron Source, as well as the Document Manager for this Environmental Impact Statement. That is a marriage by choice in that it provide to this process some continuity between the evolution of the technology that this EIS is evaluating, as well as if in the evaluation of that Environmental Impact of this facility, it turns out that there are mitigation actions required as we ultimately design and construct the Spallation Neutron Source, then I am in a very good position to assure that those commitments and those corrective actions or mitigating actions are, in fact, incorporated into the facility.

I'd like to speak for a few minutes about the Office of Science, in particular the Office of Basic Energy Sciences, within the Department of Energy. The Department of Energy is one of the five top agencies in the Federal Government providing advanced research or supporting advanced research across the country. And for the Department's purpose, the primary reason for this is fueling the nation's future in terms of efficient and clean, affordable energy, exploring in particular matter energies, building blocks. One of the key tools or one of the key missions of the Department of Energy in this area is to provide the tools necessary -- i.e., the big, scientific research machines necessary -- to support broad-based research over many areas of science, which I'll touch on in just a moment. But the fundamental and the bottom line is basically to enable this country the capability to provide world-class evolution and development of science.

Within the Department of Energy, within the Office of Science, the Office of Basic Energy Sciences has two fundamental missions. And these are actually established by Congressional language in the enabling legislation which created the Department of Energy. And one of those activities is to plan, construct and operate major scientific user facilities, again, to provide these very expensive, very large tools that will allow individual scientists to come in and perform their piece of research, get their data and go out and produce their new science.

As I mentioned, the areas that Basic Energy

Sciences focuses on are the areas of material and chemical sciences, geo sciences, bio sciences, engineering science, and all again towards the purpose of helping the United States be competitive in the scientific and commercial markets of the future.

The Office of Basic Energy Sciences funds a series of activities around the United States, some eighteen user facilities indicated by the stars on this map, of which five of these are high-flux neutron sources for the kinds of science that require neutrons as interrogating devices to learn about the fundamentals of matter, crystal structure, and the behavior of materials under various conditions.

It gave us many, many, many locations where there are research projects and institutions funded, but there are eight currently. Including the Spallation Neutron Source, there would be eighteen major scientific user facilities.

The science -- and, in particular, the science associated with the Spallation Neutron Source, that of neutron scattering -- originally evolved following World War II, actually in the late 1940's, early 1950's, when Cliff Schull and Brockhouse (phonetic), Schull and Brockhouse, developed this concept of using neutrons as an interrogating tool to understand molecular and crystal structures of materials. And it was out of that work that eventually they received a Nobel Prize in 1994.

The science that Office of Science, Basic Energy Sciences supports in terms of research activities over the years has actually resulted in a total of 71 Nobel Prizes out of that research and some 450 Iowa 100 awards. So, it is a very productive scientific research program that Offices supports.

In this proposal for the Spallation Neutron Source, the new instrument that is being supported by the Office of Science, Basic Energy Sciences, is again a neutron investigating tool that uses an accelerator to produce short pulses of neutrons for the materials evaluation. It's a collaborative machine involving five national laboratories involved in this project, beginning with the ion source on the front end of the machine which is being designed and the material, the components to be provided by Lawrence Berkeley National Laboratory.

There's a linear accelerator that accelerates the protons up to about 80 percent the speed of light. And, again, the design, construction of components to deliver that capability is being managed by Argonne National Laboratory. As these protons are accelerated in

pulses to this one GEV, meaning the 80 percent speed of light, they are then collected in a storage ring to accumulate a larger number of protons so that once the ring is filled in a one-microsecond burst, we in fact can release all of those stored protons onto a target. The ring, incidentally, is being managed for design construction of components by Brookhaven National Laboratory. And the one microsecond release of the protons onto a target -- the target is the responsibility of Oak Ridge National Laboratory.

We are delivering all of these protons onto a mercury target, liquid mercury target. The target needs to be a high-z material -- i.e., one that has a large neutron to proton ratio -- so that when impacted by these high-energy protons, there is a release of neutrons which, because of the pulse nature of the protons onto the target, you get a pulse of neutrons out of the target.

These pulses of neutrons are then slowed to energies of interest to the researchers who then have instruments located around the facility. The development of these instruments, the manufacturer of these instruments, is a collaborative effort between Oak Ridge National Laboratory and Argonne National Laboratory, here, to provide these instruments for this machine. There will be an initial complement of about ten instruments, though the target station will be capable of housing eighteen.

What we're here for today is part of the National Environmental Policy Act or NEPA. We are preparing an Environmental Impact Statement on this proposed action, this proposed facility. That determination to prepare the EIS was made back in February of 1995. Martha Krebbs issued a determination letter at that time. We then went into the conceptual design of the facility and completed that in May of '97. And then, once we had that information basis of the Conceptual Design Report, that is when we began the Environmental Impact Statement process formally by issuance of a Notice of Intent in June of '97.

We then went into a roughly two-month comment period to define the scope of this document. What are the things we should cover? What are the things we should address? What do we have to analyze in order to adequately understand the potential impacts of this facility on the environment? Following that input, we were then in a process of actually developing the draft document which we issued just before Christmas in

December of '98.

We are currently in the comment period between December 24 and February the 8th, where we are collecting public comment on the content of that document. Did we analyze things as we said we would? Did we, in fact, come up with the right kinds of data and conclusions? Is this document an adequate source of information that would lead to a reasonable decision or knowledgeable decision with regards to whether to build this facility and where to build the facility?

The events that will occur are that we will then take these comments that we collect; we'll prepare a final Environmental Impact Statement, hoping to issue that by April of this year, leading to a record of decision in May of this year. The decision authority on this document is, in fact, the Secretary of Energy.

The proposed action that we are addressing in this Environmental Impact Statement is to construct and operate a state-of-the-art, short-pulse Spallation Source that has an initial power level of one megawatt of proton energy onto the target, but that it can be economically upgradeable at a later time to four megawatts.

The alternatives that are evaluated in this document are, first, the location of the facility. Oak

Ridge National Laboratory in Tennessee was identified in the beginning of the process with the determination of preparing a document as the preferred location for the facility. But NEPA requires evaluation of alternatives to be sure or to understand whether or not there are locality variations and environmental impact. We are also evaluating as potential alternate sites for the facility, Argonne National Laboratory here in Illinois; Brookhaven in New York; and Los Alamos in New Mexico.

The no-action alternative is also being evaluated. Basically, are we gonna build this thing or not, to be able to make that knowledgeable decision on what are the environmental consequences of building versus not building. We also addressed in the document technology for the facility, but actually found that there is only one technology, what I've just described, as the facility that meet all of the criteria associated with the proposed action.

For the Argonne National Laboratory, a siting study was done. There were a series of candidate sites identified and using some evaluation criteria, best judgment by those knowledgeable of the circumstances on your reservation. This study was performed by Argonne National Laboratory.

The proposed site for the facility is over on the west end of the reservation just north of the APS where we are right now, and it does extend across the west entry road, which would have to be relocated around the facility were it to come here. But that's the proposed location for the evaluation of the Argonne National Laboratory.

Within the document itself, the process that we have been going through or we went through in creating this document is, first: We used the conceptual design report as a basis, a technology basis for this facility. There has been an ongoing evolution of the design since the CDR was issued so that things are changing. But what we find is that as the design is being refined, the items that have environmental consequence actually are improving, the circumstance or the consequences would likely be less, so that the conceptual design constitutes a good bounding set of information as to the impact of this facility.

After using the conceptual design report as a technology basis, then we went into this evaluation of site locations. We found a total series of candidates of 34 Department of Energy sites. We identified four evaluation criteria to narrow that field down. And that criteria basically came down to the four sites that I've identified, which includes Argonne National Laboratory.

We then went about a process of collecting comparable environmental data from the sites. It is remarkable how much variation there is in the quality and content of data for each of these four different laboratories. We had to get this document to a point where it is an apples and apples comparison. So, we worked very hard to get this comparable data base for comparison of the alternatives.

Then we went into the analysis process to evaluate what are the consequences of this facility being located at each of these four locations. And in all cases, we adapted a philosophy of: We wanted to be conservative; that is, we wanted to make sure that whatever consequences we defined, that when the facility would be actually designed and built, it would be that or less in terms of consequence, not more. We wanted to make sure we bounded what the circumstances are.

At the same time, we tried to be realistic, meaning we're not going to pick arbitrary values for source terms that are way beyond reality. We tried to keep things real but conservative.

What we found as the principal findings:

Accelerator facilities have been built across the country over many years. They've been operated for many years. They tend to be generally very benign facilities in terms of environmental consequence. And the predominant environmental consequence that we find is that it involves land use as a facility footprint. This thing is gonna displace whatever's in that 110 acres, roughly, that we plan to build this facility in.

There may also be research, production, other kinds of activities that are on the perimeter, on the fence around this thing. And there may be some impact by the fact that we are there. So, it is simply the land use issues is the major consequence.

We also gave quite a bit of attention to the potentials for emissions and soil activation of both water in the ground, as well as air emissions, and evaluated those for both normal operations and for accident scenarios. It came to trying to find: What is the bounding condition of consequence for normal operation in terms of emissions from this facility, as well as accident scenarios?

And finally, the area of consequence that we spent a lot of time on was in waste in terms of differing facilities, the four potential candidates. There's different capabilities for the treatment, storage, disposition of waste. So, we evaluated those in an equally comparable basis amongst the facilities. But these three areas constitute, really, where we found the bulk of the environmental consequences for the construction of this facility.

As I said, we are in the process right now of collecting public comment on the content of our Draft Environmental Impact Statement. We welcome your input, and we will value your input. So, I thank you for coming.

MR. HAAS: Thank you. We now move to the public comment phase of the meeting. Is there anyone present wishing to make comment on the Draft Environmental Impact Statement for the Spallation Neutron Source?

There being no one present indicating interest on speaking, I'll recess the meeting in just a moment. Prior to doing so, let me make it known that there are a number of individuals who are willing to speak on an informal basis with members of the audience concerning the project. Mr. David Wilfert and Mr. Clarence Hickey will be available to talk about NEPA, as well as the Spallation Neutron Source Project. Dave Bean and Bill

Fleming will also be available to talk about the Environmental Impact Statement document if you should desire. Until such time as anyone is interested in making comment, the meeting is recessed.

(Whereupon, a recess was had in this matter.)

MR. HAAS: Call the meeting to order. Let the record show that it is 4:00 p.m. Is there anyone present wishing to make comment on the Draft Environmental Impact Statement for the Spallation Neutron Source?

There being no one present wishing to make comment, the afternoon meeting is adjourned.

(Whereupon, the public hearing in this matter was adjourned at 4:00 p.m. and continued at 7:00 p.m.)

MR. HAAS: Good evening. Welcome to the Public Review Meeting concerning the Draft Environmental Impact Statement for the Spallation Neutron Source. Translator services are available, and seats have been reserved at the front of the meeting room immediately to my right for those requesting translator services.

My name is John Haas. I'm Associate Professor and head of the Department of Speech Communication at the University of Tennessee. And I have been asked to

17

moderate tonight's meeting. The goal of tonight's meeting is to solicit comment on the Draft Environmental Impact Statement for the Spallation Neutron Source.

Additional methods of providing comment are also available. Comment forms are available at the information desk immediately outside the meeting hall, and comments can also be provided by mail to Mr. David Wilfert at the U.S. Department of Energy, Post Office Box 2001, Oak Ridge, Tennessee, 37831. Comments can be provided by phone at 1/800/927-9964; by fax at 423/576-4542; or by E-mail at nsnseis@ornl.gov. All of that information that I've just provided you with is available at the information desk on the comment form.

Copies of the Draft Environmental Impact Statement are available in local and Department of Energy Headquarters public reading rooms. For the Argonne National Lab, that Draft Environmental Impact Statement is available in the Documents Department at the University Library at the University of Illinois at Chicago.

In addition, information about the Draft Environmental Impact Statement is available at the DOE NEPA home page. I want to spend a minute or two reviewing with you the procedures that will be used for

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18

tonight's meeting. Each speaker will be allotted five minutes to make his or her presentation, and we request that speakers sign in prior to making the presentation. Tonight's meeting will begin with a presentation from Mr. David Wilfert. He will be speaking to us tonight about the purpose and need for the Spallation Neutron Source.

In addition, he will discuss the Environmental Impact Statement process. Mr. Wilfert is the Deputy Project Manager for the Spallation Neutron Source, as well as the Environmental Impact Statement document manager.

I will now turn the meeting over to Mr. Wilfert.

MR. WILFERT: Thank you. I appreciate your turning out for this meeting, your interest in this project and this proposed facility. As John mentioned, I do wear two hats as both the Deputy Project Manager and the EIS Document Manager, which was not a random occurrence. There is methodology in that madness in that by being in a key position on the project, I have been able to provide the continuity of information about this project, about this facility and its potential for impact on the environment.

I am responsible for the development of the

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Environmental Impact Statement to utilize that information to develop the analyses to evaluate the impacts, and then if in that evaluative process, there were to be items identified in terms of mitigating actions that have to be included ultimately in the facility in order to control the impacts on the environment, I remain in a very key position to assure that those commitments and those needs that are identified in the Environmental Impact Statement get carried forward into the design and construction of the facility.

I'd like to speak a little bit about the Department of Energy and its role in science, science and America's future. The Department of Energy is one of the top five agencies in the United States and the government for sponsoring, promoting and performing research, the development of new science and new technology, predominantly to fuel America's future, having to do with clean, available energy resources, effective utilization of those energy resources, and expanding that technology out into other parts of our economy and our society, whether that be in the development of materials that improve our lifestyle, via more fuel-efficient automobiles, whether that be for medical advances,

medical technology, understanding disease processes and treatments and those kinds of things.

One of the predominant areas that the Department provides to the scientific community across the country is the providing of tools, major, large research facilities like the proposed Spallation Neutron Source, whereby scientists from industry, from universities, from other DOE laboratories, can come to and utilize these very high-capital cost facilities to do their research and extend the science and technology, the bottom line being to enable the scientists of the United States to help the United States remain competitive in our world economic markets.

Within the Department of Energy, the Office of Science, and sub to that, the Office of Basic Energy Sciences, there are two Congressionally mandated missions for that entity, for Basic Energy Sciences, the second of which -- and it's the reason why we're here tonight -- has to do with the planning, construction and operation of major scientific user facilities. Congress has directed and asks, wants this kind of an activity to go on for the promotion of excellence in basic research, relevance to the nation, stewardship to the economy, and the promotion of science.

In this area, the Office of Basic Energy Sciences has eighteen user facilities, as indicated by the stars on this map, across the United States for scientists, engineers to come and utilize these major tools to help in the development of their new technologies. The eighteen number includes the proposed Spallation Neutron Source. In addition to that, there are a number of other research projects and institutions that are supported by the Office of Basic Energy Sciences.

One of the areas of science which has proven to be very valuable to the United States is in the area of neutron scattering research. Neutron science in the Department of Energy has promoted the development of, as I say, many advanced materials. Lightweight, high-strength, temperature-resistant materials, again, make automobile use more efficient. Lighter aircraft. Better energy utilization, whether that be in electric motor magnets; the developments in high-temperature super-conductivity; understanding many of the biological processes that go on in the body, whether they be normal or errant in terms of identifying disease processes and promoting the development of treatment for those kinds of diseases.

The area of neutron science was created back just in the late 1940's at the graphite reactor in Oak Ridge. Schull and Brockhouse in 1994 were awarded the Nobel Prize for the development of neutron scattering as a technique for investigating the crystal structures, molecular structures of materials and how those structures are changing under differing environments to better understand the properties of the overall material.

Beyond just this Nobel Prize, other work that the Department of Energy has sponsored has fostered the total of 71 Nobel Prizes over the years, along with 450 R&D 100 awards. With regards to the area of neutron science, it is recognized as a very important area, one that needs support from the Department for the benefit of the nation.

The facility that we are proposing, the Spallation Neutron Source, consists of a linear accelerator system that provides high-energy protons that are accelerated to a velocity of about eight-tenths the speed of light. These protons are accumulated in a ring so that in a single pulse extending one microsecond, we can release all of those stored protons onto a target, a liquid mercury target. And through a process of spallation -- hence, the name, "Spallation Neutron Source

23

Project" -- where through the process of spallation, you have a high-Z material, high atomic number material which has a very high neutron to proton ratio. And when impacted by high-energy protons, spallates or splatters out, basically, neutrons, which are then slowed to more usable energies and provided down beam tubes to individual instruments for scientists to perform their work.

This project, as proposed, is a collaborative effort amongst five national laboratories across the country. We have given responsibility for the ion source, the creation of the protons for the acceleration process, to Lawrence Berkeley Laboratory in California.

Los Alamos National Laboratory is responsible for the linear accelerator. And when I say these laboratories are "responsible for," that means they are responsible for the design, fabrication and delivery to the site of the technical components necessary to perform this mission.

After we get the protons out of the "lin acc", they go into the storage room, which is the responsibility of Brookhaven National Laboratory, for the design, fabrication, delivery of components.

Oak Ridge National Laboratory is responsible

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24

for the target and its systems. And a joint effort between Oak Ridge National Laboratory and Argonne National Laboratory is responsible for the development of the additional complement of instruments which we believe to be ten instruments. The target station will be designed to house up to eighteen. The initial complement of ten instruments is a joint effort between Oak Ridge and Argonne National Laboratory.

The reason that we are here tonight has to do with the National Environmental Policy Act, whereby the Congress has declared that before proceeding with major federal action, that a knowledgeable decision be made of the impact of that action on the environment. Along these lines, back in February of '95, Martha Krebbs, the Director of what is now the Office of Science, then the Office of Energy Research, made the determination that we would, in fact, prepare an Environmental Impact Statement on this project. In the following approximately two years, we developed the conceptual design for this facility. That conceptual design is an information basis to define the technology, the source terms, the emissions from the facility, to serve as a basis for information for the creation of an Environmental Impact Statement.

Following completion of the conceptual design,

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in May of '97, we immediately began the actual EIS process by issuance of the Notice of Intent in June, '97, followed by a comment period which was July through September -- we were here in August, I believe -- to collect input from the public on what should the scope of this document be, to assist us, to make sure that we were covering the things that were of interest to the public.

We then went off in the process of the following little over a year to actually create the Draft Environmental Impact Statement which was issued just before Christmas of '98 on December the 24th. We are now in this public comment period beginning December 24th and going through February the 8th to collect input from the public of: Did we do an adequate job in assessing the impacts of this facility? Are there things we missed? Is there more work that we need to do to make sure that we have a document that will serve as a good basis for a decision on whether to build the facility and where to build the facility.

The information base as modified by the comments that we get through this process will be incorporated in the final Environmental Impact Statement which we hope to issue in April of this year. Then that will lead to the record of decision -- this decision of

do we build, where do we build -- in May of this year. That's kind of the target of our schedule. The decision authority in this instance is the Secretary of Energy, and he will be the one who will make that decision.

The information that we are developing for this decision process initiates with a proposed action. The proposed action by the Department is to construct and operate a state-of-the-art, short-pulsed neutron research facility that has the capability of providing one megawatt of proton power onto the target at its initial operation with the potential for economically upgrading the facility to four megawatts of proton power under the target. The significance of the one megawatt, four megawatt has to do with how many neutrons can be provided to the researchers, that more neutrons allow them to do better, quicker and in some instances research that cannot be done otherwise without the greater number of neutrons.

The alternatives that are evaluated in this report are, first, the facility location. Oak Ridge, Tennessee was identified at the inception of this process as the preferred location for the facility. But it is required under the National Environmental Policy Act to evaluate alternatives to your proposed action; and alternative siting is one of the issues that has to be evaluated to determine whether or not there are significant variances impact for this facility based upon its location and placement. So, the alternate locations are Argonne National Laboratory here in Illinois; Brookhaven in New York; and Los Alamos in New Mexico.

Another of the alternatives we evaluated was the no-action alternative -- i.e., what if we don't build the thing -- and the impacts that are associated with that as compared to building the facility.

The third alternative that we investigated was one of technology. What is the right machine to perform this research mission? And, in fact, though, what we found was: There was only one technology, the one I've described with the linear accelerator storage ring target, that met all of the criteria necessary in the proposed action.

For Argonne National Laboratory, there was a siting process done that identified the candidate location for the facility on the western edge, northwestern edge of the overall reservation. The siting evaluation that was done here -- I think there were four specific sites that were given consideration. And based upon a study done by Argonne National Laboratory with

those people who are knowledgeable about this site, tried to identify a location which met the mission parameters of the facility and at the same time, to the extent possible, avoided environmentally sensitive areas.

What we found in the document as we prepared it -- well, the process that we went through in preparing the document -- as I mentioned earlier, the Conceptual Design Report constituted the basis for the preparation of our Environmental Impact Statement that it provided a common basis of information even though conceptual design activities and advanced conceptual design activities have continued, and we know more about this facility today than we did back in the middle of 1997 when we started the EIS process. Essentially, everything we know about this facility has had the effect of reducing impacts on the environment. But what we're trying to accomplish with this document is to be sure that we have bounded the worse-case or what is the most impact this facility could have on the facility [sic].

Having the Conceptual Design Report as the basis, the next step was to identify the alternate sites. And we looked at a potential universe of 34 Department of Energy sites for the placement of this facility; defined criteria having to do with availability of power, space requirements, buffer zones to surrounding population, whatever. And we narrowed the 34 down to 4 candidate locations, the four I mentioned: Oak Ridge, Argonne, Los Alamos, Brookhaven.

Within each of those candidate locations, we had a study done at each of the sites, whereby we identified a specific site at the location that would best serve the needs of the facility and at the same time provide minimal impact on the environment.

Our next challenge -- indeed, was a challenge-- was the collection of comparable environmental data amongst the four sites. There seems to be an awful lot of differential in the way data is collected and managed at all the Department of Energy laboratories, and we had to come up with a means of coming up with an apples and apples comparison of the facilities, again, since this document is to serve the purpose of a decision resource for the Secretary in his record of decision.

Having developed that comparable data, we then went into the analysis that is contained in the document, and we adopted a philosophy of: be conservative but realistic -- i.e., we are trying to be sure that we have absolutely bounded the impacts on the environment, but at the same time not drawn the box so big that it has no

basis in reality. We wanted to be sure that we were showing the extent that the impacts could be without overstating those impacts.

The basic results, the principal findings that we have identified and documented in the Draft Environmental Impact Statement is -- actually, not surprising to those in the business -- is that land use is the predominant impact for the facility. Accelerator facilities have been designed, built and operated across the United States for many years, and they tend to be very benign facilities. So, it's basically the clearing away of the 110 acres that we need for this facility and the displacement of whatever is there, as one of the major impacts and the satellite impacts of the activities that might be going on immediately around the facility and how we might impact that.

Another area that we paid very careful attention to was the emissions and soil activation of the facility, how might this facility put something out that would impact the environment, the surrounding communities, those kinds of things, both in air and water-borne transport mechanisms, and both under normal operations and conceived accident scenarios.

The third area that we focused attention on was

31

in the process of waste -- waste handling, waste treatment, disposition -- because the capabilities for handling and treating waste varied amongst the four different locations.

So, these were the areas that we spent most of the effort on in this document, and they are the areas that provided the greatest insight into the impacts of this facility. As I said earlier, we are here tonight to collect comments on this draft document. We seek your input, we value your input and ask that you provide comments. And we'll honor them accordingly. Thank you.

MR. HAAS: Thank you. We now proceed to the public comment phase of the meeting. I believe Mr. Russ Zizek is the individual who has registered to speak first.

Mr. Zizek, would you please approach the front of the room and, for the record, state your name and spell that if you would, please.

1 MR. ZIZEK: My name is Russell Zizek. I'm a homeowner. I live on Kearney Road directly outside this facility, second house outside the facility. Being situated there, I dare to object on record against this project being put in this location. There are several criteria which you mentioned, and I've read them in your

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32

1 vast information here. And it seems like there's a lot of criteria brought up by the Department of Energy that's been either overlooked or ignored. Perhaps you operate by leaving this go 'til after this particular part of the function and then taking a name off the table. However, I would hope that with all of the criteria failing, Argonne would have already been taken off.

Brings me to the question I asked myself: Why are we even here? The first criteria: There's a one-mile buffer around the site that's your criteria. There's no way 1500 acres of land, which it states in here somewhere, that Argonne possesses can create a one-mile buffer around any point on the facility. Can't do it.

2 Another point I object to is the possible contamination of ground water. In your EIS Statement, it says that drinking water is taken not from the upper ground water which is, I believe, 65 feet; and that's the point at which you believe the contamination will get down to. Below that, you don't believe -- again, according to the EIS -- that it will reach the lower level of about 165 feet due to the clay and so forth above it.

However, you do state that it's not a hundred

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33

2 percent sure that that won't happen due to the various types of materials in the ground. So, in a way, you're saying it won't happen. But you're saying you can't be sure of that. I drink well water. There's 35 homes -- I live in the area between I-55 and Argonne and between Lemont Road and Cass Avenue. In that area, there's 35 original houses, I'll call them. Let's say they're 30 years old or better.

3 In addition to those houses, there's a project which is going to be located 750 feet from the site of this SNS, which is gonna contain 115 townhouse units, 64 condominium units, a hotel, and a gymnasium. They are on Lake Michigan water, as you are. So, I guess as far as the water issue is concerned, they're protected from that. But those of us who have wells, the only way we can get Lake Michigan water is to genuflect in front of the Mayor of Darien and ask him if we can please have some Lake Michigan water. They tried that with Argonne; and Argonne, I guess, told them they would take other ways. And they got it directly from the County. We all would appreciate Argonne using that same maneuverability to get Lake water for us without going through Darien since we are in this no-man's land of water situation.

4 The other impact is on human health. I went

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34

4 through all the tables as comparisons of the different laboratories. And it's shown on one page, "Operation would result in 1.3 LCF's." I don't know what "LCF" meant. But, anyway, it would result in something in the offsite population attributed to the SNS.

On the next page, it showed, "Anticipated effects to offsite population would be 1.3 excess LCF's over 40 years." And then it addresses one anticipated accident resulting in 2.1 LCF's. Well, this I read in a summary, and the summary didn't contain the definitions for the acronyms. But then later, I got the full manual, and I discovered "LCF" means latent cancer fatalities. Well, I don't know -- You know, there's a lot of tradeoffs in life. And I imagine the community that you people live in maybe feel this is not a significant number. But I'm sure if you were one of the two LCF's, it would be rather significant.

MR. WILFERT: You are absolutely correct.

MR. ZIZEK: 3 As far as the water, I quite frankly don't trust the water anymore. I've been buying water in the store for 20 years. Feel like sending the bills to Argonne for that. But the LCF's don't thrill me to any means. 5 I think it would be enlightening and maybe a little more neighborly if in any future charts of this

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type, maybe once a page you would spell out what these acronyms mean. A lot of people, they read things -- and especially laymen like myself -- you read something, you
5 don't understand it, you say, "Well, it can't be too bad." It just means something. Inside joke. So, you go over it.

It sums up on Page S62 that there is a potential for adverse radiological impacts on human health from normal operations. I take that to mean just what it says, "normal operations." Nothing out of the unusual. And the main thing which makes me wonder why we're here is this, seems to me, total disregard of the DOE's own criteria. I've already stated the one-mile buffer; no way you can meet that. And that's been overlooked. And it seems to me that should have been an initial move to pull Argonne out of the mix.

And then later on, there's another, a criteria
1 of 500 meters to any existing occupied structure. Well, I'm not a scientist, but I think 500 meters is 1500 feet. And 1500 feet from the current crossroads of -- I wouldn't say the current crossroads -- from your map showing where this site ends, the northerly portion of the site, is 1300 feet to occupied residents. And I'll even go so far as not to lie to you. It's not occupied

right now. In fact, the house is empty because it's been
1 sold. And it's already been rezoned to build thirteen single-family houses there. So, they're gonna be within your 500-meter lower criteria.

MR. WILFERT: Yeah.

MR. ZIZEK: 750 feet from the northwest corner of your footprint is where the 115 townhouses, 64 condominiums and so forth are located.

Kearney Road has three, four houses along it between the forest preserve property and frontage road. And there's a new house built there, which is now in Darien. They get city water, however. There's another street to the west. Ruth Drive has about ten houses. They all have well water. And they're within the same,
1 within the 1500-foot criteria.

In addition, between our houses is the forest preserve. And the forest preserve has a designated hiking, riding, recreation pact which is 250 feet only from your fence. And your fence would be maybe, I would guess, 400 feet from the end of this footprint to your new facility. So, it seems like you set up these criteria, and you stumble over them, but you never recognize them. I hope you're gonna recognize them now sometime in the very near future and agree that this

37

1 shouldn't be built here at Argonne.

MR. WILFERT: If it's a good time just to make a comment, it's clear you have read this document well. I appreciate that. I appreciate your insight. Many of the criteria were established from distances far away with lack of knowledge of the facility. It is geographically possible to place the facility here and have the mild buffer kind of thing. And that criteria was established and the choice made like two years ago. Yes, a lot of information has been created. And that's what we're trying to do, is to actually identify that the realities of the situation were different than the perception two years ago, and have that information for the decision-maker. So, your input is very valuable; and it will be included in the documentation as is provided to the Secretary for his decision.

6 MR. ZIZEK: All right. Thank you for that. I thank you for listening to me. I would also ask, though, in the future -- I discussed with various neighbors in the area. And no one, I don't believe, has received any information on this. Maybe they refused it if they were asked if they wanted it. But I would say a very small portion of the 35, 40 houses in the area received any information on this proposed project. I think it would

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38

6 be far more correct if when Argonne was contemplating anything that would change drastically their operation, that the public around the facility be informed to participate in meetings such as this. If they're not informed, they can't participate.

MR. WILFERT: Certainly. We have a member of the Public Information Office here at Argonne available. They are our resource -- because I'm out of Oak Ridge -- as to the list of stakeholders for the area. And they need to listen to that and be sure that the individuals you're speaking to are included on the list of stakeholders. And, certainly, if there's any of these people who desire the documents, please, I'd ask, carry to them one of those comment cards; have them call the 800-number, anything. Ask us for the documentation, and we'll certainly get it to them as quickly as possible.

6 MR. ZIZEK: What I was speaking, though, was prior to this meeting so that they would have a chance to also participate. You know, maybe they don't have the same view as I do. Maybe you would benefit from something they might say, too. But in County procedures, when a simple thing like zoning is changed, they have to by law notify everyone in the immediate area that owns property so that they know what's going on and

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39

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participate. And if I'm not mistaken, I believe some air and water permits from the EPA require large facilities to keep the public informed as to what's going on in their facilities. So, that might be an idea. I would hope it would be, that it would be more an automatic thing to give the information to the local people rather than make them seek it out. Thank you for your time.

MR. WILFERT: Sure. Thank you. Appreciate it.

MR. HAAS: Thank you. I believe we have a second speaker who has also indicated an interest in making comment. I would ask that individual to step to the table and identify himself or herself. Is that the case?

No one present wishing to speak about the Draft Environmental Impact Statement? Surely, then, I will recess the meeting. In the meantime, however, let me make you aware that there are a number of individuals here who will discuss the project on an informal basis. David Wilfert is available, as well as Clarence Hickey, to discuss NEPA as well as the Spallation Neutron Source Project.

David Bean and Bill Fleming are also available to discuss the Environmental Impact Statement document, and they'll be happy to speak with you during the recess.

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40

There being no one present wishing to make public comment, the meeting is in recess.

(Whereupon, a recess in this matter was held.)

MR. HAAS: Call the meeting to order. Let the record show that it is 9:00 p.m. Is there anyone present wishing to make comment on the Draft Environmental Impact Statement for the Spallation Neutron Source? There being no one present, the meeting is adjourned.

(Whereupon, the public hearing in this matter was concluded at 9:00 p.m.)

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C E R T I F I C A T I O N

CAROL DAWLEY hereby certifies that this is the transcript of the proceedings in the following matter:

In the Matter of: National Spallation Neutron Source - Argonne Area Public Scoping Meeting

Date: January 25, 1999

Place: Argonne, Illinois

That the foregoing public hearing was reported by her by means of electronic audio sound recording, was thereafter reduced to typewriting under the direction and supervision of AIN Reporting Service and constitutes a true and correct record of the above-referenced proceedings.

That said proceedings were taken before her at the time and place specified;

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ANNE I. MAZIORKA
Notary Public, State of Illinois
My Commission Expires 2/21/2000

CAROL DAWLEY

SUBSCRIBED and SWORN to before me
this 31st day of January, 1999.

Notary Public

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Public Hearing Transcript – Comment Number H-8
Brookhaven – Afternoon Session

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SITE PLAN MEETING

SPALLATION NEUTRON SOURCE

Brookhaven National Laboratory

January 21, 1999

2:00 p.m.

A P P E A R A N C E S

JOHN HAAS- MEDIATOR

DAVE WILFORT- DEPUTY PROJECT MANAGER and ENVIRONMENTAL IMPACT STATEMENT DOCUMENT MANAGER

JEFF HOY- PROGRAM MANAGER

DAVE BEAN

BILL FLEMMING

FRANK KARNEGAY

3

MR. HAAS: Good afternoon. Welcome to the public review meeting concerning the Draft Environmental Impact Statement for the Spallation Neutron Source. My name is John Haas. I am an associate professor and head of the Department of Speech Communication in the University of Tennessee and I have been asked to moderate the meeting.

The goal is to solicit comments on the Draft Environmental Impact Statement for the Spallation Neutron Source.

Before we begin, I wish to review a couple of items of interest. Translation services are available for those in need of them, and we do have reserved seats for those requiring translation services.

In addition to providing public comments to today's meeting, there are other ways of providing comments. These other mechanisms for those wishing to provide comments are; comments can be mailed -- and there are some information sheets and comment sheets that are available at today's meeting that have the return address on them. Comments can be mailed to David

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4

Wilfert, PO Box 2001, Oak Ridge, Tennessee 37831.

In addition, there are some other mechanisms. There is an 1-800 number. People wishing to provide comment on the EIS phone 1-800-927-9964. Fax services are also available, and that number for faxing, which is on the comment form. That number is area code (423) 576-4542. There is also an E-mail address by which comments can be sent that is also on the comment form that is available here at today's meeting; that address is NSNSEIS@ornl.gov, G-O-V. There is also a web site that is available where people can receive a DOE statement, and that is tis.eh.doe.gov/nepa/.

If anyone also wishes to acquire a draft of the Environmental Impact Statement, those are available at all four sites where the facility is under consideration. Here at Brookhaven the site is located at building 477A, Brookhaven Avenue.

Today, for those wishing to make public comment, each speaker will have approximately five minutes to make comment

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5

concerning the Draft Environmental Impact Statement for the Spallation Neutron Source. We ask that those wishing to make comment sign up, and those wishing to make comment identify themselves prior to making the comment so we might keep that information for the record.

At today's meeting we have two individuals who will provide us with the information concerning the Spallation Neutron Source; Mr. Jeff Hoy, the program manager for the Spallation Neutron Source out of the Office of Basic Energy Science, Department of Energy headquarters, will speak to us for approximately ten minutes concerning the purpose and need of the Spallation Neutron Source; and his presentation will be followed by Mr. David Wilfert who wears two hats. He is the deputy project manager for the Spallation Neutron Source, in addition to being the Environmental Impact Statement document manager, and he will be speaking to us today about the Environmental Impact Statement process.

So, let me go ahead and turn the meeting over then to Mr. Jeff Hoy.

MR. HOY: Thank you, John,

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6

and thank you for coming here.

I wanted to spend just a few minutes giving you some background to help explain the purpose and need for SNS. You may know the Department of Energy, one of its major missions has to do with advancing the frontiers of science on behalf of the United States.

We are one of the five largest government agencies sponsoring basic and applied science in the United States. We are the number one sponsor of RD facilities in the United States. It is no surprise that the purpose of that research is primarily directed in considering that we have affordable and clean energy sources to use now and in the future. It's all aimed at investigating the impacts on the population and the environment generating and using this energy.

We also do a large amount of basic original research and understanding the fundamental nature of matter and energy, and we have a system of national laboratories, Brookhaven being one, that houses a number of facilities and tools for supporting research in the United States, and we are very proud of the track record

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that we have accumulated over the past few decades in research.

We sponsored seventy-one Nobel prises and over 450 RND 100 awards. That is twice as many as any other federal agencies and more than any other single entity in the United States.

Within the Office of Science I represent, as John mentioned, the Office of Basic Energy Sciences. We are charged, actually, by federal law to plan, construct and operate major scientific user facilities to be used by the general research community. This is a public service that we provide. These researchers come from all sorts of institutions, universities, private industry, as well as federal laboratories.

As you can see at the bottom here, we sponsor research that covers a wide range of disciplines from material science to bio-engineering, experimental sciences and so forth.

To give you a bird's eye view of the major user facilities that we support, there are eighteen of these, if you include the

proposed SNS, around the country. Five of these are, if you include SNS, high-flux neutron sources.

The nature of neutron research is as follows: DOE has been on the ground floor of the development of this field. As you might know it involves the use of subatomic particles, neutrons, as probes to understand the structure of dynamics of matter. We have been pleased that this has been an expanding area of research with a very strong track record of accomplishments.

There have been a large number of applications from this basic research that resulted in development of new light-weight high-strength materials for a variety of applications; super-conducting magnets, semi-conducting materials for electronics industry and so forth. Materials that people see and use in their everyday lives.

Since 1984 the department has sought advice on what it should be doing to build new facilities to support the field of neutron science in the United States, and it's

9

been from these external advisory committees of scientists that we have developed the proposal to build this Spallation Neutron Source.

So without any further delay, I will turn the floor over to my colleague, Dave Wilfert, who would tell you more about the project and the need of Draft Environmental Impact Statement.

MR. WILFERT: As John mentioned a few moments ago, I am Dave Wilfert. I am with the Department of Energy. I am functioning currently as the department project manager for the Spallation Neutron Source project and also the document manager.

The significance of that dual role and the value of that dual role is that I have been in a position to bring to the NEPA process the preparation of the Environmental Impact Statement, the resources of information about the physical machine that we are proposing to build; and second, the result of this evaluation of the machine's impact on the environment, if there are mitigating actions that have do be taken in the evolution of the design of

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10

the machine, and having a good position to insure that those commitments follow on through until the completion at the facility is designed and constructed.

The NEPA, National Environmental Policy Act, process as a series of activities that it flows through to completion that began back in February of 1995 where the determination was made to produce an Environmental Impact Statement for the proposed SNS. We then completed the conceptual design report in May of'97, and that formed the technical basis for what this machine is for the purpose of evaluating the impacts on the environment.

Following the conceptual design and exclusion, we then issued a notice of intent to begin the actual NEPA process, the environmental process, back in June of '97.

We shortly thereafter went through a public scoping process. We came here to Brookhaven, had a meeting and received comments on the scope of the document that should be created. Since that we have been working on the impact statement and asked that document as a draft

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document just prior to Christmas of '98.

We currently are in a comment period with regards to the content that that document, the analysis that we performed, the conclusions that are reached, the solicit input from the public to the research of that document to find our what is missing to make sure that the public understands what information is contained there.

This document will serve as a discussion document for the Department of Energy and we will take the draft document as modified based on the comments that we get and produce a final Environmental Impact Statement trying to have that out by April of this year, and this will be the basis for the discussion by the department with the secretary of energy, being the decision official to decide fundamentally on this project, is; do we build this project or not, or where do we build it, and there is an array of locations that are considered for the facility, which I will get into in just a second.

The proposed action for this facility is to construct and operate

state-of-the-art accelerator based neutron facility producing pulses of short pulses of neutrons that would have an initial operating power of one megawatt of accelerated protons delivered on the target for the potential of upgrade to four megawatts.

The alternatives that were considered in this, and I mentioned there were an array of locations considered, being considered for this facility are Oak Ridge National Laboratory, which is identified as the preferred for the department, but in order to understand why there are variations in environmental impact based upon physical location of the facility, we also are evaluating alternate sites of Argonne National Laboratory, Illinois, Brookhaven National Laboratory here in New York, Los Alamos National Laboratories out in New Mexico.

The no action alternative, what if we don't build this facility, is again that piece of information necessary on whether or not we should build this facility understanding environmental consequences of that action, the building, the facility. We negotiate for construction of the facility and actually found that there is only one technology valuable that met all of the action criteria.

The facility, as it is conceived at the present time, consists of a linear accelerator, which is about 550 to 600 meters long to accelerate protons to eighty percent the speed of light. We collect those protons in a storage ring so we could release all of the stored protons to a target in one microsecond, because we are trying to get charge. We reduce the protons on the target liquid mercury. It is the interaction of these high protons with the nuclei of the mercury that splatter off neutrons from the nuclei of the mercury which those neutrons are to useable energies and distributed out to research instrumentation for the actual instrument that the structure of the materials.

This is a collaborative method that's a multi-laboratory activity. We have Lawrence Berkeley report responsible for the ion source; Los Alamos is responsible for the design construction of components of the

accelerator; here at Brookhaven the design and fabrication of the components for the storage ring; Oak Ridge is responsible for the target instrument, and a combination are responsible for the actual instrumentation that would be used for the management on the facility.

Here at Brookhaven National Laboratory we did an evaluation of the location of the facility and found the best location, and this was based upon criteria of availability of power, access to cooling water, time sources, avoidance of environmentally sensitive areas. And the location is just to the east and slightly to the south of the rick facility (phonetic spelling), that is just near completion here at Brookhaven.

With regards to the actual Draft Environmental Impact Statement as it is currently out on the street, again, we used the conceptual design report for the basis of that document. We went through alternate analysis identifying the four candidate locations for the facility out of potential thirty-four DOE locations. We then came up with site specific criteria to determine and specifically lead to the

15

location I just identified on the map. We then went through a process for all four of the specific locations to try and develop comparable data. There is actually an awful lot of variability among the different laboratories. We focused on getting the right kinds apples and apples comparison on the site. We then went into an analysis to evaluate impacts of the facility being placed at these four locations, and in all instances we try to install a philosophy of being conservative yet realistic. We do bound the impacts of the facility making sure that whatever it turns out to be will be that or less than.

In terms of impact, we are trying to be realistic, not to be unrealistic. What we found, in terms of the evaluation, is that there are actually three areas of impact that this accelerator facility has it's most notable -- its greatest level of impact, and those are; first, in terms of land use, the fact that we will identify a footprint and that there may be some disruptions of spaces with rendering environmental research around the facility.

The second area has to do

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16

with emissions and soil activations of both air and water both in normal and accident scenarios, and have evaluated what those impacts are at each of the four sites; and then ultimately, in terms of waist, the facility will generate and how that waist is going to be imagined, treated, disposed of, as the candidates of each of the four sites.

I am not saying that they are major impacts. I am just saying that those were the ones that we found were the most significant with that bit of information.

Again, we have the Draft Environmental Impact Statement on the street and we are soliciting comment on the contact of the evaluation.

I appreciate your attention. Thank you.

MR. HAAS: We move now to the public comment phase of the meeting. So let me ask if there is anyone present who wishes to make comment on the Draft Environmental Impact Statement for the Spallation Neutron Source.

(NO RESPONSE)

MR. HAAS: There being no

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one present wishing to make comment, I will adjourn the meeting in a moment.

Let me provide you information prior to the adjournment. If you wish to discuss the project on an informal basis, there are a number of individuals here, resource people, for discussing the project; Mr. Jeff Hoy and Mr. David Wilfert can talk about the project, its blueprints and the NEPA as well. Mr. David Bean and Dr. Bill Flemming can talk to you about the Environmental Impact Statement document, and also Frank Karnegay. Mr. Frank Karnegay can talk to you about any technical questions concerning the Spallation Neutron Source, and those individuals are available to speak to you concerning those topics.

Once again, is anyone present wishing to make comment on the draft Environmental Impact Statement for the Spallation Neutron Source?

(NO RESPONSE)

MR. HAAS: The meeting stands adjourned until such time someone wishes to make comment.

(Whereupon, at 2:19 p.m. the meeting recessed until 4:00 p.m.)

MR. HAAS: I call the meeting to order.

Let the record show that it is 4:00 p.m. Is there anyone present wishing to make comment on the Draft Environmental Impact Statement for the Spallation Neutron Source?

(NO RESPONSE)

MR. HAAS: There being no one present wishing to make comment, the afternoon meeting is adjourned.

(Time noted 4:01 p.m.)

19

C E R T I F I C A T E

I, JOANN BUNZE, reporter, hereby certify that the foregoing transcript consisting of 19 pages is a complete, true and accurate transcript of the foregoing site plan meeting, held on January 21, 1999 at Brookhaven National Laboratories in the matter of the Spallation Neutron Source.

I further certify that this proceeding was recorded by me, and that the foregoing transcript has been prepared under my direction.

JOANN BUNZE

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Public Hearing Transcript – Comment Number H-9
Brookhaven – Evening Session

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1

SITE PLAN MEETING

SPALLATION NEUTRON SOURCE

Brookhaven National Laboratory
January 21, 1999
6:00 p.m.

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2

A P P E A R A N C E S

JOHN HAAS- MEDIATOR

DAVE WILPERT- DEPUTY PROGRAM MANAGER and ENVIRONMENTAL IMPACT STATEMENT DOCUMENT MANAGER

JEFF HOY- PROGRAM MANAGER

DAVE BEAN

BILL FLEMMING

FRANK KARNEGAY

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3

MR. HAAS: Good evening. Welcome to the public review meeting concerning the Draft Environmental Impact Statement for the Spallation Neutron Source. For those needing translator services, those services are available. We have reserved seats in the meeting for those needing those services. Anyone wishing to identify the need I ask to step forward. We don't appear to have any takers.

My name is John Haas. I am an associate professor and head of the Department of Speech Communication in the University of Tennessee and I have been contacted to moderate today's meetings. The goal is to solicit comments on the Draft Environmental Impact Statement for the Spallation Neutron Source.

In addition to providing public comments to today's meeting, there are other ways of providing comments. These other mechanisms include; via the phone there is a 1-800 number, that number is 1-800-927-9964; by fax, (423) 576-4542; through electronic mail, NSNSEIS@ornl.gov, and also there is a web page with the address of tis.eh.doe.gov/nepa/, and

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4

information concerning the Draft Environment Impact Statement can be obtained from there as well. Copies of the Draft is available at all of the sites and at the Brookhaven National Laboratory area.

There are three separate sites where draft copies can be obtained. That includes the Brookhaven National Laboratory research facility in building 477A on Brookhaven Avenue; at the Longwood Public Library in Middle Island and at the Mastic/Shirley Community Library in Shirley.

For those wishing to make public comment here tonight, we ask that each speaker make his or her comments in five minutes, and providing that the opportunity presents itself, you will have the opportunity to provide additional comment beyond that. We do ask that speakers take the opportunity to sign up, and when they are making their presentation, if they would identify themselves so we have their name on the record.

With us tonight we also have two individuals to discuss the Spallation Neutron

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5

Source; Mr. Jeff Hoy, who is the program manager for the Spallation Neutron Source, Office of Basic Energy Sciences at DOE headquarters, will discuss with us the purpose and need for the Spallation Neutron Source; and Mr. David Wilfert, who is wearing two hats, he's the deputy project manager for the Spallation Neutron Source as well as the Environmental Impact Statement document manager. He will be discussing with us today about Environmental Impact Statement process.

Let me turn the meeting over now to Mr. Jeff Hoy.

MR. HOY: Thank you, John, and thank you for coming out on a cold rainy night to be with us here.

As John mentioned, I represent the Office of Science of DOS headquarters in Germantown, Maryland. I just want to take a few minutes to give you some background behind the Department of Science programs support of the facilities, such as the SNS.

One of the department's primary missions is to support advancement of the frontiers of science on behalf of the United

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6

States. We are one of the top five federal agencies that fund both basic and applied research. We are the number one federal agency that funds RD facilities.

As you might expect, our research is aimed at insuring that we have affordable and clean supplies of energy to use in the present day and in the future. We also aim our research at understanding the impacts on the population and the environment generating and using this energy. Thirdly, we do a lot of basic research and understanding the basic nature of matter and energy, and we have a system of national laboratories that host a number of extraordinary tools and facilities the scientists use for advancing our knowledge.

We are very proud of the quality of the research that has been done under the sponsorship of the department. We have funded seventy-one Nobel prises over the years, and over 450 RND 100 awards. This is more than anyone, any one single entity in the United States, and more than twice as many as any federal agency.

Within the Office of Science

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I represent the Office of Basic Energy Sciences. It is actually charged by federal law with responsibility for planning, constructing and operating scientific user facilities around the country, and we do this as a public service. Part of our mission is to foster community of scientists and researchers from a variety of institutions, both in academia at national laboratories such as Brookhaven, and private industrial laboratories.

The research, as you see along the bottom, spans a very wide range of scientific disciplines. To give you a bird's eye view of the major facilities that we support, including the proposed Spallation Neutron Source, we will support eighteen scientific user facilities. These are used by some 6,000 researchers annually. We support 1,400 research projects from roughly 200 institutions. Among these research facilities are five, including the proposed SNS high-flux neutron sources.

Just to say a few brief words about neutron science, DOE was responsible for the genesis of this discipline back in the

1940s and has helped foster its growth. We operate most of the neutron sources in the United States. Not all of them.

As you might know, the neutron is a subatomic particle that is used as a probe to explore the inner structure and dynamics of a variety of materials. This type of basic research has lead to a number of applications that we encounter in our everyday lives. Applications that involve things such as light-weight strong materials, advanced super conducting materials for magnets, semi-conductors for the electronics industry and so forth. Also, medical advances have been made with the help of neutron research.

So, the department, in making sure that users have an adequate set of facilities to conduct neutron research in the future, the department has charged scientific advisory committees to give us advice on what the next generation of neutron sources should look like, and they have given us a series of reports, recommendations dated from 1984 that have lead to the SNS conceptual design.

So, without any further

adieu, I will turn the floor over to my colleague, David Wilfert who will tell you more about the Environmental Impact Statement, the process that was used to develop it and also about the project, itself.

MR. WILFERT: Again, I am David Wilfert and I do wear two hats, but that is a strategic choice, not a random event.

By being both the department project manager for the Spallation Neutron Source and the NEPA document manager, the EIS document, for example, I can provide a series of continuity of the evolution of the design, the technology of the machine and how that machine is expected to be, in terms of its influence on the environment, as well as being in charge of the evolution of the document, itself, to be sure that information is properly utilized, and should the impacts on the environment allow for mitigation actions, and so forth, as we get through the Environmental Impact Statement and the NEPA process, I am in a key management position to insure that those commitments from mitigations get carried on into the ultimate design of the facility. That was not

a random act.

The process, the National Environmental Policy Act process, began back in 1995 when the director of the Office of Energy Research now called the Office of Science made the determination that for this project we would prepare Environmental Impact Statements. We then went to the process of preparing the conceptual design in May of 1997, which formed the technical evaluation of the facility on the environment, and immediately following that we came out with the formal notice of intent that we would be preparing that document, and followed by a public scoping period of the scope of the document.

What we have analysed over a period of over a year and actually developed the document out for review in comment, and that's the period we are in right now, with the comment period going through February the 8th, where we are soliciting input from the public of; do you understand the analysis, is there something we missed trying to get that input from the public; and what this is for, is for the purpose of supporting the creation of a final Environmental

11

Impact Statement targeting from April of this year, and this document will serve as a decision tool for the secretary of energy who will be the decision authority on this project, who will be making and issuing a record of decision targeting for May of this year.

Now, that decision, what is that? What's it about? It addresses first the proposed action to construct and operate a state-of-the-art short pulsed neutron research facility. It's accelerator based. It would have an initial power level of one megawatt of proton, high-energy proton power on the target, but having a capability to upgrade as high as four megawatts of power on target.

The alternates we evaluated-- and this is getting into what that decision is all about that the secretary would be making -- first was on the facility location, the proposed action. The preferred alternate for the facility is to locate it in Oak Ridge, Tennessee. NEPA requires the evaluation of alternates, and we are evaluating Argonne National Laboratories, Illinois; Brookhaven National Laboratories here in

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12

New York and Los Alamos, New Mexico as other sites for the facility to determine whether or not there are any environmental variations of the placement of the facility.

Another of the potential alternates is no action. Don't build it. So, the decision the secretary will be making is whether or not to build and where would it be built, and that's what would be documented in that record of decision.

We also evaluated some technology alternates within the document, but the actual result was there is only one technology valuable that meets all of the criteria of the proposed action for the specific machine that we are trying to create.

The SNS, in its concept, is basically a linear accelerator that's about 550, 600 meters long that accelerates protons to a speed of velocity of eighty percent the speed of light to one billion electron volts. Then we collect those high energy protons in a storage ring.

After collecting a large

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number, then in one micro-second we release all of those stored protons to a target. The target is liquid mercury, and through the process of spallation, basically striking a neutron rich nuclei of mercury, neutrons are splattered, boiled off instant, what spallation is, where the name comes from, those neutrons, they are born in the target are distributed out for the research community and charged out to research in the target state.

The overall facility design and construction is a collaborative effort among five laboratories; the department Lawrence Berkeley, who is responsible for the design and the creation of all the components for the ion source; the Los Alamos Laboratory is responsible for the design and development, procurement, delivery of materials for the accelerator. Brookhaven here is responsibly for the components associated with the storage ring. Oak Ridge is responsible for the target, and collaboration between Oak Ridge and Argonne Laboratory is responsible for the development of the particular instruments that would be used in the particular

facility.

On the reservation here at Brookhaven National Laboratories a site and study was done by defining a series of selection criteria; of availability of power, access to cooling water, footprints, attempts to avoid environmentally sensitive areas. And the location to be optimum for the location of this facility on the reservation of Brookhaven is just to the east and very slightly to the south of what would be the rick facility (phonetic spelling) that is just near completion.

In preparing the Draft Environmental Impact Statement, as I said earlier, we used the conceptual design report as a basis for the analysis performed. The design is in the process of continuing to mature and there are things that we learn to make this a better facility; not only technically, in terms of what the machine will be capable of doing, but also in terms of its impact on the environment; meaning as the design is evolving, it's becoming less impacted, but we use the conceptual design report as a fixed document.

We went through this site selection process where we identified four candidate locations, among thirty-four potential in the United States, and using a set of four selection criteria we narrow the four locations that we identified on the earlier slide, and then we did a specific value to specific locations on each of those four national laboratory reservations.

We then went about a process of collecting comparable information from each of the four locations. This is an awful lot of variability in the way data is compiled and collected in the process to get apples and apples information for comparing the laboratory alternates.

Next we went into the analysis process where we analyzed the information from the conceptual design report in terms of source, terms and the site data in terms of the receptors, the types of soils, air, all of the parameters that involve what the impacts would be and we adopted the philosophy and creation of this

document that we tried to be conservative, but realistic.

What I mean is, we try to also cover the -- be expected to be if we had to, we bump up the potential terms, but we didn't ordinarily raise things to the points of absurdity. We tried to create a document that is conservative in terms of its impact would it ever be built, but that it is realistically conservative.

What we found, in terms of the evaluation; first we kind of going in based on other accelerator facilities. They are relatively benign facilities from the standpoint of how does it impact the environment. There were three areas that the impacts are most notable, but again, they are consistent with other accelerator facilities, and are not terribly severe, but have to be assessed, and those are in the area of land use, and this facility would have 110 acres of whatever is there have to go away, and there would be things that will be going on around that activity that we may have some amount of disruption on research activities and whatever the lands usage

17

is is really the thing that has impact on the facility.

Secondarily the emissions and soil activations of both water and air emission even under normal activating conditions or possible accident scenarios for the facility.

And third being the waist in that each of the facilities has differing waist management handling and processing or treatment capabilities, and we have to evaluate how waist would be treated at each of the four locations that are potential candidates for this facility.

So that kind of summarizes the process we went through in creating this document. Right now we are soliciting comments so we could finalize, as a decision for the secretary, and we appreciate your attendance here, and I would like to make one correction. There are public reading rooms in the area at which the document can be viewed, but if you actually want a copy of the document, I ask that you make a request through the phone number, fax number, the E-mail address or making to me at Oak Ridge. Thank you.

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18

MR. HAAS: We now move to the public comment phase of the meeting. Is there anyone present wishing to provide comment on the Draft Environmental Impact Statement for the Spallation Neutron Source; if so, would you please step forward?

(NO RESPONSE)

MR. HAAS: There being no one present wishing to make comment, we will recess the meeting in a moment.

Before I recess the meeting, let me again underscore the opportunity to provide comments in other forms. All of that information is available in the comment forms that are in the information desk at the entrance to the meeting hall, and all of those addresses and electronic mail addresses and numbers are available there.

In addition, during the recess, if you wish to speak with individuals who are involved with the project, Mr. Jeff Hoy and Mr. David Wilfert would be available to discuss the project; Mr. Dave Bean and Bill Flemming will be available to discuss the Environmental Impact Statement and the process of developing that and

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19

Mr. Frank Karnegay will be available to discuss any technical questions concerning the Spallation Neutron Source.

There being no one present wishing to make comment, the meeting stands in recess.

(Whereupon, at 6:22 p.m. the meeting was recessed until 9:00 p.m.)

MR. HAAS: I call the meeting to order.

Let the record show that it is 9:00 p.m. Is there anyone present wishing to make comment on the Draft Environmental Impact Statement for the Spallation Neutron Source?

(NO RESPONSE)

MR. HAAS: There being no one present wishing to make comment, the meeting is adjourned.

(Time noted: 9:01 p.m.)

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20

CERTIFICATION

I, JOANN BUNZE, reporter hereby certify that the foregoing transcript consisting of 20 pages is a complete, true and accurate transcript of the foregoing site plan meeting, held on January 21, 1999 at Brookhaven National Laboratories in the matter of the Spallation Neutron Source.

I further certify that this proceeding was recorded by me, and that the foregoing transcript has been prepared under my direction.

JOANN BUNZE

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Chapter 4
DOE Responses to the Public Comments

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CHAPTER 4

DOE RESPONSES TO THE PUBLIC COMMENTS

The formal U.S. Department of Energy (DOE) responses to the public review comments on the Draft Environmental Impact Statement (DEIS) are presented in this chapter. Each response is accompanied by a comment code (refer to Section 3.2 in this appendix) unique to the comment that it addresses. This code may be used to locate the exact text of the comment in Section 3.4.2 of this appendix. If a comment resulted in the revision of text for the Final Environmental Impact Statement (FEIS), the locations of the revisions are indicated beneath the responses.

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COMMENT CODE
F-1-1

We recommend that the final document include more site specific information relating to water resources, ecological resources, cultural resources, human health, support facilities and infrastructure, long-term productivity of the environment, and lastly, cumulative impacts resulting from construction and operation. The DEIS assesses these impacts at a general level. We recommend including site specific NEPA analysis or information so that each of the identified potential impacts for each facility are fully assessed.

RESPONSE
The DEIS contains sufficient information to determine the environmental impacts of the proposed action at each of the alternative sites. The information presented in the EIS 1) is the best currently available given the level of design work allowed to be completed; 2) was corroborated through reconnaissance level surveys at all four locations; and 3) is adequate to support a siting and construction decision among the four alternative locations. The analysis in the EIS is intentionally designed to conservatively anticipate or "bound" all of the foreseeable environmental impacts at each location, not to present details about the site required to actually go forward with construction. Once DOE identifies the selected site in its Record of Decision, the agency will begin detailed design work and prepare additional evaluations, including a three-season survey for protected species, detailed archeological survey, geotechnical investigation, building placements, and other reviews. While these studies will substantially expand our information base for the construction site they normally would not call into question the facts or assumptions in the EIS analysis. In the unlikely event that the additional analyses identify significant new information or adverse environmental impacts beyond those identified in this FEIS, the Department would prepare a supplemental EIS.

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COMMENT CODE
F-1-2

We were unable to find anywhere in the DEIS a request for an alternate methodology for demonstration of compliance with the Radionuclide NESHAPs. It is unclear whether DOE intends to seek such approval for the values provided within the DEIS. The values DOE has provided for ede, with the pathways of exposure chosen, are presented as having to meet the 10 millirem per year ede dose standard for all public exposures. Prior US EPA approval must be obtained for any alteration of Clean Air Act Assessment Package 1988 (CAPP88-PC). This includes other radionuclides of concern. If this prior approval is not sought and obtained, the calculated ede exposures cannot be accepted as being adequately protective of public health and safety. We recommend that is this is not the case, then that the request, along with the approval letter be provided in this EIS.

RESPONSE

DOE did not intend the EIS to include a request for an alternate methodology for demonstration of compliance with the radionuclide National Emissions Standards for Hazardous Air Pollutants (NESHAPs). DOE has not made a decision on seeking such approval. After the Record of Decision is issued identifying the selected site for construction of the SNS, DOE would consult with the appropriate State agencies and EPA to determine the most efficient method of compliance with the Radionuclide NESHAPs.

The reference to the 10 mrem annual dose limit (40 CFR Part 61) was included to show that DOE expects the facility to be within this limit. Further explanation of this has been included in the FEIS.

LOCATION OF EIS REVISION(S): Sections 5.2.9.2.1, 5.3.9.2.1, 5.4.9.2.1, 5.5.9.2.1

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COMMENT CODE

F-1-3

We recommend that DOE clarify the state authorities for each alternate site. For example, the State of Illinois Environmental Protection Agency has not authorities delegated to it with regards to the Radionuclide NESHAPs, or radiation in any form. Radiation issues for the State of Illinois is dealt with by the Illinois Department of Nuclear Safety, which also has no delegated authority for the radionuclide NESHAPs. All enforcement authority resides with the United States Environmental Protection Agency, Region 5 office for radionuclide NESHAPs issues. The DEIS needs to be changed to reflect this confusion.

RESPONSE

EPA has delegated authority for the regulation of Radionuclide NESHAPS to the Tennessee Department of Environment and Conservation (TDEC). The authority to regulate Radionuclide NESHAPS in New Mexico, Illinois, and New York is retained by EPA. The text of the EIS has been revised to indicate this distribution of regulatory authority.

LOCATION OF EIS REVISION(S): Table 6.1-1 and Section 6.1.1

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COMMENT CODE

F-1-4

The DEIS should address how operation of the facility would contribute to radionuclide emissions in the atmosphere and how it would contribute to the existing NESHAP reports.

RESPONSE

Section 6.1.1 summarizes the requirements of NESHAP. Based on the information presented in Sections 5.2.9.2.1, 5.3.9.2.1, 5.4.9.2.1, and 5.5.9.2.1, DOE anticipates the need for a NESHAP Permit to Construct. The effective dose equivalent caused by all potential emissions from SNS operations is projected to be greater than 1 percent of the 10 millirem per year NESHAP standard.

The current annual NESHAPs reports from the site selected in the Record of Decision for construction of the SNS would be modified to include the radioactive emissions from the SNS.

LOCATION OF EIS REVISION(S): Section 6.1.1

....

COMMENT CODE
F-1-5

While the EIS contains tables which provide monitoring data for all of the criteria pollutants for 1996, it does not state whether or not ANL and BNL are in areas classified as non-attainment or maintenance of the National Ambient Air quality Standards (NAAQS). If they are in non-attainment or maintenance status they would be subject to the general conformity rules (40 CFR Part 93: "Determining Conformity of General Federal Actions to State or Federal Implementation Plans"). The final EIS should address both the status of all of the alternatives and the applicability of the general conformity rule.

RESPONSE
The Illinois Environmental Protection Agency (IEPA) and the New York State Department of Environment and Conservation (NYSDEC) were contacted to obtain information pertinent to addressing this comment. The proposed SNS sites at ANL and BNL are in nonattainment areas for ozone only. Both areas are listed as severe nonattainment for this criteria pollutant. The proposed SNS sites at Oak Ridge National Laboratory (ORNL) and LANL are not located in such areas. Text stating the air quality attainment status for this criteria pollutant in DuPage County (ANL location in Illinois) and Suffolk County (BNL location in New York) have been added to the text of the FEIS (Sections 4.3.3.3 and 4.4.3.3).

Because the proposed SNS sites at ANL and BNL are located in severe nonattainment areas, regulations (40 CFR 93) under the Clean Air Act require DOE to demonstrate that the proposed action would conform to the State Implementation Plans for ozone in Illinois and New York. Text pertinent to this demonstration has been added to the FEIS (Sections 5.4.3.2 and 5.5.3.2).

LOCATION OF EIS REVISION(S): Sections 4.3.3.3, 4.4.3.3, 5.4.3.2, and 5.5.3.2

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COMMENT CODE
F-1-6

The DEIS states that the Till formation at Argonne is classified as having low permeability which renders this formation unusable. EPA believes this groundwater information is inaccurate. It has been well documented that the Wadsworth Till formation possess extensively high yielding sand and gravel scams. Although several municipalities in the Chicago land area have recently switched to using Lake Michigan water as a potable source, several private residences in northeastern Illinois are still dependent on shallow groundwater as a potable supply source. EPA recommends that further consideration must be given to potential impacts to shallow ground water resources in the area.

RESPONSE
Information obtained and reviewed concerning geologic conditions at the ANL site indicate that the sands found in the Wadsworth Till formation are localized and do not represent a large scale regional formation (see Sandia National Laboratory, 1996. *Performance Evaluation of the Technical Capabilities of DOE Sites for Disposition of Mixed-Low-Level Waste*, Volume 5. DOE/ID-10521, March). Thus, the major portion of the underlying geological formation at the ANL site consists of silty clay with extremely low permeability. Accordingly, despite the localized high-yield portions of sands, the overall low permeability of the silty clay should minimize the potential for offsite groundwater migration from the SNS site. Groundwater within the Silurian dolomite and Ordovician sandstone layers under the property is used as a drinking water supply by ANL and neighboring communities. However, no documentation of

drinking water wells within the Till formation was observed. The text of the EIS has been modified to better describe shallow groundwater movement at the ANL site.
As discussed in the DEIS, appropriate mitigation measures, including construction of an earthen shielding berm, would be undertaken to minimize potential impacts to the groundwater at the site. If during the investigation of the selected site it is found that soil conditions and groundwater travel times do not agree with the assumptions used in the EIS, the design of the earthen berm would be modified to assure that the severity of the impacts to groundwater would not be greater than those expressed in the FEIS.

LOCATION OF EIS REVISION(S): Section 4.3.2.3

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COMMENT CODE
F-1-7

The document references several conflicts surrounding the siting of the SNS at the preferred alternative, ORNL. As noted, an Oak Ridge citizens advisory organization, the End-Use Working Group, has drafted land use guidelines and recommendations for the DOE – Oak Ridge Operations. One of the draft guidelines recommends the siting of additional DOE facilities at ORNL on brownfield sites instead of greenfield sites (Page S-17). EPA has an initiative – the Brownfields Economic Redevelopment Initiative – designed to empower stakeholders in economic redevelopment of abandoned industrial areas to clean up and reuse brownfields. We note that DOE is currently participating in the Interagency Working Group on Brownfield development [DOE contacts are Martha Crosland 202-568-5793 and Chris Camillo 202-401-3819, April 1997 data]. We recommend that the Final EIS examine the potential for using brownfield sites for the SNS project. Instead of committing 110 acres of hardwood and pine forest habitat for this project, EPA Region IV supports the examination of brownfield sites within ORNL to determine what sites might serve DOE's needs in this regard.

RESPONSE
The process of selecting the preferred site for construction of the SNS on the Oak Ridge Reservation was a two phase process. In the first phase, the entire reservation was screened to eliminate areas that were not suitable for construction of the SNS. Brownfield and greenfield areas of the reservation were both included. Areas of land within the ORR with waste area groupings, environmental restoration projects or waste management areas were eliminated from consideration because these areas would require cleanup, with some attendant uncertainty on the extent of cleanup required, prior to excavation for the SNS foundations. This activity could increase worker exposure to radioactive and nonradioactive contaminants and would require the disposal of material removed during clean up in a licensed land fill. This could affect both the budget and schedule of the project. Working in a contaminated area could increase labor costs and disposal costs of the contaminated materials. Coordinating with the Environmental Management program for the cleanup of these areas may resolve the budget issue, however, long schedule delays may result. Coordination of this construction effort with the requirement of RCRA or CERCLA for cleanup of these areas could add a year or more to the construction schedule of the SNS. Siting the SNS in a waste management area could require cleanup of the area, with associated cost increases and schedule delays, and possibly the relocation of waste management activities likely. The result of this first phase was the identification of four candidate sites, however, none of these were brownfield sites.

The second phase consisted of a comparative evaluation of the candidate sites using specific site evaluation criteria. One of the Functional Criteria was the avoidance of contaminated soils. One of the Health and Safety criteria was avoiding existing hazardous materials areas and waste areas (i.e. Waste Area Groups and RCRA sites). Again, these criteria were included to avoid the increased risk to construction workers and the increased costs and schedule delays associated with placing a large scale construction project at a site with contaminated soils or hazardous materials.

LOCATION OF EIS REVISION(S): Sections S 1.4.2 and 3.2.4.2

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COMMENT CODE
F-1-8

A potential conflict at the ORNL site stems from on-going environmental monitoring and ecological research projects in the proposed project area (Page S-17) being conducted by National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ADD). The proposed site is situated within a buffer zone designed to protect an ecological monitoring project from carbon dioxide and other pollutant emissions. The Final EIS needs to include: a) how long the NOAA/ADD monitoring project are expected to continue; b) what is the projected building schedule of the SNS project, including the proposed upgrade to peak operation to the proposed build-out of 4 MW beam; and c) indicate if there are any of the NOAA/ADD ecological monitoring projects that can be completed prior to addition to the atmosphere of combustion products from the natural gas-fired boilers at the proposed SNS site.

RESPONSE
National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) personnel cannot specify a precise duration period for their continuing environmental monitoring activities in the Walker Branch Watershed. However, their general plan is to continue for an indefinitely long period of time. The text of the EIS has been revised to reflect these general plan.

The projected site preparation and construction periods for the proposed SNS are shown in Figure 3.2.2-1 of the EIS. At this time, DOE cannot specify when the eventual SNS upgrade to an operating power of 4 MW would occur, since it is not definite that the upgrade will be necessary.

If natural gas-fired boilers are installed in the proposed SNS, emissions would begin in the late fiscal year (FY) 2005 date, the start of operations (Figure 3.2.2-1). The NOAA/ATDD monitoring in the Walker Branch Watershed would not be completed by this date. The anticipated durations and completion dates for the ORNL Environmental Sciences Division (ESD) ecological research projects in the Walker Branch Watershed are shown in Tables 4.1.8.2-1, 4.1.8.3-1, and 4.1.8.3-2 of the EIS.

LOCATION OF EIS REVISION(S): Section 4.1.8.3

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COMMENT CODE
F-1-9

EPA requests that the final EIS includes discussion on avoidance and reduction of wetland impact, as well as, mitigation necessary to offset unavoidable wetland impacts.

RESPONSE
Appendix H, Floodplains/Wetlands Assessment of Potential Impacts at the Oak Ridge National Laboratory and Argonne National Laboratory, has been included in the EIS. This appendix describes the potentially affected wetlands, the potential impacts to the wetlands, the potential cumulative impacts to wetlands, and the potential mitigation measures to minimize these impacts. If a final site for the proposed SNS is selected, DOE will prepare a Mitigation Action Plan to explain how and when mitigation

measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness.

LOCATION OF EIS REVISION(S): Appendix H

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COMMENT CODE
F-1-10

Our limited review indicates that based upon population, health impacts, and groundwater issues, that the best site for the facility would be LANL. We would suggest that additional information be provided explaining why Oak Ridge is the preferred alternative.

RESPONSE
Based on population and health impacts, DOE agrees that, the preferred site for the proposed SNS might have been LANL. However, there are other aspects of the proposed LANL site that detract from its suitability (e.g., the lack of sufficient electrical capacity and the impacts associated with providing the water necessary for the facility). The preferred alternative, the proposed ORNL site, has advantages such as easy access to adequate utilities. In addition, this location allows DOE to take advantage 1) of the highly trained scientific and technical staff who operate and utilize the reactor-based neutron source at ORNL; 2) of the design experience for neutron sources gained during conceptual design of the Advanced Neutron Source; and 3) of the existing advanced materials program at ORNL.

DOE will identify the environmentally preferred site in the Record of Decision. The final decision would take into account other issues besides the environmental analysis presented in the EIS. The Record of Decision will contain a full explanation of the decision.

LOCATION OF EIS REVISION(S): Sections S 1.2.2. and 3.2.4.2.

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COMMENT CODE
S-1-1

The Illinois site has no significant agricultural impacts since it is located on the grounds of the Argonne National Laboratory. The site consists of support service buildings, open space, and undeveloped ecological plots. If any agricultural land remains on the site, its viability for long-term agricultural use would be very low given the development that has occurred around it. Land use plans designate the area for nonagricultural uses. The IDOA would have no objection to the project if the Argonne National Laboratory was eventually chosen for the site of the SNS.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
S-1-2

1. It is the responsibility of the USDA Natural Resources Conservation Service (NRCS) to determine whether a site is subject to the provisions of the federal Farmland Protection Policy Act. Section 4.3.1.3 (Soils), page 4-117 of the DEIS indicates that the preparer of the DEIS has made this decision rather than the NRCS.

RESPONSE

The provisions of the Farmland Protection Policy Act are implemented through the federal regulations in 7 CFR 658. The regulations in 7 CFR 658.4 (a) state that a federal agency "…may determine whether or not a site is farmland as defined in Sec. 658.2(a) or the agency may request that NRCS make such a determination." In accordance with this regulation, DOE has elected to make its own determinations as to the presence or absence of farmland on the proposed sites for the SNS.

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COMMENT CODE
S-1-3

2. Numerous references to "open space" were made in the DEIS. The term need to be defined in the glossary. If the term includes farmland, then farmland needs to be broken out and assessed separately. Farmland is a natural resource and a land use just like wetlands, woodlands, and prairies, etc. Impacts to this natural resource must be properly evaluated in the NEPA documents.

RESPONSE
The term "open space" is a formal land use category applied to areas of land that exist in a predominantly natural, undeveloped state. This definition has been added to the Glossary in the FEIS. No farmland is present within open spaces or at any other location within the ORR, LANL, ANL, or BNL.

DOE agrees that farmland is both a natural resource and a land use. The text of the FEIS has been revised to more clearly indicate that potential effects on farmland were evaluated.

LOCATION OF EIS REVISION(S): Glossary, Table S 1.5.2-1 (1a) (1b), Table 3.5-1 (1a) (1b), Sections 4.1.1.3, 4.2.1.3, 4.3.1.3, 4.4.1.3, 5.2.1.3, 5.3.1.3, 5.4.1.3, 5.5.1.3, 5.7.1.1, 5.7.2.1, 5.7.3.1, 5.7.4.1

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COMMENT CODE
S-2-1

Considering the information provided, we find that the area of potential effect for this undertaking contains no cultural resources eligible for listing in the National Register of Historic Places. You should notify interested persons and make the documentation associated with this finding available to the public.

RESPONSE
DOE acknowledges this finding of the Tennessee Historical Commission. A December 29, 1997, letter documenting this finding was included in Appendix D of the DEIS (see page D-11).

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COMMENT CODE
S-2-2

If you agency proposes any modifications in current project plans or discovers any archaeological remains during the ground disturbance or construction phase, please contact this office to determine what further action, if any, will be necessary to comply with Section 106 of the National Historic Preservation Act.

RESPONSE
Should the ORNL site be selected, DOE would consult with the Tennessee Historical Commission concerning any proposed modifications in current project plans that could affect cultural resources. Such consultations would also occur if cultural resources were encountered during the ground disturbance or construction phase of the proposed action.

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COMMENT CODE
S-3-1

Our staff has reviewed the "Draft Environmental Impact Statement for the Construction and Operation of the Spallation Neutron Source" dated December 1998. We understand from the draft EIS that the proposed location for the project is the 800 Area at Argonne Naitonal (*sic*) Laboratory-East. Recently Building 829 was determined as not eligible for listing on the National Register of Historic Places. At this time, our office is not sure is there are any other buildings located in the 800 area. Even though these buildings may be less than fifty years old, if they are located in the 800 Area they should be assessed for National Register eligibility.

RESPONSE
Buildings 809, 826, and 829 were standing in the 800 Area at ANL when the text of the DEIS was first written. Subsequently, the DOE Chicago Operations Office consulted with the Illinois State Historic Preservation Officer (SHPO) concerning the cultural resources status of these buildings. As a result of these consultations under Section 106 of the National Historic Preservation Act (NHPA), none of these buildings were determined to be eligible for the National Register. Buildings 809 and 826 were demolished as part of an ongoing building removal program in the 800 Area. Subsequently, Building 829 is the only remaining Historic Period building in the 800 Area at ANL. The text of the FEIS has been revised throughout to indicate the current historic resources environment of the 800 Area.

LOCATION OF EIS REVISION(S): Tables S 1.5.2-1 (7a) and 3.5-1 (7a); Sections 4.3.7.2, 5.4.7.2, and 5.7.3.7.2

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COMMENT CODE
S-3-2

The process set forth in Table S 1.5.2-1 (page S-36) of the EIS for addressing possible impacts to prehistoric site 11DU207, if Argonee (*sic*) National Laboratory were selected for construction of the Spallation Neutron Source, is acceptable to our office. If you have any further questions, please contact Tracey A. Sculle, Cultural Resource Manager, at 217/785-3977 or Joseph S. Phillippe, Staff Archaeologist, at 217/785-1279.

RESPONSE
DOE appreciates concurrence of the Illinois Historic Preservation Agency with the proposed process for management of prehistoric site 11DU207.

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COMMENT CODE
S-4-1

- Threatened and Endangered Species. While no listed species are known to occur on the exact site for the SNS, several have been observed within the limits of ANL and the adjacent Waterfall Glen Forest Preserve. Surveys for the Kirtland's snake, red-shouldered hawk, and their respective habitats should be performed if ANL is chosen for the SNS.

RESPONSE
DOE agrees with this comment. In Section 5.4.5.4 of the DEIS, DOE commits to a three season survey of the proposed site at ANL for protected species and their habitats. This survey would be completed at the ANL site if it is selected in the Record of Decision as the site for construction of the SNS. The survey would be completed prior to the start of construction.

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COMMENT CODE
S-4-2

- Waterfall Glen Forest Preserve District. The DuPage County Forest Preserve District should be consulted for impacts to Waterfall Glen, one of the county's largest preserves.

RESPONSE
DOE agrees with this comment. If the ANL site is selected in the Record of Decision for construction of the SNS, DOE will consult with the DuPage County Forest Preserve District concerning potential impacts to the Waterfall Glen Forest Preserve.

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COMMENT CODE
S-4-3

- Stream Resources. While the Department does not have authority over the floodways on the two small tributaries on the ANL site (because they both drain less than one square mile), a permit may be needed from the Department's Office of Water Resources if an impoundment is proposed. Additionally, any proposal to alter the streams on site should have a thorough macroinvertebrate and fish survey.

RESPONSE
DOE agrees with this comment and understands that a permit may be needed from the Illinois Department of Water Resources if an impoundment is included in the design of the SNS. If the ANL site is selected in the Record of Decision for construction of the SNS, DOE would consult with the Illinois Department of Natural Resources concerning details of macroinvertebrate and fish surveys that would be performed prior to the alteration of any streams on ANL.

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COMMENT CODE
S-4-4

- Wetlands. Before a permit is sought from the Department of Environmental Concerns and the US Army Corps of Engineers to fill or alter any wetland, a thorough floristic survey should be performed to determine appropriate mitigation strategies.

RESPONSE
DOE agrees with this comment. If ANL is selected as the site, DOE will consult with the Illinois Department of Natural Resources, the Department of Environmental Concerns and the U.S. Army Corps of Engineers (USACOE) to determine the type and extent of biotic surveys to be conducted in wetlands that may be altered to determine appropriate mitigation strategies. DOE also will prepare a mitigation action plan to explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness.

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COMMENT CODE
S-5-1

…(1) the design life and decontamination and decommissioning (D&D) plans for the facility and

RESPONSE

The SNS is being designed to operate for 40 years beginning in 2006. DOE estimates that the facility would be producing neutrons for scientific research approximately 75 percent of this time, or 30 years. Thus, 30 years was used in the DEIS to determine the amount of activation products produced. Advances in technology over the next 46 years may allow the life of the facility to be extended beyond 40 years, provided there is a continued need for the facility.

The proposed action of this EIS does not include decommissioning of the proposed SNS. The scope of this EIS includes construction and operation of the proposed facility. DOE will prepare a decommissioning plan for the SNS at the selected site after release of the Record of Decision and before the start of construction. This plan will include estimates of the amount of scrap and wastes that would be generated during decommissioning of the facility. At present, DOE estimates the cost of decommissioning the facility to be 150 million dollars (year 2006 dollars) (Spallation Neutron Source Project Execution Plan; SNS/97-1). DOE has also committed to prepare the appropriate National Environmental Protection Act (NEPA) documentation prior to decommissioning the facility.

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COMMENT CODE
S-5-2

…(2) health and safety, including radiologically activated and contaminated materials.

RESPONSE
Health and safety issues, discussed generally in Section 6.1.10, are site specific and are assessed after the selection of a site in the Record of Decision. Specific health and safety issues will then be addressed in project safety documents (Safety Analysis Report/Safety Assessment document). This site-specific report would be prepared after release of the Record of Decision, but prior to construction of any facilities. All activities dealing with radiologically activated and contaminated materials would be subject to regulations in 10 CFR 835 Occupational Radiation Protection.

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COMMENT CODE
S-5-3

It is the State of Tennessee's understanding that the SNS will be designed, constructed, and operated in a manner that is compliant with applicable laws, regulations and DOE Orders. The DEIS needs additional information to clearly demonstrate groundwater protection requirements, radioactive wastewater treatment capacity to support ORNL's active waste management, environmental restoration waste and SNS waste needs.

RESPONSE
Because of the uncertainties in the amount of soil activation products and uncertainties regarding the site-specific groundwater at the ORNL site, the analysis in the EIS is based on very conservative assumptions. The results of these analyses present what DOE considers to be an upper limit of releases to groundwater. After publication of the ROD, detailed groundwater characterization at the site would indicate what design features would need to be incorporated into Title I and Title II design to ensure protection of the groundwater.

The analysis in the EIS indicates that ORNL can accommodate the radioactive wastes expected to be generated by the SNS. This conclusion is based on the best available information at this time; the SNS would not begin generating wastes until the year 2006.

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COMMENT CODE

S-5-4

The State will expect best available technology in design and construction for pollution prevention, emission controls, and monitoring. It will also expect adequate funding for compliant treatment, storage and disposal of waste.

RESPONSE
DOE agrees with the State of Tennessee and commits to developing detailed design and constructing the SNS using the best available technology for pollution prevention, emissions controls, and monitoring. DOE will also provide sufficient funding to meet all regulatory requirements for the construction and operation of the SNS including treatment, storage, and disposal of wastes.

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COMMENT CODE
S-5-5

Several environmental health and safety issues, including radiologically activated and/or contaminated materials, need to be addressed. Possible release of radiological materials to the environment during future upgrades to the facility should be addressed in the Final EIS. According to page A-15 of the Draft EIS, it may be ten years after initial operation before the power is upgraded to 4 megawatts. Significant radioactivity levels may have been reached in various facility locations and equipment by that time subjecting the public and environment to undue risks unless proper precautions are taken.

RESPONSE
DOE expects very limited release of radiological materials, well within the limits of applicable regulations, to the environment during future upgrades to the SNS. The source terms used in the analyses of potential exposures to radiation in the DEIS were very conservative. The SNS would be designed to operate within the envelope described in the DEIS. All construction associated with upgrading the facility would be subject to regulations in 10 CFR 835 Occupational Radiation Protection. This document sets the limits of radiation release and worker exposures that DOE will comply with during the facility upgrades. The planned upgrades, if implemented, would be constructed while the SNS is operational and would entail a minimal amount of disassembly of previously constructed facilities. The upgrades would include construction of new facilities, e.g. the second accumulator ring and the second target and experimental building, and connection of these facilities to the existing linear accelerator and accumulator ring.

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COMMENT CODE
S-5-6

In addition, a more thorough examination of transport of radiological components through the soil and groundwater is required. Design criteria should include protection of groundwater from any contamination including leaching of radionuclides from neutron activated soil.

RESPONSE
Section 3.2.2.9 presents the shielding design for the linear accelerator and accumulator rings. The design is an engineered earthen berm designed to isolate the activation products generated by the particle beam. In Chapter 5 the potential impacts to groundwater are presented. These impacts are based on very conservative assumptions concerning groundwater travel times, dilution, and levels of radionuclides in the earthen berm (see Section 5.2.2.3.2). The results of this analysis present a bounding estimate of the potential impacts. This bounding estimate becomes the maximum design limit for Title I and Title II (preliminary and detailed) design, that takes place after the publication of the Record of Decision. If,

during the investigations of the selected site, it is found that soil conditions and groundwater travel times do not agree with the assumptions used in the EIS, the design of the earthen berm would be modified to assure that the severity of the impacts to groundwater would not be greater than expressed in the EIS.

A discussion of transport of radionuclides for each of the four alternative sites is presented in Chapter 5 of the DEIS (Sections 5.2.2.3.2, 5.3.2.3.2, 5.4.2.3.2, and 5.5.2.3.2). Because of the uncertainties in the amount of soil activation products and uncertainties about the groundwater at each of the four sites, these analyses are based on very conservative assumptions. The results of these analyses present what DOE considers to be an upper limit of releases to groundwater. After the release of the Record of Decision, characterization of the selected site would determine if additional design features are necessary to stay within the bounding impacts presented in the EIS.

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COMMENT CODE
S-5-7

The Department commented on the SNS Notice of Intent by a letter from Mr. Earl C. Leming to Mr. David Wilfert dated August 29, 1997. It was requested in those comments that selection of a "green field" site over a "brown-field" site be addressed and justified in the EIS. It appears this has been done; however, the information is scattered over several sections of the document. Please consolidate the "green field" versus "brown-field" site information under a specific section and list some of the Oak Ridge brownfield sites that were initially considered and explain why those sites were rejected.

RESPONSE
The process of selecting the preferred site for construction of the SNS on the Oak Ridge Reservation was a two phase process. In the first phase, the entire reservation was screened to eliminate areas that were not suitable for construction of the SNS. Brownfield and greenfield areas of the reservation were both included. Areas of land within the ORR with waste area groupings, environmental restoration projects or waste management areas were eliminated from consideration because these areas would require cleanup, with some attendant uncertainty on the extent of cleanup required, prior to excavation for the SNS foundations. This activity could increase worker exposure to radioactive and nonradioactive contaminants and would require the disposal of material removed during clean up in a licensed land fill. This could affect both the budget and schedule of the project. Working in a contaminated area could increase labor costs and disposal costs of the contaminated materials. Coordinating with the Environmental Management program for the cleanup of these areas may resolve the budget issue, however, long schedule delays may result. Coordination of this construction effort with the requirement of RCRA or CERCLA for cleanup of these areas could add a year or more to the construction schedule of the SNS. Siting the SNS in a waste management area could require cleanup of the area, with it associated cost increases and schedule delays, and possibly the relocation of waste management activities. The result of this first phase was the identification of four candidate sites, however, none of these were brownfield sites.

The second phase consisted of a comparative evaluation of the candidate sites using specific site evaluation criteria. One of the Functional Criteria was the avoidance of contaminated soils. One of the Health and Safety criteria was avoiding existing hazardous materials areas and waste areas (i.e. Waste Area Groups and RCRA sites). Again, these criteria were included to avoid the increased risk to construction workers and the increased costs and schedule delays associated with placing a large scale construction project at a site with contaminated soils or hazardous materials.

LOCATION OF EIS REVISION(S): Sections S 1.4.2 and 3.2.4.2

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COMMENT CODE
S-5-8

From a groundwater perspective, if this facility were located in Melton Valley over the relatively tight clastic formations such as the Pumpkin Shale, rather than over the Knox Aquifer (the Knox Aquifer is the best source of usable groundwater in E. Tennessee), there would be less risk of groundwater contamination. Further the relatively tight shales under Melton Valley, would offer an advantage from a standpoint of contaminant travel times, absorption, and matrix diffusion compared to the conduit flow that exists beneath Chestnut Ridge.

RESPONSE
The selection of the Chestnut Ridge site for construction of the SNS at ORNL is discussed in Appendix B of the DEIS. Two of the alternative sites on ORNL were located in the vicinity of Melton Valley (Alternatives 1 and 2) but were not selected because they did not meet all of the five siting criteria.

Alternative 1, the area south of the High Flux Isotope Reactor, and Alternative 2, the area east of the Health Physics Research Reactor, did not meet the constructibility criterion. The sites have slopes of greater than 25 percent. Utilities, with the exception of electricity, are not nearby and road access to both sites is poor. These sites also do not meet the criterion concerning proximity to historic places. Several areas within close proximity of these sites have historical value.

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COMMENT CODE
S-5-9

If Chestnut Ridge remains the preferred site, every effort should be made to reduce impact to the area.

RESPONSE
DOE agrees with this comment. Should the ORNL site be selected, there are design features which could be included in the SNS for the purpose of minimizing potential impacts to Chestnut Ridge and the surrounding area. DOE will prepare a Mitigation Action Plan after publication of the Record of Decision.

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COMMENT CODE
S-5-10

In addition, DOE should respond to citizens' concerns about loss of data quality for the long-term ORNL ecological research projects at Walker Branch Watershed by exploring mitigation opportunities.

RESPONSE
The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2, and 5.8.1 of the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects from CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE

will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.331, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
S-5-11

The draft EIS does not acknowledge that there is currently no outlet for Oak Ridge Reservation Low Level Waste.

RESPONSE
The analysis presented in the DEIS indicates that the waste management facilities at ORNL can accommodate the low-level radioactive waste generated by the proposed SNS. It is true that, as of February, 1999, no low-level radioactive waste have been shipped from ORNL; however, there are contracts in place with permitted facilities to accept low-level radioactive waste from ORNL, as generated. The proposed SNS would not begin generating low-level radioactive waste until the year 2006. The EIS has been revised by stating the status of low-level radioactive waste at ORR as discussed under the preferred alternative of the Waste Management Programmatic EIS.

LOCATION OF EIS REVISION(S): Section 5.2.11

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COMMENT CODE
S-5-12

Several topics that were not covered in the Draft EIS should be included in the final document. These include disposal of Cooling Tower Basin Sludge, handling and disposal of the sediments in the Retention Basin, and processing of activated cooling water from the target areas. Also discuss the expected residence lifetime (in the system) of the cooling water.

RESPONSE
The disposal of cooling tower basin sludge and sediments from the retention basin would be in accordance with waste management procedures in effect at the selected site at the time the waste is generated. Treatment and disposal of these wastes would be done in accordance with all applicable laws and regulations in the state where the SNS is constructed.

The analyses included in the DEIS were based on information from the conceptual design of the SNS. Details of the residence time of water in the target cooling system and the treatment of this water should it have to be replaced are not known yet. These analyses would be done as part of the Title I and Title II (preliminary and detailed) design efforts.

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COMMENT CODE
S-5-13

Include detailed facility maps in the final document. Theses maps should show expected locations of the facility, retention basins, cooling towers, etc.

RESPONSE
The analyses presented in the DEIS are based on the site layout presented in the Conceptual Design Report. The site layout figures in the DEIS have been modified to show reasonable locations of the retention basin. After the selection of the site for the SNS in the Record of Decision, the layout of the proposed SNS would be optimized for the selected site. The specific locations for the retention basin, cooling tower, electrical substation, and other ancillary facilities would be determined during this optimization process.

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COMMENT CODE
S-5-14

Page S-53, Table S 1.5.2-1. Comparison of impacts among alternatives, ORNL Alternative, Low-Level Radioactive Wastes
Although "contracts are in place", there is currently (Jan. 19, 1999) no outlet for Oak Ridge Reservation Low level Waste.

RESPONSE
The analysis presented in the DEIS indicates that the waste management facilities at ORNL can accommodate the low-level radioactive waste generated by the proposed SNS. It is true that, as of February, 1999, no low-level radioactive waste have been shipped from ORNL; however, there are contracts in place with permitted facilities to accept low-level radioactive waste from ORNL, as generated. The proposed SNS would not begin generating low-level radioactive waste until the year 2006. The FEIS has been revised by stating the status of low-level radioactive waste at ORR as discussed under Preferred Alternatives of the Waste Management Programmatic EIS.

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COMMENT CODE
S-5-15

Page 3-47, Table 3.5-1. Comparisons of impacts among alternatives, ORNL Alternatives
What does "(4%) in radionuclide flux over White Oak Dam" mean? Describe this in terms of an increase in radiological activity in addition to a percentage increase.

RESPONSE
The flux refers to the amount of radioactivity that would be expected to pass over White Oak Dam per period of time. It is the product of activity and flow rate. The 4 percent increase would represent an increase in the total amount of radioactivity (curies) over the dam because of increased flow but not due to an increase in the activity within the water medium.

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COMMENT CODE
S-5-16

Page 4-1, Section 4.1.1, Geology and Soils
This section of the Draft EIS does not discuss the transport of radiological contamination through the soils. Page 9-3 of the Conceptual Design Report NSNS/CDR-2/V2 states in the third paragraph: "A

study of soil groundwater transport and migration of various radionuclides at the preferred NSNS (SNS) site must be performed as part of the EIS in order to determine if the indicated soil concentrations are capable of imparting a radiologically significant component to the groundwater." Please include this study in the Final SNS EIS.

RESPONSE
A discussion of transport of radionuclides for each of the four alternative sites is presented in Chapter 5 of the DEIS (Sections 5.2.2.3, 5.3.2.3, 5.4.2.3, and 5.5.2.3). Because of the uncertainties in the amount of soil activation products and uncertainties about the groundwater at each of the four sites, these analyses are based on very conservative assumptions. The results of these analyses present what DOE considers to be an upper limit of releases to groundwater. After the release of the Record of Decision, characterization of the selected site would determine if additional design features are necessary to achieve the groundwater protection levels presented in the EIS.

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COMMENT CODE
S-5-17

Page 4-7, Section 4.1.1.4, Site Stability
The discussion of soils states that the soils "are not susceptible to liquefaction or mass movement." This section does not discuss karst sinkhole development which is an active process on Chestnut Ridge. There is a small depression within the footprint of the facility. Please discuss the implications on groundwater, surface water and structural stability following the discovery of karst landforms and how will karst be dealt with during design, construction, and operation of the facility.

RESPONSE
Soil liquefaction and mass movement of soils would only occur in a karst environment if there were a catastrophic failure of the bedrock, as caused by a large void. If ORNL is chosen as the site for the proposed SNS in the Record of Decision, comprehensive site investigation would determine if significant karst development occurs under the Chestnut Ridge site. If this is shown to be the case, specific facilities would be located to avoid these karst areas and the foundations would be designed to mitigate the potential effects of the karst formation.

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COMMENT CODE
S-5-18

Page 5-17, 5.2.1.1, Site Stability
Consideration should be made to the active doline formation encountered in the two barrow areas that exits along strike with the proposed SNS site. The two barrow areas suggest that anthropogenic factors can drastically increase the rate of sinkhole formation on Chestnut Ridge. Please discuss the implications of the above in the final document.

RESPONSE
Site characterization studies of the SNS site selected in the Record of Decision would discover active sinkholes. DOE agrees that anthropogenic factors can increase the rate of sinkhole formation; however, there are cost effective engineering methods available to mitigate such circumstances. After the Record of Decision, DOE would complete an optimization study at the selected site. This study would determine the optimal layout of facilities at the site. This would include avoiding sinkholes.

LOCATION OF EIS REVISION(S): Section 5.2.1.1

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COMMENT CODE
S-5-19

Page 5-18, Section 5.2.1.2, Seismic Risk, 5.2.1.2-1 Seismic design criteria for ORR
The discussion says Table 5.2.1.2-1 will present "estimated peak ground acceleration (PGA) at locations with greater than 30 ft (10m) of soil cover…," but the table presents "soil >10 ft (3m)."

RESPONSE
The table heading has been revised. The table does present "estimated peak ground acceleration (PGA) at locations with greater than 30 ft (10m) of soil cover...".

LOCATION OF EIS REVISION(S): Section 5.2.1.2 and Table 5.2.1.2-1
....

COMMENT CODE
S-5-20

Page 5-22 Section 5.2.2.3.1 Resources
Describe the "appropriate measures" if a karst formation is encountered during site characterization at the location of the retention pond.

RESPONSE
The final location of the retention basin has not been determined yet. If the ORNL site is selected in the Record of Decision for construction of the SNS, the Chestnut Ridge site will undergo an extensive characterization to provide detailed information necessary for Title I and Title II (preliminary and detailed) design. A site optimization study would also be completed to identify the optimal layout of the SNS facilities including the retention basin. If problematic karst features are discovered, the optimal site layout may avoid these features. If the retention basin cannot be placed in an area that avoids karst formation, the appropriate engineering solutions, such as grouting, would be implemented.

LOCATION OF EIS REVISION(S): Section 5.2.2.3.1
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COMMENT CODE
S-5-21

Page 5-22 through 5-24, 5.2.2.3, Groundwater
There is a closed depression shown on the S-19-A Oak Ridge Area Map, located within the map south and east area shown as the footprint of the proposed SNS facility. There is also a closed depression shown on the above referenced map to the east of the proposed facility. In all probability these closed depressions represent dolines. The East End barrow area, opened up with numerous swallets, suggests that the West End barrow area may have similar sinkhole development. These two areas are on strike with the proposed SNS facility. This suggests that the Knox Group beneath the site is an active karst aquifer with conduit flow. Dye traces conducted by TDEC demonstrates travel times in the order of 2 cm/sec, not the 2.9 m/yr. ground water velocity provided in this document.

RESPONSE
The groundwater travel times were based on the best available information at the time the EIS was developed. Detailed site specific characterization of the site selected in the Record of Decision would include further groundwater investigation.

The transport rates quoted in the DEIS for the Chestnut Ridge site represent groundwater travel through the upper soil horizon, assumed but unlikely to be under continuously saturated conditions, not through the carbonate bedrock. The engineered berm that would cover the linear accelerator and accumulator rings would be constructed of compacted native soils. The berm would be engineered to isolate activation products by minimizing the amount of water infiltrating the berm.

LOCATION OF EIS REVISION(S): Sections 5.2.1.1 and 5.2.2.3.1

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COMMENT CODE
S-5-22

A large karst spring SS-5 emerges at the base of Chestnut Ridge just to the map north of the proposed SNS site SS-5 is one of a series of large karst springs located in similar geologic situations at the base of Chestnut Ridge. A tracer study to determine travel times from this site utilizing potential karst features on or near the site to various receptors cross strike (SS-5) and along strike should be referenced in the final EIS.

RESPONSE
DOE has not conducted a tracer study at the Chestnut Ridge site. If this site is selected in the Record of Decision for construction of the SNS, further study of potential karst features and groundwater travel time will be conducted if warranted.

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COMMENT CODE
S-5-23

Page 5-24, Table 5.2.2.3.2-1 Estimates of radionuclide concentrations in soils and water surrounding the proposed SNS
Please explain how the list of radionuclides and the quantities in this table were generated. Free release criteria should apply when there are uncontrolled releases to the environment. The quantities shown exceed the NRC Limits.

RESPONSE
This table was originally presented in the following technical memorandum:

> Dole, L., 1998, *Preliminary Assessment of the Nuclide Migration from the Activation Zone Around the Proposed Spallation Neutron Source Facility,* ORNL/TM-13665, September, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

This reference has been added to the text of the EIS. There are no specifically applicable regulations for the SNS situation. Therefore, Nuclear Regulatory Commission (NRC) Limits for Uncontrolled Releases (10 CFR 20) were included in Table 5.2.2.3.2-1 as a benchmark for comparative purposes. The assessment in the EIS indicates that an exceedance of drinking water limits for an actual receptor under realistic conditions would be highly unlikely. If, during preliminary design, it is found that the NRC Limits for Uncontrolled Releases would not be met, additional protective measures, such as the capillary break, would be included in the design of the engineered berm for the proposed SNS.

LOCATION OF EIS REVISION(S): Section 5.2.2.3.2

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COMMENT CODE
S-5-24

Page 5-24, Section 5.2.2.3.2, Contamination, Last Paragraph
The concept of a barrier to isolate the soil below the tunnel should be added to the design as a matter of course. This will help mitigate most chances of groundwater being affected by percolating surface water. A rainwater cover or protection of some type over all or selected portions merit consideration.

RESPONSE
Section 3.2.2.9 describes the design features of the shielding berm. The design presented shows two groundwater interceptor systems designed to collect any water that may get through the engineered berm. This water would be sampled and if found to contain any radionuclides, treated as low-level radioactive waste. Otherwise, the water would be released to the retention basin.

The need for an additional rainwater cover or additional protection of some type over all or selected portions of the linear accelerator and accumulator rings would be investigated for the site selected for the SNS in the Record of Decision, during preliminary design and site characterization.

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COMMENT CODE
S-5-25

Page 5-31, Section 5.2.5.3, Aquatic Resources
Large volumes of water containing biocides and antiscaling agents are to be discharged from the retention basin into a relatively small creek. There should be further consideration of the effects of the chemicals and flow increase to White Oak Creek. Alternatives should be evaluated.

RESPONSE
The decision on what chemicals would be used for biocides and antiscaling agents in the cooling tower has not been made. This decision depends, to some extent, on which site is selected and details of the design of the cooling towers and retention basin. If the ORNL site is selected in the Record of Decision, water from the retention basin would be discharged to White Oak Creek through a National Pollutant Discharge Elimination System (NPDES) permitted outfall. This water would be piped down Chestnut Ridge, and discharged into White Oak Creek south of Bethel Valley Road. Thus, this outfall would not impact the upper reaches of White Oak Creek.

Details of the design of the outfall have not been completed. For the ORNL site, the State of Tennessee would be involved in the design through the NPDES permitting process. The selection of the actual discharge point, the use of diffusers, and the rate of discharge would be determined with consultation with the State of Tennessee Department of Environment and Conservation.

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COMMENT CODE
S-5-26

Page 5-207, Section 5.9, Short-Term Use and Long-Term Productivity
The Draft EIS mentions design life and decontamination and decommissioning (D&D) plans for the facility but contains insufficient detail. The EIS should also include the estimated costs associated with D&D and a plan for accumulating the finances required for D&D purposes.

RESPONSE
DOE will prepare a decommissioning plan for the SNS at the selected site after release of the Record of Decision and before the start of construction. This plan will include estimates of the amount of scrap and wastes that would be generated during decommissioning of the facility. At present, DOE estimates the

cost of decommissioning the facility to be 150 million dollars (2006 dollars) (Spallation Neutron Source Project Execution Plan; SNS/97-1). DOE has also committed to prepare the appropriate NEPA documentation prior to decommissioning the facility.

Congress does not ordinarily provide funding specifically for the decommissioning of a project at the outset of the projects life. Rather, it provides funding through the annual appropriation process.

The SNS is being designed to operate for 40 years beginning in 2006. DOE estimates that the facility would be producing neutrons for scientific research approximately 75 percent of this time, or 30 years. Thus, 30 years was used in the DEIS to determine the amount of activation products produced. Advances in technology over the next 46 years may allow the life of the facility to be extended beyond 40 years, provided there is a continued need for the facility.

LOCATION OF EIS REVISION(S): Section 1.3.1

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COMMENT CODE
S-5-27

Page 6-1 through 6-18, Chapter 6, Permits and Consultations
The Permitting and licensing requirements' section of the Draft EIS does not mention the Nuclear Regulatory Commission (NRC). The EIS should discuss the possibility of a NRC or State of Tennessee radiological permit/license being required for facility startup and /or operation.

RESPONSE
DOE believes that a discussion of the possibility of an NRC or State of Tennessee radiological permit or license being required for startup and operation of the proposed SNS is not within the scope of this EIS because neither NRC nor the state regulates accelerator-produced waste. If, in the future, after publication of the Record of Decision, the NRC and/or state begin to regulate accelerator produced radiological wastes, DOE will develop a plan for compliance with the regulations. DOE would also work with the NRC and state agencies to help develop effective regulations for this type of wastes.

LOCATION OF EIS REVISION(S): Section 6.1.4

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COMMENT CODE
S-5-28

Page 6-3, Section 6.1.1, AIR QUALITY
Tennessee has jurisdiction over radiological NESHAPS. Please correct the statement and Table 6.1-1.

RESPONSE
DOE understands that the State of Tennessee has jurisdiction over radiological NESHAPs. The text of the FEIS has been revised to indicate such jurisdiction.

LOCATION OF REVISION(S): Table 6.1-1 and Section 6.1.1

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COMMENT CODE
S-5-29

Page D-11, Table 2-1, Protected vertebrate species with potential habitat on the NSNS site, their preferred habitats. and federal or state protection status.

The first and fourth entries under the "Preferred Habitat" column are incomplete.

RESPONSE
The preferred habitat for the sharp-shinned hawk is a mixture of woods and open country. The preferred habitat for the grasshopper sparrow is grassy fields and farmlands. The table in Appendix E has been corrected.

LOCATION OF EIS REVISION(S): Page D-11

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COMMENT CODE
S-5-30

Page D-12, Figure 2-1, Potential habitat areas for T & E animal species within the proposed NSNS site.
The map would be more useful with the inclusion of the approximate locations of pools and sinkholes where threatened and endangered species and species in need of management might occur.

RESPONSE
This figure is from a report by Rosensteel et al., 1997. The complete report was included in the appendix of the EIS because it contains additional details about the biotic resources at the proposed site for the SNS at ORNL. DOE has committed to a three-season survey of the site selected in the Record of Decision for protected species. The approximate locations of pools and sinkholes where threatened and endangered species and species in need of management might occur will be included in this survey.

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COMMENT CODE
S-5-31

Page D-25, Section 3.4.2, Functional Assessment, Wildlife Diversity
There is no mention of fish being a possible inhabitant of wetlands on this site.

RESPONSE
This comment refers to the surveillance survey of wetlands on and in the vicinity of the Chestnut Ridge site at ORNL. This site is one of four alternative sites included in this EIS. Surveillance surveys for wetlands were done at all four sites for the purpose of comparison and selection of the preferred alternative for construction of the SNS. The information included in the EIS was primarily based on information available from existing sources. After the publication of the Record of Decision, additional information about the wetlands at the selected site for the SNS may be necessary to plan for effective minimization and mitigation of potential impacts. DOE would prepare a Mitigation Action Plan explaining how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness. Information about the fish populations in the wetlands at the selected site would be collected at that time.

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COMMENT CODE
S-5-32

Page D-26, Section 4.0, Summary
The second paragraph states "..no habitat suitable for any fish species that have been previously documented on the ORR..." Should this read "Threatened and Endangered fish species" instead?

RESPONSE

DOE agrees with this comment. The following report is included in Appendix E of the DEIS:

Rosensteel B., D. Awl, J. Mitchell, and L. Pounds, 1997. *Ecological Resource Surveys for the Proposed National Spallation Neutron Source Site on the Oak Ridge Reservation: 1. Potential Habitat for Federal and State Listed Animal and Plant Species, 2. Jurisdictional Wetlands*, JAYCOR, April 22.

The paragraph referenced in the comment is concerned with protected species. Inclusion of "threatened and endangered" in this paragraph would help the context of the sentence, however, because this report has already been published in its final form, DOE cannot make this change.

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COMMENT CODE
S-5-33

As addressed in our original comment letter, the current draft EIS fails to provide specific information on health and safety issues, potential radiological releases, proposed mitigation for protection of groundwater, and the location or occurrence of protected and endangered species within the proposed sites. In addition, specific locations of structures including roads, retention basins, cooling towers and the facility are not provided.

DOE has responded that requested information will be provided in studies and other documents after the ROD is issued. Because these items are necessary to fully evaluate the Environmental Impact of this project, we agree, after concurrence with your office, that it would be appropriate for DOE to issue a supplemental EIS in order to reference those studies and documents. This would formalize the commitments the DOE has made in their responses to comments on the Draft EIS. A supplemental EIS should be issued after the ROD but before construction is begun on the SNS project. The supplemental EIS should also include other appropriate environmental information that will not be available until that time.

RESPONSE
The DEIS contains sufficient information from which to determine the environmental impacts of the proposed action on each of the alternatives. The information presented in the EIS 1) is the best currently available given the level of design work allowed to be completed; 2) was corroborated through reconnaissance level surveys at all four locations; and 3) is adequate to support a siting and construction decision among the four alternative locations. The analysis in the EIS is intentionally designed to conservatively anticipate or "bound" all of the foreseeable environmental impacts at each location, not to present details about the site required to actually go forward with construction. Once DOE identifies the selected site in its Record of Decision, the agency will begin detailed design work and prepare additional evaluations, including a three-season survey, detailed archeological survey, geotechnical investigation, building placements, and other reviews. While these studies will substantially expand our information that would call into question the facts or assumptions in the EIS analysis. In the unlikely event that the additional analyses identify significant new information or adverse environmental impacts beyond those identified in this FEIS, the Department would prepare a supplemental EIS.

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COMMENT CODE
S-5-34

Comment Code S-5-1
Although the scope of the EIS is construction and operation of the SNS, decommissioning is an inevitable end result. It would seem prudent to have some type of funding assurance for D&D after the project life has been exceeded.

RESPONSE
Congress does not ordinarily provide funding specifically for the decommissioning of a project at the outset of the project's life. Rather, it provides funding through the annual appropriations process.

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COMMENT CODE
S-5-35

Comment Code S-5-9 & S-5-12
Based upon our current understanding of the processes associated with the SNS, it is highly unlikely that all radiological waste generated by operation of the Facility can be treated or disposed on site. What commitment will the Department make with regard to management of waste which will not meet an Oak Ridge Waste Acceptance Criteria or will in fact be characterized Special Case Waste (meaning it has no disposition alternative?)

It should be noted that commercial Low-Level Waste disposal contracts are for very low concentrations of radionuclides and certainly could not be utilized for disposition of all low-level waste generated for this proposed facility.

RESPONSE
DOE intends to treat radiological waste from the SNS for volumetric reduction or immobilization, and to dispose of it in properly licensed repositories. The extent of treatment would depend upon the treatment capabilities of the host laboratory for each alternative location. In the case of ORNL, SNS-generated waste would be treated in existing facilities along with other similar wastes and be shipped off-site for disposal. Similarly, DOE expects that special case waste would be shipped off-site for ultimate disposal.

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COMMENT CODE
S-6-1

However, I believe that I may have misunderstood statements in the document pertaining to avoidance of cultural resources in areas on the ORNL site that had not been surveyed yet (page 4-38 and page 5-37, for example). I took these statements to mean that all cultural resources identified during the survey would be avoided, but in reviewing the Draft EIS again, I am not sure I understood this correctly.

RESPONSE
Considerable information is available on the cultural resources of the ORR, particularly the historic resources. The text on page 4-38 indicates that the SNS design engineers would establish the routes of the southwest access road and utility corridors to avoid such known resources, if the proposed site at ORNL is selected for implementation of the proposed action. The text on pages 4-38 and 5-37 also indicates that the established areas would be surveyed for cultural resources. If any are identified, an assessment of the potential effects of the proposed action on these resources would be conducted, and any potential effects would be appropriately mitigated. The potential mitigation measures for these effects would be data recovery or avoidance (e.g. choosing another route or fencing a prehistoric site to protect it). DOE would prepare a mitigation action plan to explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness. The text of the FEIS has been revised for clarification purposes.

LOCATION OF EIS REVISION(S): Sections 4.1.7 and 5.2.7

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COMMENT CODE

S-6-2

My specific concern is with the site identified as 40RE488, a multicomponent site located in an area that will be affected by road improvements. I understand that the survey does not indicate that this site is eligible for listing on the National Register of Historic Places, even though prehistoric artifacts were found. My concern is that 10 shovel tests in an area covering 262 feet by 67 feet could have missed Native American graves in this area.

If site 40RE488 will not be avoided during road construction, I would request that more extensive tests be done to determine if burials are present in this area. I realize that DOE has fulfilled the requirement to determine if this site contains resources eligible for the NRHP, but I feel that under the circumstances, more tests are warranted. If Indian burials were found before construction began, it would be easier to avoid them, thus saving time and money.

Please let me know if it will be possible for more tests to be done on 40RE488, and please keep me informed of the progress of the SNS project. Thank you for your time.

RESPONSE

Performance of further archaeological investigations at 40RE488 would be contingent upon selection of the ORNL siting alternative for the SNS in the Record of Decision. As indicated in Sections 5.2.7.1 and 5.2.7.8 of the DEIS, a portion of 40RE488 may be destroyed by road construction under the proposed action. Survey data and the results of limited shovel testing at this site indicate that its prehistoric and historic occupational components are not cultural resources eligible for listing on the National Register of Historic Places. However, if road or other SNS-related construction activities cannot avoid destroying all or a portion of 40RE488, DOE would conduct systematic archaeological shovel testing of this site to assure the Tennessee Commission of Indian Affairs that no prehistoric human burials are present. This testing would be conducted prior to the start of road or other SNS-related construction on or in the immediate vicinity of the site. If prehistoric human burials are encountered during the shovel testings, DOE would comply with applicable requirements under the Native American Graves Protection and Repatriation Act (NAGPRA). These would include taking any appropriate measures necessary to protect the human remains and funerary objects, sending notification to the Qualla Cherokee tribe of the discovery, and entering into consultations with the tribe on appropriate treatment and disposition of the remains.

As previously noted, available survey and shovel test data indicate that 40RE488 is not a cultural resource. However, if artifacts or other remains indicative of a prehistoric or historic cultural resource are unexpectedly discovered during systematic shovel testing, DOE would consult with the State Historic Preservation Officer (SHPO) at the Tennessee Historical Commission. In accordance with NHPA, this consultation would seek ways of avoiding or reducing potential effects on the site. As required by the federal regulations in 36 CFR 800.5(e)(1)(iii), the Advisory Council on Historic Preservation and other interested persons would also be afforded an opportunity to participate in these required consultations.

If artifacts or other remains indicative of a prehistoric or historic cultural resource are discovered inadvertently during SNS-related construction activities on 40RE488, construction activities in the immediate vicinity of the site would cease and DOE would perform the foregoing consultation with the SHPO. For purposes of compliance under Section 3(d) of NAGPRA, the inadvertent discovery of human remains and funerary objects (associated and unassociated) would result in the cessation of construction activities, protection of the discovered items, notification of the discovery to the Qualla Cherokee, and consultation with the tribe on appropriate treatment and disposition of the human remains and funerary objects. The 30-day delay period following certification that notification of the discovery has been received by the tribe would be followed.

This comment response is based on methodological information presented in Sections 5.1.7.1 and 5.1.7.2 of the DEIS. In further response to this comment, the text in these sections has been revised for clarification purposes.

LOCATION OF EIS REVISION(S): Sections 5.1.7.1 and 5.1.7.2

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COMMENT CODE
S-7-1

1. LANL has the rights to approximately 1.8 billion gallons of water per year. They currently use 0.5 billion gallons, the surrounding communities use approximately 0.9 billion gallons, and the proposed SNS could use up to 0.7 billion gallons of water per year. Ground water pumping may lower the water table in nearby wells, reduce long term main aquifer productivity, and directly compete with surrounding communities for water. The DEIS did not describe measures to mitigate this impact.

RESPONSE
DOE recognizes that due to the arid climate in the LANL region, aquifer drawdown is a concern. Information reviewed for this EIS revealed that historic water level measurements in the main aquifer wells in the LANL region have indicated water level declines due to pumping and natural discharges exceeding recharge and inflow (DOE-AL 1998). However, the drawdown is not considered to be a major depletion. Mitigation measures to reduce the drawdown of the aquifer, including the possible construction of a dry cooling tower to recycle process water used at the site, can be undertaken if LANL is selected for the proposed SNS. DOE will prepare a mitigation action plan to explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness.

Based on the aforementioned historic studies that indicate water declines, some decline in the groundwater level from SNS operations may be inevitable, although the decline is not expected to impact the available municipal water supply. The text of the EIS has been modified to describe potential aquifer drawdown resulting from operation of the proposed SNS as well as mitigation measures that may be undertaken to minimize the drawdown.

LOCATION OF EIS REVISION(S): Sections 5.3.2.3 and 5.11.2

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COMMENT CODE
S-7-2

2. The proposed site at TA-70 is an undeveloped area at LANL within 1 to 2 miles of Bandelier National Monument. Large scale development would eliminate existing public use, be highly visible during the day and night, and increase traffic congestion. Over 330,000 people visit the Monument each year. We expect a greater negative impact to monument visitors and local residents than described.

We also expect noise levels and traffic congestion to be greater than described.

RESPONSE
DOE acknowledges and shares the state's concern for the potential effects of the proposed action on visitors to Bandelier National Monument and area residents, especially with respect to recreation, traffic,

and visual resources. However, based on the information reviewed during preparation of the EIS, DOE does not expect greater negative effects than those already stated in the EIS.

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COMMENT CODE
S-7-3

3. White Rock was described to be 3 miles from the SNS. Pajarito Acres is a subdivision of White Rock and appears to be within 1.5 miles of the facility. If the Maximum Exposed Individual (MEI) is based on exposure to individuals in White Rock, we expect it to be greater for residents of Pajarito Acres.

RESPONSE
For the SNS DEIS, the MEI is a hypothetical individual that is assumed to live at the LANL site boundary and to eat only foods grown at that location. The dose to such an individual is evaluated in each of the 16 principal compass directions. At LANL, the MEI is located 1.4 miles (2.2 km) northeast of the Target Building Exhaust Stack. This is in the direction of White Rock; however, since residences are not allowed inside the LANL site boundary, this is the closest possible residence in this direction. The dose at Pajarito Acres and White Rock would be less because they are a greater distance from the target Building Exhaust Stack.

The estimates of noise and traffic levels are derived from the number of workers (during construction and operations) that would commute to the site in addition to current workers. We have also included estimates of truck traffic that would make trips to the site during construction and operations. The methodology for this assessment is contained in Section 5.1.10.1.

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COMMENT CODE
S-7-4

4. Siting the SNS at TA-70 would require development of extensive utility infrastructures, such as a 60 to 90 MW power source, natural gas lines, steam lines, a water delivery system and access to sanitary waste facilities. The DEIS did not adequately describe the expense or environmental impacts that would occur from these actions.

RESPONSE
The expense of providing additional utility infrastructure at LANL is an issue separate from the environmental impacts, but cost would also be considered by the Secretary as part of the decision to locate the SNS. The purpose of the EIS is to identify and assess the environmental consequences of locating the SNS at the alternate sites. DOE believes it has identified and assessed the environmental issues associated with locating the SNS at LANL. Section 5.3.10.2, Utilities, states that “Although the existing utilities at LANL are extensive, the logistics of using these site services to support the proposed SNS at TA-70 would involve considerable investment in new infrastructure for all services.” Section 5.3.10.2.1, Electricity, identifies significant deficiencies with the current power system and states that the current system has inadequate capacity to support the SNS. Section 5.3.10.2.2, Natural Gas, acknowledges that LANL could meet the capacity for natural gas to support the SNS, “However since no existing gas lines or distribution systems are located in the vicinity of the proposed SNS site, an expansion of natural gas infrastructure would be required to serve future needs of the proposed SNS facility.” Section 5.3.10.2.3, Water Service, identifies that the current water service cannot meet the demands of the SNS and that “Significant water supply effects would be expected with the implementation of the proposed SNS facility.” Section 5.3.10.2.4, Sanitary Waste Treatment, identifies the lack of facilities on the proposed site and gives two alternatives for sewage treatment. In addition, the lack of utilities infrastructure is summarized and compared to the other candidate sites in the Summary

and Chapter 3. The Secretary can compare the environmental impacts on each resource (including utilities) at the four candidate sites. The DEIS acknowledges that extensive new infrastructure would be required for all utilities at LANL, and even with these improvements, the electricity and water supplies would be inadequate to support the SNS project.

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COMMENT CODE
S-7-5

5. This document described cooling-tower blowdown discharge of 250 to 350 gpm into TA-70 drainage. It also stated that the water would infiltrate before reaching the Rio Grande. We believe the shallow alluvium, the short distance to the Rio Grande, and existence of Ancho Spring make it possible for water to flow to the Rio Grande. Surface water flows should meet New Mexico Cold Water Fishery Standards.

RESPONSE
Section 3.2.3.6 of the DEIS indicates that between 500 and 700 gpm of water would be required for operation of the cooling towers and that approximately half of this water would be released to the atmosphere, mostly in the form of water vapor. The other half (250-350 gpm) would be released as blowdown to surface water. However, the water would initially be released to the retention basin, where it would reside until the water cools further before being released to the environment. The rate at which the water would be released from the retention basin has not been determined; however, it would likely be less than 250 gpm. The discharge rate from the retention basin could also be altered to prevent large-scale surface water runoff. Accordingly, DOE believes the water would infiltrate before reaching the Rio Grande. If the LANL site is selected in the Record of Decision for construction of the proposed SNS, DOE will ensure that all surface water discharge meets the requirements of the New Mexico Cold Water Fishery Standards. The text of the EIS has been modified to better describe how the cooling tower water would be discharged to the surface.

LOCATION OF EIS REVISION(S): Section 4.2.2.1

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COMMENT CODE
S-7-6

6. This document states that waste management facilities at LANL have sufficient capacity to handle the waste volume projected for the period 1998-2030. Therefore, construction and operation of the SNS would have a minimal contribution to cumulative impacts on waste management facilities. However, it also concludes that the existing treatment facilities do not have the capacity to treat all of the low-level waste from the proposed SNS. It correctly states that the low-level waste (with accelerator-produced tritium) would not meet the waste acceptance criteria for the existing treatment facility at TA-50. Therefore, additional facilities that will accept these wastes are required. A new facility at TA-53 is under construction and expansion at TA-54 would be required. These expansions would be for treatment of waste with accelerator-produced tritium and low-level waste disposal. They do not appear to be minimal impacts.

RESPONSE
The facility that is currently under construction (TA-53 RLW) for the treatment of low-level radioactive wastes with accelerator-produced tritium is not a result of the waste management needs that will be generated by the proposed SNS. This facility is being built because of the present need for this type of facility. TA-53 RLW is scheduled to be built whether or not the SNS is built at LANL. The additional waste that the SNS facility may generate will add to the overall waste but will be within the capacity of

this new facility. Therefore, the impact would be minimal. The text of the FEIS has been revised to clarify this impact.

LOCATION OF EIS REVISION(S): Section 5.3.11

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COMMENT CODE
S-7-7

7. Air Quality: a) The project is in an area that is currently in attainment for all National Ambient Air Quality Standards (NAAQS). (Incidentally, the reference on Page 5-69 to Table 5.2.3.2-1 should probably be changed to Table 5.3.3.2-1.) Should LANL be chosen as the preferred site, LANL personnel should meet with the Department's Air Quality Bureau permitting personnel prior to construction of the proposed project to determine the appropriate level of air quality permitting for it.

RESPONSE
The text in Section 5.3.3.2 refers the reader back to an earlier table involving natural gas combustion products. The correct focus of this referral is Table 5.2.3.2-1.

If the SNS site at LANL is chosen for implementation of the proposed action, DOE would meet with personnel from the New Mexico Environment Department, Air Quality Bureau, to determine the appropriate level of air quality permitting required for this facility. Such meetings would occur prior to the initiation of construction on the proposed SNS.

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COMMENT CODE
S-7-8

b) The DEIS states that the MEI would receive a radiation dose from this project of approximately 2.9 mrem/year. The DEIS does not provide the location of this individual. Currently, LANSCE (a linear accelerator) at LANL provides between 2.9 and 5.0 mrem per year to the current MEI. The report does not state whether the contributions from LANSCE have been considered in the 2.9 mrem present in this report. Communication with LANL personnel indicates that none of the staff responsible for the calculation of dose from airborne radiation were consulted in the development of the report. LANL is a very unique site due to its topography and climate (as opposed to Oak Ridge). If these considerations were not taken into account, the number reported in the DEIS could be significantly off. Concern about this possibility increases when noting the statement in the DEIS that the MEI reported in 1997 by LANL personnel is too large and should be reduced.

RESPONSE
The DEIS states (page 5-82) that the MEI for SNS airborne emissions would receive an estimated dose of 0.47 mrem/yr for operations at 1 MW and 1.8 mrem/yr for operations at 4 MW.

As indicated in the response to Comment S-7-3, the MEI for SNS operations at LANL is a hypothetical individual assumed to live at the LANL site boundary, 1.4 miles (2.2 km) northeast of the SNS Target Building Exhaust Stack.

In the comment, the source of the MEI dose of 2.9 to 5.0 mrem/yr attributed to Los Alamos Neutron Science Center (LANSCE) is unclear. The LANSCE releases short-lived positron emitters that can cause doses above background in the area of the East Gate. These doses are primarily from direct radiation and air immersion. LANSCE is in TA-53, and the East Gate is north-northeast of LANSCE. The proposed SNS location at LANL is in TA-70, south-southeast of TA-53. Only in TA-33 would the SNS site be further removed from LANSCE. In 1996, the East Gate was the location of the maximum individual dose for off-site locations, and the LANSCE was identified as the principal contribution to dose to the NESHAP MEI from airborne emissions from existing operations, (See pages 50 and 23 of *Environmental Surveillance and Compliance at Los Alamos during 1996*). The location of the NESHAP MEI is not identified in the cited report. The median dose to the maximum individual at the East Gate was 1.4 mrem/yr, and the dose to the NESHAP MEI was 1.93 mrem/yr. Both doses are given on page 5-82 of the DEIS and are described as representative of dose to MEIs from existing LANL operations. LANSCE is obviously an "existing operation." The total dose to the MEI from the combination of existing airborne emissions and SNS emissions is 2.4 mrem/yr at 1 MW (1.93 mrem/yr existing + 0.47 mrem/yr SNS). This dose is also given on page 5-82 of the DEIS.

DOE designated an individual at each site as a contact for obtaining site-specific information for preparation of the DEIS. The site contacts either furnished the information or directed the preparer to the appropriate technical specialist. At LANL, data used in airborne dispersion calculations were obtained directly from staff in the Air Quality Group or obtained directly from http://weather.lanl.gov.

Each of the alternative SNS sites has unique features that influence airborne dispersion and transport of emitted radionuclides and environmental transport of deposited radionuclides. For an EIS, it is desirable to use methods and models that provide a common basis for comparison of impacts of each alternative and for comparison of the impacts of the proposed actions to those of existing activities at each site. These considerations led to use of the models incorporated in the CAP88 and CAP88-PC computer codes (The models and not the codes themselves were used. Section F.4.1 explains the modifications that were necessary to address emissions associated with the mercury target of the SNS. These codes are used routinely at all four SNS alternative sites to demonstrate compliance with NESHAP requirements and do not model complex terrain. Meteorological input data are readily available and were obtained from the designated individuals at each site or from on-line databases maintained by the sites. Because these codes are run routinely at each site, dose estimates for airborne emissions from existing operations at all sites calculated with site-specific meteorological, agricultural, and demographic data and a consistent methodology are also available for each site. Using this approach, airborne dispersion calculations performed for this DEIS consider the unique climate and topography of LANL (and the other sites) to the same extent that they are considered by these sites in their annual demonstration of compliance with NESHAP.

The DEIS does not state that the "MEI reported in 1997 by LANL personnel is too large and should be reduced." Instead, the DEIS indicates on page 5-82 that, in addition to the calculations required to demonstrate NESHAP compliance, LANL performs "More realistic calculations, based on a combination of environmental measurements and transport modeling . . ." For 1996, it appears from the discussion on page 48 of the LANL surveillance and compliance report that both calculations were based on CAP88 modeling because environmental monitoring data were incomplete. The difference in the calculations appears to be that the NESHAP result is based on all existing LANL emissions, and the more realistic case considers only LANSCE emissions.

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COMMENT CODE
S-7-9

c) The DEIS does not address the Tribal Authority Rule (TAR) which is a vague EPA document that may empower the tribes to receive regulatory authority over LANL instead of the state. The new Neutron Source may place the MEI on tribal land, which would give the tribe excellent leverage to receive authority. However, since the location of the MEI was not adequately described nor were data provided showing that proper meteorological and topographical considerations were taken into account, it is not possible to reach any specific conclusion.

RESPONSE

The MEI is located 7,313 ft (2,229 m) northeast of the SNS Target Building Exhaust Stack at the center of the "hammerhead" on the footprint of the proposed SNS at LANL (see Section 5.3.9.2.1). This location is essentially at the LANL boundary southwest of White Rock, and it is not on tribal land. Therefore, its location would not result in a shift of environmental regulatory authority from the state of New Mexico to a tribal government.

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COMMENT CODE

S-7-10

8. If the SNS is located at LANL, locations other than TA-70 should be considered. For example, there is an existing accelerator facility at TA-53. This location appears to have many of the features described as necessary for the SNS.

RESPONSE

The siting of the proposed SNS facility was determined based upon a site-selection process that is presented in Appendix B of the DEIS. The site-selection process included an evaluation of several potential sites within LANL. Based on the site-selection process, TA-70 was a more preferred siting than TA-53.

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COMMENT CODE

S-7-11

1. 4.2 Los Alamos National LANL, Page 4-63, paragraph 1, line 11

The Rio Grande is the only permanently flowing river near the project area.

This statement is incorrect. Ancho Canyon contains a perennial reach, which is supplied by Ancho Spring, that normally extends to the Rio Grande from a position about 0.5 miles southeast of the proposed SNS facility site.

2. 4.2.2.1 Surface Water, Page 4-70, paragraph 2, line 1

There are no permanent surface water resources within 0.25 miles (0.44 km) of the proposed SNS facility site.

The statement is true; however, the document should not that approximately 0.5 miles downstream of the proposed facility, a perennial reach exists in Ancho Canyon.

RESPONSE

DOE acknowledges that the Ancho Canyon spring is located approximately 0.5-miles from the proposed SNS site. The statement in the DEIS was meant to identify *major* surface water bodies. The Ancho Canyon spring is a small surface water body. The text of the EIS has been edited to specify that no major surface water bodies are located within 0.25-miles of the proposed SNS facility, but that Ancho Canyon Spring, a smaller surface water body, is located approximately 0.5-miles from the proposed site.

LOCATION OF EIS REVISION(S): Sections 4.2 and 4.2.2.1

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COMMENT CODE
S-7-12

3. 4.2.2.1 Surface Water, Page 4-72, paragraph 2, line 13
Los Alamos, Water, and Pajarito canyons/streams originate upstream of LANL facilities.

This statement is not entirely correct. Several perennial streams exist onsite, and they include: 1) a 2-3 mile reach in Sandia Canyon exists as a result of the discharge of treated sanitary-sewage effluent, and heads at Technical Area 3, 2) a 1.5-2.0 mile reach in Canon de Valle that heads at Technical Area 16, and 3) 2-3 mile reach in Pajarito Canyon that heads near Technical Area 22 (Dale, 1998). A more accurate description of the hydrologic setting should be incorporated into the document.

4. 4.2.2.1 Surface Water, Page 4-72, paragraph 2, line 15
Perennial streams in the lower portions of Ancho and Chaquehui Canyons extend to the Rio Grande without being depleted by recharge to the ground.

A more accurate description of the flow conditions in the referenced canyons should be included in the document. Field observations and documentation during 1996, 1997 and 1998 showed that perennial flow in Chaquehui Canyon extended for approximately 300 ft from Spring 9A, and did not reach the Rio Grande. On September 29, 1998, field observations showed that perennial flow Ancho Canyon extended from Ancho Spring to within about 600 ft of the Rio Grande. In other words, these perennial reaches do not always reach the Rio Grande.

RESPONSE
DOE agrees that several perennial streams exist onsite, including reaches in Sandia Canyon, Canyon de Valle, and Pajarito Canyon. Figure 4.3.1.3-1 of the Site-Wide EIS for LANL indicates that perennial flows in Chaquehui Canyon and Ancho Canyon do reach the Rio Grande. However, DOE acknowledges that various climatic conditions may prevent the perennial flow from always reaching the Rio Grande and that at certain times the perennial streams may infiltrate the ground. The text of the EIS has been revised to state that perennial streams within the LANL region do not always reach the Rio Grande.

LOCATION OF EIS REVISION(S): Section 4.2.2.1

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COMMENT CODE
S-7-13

5. 4.2.2.2. Flood Potential, Page 4-72, paragraph 1, line 10
The overall flood risk to LANL and facilities at TA-70 is small because of the position of this site on a mesa top.

We agree that the flood risk on the mesa top is minimal. However, the flood risk downstream in Ancho Canyon and the unnamed canyon may be increased due to the additional outfall and runoff from parking lots, roofs, etc., at the site. The increase in runoff may affect the physical conditions and biological communities downstream from the proposed facility.

RESPONSE
DOE agrees that some additional surface water runoff would occur with construction and operation of the proposed SNS. However, storm drains and curbs in the parking lots would capture most of the runoff from parking lots, roofs, and other surface water transporters at the facility. Some of the surface water

runoff would also be directed to the retention basin (see Section 3.2.2.7). Additionally, the LANL site is vast compared to the proposed SNS site, and the LANL site already receives a large amount of surface water runoff. Any additional runoff resulting from the proposed SNS facility would be minor compared to the already existing runoff at the site. Thus, no obvious effects to the physical conditions and biological communities downstream of the proposed facility would be anticipated.

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COMMENT CODE
S-7-14

6. 4.2.2.3 Groundwater, Page 4-73, paragraph 2, line 9
Depth to groundwater, 840 ft (256 m), at TA-70 inferred from a monitoring well adjacent to the site.

To the best of our knowledge there is no regional monitoring well adjacent to the TA-70. DT-9 is the closest well, and it is located approximately 4 miles northwest of the proposed SNS site.

7. 4.2.2.3 Groundwater, Page 4-73, paragraph 2, line 11
The depth to groundwater at the bottom of Ancho Canyon along the southern edge of TA-70 is 600 ft.

The statement may not be correct considering the fact that Ancho Canyon discharges within the canyon bottom.

RESPONSE
DOE agrees that there are no monitoring wells on or adjacent to the proposed SNS site. The depth to groundwater at the proposed site (840 feet) can be inferred by taking the difference between the surface elevation (6,445 feet) of the proposed site and the groundwater contour elevation (approximately 5,605 feet, as referenced in the DEIS and the Site-Wide EIS for LANL) beneath the proposed site. The text of the EIS has been modified to describe how the 840 ft depth to groundwater was inferred.

DOE acknowledges that Ancho Spring in Ancho Canyon is sourced by the main aquifer. Accordingly, the sentence in Section 4.2.2.3 of the EIS stating that "The depth to groundwater at the bottom of Ancho Canyon along the southern edge of TA-70 is 600 ft (183 m)" has been removed.

LOCATION OF EIS REVISION(S): Section 4.2.2.3

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COMMENT CODE
S-7-15

8. 4.2.2.3 Groundwater, Page 4-75, paragraph 4, line 14
Background concentrations of radionuclides and trace metals are shown in the Ancho Spring results.

o The text should explain what "background concentrations" were used. To the best of our knowledge, background concentrations for ground water at LANL have not been agreed upon.

o It should be noted that in 1995, the high explosive compounds HMX (4.9 ppb), RDX (23 ppb) and 2,4-DNT (0.18 ppb) were detected in Ancho Spring waters (data from LANL Report: Environmental Surveillance at Los Alamos during 1995), which may indicate that Ancho Spring is not an appropriate background station.

o Contaminants were also found in Ancho Spring at earlier times. From 1951 through 1955 some contaminants were found: nitrate as nitrate (NO3), 0.2 to 30.0 ppm; phosphate (NO3), 3.0 to

30 ppm; chloride (Cl), 2.8 to 93 ppm; and Fluoride (F), 0.2 to 3.2 ppm (data from Weir, et al., 1963, USGS report titled "The hydrology and the chemical and radiochemical quality of surface and ground water at Los Alamos, New Mexico, 1949-55").

RESPONSE
DOE acknowledges that background concentrations for groundwater at LANL have not been agreed upon. Table 4.2.2.3-1 in the DEIS is meant to be representative of groundwater quality near the proposed SNS site. Accordingly, the word "background" has been removed from the referenced sentence in the EIS.

DOE also acknowledges that contamination was previously identified in Ancho Spring. However, as mentioned previously, Table 4.2.2.3-1 is meant only to show the water quality levels in the main aquifer at the LANL site and is not meant to compare the values to background levels.

LOCATION OF EIS REVISION(S): Section 4.2.2.3

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COMMENT CODE
S-7-16

9. 4.2.2.3 Groundwater, Page 4-75, paragraph 5, line 1
Long-term trends of the water quality in the main aquifer beneath LANL have shown little impact resulting from operations (LANL, 1997d).

The regional-aquifer monitoring system at LANL is probably inadequate to monitor long-term trends (e.g., long-screened intervals, spacing, casing degradation, possible borehole leakage, etc.). Recent data show that the regional aquifer beneath several historical release sites has been impacted by LANL activities.

RESPONSE
The information used by DOE in formulating the referenced statement was obtained from a document entitled *Environmental Surveillance and Compliance at Los Alamos During 1996*. This document was provided to DOE by LANL. Additionally, the shielding design of the proposed SNS would include a crushed limestone interval covered by a geomembrane liner to protect the groundwater, as discussed in Section 5.11.2 of the EIS.

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COMMENT CODE
S-7-17

10. 4.2.5.3 Aquatic Resources, Page 4-85, paragraph 1, line 2
These habitats currently receive NPDES-permitted wastewater discharges from LANL.

This statement is incorrect. A total of three perennial reaches or aquatic habitats at LANL do not receive wastewater effluent: 1) lower Ancho Canyon, 2) Canon De Valle near TA-16, and 3) Pajarito Canyon from TA-9/22 to approximately the mouth of Two-mile Canyon.

RESPONSE
The statement referred to in the comment is incorrect and has been deleted from the text of the EIS.

LOCATION OF EIS REVISION(S): Section 4.2.5.3

....

COMMENT CODE
S-7-18

11. 4.2.9.1.2 Water, Page 4-108, paragraph 1, line 21
Surface and runoff water results from Ancho Canyon (TA-70) indicate all radionuclides well below the DOE DCGs for public dose, with many reported values below analytical detection limits (Table 4.2.9.1.2-1).

Surface-water data should be compared to more applicable standards such as New Mexico Water Quality Act or the federal Clean Water Act.

RESPONSE
DOE recognizes the standards set forth in the New Mexico Water Quality Act and the federal Clean Water Act. However, these standards deal with general groundwater quality, whereas the DOE derived concentration guides (DCGs) are for public dose from radionuclides. Additionally, the New Mexico Water Quality Act and the federal Clean Water Act standards are developed for a vast number of contaminants, whereas the standards set forth by DOE are more specific to isotopes including radionuclides. Because DOE specializes in these types of isotopes and because the proposed SNS facility would be constructed on DOE property, the standards set by DOE are more applicable to this particular project.

Because of the uncertainties in the amount of soil activation products and uncertainties about groundwater at each of the four sites, DOE's standards are based on very conservative assumptions. After the release of the Record of Decision, characterization of the selected site would determine if additional design features are necessary to achieve the groundwater protection levels presented in the EIS.

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COMMENT CODE
S-8-1

In general, the Division of Solid & Hazardous Materials found the Draft Environmental Impact Statement (DEIS) to be technically rigorous, thoroughly researched, and conscientiously presented. There are not subjects related to the radioactivity involved that we believe should be addressed in greater detail, and we were pleased to see the level of attention paid to radioactive emissions, their environmental impacts, and potential accident scenarios involving radioactive materials.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
S-8-2

A comparison using Table S 1.5.2-1 starting on page S-27 shows several reasons why Brookhaven National Laboratory (BNL) should not be the preferred alternative. The BNL alternative has the highest potential for increasing the radionuclide concentrations in groundwater due to soil activation by the linear accelerator (linac). The estimated radiation dose to the maximally exposed individual (page S-45) and the estimated latent cancer fatalities (page S-46) due to the presented accidents scenarios are greater than those for the Oak Ridge National Laboratory (ORNL) and Los Alamos National Laboratory (LANL) alternatives. This leads to the conclusion on page S-62 of Table S1.5.2-1 that the BNL alternative has the "potential for adverse radiological impacts on human health from normal BNL and SNS operations." In addition, the projected annual amount of low-level radioactive wastes (page S-53) generated by the SNS (16,400 m^3/yr) exceeds BNL's total annual capacity (300 m^3/yr), which would require additional low-level waste treatment capacity be provided. For all of these reasons, we agree that BNL should not be the preferred alternative.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
S-8-3

Section 5.8.4 on page 5-205 lists the unavoidable adverse environmental impacts, should the SNS be constructed and operated at BNL. The first impact listed, neutron activation of soils in the berm used to shield the linac tunnel, is our primary concern. Activation of the soil berm, which is approximately 20 feet above the groundwater table, and the high permeability of the soils in which the SNS would be built, will lead to the rapid contamination of groundwater in much greater concentrations than will be experienced at ORNL or LANL. The intentional contamination of groundwater in the Upper Glacial Aquifer on Long Island without any mitigating measures is unacceptable.

RESPONSE
As discussed in Section 5.11 of the DEIS, appropriate mitigation measures would be undertaken to minimize potential impacts to the groundwater at the site. If the site at BNL is selected for the SNS and if during the investigation of this site it is found that soil conditions and groundwater travel times do not agree with the assumptions used in the EIS, the design of the earthen berm would be modified to assure that the severity of the impacts to groundwater in the Upper Glacial Aquifer would not be greater than those expressed in the FEIS.

If the site at BNL is selected for the SNS in the Record of Decision, DOE would investigate appropriate measures to mitigate the potential effects of the proposed action on contamination of groundwater in the Upper Glacial Aquifer on Long Island. The evaluation and selection of appropriate mitigation measures would be documented in the mitigation action plan, which would be issued after publication of the Record of Decision.

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COMMENT CODE
S-8-4

Under the measures described to mitigate the adverse environmental impacts within sections 5.11.4 on page 5-217, the only measure that BNL has <u>not</u> committed to implementing is a multi-layer shielding design to minimize the activation of the berm soils and the subsequent spread of contamination through subsurface soils and groundwater. If the SNS were to be constructed at BNL, the Department of Environmental Conservation would expect BNL's commitment to construction of the additional shielding, or some equivalent measures, in order to offer the greatest protection of the Upper Glacial Aquifer. Without such measures, this Department opposes the siting of the SNS at BNL.

RESPONSE
After publication of the Record of Decision, characterization of the selected site would determine if additional design features are necessary to stay within the bounding impacts presented in the EIS. If the BNL site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan that would include the multi-layer shielding design to minimize activation of the berm soils. In the mitigation

action plan, DOE will identify potential mitigation measures for the Upper Glacial Aquifer on Long Island and evaluate them for effectiveness.

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COMMENT CODE
M-1-1

1. **Site maps.** Different maps in the EIS show different shapes and boundaries for the proposed facility site on the Oak Ridge Reservation (for example, compare the figures on pages 4-20 and 4-27). This is confusing. Please give an explanation for the different site configurations shown on the different maps.

RESPONSE
Figure 4.1.5.2-1 on page 4-20 is a representation of the footprint of the proposed SNS at ORNL. Figures 4.1.5.4-1 (page 4-25) and 4.1.5.4-2 (page 4-27) show an outline of the area that was included in the surveillance surveys for protected species. Figures 4.1.5.4-1 and 4.1.5.4-2 have been modified to include the footprint of the proposed facility.

LOCATION OF EIS REVISION(S): Figures 4.1.5.4-1 and 4.1.5.4-2

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COMMENT CODE
M-1-2

2. **Section 4.1:** There is a puzzling absence of reference citations in some subsections of this chapter. For example, the discussions of the bedrock geology and geologic structure of the Oak Ridge Reservation (pages 4-1 to 4-6) surely are not original to this EIS, but there are no citations to the actual source or sources. Among the other sections where supporting references are absent or incomplete are Section 4.1.2.2 (pages 4-12 to 4-13), which cites no references; Section 4.1.5 (pages 4-18 to 4-27), which directs the reader to "the references compiled for this section" for more detail, but cites only two references that are related to only two of the several topics covered; and the discussion of the End-Use Working Group recommendations (page 4-56), which describes the Working Group's draft recommendations but does not include a reference citation.

In other instances, sources are identified informally, without full citations. For example, the discussion of emissions from non-DOE facilities (beginning at the bottom right on page 4-57) states that information about airborne emissions was "supplied by the facilities," but it does not name the facilities, give the dates for which the supplied information was valid, give the dates of the communications by which this information was supplied, nor identify the basis or source for the conclusion about the effective cumulative annual dose equivalent from these facilities. Similarly, Section 4.2.5.3 (page 4-18) names "the Forest Compartment Maps for the ORR" as a source, but gives no citation.

In these cited locations and throughout the EIS, please make sure that the final EIS identifies the sources of information relied upon, both to give appropriate credit to the sources and to help readers investigate the various subjects further, if they wish to do so.

RESPONSE
The commenter is correct. Citations have been included in the text of the FEIS to assist the reader with investigating the subject matter in more detail. The reference for the forest compartment maps for ORNL is complete.

LOCATION OF EIS REVISION(S): Section 4.1

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COMMENT CODE
M-1-3

3. Page 4-7, last paragraph in first column. It appears that the second sentence should say "The soils tested ranged from clayey sandy silt *with* gravel-sized chert (Unified Soil Classification System-"GC") to…" (emphasis added to show insertion).

RESPONSE
The commenter's analysis is correct. The word "with" has been added to the text of the FEIS.

LOCATION OF EIS REVISION(S): Section 4.1.1.4

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COMMENT CODE
M-1-4

4. Page 4-30, Table 4.1.6.1-2. The entry for "Lenoir" should be "Lenoir City."

RESPONSE
The commenter's analysis is correct. The entry for "Lenoir" in the table has been corrected to read "Lenoir City."

LOCATION OF EIS REVISION(S): Table 4.1.6.1-2

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COMMENT CODE
M-1-5

5. Page 4-31, Section 4.1.6.3.1. No source is identified for the information in the second paragraph of this section. However, data from the State Department of Education at http://www.k-12.state.tn.us/arc/fa_asr/table19.htm (essentially the same source that is cited elsewhere in the Education section) disagree with the numbers presented here. The lowest local funding percentage (30%) is in Loudon County (not Roane County) and the highest local funding percentage is in Oak Ridge (55%), not Knox County. State funding ranges from 38% in Oak Ridge (lower than Knox County's 43% figure) to 62% in Loudon (not Roane) County.

RESPONSE
The commenter's analysis is correct. The percentages currently in the DEIS are incorrect. The correct percentages for federal, state, and local funding along with their sources have been included in the text in Section 4.1.6.3.1 of the FEIS.

LOCATION OF EIS REVISION(S): Section 4.1.6.3.1

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COMMENT CODE
M-1-6

6. Page 4-32, Table 4.1.6.3.1-1. This table of public school statistics sometimes omits city-operated school systems and sometimes lumps them in with the counties. Cities in the region that operate separate school systems are Oak Ridge, Clinton, Harriman, and Lenoir City. Based on comparison with the cited source (which gives data for the city and county systems separately), it appears that the table includes data for Oak Ridge and Clinton in some of the measures for Anderson County (e.g., the number of schools) but not others (e.g., student enrollment and per-pupil expenditures), while data for Lenoir City and Harriman seem to be completely missing. Please revise this table to include data for the city school systems. It is misleading to combine the data for city and county systems, since measures such as per-pupil expenditures can differ significantly between different systems in the same county (for example,

Oak Ridge spent $6,794 per pupil, while Anderson County spent $4,900). Also, please check all the figures in the table for accuracy (some of them do not match any of the data in the source).

RESPONSE
The commenter's analysis is correct. An updated table is included in the FEIS to show the city operated school systems.

LOCATION OF EIS REVISION(S): Table 4.1.6.3.1-1
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COMMENT CODE
M-1-7

7. Page 4-32, first paragraph. The City of Oak Ridge Fire Department does serve the Oak Ridge community, but it is not the primary source of fire protection for ORNL. ORNL operates its own separate fire department, although there is a mutual aid agreement with the City. Please obtain the correct information from ORNL or from DOE Oak Ridge Operations and revise this passage accordingly.

RESPONSE
The commenter's analysis is correct, the Oak Ridge Fire Department is not the primary source of fire protection for ORNL. The last sentence, "The Oak Ridge Fire Department provides fire suppression, medical/rescue, wildland fire suppression, and fire prevention services to both ORNL and the Oak Ridge community," will be deleted and replaced with the following: "Fire protection for ORNL is provided on site by the ORNL Fire Department. The ORNL Fire Department has 30 firefighters and operates one rescue vehicle, two pumper engines, and two ambulances. The ORNL Fire Department has mutual agreements with the Y-12 Fire Department, the East Tennessee Technology Park (ETTP) Fire Department, and the Oak Ridge Fire Department (Rosenbalm, 1999)."

LOCATION OF EIS REVISION(S): Section 4.1.6.3.3
....

COMMENT CODE
M-1-8

8. Pages 4-35 to 4-40, Section 4.1.7. This Cultural Resources section mentions several properties on the Oak Ridge Reservation as being "eligible" for National Register listing, but does not mention the properties that are listed on the National Register of Historic Places, nor indicate that the Oak Ridge Graphite Reactor is a National Historic Landmark. Please include this information.

RESPONSE
No prehistoric sites on the ORR are listed on the National Register of Historic Places (NRHP). However, seven historic sites on the ORR are listed on the NRHP. The text of the DEIS has been revised to include this information and the names of the listed sites.

LOCATION OF EIS REVISION(S): Section 4.1.7
....

COMMENT CODE
M-1-9

9. Page 4-41, first paragraph in second column. The north corner of the original reservation was never "politically separated from the reservation and incorporated as the City of Oak Ridge." From the City's inception, the corporate boundaries of the City of Oak Ridge have included the entire reservation area.

RESPONSE
The sentence, "In the late 1950s, this area was politically separated from the reservation and was incorporated as the city of Oak Ridge" has been removed.
LOCATION OF EIS REVISION(S): Section 4.1.8.1

....

COMMENT CODE
M-1-10

10. Page 5-22, Section 5.2.2.3.1. Regional construction experience indicates that infiltration from retention basins built over the Knox Group can sometimes accelerate karst processes and lead to formation of sinkholes, even when no preexisting sinkhole features have been identified. Therefore, DOE should consider constructing the retention basin in a manner that prevents or minimizes infiltration of collected runoff.

RESPONSE
DOE agrees that infiltration from retention basins can sometimes accelerate karst processes and lead to the formation of sinkholes, even when no preexisting sinkhole features have been identified. After the publication of the Record of Decision, DOE would complete an optimization study at the selected site. This study would determine the optimal layout of facilities at the site, including the retention basin. DOE will include consideration of engineering the retention basin to minimize infiltration.

....

COMMENT CODE
M-1-11

11. Page 5-22, last paragraph. It is not conservative to assume that the hydraulic conductivity of the vadose zone is equal to the saturated hydraulic conductivity of the soil matrix in the saturated zone. There is an extensive body of evidence (including research observations on the Walker Branch Watershed, published in ORNL reports and the open literature by researchers including Robert Luxmoore, Glenn Wilson, and Philip Jardine) demonstrating that most vadose zone flow is in "macropores," including fractures and root channels, not in the soil matrix. As a result, transit time through a 10-m distance in the vadose zone could be measured in minutes or hours, not years. Please use Walker Branch research results as a basis for revising the analysis of groundwater contamination impacts to include a more realistic assessment of radionuclide transport in the vadose zone.

RESPONSE
DOE is familiar with the Walker Branch Watershed research cited by the commenter. However, the macropore flow would not be appropriate to calculated travel time. The transport rates quoted in the DEIS for the Chestnut Ridge site represent groundwater travel through the upper soil horizon (assumed but unlikely to be under continuously saturated conditions). The soil removed during excavation of the site for construction of the tunnels for the linear accelerator and accumulator rings would be stored on-site and would later be used to construct the earthen berm. The engineered earthen berm that would cover the linear accelerator and accumulator rings would be constructed of compacted native soils, thus eliminating macropore flow of groundwater. The berm would be engineered to isolate activation products by minimizing the amount of water infiltrating the berm.

....

COMMENT CODE
M-1-12

12. B-34, Table. This table indicates that the Clinch River Breeder Reactor Site is currently used for waste management. As we understand it, the site is vacant and available for industrial development. Please check the information and correct table.

RESPONSE
The land use designation for the Clinch River Breeder Reactor Site has been changed from "waste management" to the correct designation of "industrial."

LOCATION OF EIS REVISION(S): Appendix B, Table 2

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COMMENT CODE
M-2-1

You may recall that in April of 1997, you received a copy of a resolution adopted by the Oak Ridge City Council (Resolution No. 4-61-97) supporting and endorsing the National Spallation Neutron Source (SNS) and the companion Joint Institute for Neutron Science (JINS). The resolution was accompanied by a letter enlisting your support for these projects. I am once again enlisting your support as a fellow Tennessean.

Enclosed is a copy of Resolution No. 2-14-99 which was unanimously adopted by the Oak Ridge City Council during its regular meeting on Monday, February 1, 1999. This resolution reinforces our strong support for the Spallation Neutron Source (SNS) and urges its construction and operation at the preferred site in Oak Ridge. As explained in the resolution, the Department of Energy (DOE) has identified four alternative sites for the SNS: Oak Ridge National Laboratory (ORNL), Argonne National Laboratory in Illinois, Brookhaven National Laboratory in New York, and Los Alamos National Laboratory in New Mexico. We want to ensure that this project which will benefit not only Oak Ridge but our entire state, both economically and prestigiously, is located on the ORNL site. I am enclosing a publication titled, "Spallation Neutron Source, the Next-Generation Neutron Scattering Facility for the United States," that I believe you will find helpful in understanding the scope of this project and the opportunities it offers for future scientific and industrial research and development.

Any action you may take at this time to demonstrate your support for the location of the SNS at ORNL will be helpful. I cannot state too strongly that the completion of this project, and the companion JINS, will be in the long-term best interests of our state and our country. Please feel free to call me if you have questions or would like additional information about these projects.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
M-3-1

The CAP strongly supports the selection of the Preferred Alternative to locate the SNS in Oak Ridge and have it be operated by ORNL. We recognize the importance of the research enabled by the SNS. The following comments are given for the purpose of strengthening the document and support for SNS.

The CAP reiterates its strong support for locating the SNS at the Oak Ridge Reservation.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
M-3-2

The draft EIS documents most of the concerns and issues raised at the scoping meeting except for one—the lack of public involvement in selecting the actual, physical site. The draft EIS and associated public meetings are the first opportunity to comment on the proposed physical site. Allowing public involvement earlier in the site screening process for the ORR would have been desirable.

RESPONSE
The siting of the proposed SNS facility was determined based upon a site selection process that is presented in Appendix B of the DEIS. The site selection process included an evaluation of several potential sites within the ORR.

DOE has held additional public information/comment meetings concerning the SNS project, and will continue to do so. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision. Input and comments from the public will be considered by DOE in its decisionmaking processes, as exemplified by this EIS.

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COMMENT CODE
M-3-3

1. The site plan shown on page 3-12 and elsewhere does not show the retention basin for site runoff, sediment settling, and cooling tower blowdown. This basin is discussed on pages 5-20, 5-21, 5-30, and elsewhere, but its size and location are never given. The retention basin could significantly increase the footprint of the SNS on the ridgetop.

RESPONSE
The retention basin is not shown on the site plan (Figure 3.2.1.5-1) on page 3-12 because the figure is meant to show a generic site plan illustrating the facility. The placement of a retention basin is site specific and will vary in location according to the site. The figures showing the specific SNS site location for each of the four alternative locations have been modified to include the retention basin. The text of the EIS concerning the retention basin has also been clarified. At the Conceptual Design stage of the project, the size of the retention basin required was estimated as approximately 2 acres.

LOCATION OF EIS REVISION(S): Figures 4.1-1, 4.2-1, 4.3-1, and 4.4-1; Sections 3.2.2.3, 3.2.3.6, 5.2.2.1.2, 5.2.5.2, 5.3.2.1, 5.3.5.2, 5.4.2.1, 5.4.5.3, 5.5.2.1, 5.5.5.2, 5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.11.1, and 5.11.3

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COMMENT CODE
M-3-4

2. Page 5-37, last paragraph mentions construction or improvement of utility corridors and a southwest access road not assessed at the time of the Draft EIS. Mitigation measures should be planned and implemented for impacts in addition to those on cultural resources, for example if any of the corridors run through the buffer zone for Walker Branch watershed.

RESPONSE
The CEQ regulations (40 CFR 1501.2) require integration of the NEPA process with other planning for proposed actions "…at the earliest possible time…" In the DOE system, this means that an EIS is

typically initiated during the Conceptual Design phase of a project. At this most general level of design, enough is known about a proposed action to allow the preparation of an EIS. However, the full details of a proposed action may not be established until the completion of Title I and Title II (preliminary and detailed) design at a later date.

This EIS was initiated during the Conceptual Design phase of the SNS project. Title I and Title II design for the project have not been completed. As a result, all of the final design details for the proposed SNS have not been established. For example, the final routes of access roads and utility corridors to the proposed SNS sites at the four National Laboratories are not known. In addition, the final locations of the retention basin are uncertain. Consequently, the potential effects of construction and operational activities on the environment for these specific items cannot be reasonably assessed at this time.

If a final site for the proposed SNS is selected, the locations of the retention basin, roads, and utility corridors would be established at the host national laboratory. To the maximum extent possible, these locations would be delineated to avoid known environmental features such as cultural resources, wetlands, and natural areas. In addition, the potential effects of the proposed action on the overall environment in these areas would be assessed. If effects would result, DOE would identify, evaluate, and commit to appropriate mitigation measures in the Mitigation Action Plan. These measures would be implemented prior to the initiation of ground-disturbing activities in the delineated areas.

The basis elements of the foregoing strategy are presented in the introduction to Chapter 5 of the DEIS. The test of the introduction has been revised to clarify the role of the mitigation action plan in this strategy.

LOCATION OF EIS REVISION(S): Chapter 5 (Introduction)

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COMMENT CODE
M-3-5

The Draft EIS does not effectively show the intrusion of the SNS into environmentally sensitive areas. In contrast, the CERCLA Waste Disposal RI/FS (DOE/OR/02-1637&D2 in Figures 7.2, 7.3 and 7.4) shows in detail the sensitive areas. The CAP referred to these figures in studying the proposed SNS site, as they better show the sensitive areas' proximity to the SNS preferred location. For example, a copy of Figure 7.4 is enclosed; the inclusion of a similar figure in Section 4.1.5 or 5.2.5.4 along with the figure found on page B-43 is recommended.

RESPONSE
An additional figure showing environmentally sensitive areas on and adjacent to the proposed SNS site at ORNL has been included in the FEIS. The other figure mentioned by the commenter is considered to already be part of the EIS (Volume II, Appendix B, page B-43). This figure shows biodiversity significance ranking (BSR) areas relative to the proposed SNS site on the ORR. A new paragraph referring the reader to these figures has been included in the text of the FEIS.

LOCATION OF EIS REVISION(S): Section 4.1.5.4, Figure 4.1.5.4-2 (new)

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COMMENT CODE
M-3-6

In addition, an outline of the SNS footprint should be shown on Figures. 4.1.5.4-1 and 4.1.5.4-2.

RESPONSE
Figures 4.1.5.4-1 and 4.1.5.4-2 have been revised to include an outline of the SNS footprint.

LOCATION OF EIS REVISION(S): Figures 4.1.5.4-1 and 4.1.5.4-2 (renumbered as Figure 4.1.5.4-3)

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COMMENT CODE
M-3-7

Figures 4.1.8.3-1 and 4.1.8.3-2, found on pages 4-54 and 4-55 respectively, are not readable; these maps would be improved by expanding the view of the affected area and choosing lighter shading patterns.

RESPONSE
The base map for Figure 4.1.8.3-1 was originally done in multiple colors. It was translated into a black and white format for use in the DEIS. Prior to issuance of the draft document, several attempts to improve the quality of this figure were undertaken with limited success. However, the relationship of the BSR areas to the proposed SNS site is shown in another figure in the EIS. This figure, which provides an expanded view of the affected area, is in Volume II, Appendix B, page B-43.

An attempt has been made to improve the quality of Figure 4.1.8.3-2, particularly on the legend bars.

LOCATION OF EIS REVISION(S): Figure 4.1.8.3-2

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COMMENT CODE
M-3-8

The Draft EIS does a good job of stating the potential impact of the Chestnut Ridge SNS site on the climatic research being done in the Walker Branch watershed in support of the Nations Global Change Program. If this proves to be the chosen site, the CAP would like to see a commitment to mitigation measures before construction begins. Mitigation of the SNS impact on this research is extremely important to protect the value of 30 years of climate data. In addition to replacement of natural gas boilers with electric heat pumps (page 5-41), use of an electric shuttle but to transport people to the site during the operations period is another potential mitigation mechanism. An electric shuttle would not only reduce carbon dioxide emissions from conventional vehicles but would also reduce runoff by eliminating the need for large parking lots, consequently allowing reduction of the volume of the retention basin and of the overall footprint of the SNS complex.

RESPONSE
The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2, and 5.8.1 of the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects from CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action

plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.331, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
M-3-9

A better decommissioning plan is needed. Page 5-43 (second paragraph) states: "Current plans call for in-situ decommissioning of the SNS when its operational life cycle is completed." This is unacceptable to the CAP. Such approaches typically have resulted in excessive releases of contaminants to the environment as well as disproportionate surveillance and maintenance costs.

RESPONSE
DOE will prepare a decommissioning plan after release of the Record of Decision and before the start of construction. DOE has also committed to prepare the appropriate NEPA documentation prior to decommissioning the facility, when decommissioning becomes reasonably foreseeable.

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COMMENT CODE
M-3-10

Additionally, 30-years of continuous operations (page 5-19) seems unrealistically short for this type of facility with the likely strong demand for linac time by neutron researchers. In practice, even "temporary" buildings on the ORR are still in use more than 50 years after construction.

RESPONSE
The SNS is being designed to operate for 40 years beginning in 2006. DOE estimates that the facility will be producing neutrons for scientific research approximately 75 percent of this time, or 30 years. Thus, 30 years was used in the DEIS to determine the amount of activation products produced. Advances in design and technology over the next 46 years may allow the life of the facility to be extended past 40 years, provided there is a need for the facility.

LOCATION OF EIS REVISION(S): Section 1.3.1

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COMMENT CODE
M-3-11

1. On page 4-5 the figure is mislabeled; it should be 4.1.1.1-3 (as referenced on page 4-7). In addition, the four borings discussed should be identified.

RESPONSE
The incorrect figure number on page 4-5 in the DEIS has been changed to Figure 4.1.1.1-3. The boreholes discussed in Section 4.1.1.4 are B-1, B-5, B-8, and B-11. These boreholes have been identified in the text.

LOCATION OF EIS REVISION(S): Section 4.1.1.1

....

COMMENT CODE
M-3-12

2. Page 4-19 (second paragraph of second column) states that one wetland area near Bear Creek south tributary 4 (BCST4) will be affected. However Table 4.1.5.2-1 and Figure 4.1.5.2-1 show BCST2.

RESPONSE
The paragraph identified in the comment is not intended to indicate that wetland BCST2 would be affected by the proposed action or the non-action alternative. This paragraph simply identified the wetlands in the vicinity of the proposed SNS site at ORNL. The wording "…Bear Creek south tributary 4…" in the DEIS has been changed to read "Bear Creek south tributary 2…"

LOCATION OF EIS REVISION(S): Section 4.1.5.2

....

COMMENT CODE
M-3-13

3. On page 5-38 in the first column, 40RE488 is discussed in both the prehistoric and historic resource section, it is not clear whether there are two components to this location or if this is an error.

RESPONSE
Sections 5.2.7.1 and 5.2.7.2 are not in error, but the comment indicates the need for some clarification of the DEIS text. This need for clarification rests on the meaning of the term "component", as it is typically used in American archaeology.

Many archaeological sites contain the separate and distinctive material remains of occupations by different cultural groups. Each of these occupations may be associated with a particular period in time, and the individual occupations may be separated from each other in time by thousands of years. In American archaeology, each culturally and temporally distinctive occupation of a single site is referred to as a component. One archaeological site may have a single component, but another may have numerous components. Sites with more than one component are referred to as multicomponent sites. Site 40RE488 is a multicomponent site. It contains archaeological remains indicative of a prehistoric occupation, and it was also the site of a late 19^{th} or early 20^{th} century Anglo-American occupation. Thus, in the DEIS, potential effects on the prehistoric component at this site are appropriately assessed under Section 5.2.7.1, Prehistoric Resources, and potential effects on the Anglo-American component are appropriately assessed under Section 5.2.7.2, Historic Resources.

The text of the DEIS has been revised to more clearly indicate that 40RE488 has both a prehistoric component and a historic component. This includes the insertion of an explanatory text box in Chapter 5.

LOCATION OF EIS REVISION(S): Sections 4.1.7.1, 4.1.7.2, 5.2.7.1, and 5.2.7.2 (new text box)

....

COMMENT CODE
M-3-14

4. On page 5-48 in the second paragraph of the second column the figures for annual dose to members of the public appear to be reversed for inside and outside the controlled area.

RESPONSE
The dose limits are correct as stated. The SNS shielding policy is based on the requirements of 10 CFR 835 and is intended to simplify radiation monitoring of individuals at the facility. The dose to members of the public is limited to 100 mrem/yr both inside and outside the controlled area; however, 10 CFR 835.402(a)(3) and 835.402(c)(3) require individual radiation monitoring for minors and members of the public inside the controlled area that would be likely to receive external or internal exposures of 50 percent of the annual limit. By limiting potential exposure to such individuals to no more than 50 mrem/yr, the SNS shielding policy eliminates the need to issue individual radiation monitors to visitors. Such monitors are not required for individuals outside the controlled area.

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COMMENT CODE
M-3-15

5. Table 2.1 in Appendix B should be inverted, currently much of the information is upside down.

RESPONSE
Table 2.1 in Appendix B has been oriented so that the information in the table is right side up.

LOCATION OF EIS REVISION(S): Table 2.1 in Appendix B

....

COMMENT CODE
M-3-16

6. Figures 1 and 2, respectively on pages B-27 and B-29, are unreadable.

RESPONSE
Figures 1 and 2 in Appendix B of the DEIS are part of a separate report on selection of the proposed site for the SNS at ORNL. The full text of this report is included in the EIS to document how this site was selected. In the original report, Figures 1 and 2 are highly complex color maps with subtle gradations in color from one area to another. Such maps are not very amenable to the reproduction of detail in the black and white format chosen for this EIS. Nonetheless, DOE believes it is necessary to include this report in the EIS. The color versions of these maps are available for public inspection and use in the DOE Reading Rooms. The locations of the reading rooms are provided in Volume 1, Section 1.5, page 1-17 of the EIS.

....

COMMENT CODE
M-4-1

As the Loudon Country Executive, I want to express my support for the Spallation Neutron Source Because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
M-5-1

As Knox County Executive, I am pleased to take this opportunity to express my support for the Spallation Neutron Source. It will have a positive impact in our region, and more importantly, our nation.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
M-6-1

As Mayor of Knoxville, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
M-7-1

As the Roane County Executive, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
M-8-1

As the Blount County Executive, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
O-1-1

I fully support the SNS at the Oak Ridge Reservation.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
O-1-2

1. I disagree with the decision to select the site without public involvement. The preferred site may actually be the best one, but the location being in the buffer area of Walker Branch does raise some questions. This long term research area will be impacted.

RESPONSE
The selection of the Chestnut Ridge site for construction of the SNS at ORNL is documented in the engineering study presented in Appendix B of the DEIS. The study shows how the entire reservation was assessed, using exclusionary criteria, to identify the Chestnut Ridge site as the best alternative.

The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2, and 5.8.1 of the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects from CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.331, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

....

COMMENT CODE

O-1-3

2. Better maps are required in the Final EIS. Figure S 1.3.1-1 showing the proposed SNS site on the ORR is cursory to say the least. A similar overview is fine, but a more detailed map of the site showing Walker Branch, the buffer area, relationship to EM areas in Bear Creek Valley, and any other ORR features (roads, utilities, etc.) is necessary.

RESPONSE

The introduction to Section S 1.3 states that the descriptions within it are designed to provide a brief look at each alternative site without providing a comprehensive level of detail, which would be beyond the reasonable scope of the Summary. In keeping with this statement, Figure S 1.3.1-1 was included only to show the location of the proposed SNS site on the ORR.

The level of map detail requested in the comment appears to be comprehensive in nature. Such detail would be difficult to put in a single black-and-white map suitable for a Summary without compromising legibility and ease of use. However, the additional details requested in the comment may be found on several different maps in the main text of the EIS and its appendices. These include Figure 4.1.8.2-2 (Walker Branch Watershed and its buffer zone), Figure 4.1.10.1-1 (vehicular transportation routes), Figure 5.7.1-1 [proposed locations for the Comprehensive Environmental Response and Liability Act (CERCLA) Waste Disposal Facility in Bear Creek Valley], and Appendix B, Exhibit 1 maps (utilities, historic sites, and BSR areas).

....

COMMENT CODE

O-1-4

3. The sense of the noun mitigation is “to act in such a way as to cause an offense to seem less serious.” It is used in monitoring, wetlands, and maybe other places. As Ms. Barbara Walton pointed out, there is no commitment to mitigation measures. Please consider this very seriously. We do not want the more colloquial definition to be used: “If the good lord is willing and the creeks don’t rise.”

RESPONSE

Section 1508.20 of the Regulations for Implementing the Procedural Provisions of the NEPA (40 CFR 1500-1508) defines “mitigation” to include: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree of magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments.

DOE has committed to numerous design specifications in the DEIS that avoid or minimize impacts to the affected environment. In some cases, like the potential impacts to the Walker Branch Watershed research area, DOE does agree that the DEIS presents potential mitigation measures but does not specify which mitigation measure would be implemented because, until the site is selected, specific mitigation cannot be determined. The Record of Decision will include a discussion of the mitigation measures at the selected site. In addition, DOE will prepare a Mitigation Action Plan to explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness.

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COMMENT CODE
O-1-5

4. I listened very carefully to the explanation of why the retention pond (s) is not shown on the site plan (Figure 3.2.1.5-1), but I suggest you make an educated guess. I think we deserve to know how the footprint will be affected.

RESPONSE
The text of the EIS concerning the retention basin has been clarified. At the Conceptual Design stage, the required size of the retention basin was approximated at 2 acres. The approximate location of the retention pond has been added to the figures showing the SNS site location for each of the four alternative locations.

LOCATION OF EIS REVISION(S): Figures 4.1-1, 4.2-1, 4.3-1, and 4.4-1; Sections 3.2.2.3, 3.2.3.6, 5.2.2.1.2, 5.2.5.2, 5.3.2.1, 5.3.5.2, 5.4.2.1, 5.4.5.3, 5.5.2.1, 5.5.5.2, 5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.11.1, and 5.11.3

....

COMMENT CODE
O-1-6

I would also be surprised if a heated discussion did not take place over increased flow to WOC to White Oak Lake to White Oak Dam along with the attendant subjects of velocity, erosion, sediment, transport, etc., and increase in radionuclide releases. In 5.2.2.1.2 it is stated in the last paragraph that "actual flow over White Oak Dam would be lost in the noise of monthly ..." and "Accordingly, the effect of the proposed SNS on radionuclide releases from ORNL is considered minimal." One does not necessarily follow the other and more precise language is in order.

RESPONSE
Flow of radionuclides over White Oak Dam is the product of flow rate and nuclide concentrations in White Oak Lake. The estimate of increased radionuclides over the dam is based on increased flow into the White Oak Lake, not additional contributions of radionuclide concentrations to White Oak Lake. Even if 100 percent of the discharge of the proposed SNS were to reach White Oak Lake, then only 4 to 15 percent increase in flow would be observed. This, however, contrasts to monthly variance in flow due to changing precipitation in the 100 to 200 percent range. Moreover, as discussed in Section 5.2.2.1.2, the majority of discharge from the proposed SNS would be lost before it reaches White Oak Lake and the amount that reaches the lake would dilute the radionuclide concentrations, thereby reducing the flux over the dam.

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COMMENT CODE
O-1-7

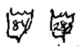
The remainder of the Draft EIS is acceptable, but I will wait for the Final version.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
O-2-1

On page 4-111, Vol. II, there is a minor mistake on the map (Fig. 4.2.10.1-1). The 4-lane highway between Santa Fe and Espanola is listed incorrectly.

Signage shows an Interstate Icon with 285 inside. Road is US-84/US-285. Signage should show a simple  instead of  the Interstate symbol.

RESPONSE
The top-shaded shields normally used to designate interstate highways have been replaced with the white-background shields used to designate U.S. highways. The labeling on the major highway between Santa Fe and Espanola has been revised to indicate U.S. Highways 84 and 285.

LOCATION OF EIS REVISION(S): Figure 4.2.10.1-1

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COMMENT CODE
O-2-2

Otherwise, the draft E.I.S. looks good.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
O-3-1

As Chairman of the Knoxville Area Chamber Partnership, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
O-4-1

As Chairman of the Blount County Chamber of Commerce, I want to express my support for the Spallation Neutron Source because of the positive impact it will have in our region and, more importantly, our nation.

The Spallation Neutron Source is important to the future of the United States as our nation seeks to maintain its technological and research supremacy in the 21st Century global economy.

Researchers from industry and universities from around the country will come to Oak Ridge to use the SNS's research capabilities. Industry partners will create new materials that will produce jobs and promote economic growth.

It is in support of this larger national endeavor that I endorse construction of the SNS in Oak Ridge.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
P-1-1

On page S-39, Table S 1.5.2-1 there is a discussion of land use impacts and a statement that "...no brownfield sites ... are available." This implies that no suitable sites were considered within the immediate area. I would like to suggest that at least one brownfield site, and perhaps others, are indeed available in the Oak Ridge Reservation and should be considered for the SNS site.

As discussed in the section on land use impacts, Section 5.7.1.8, page 5-168, the White Wing Scrap Yard site is being considered as a CERCLA disposal area. This site might also be an ideal "brownfield" site for the SNS.

The site is adjacent to ED-1 and a positive land use interaction of this "brownfield" site would be the added development for ED-1 in terms of a future hotel and potential private "spinoff" development at ED-1 that is supported by scientific work at the SNS. This location also makes the SNS more accessible to the private sector. Siting the SNS at this location can help to improve or accelerate the economic redevelopment of the City of Oak Ridge and the surrounding four county region.

Other benefits would include easier road way access and a reduction in the cost of remediation for the site, as it can be left as a "brownfield" with more relaxed cleanup or risk assessment criteria. This is clearly a better land use for this location than as a future disposal site.

RESPONSE
The White Wing Scrap Yard is a major brownfield site located on the ORR near the intersection of State Highways 58 and 95. It consists of approximately 30 acres of land known to be radioactively contaminated. This contamination extends to areas of land immediately adjacent to this area on all sides and extends along two unnamed tributaries of Bear Creek that flow out of this area to the south and southeast. This site would not be an environmentally desirable location for the proposed SNS because of its location relative to environmentally sensitive areas and the presence of a potentially unstable geological feature, as described below.

The southeast corner of the scrap yard contains portions of Habitat Area 7, Aquatic Natural Area 2, and a wetland area. In addition, this site is closely surrounded on all sides by the rest of these areas, small streams and their floodplains, Aquatic Natural Area 3, and Natural Areas 2, 4, 24, and 50. If the footprint of the proposed SNS were superimposed with varying directional orientations on all or a portion of the White Wing Scrap Yard, it would extend beyond the scrap yard boundaries and into various combinations of these natural features. Implementation of the proposed action would potentially impact these features.

A thrust fault line underlies the southwest corner of the White Wing Scrap Yard. If the SNS were constructed on this site, this fault line would either crosscut a major portion of the SNS footprint or be immediately adjacent to it, depending on the exact position and directional orientation of the footprint. A major criterion used during the site-selection process for the proposed SNS was avoidance of ORR sites with geological faults. Construction of the SNS on or adjacent to such geologically unstable features would add another mechanism for beam loss by equipment misalignment and add to equipment and soils activation during SNS operations.

The process of selecting the preferred site for construction of the SNS on the Oak Ridge Reservation was a two phase process. In the first phase, the entire reservation was screened to eliminate areas that were not suitable for construction of the SNS. Brownfield and greenfield areas of the reservation were both included. Areas of land within the ORR with waste area groupings, environmental restoration projects or waste management areas were eliminated from consideration because these areas would require cleanup, with some attendant uncertainty on the extent of cleanup required, prior to excavation for the SNS foundations. This activity could increase worker exposure to radioactive and nonradioactive contaminants and would require the disposal of material removed during clean up in a licensed land fill. This could affect both the budget and schedule of the project. Working in a contaminated area could increase labor costs and disposal costs of the contaminated materials. Coordinating with the Environmental Management program for the cleanup of these areas may resolve the budget issue, however, long schedule delays may result. Coordination of this construction effort with the requirement of RCRA or CERCLA for cleanup of these areas could add a year or more to the construction schedule of the SNS. Siting the SNS in a waste management area could require cleanup of the area, with it associated cost increases and schedule delays, and possibly the relocation of waste management activities. The result of this first phase was the identification of four candidate sites, however, none of these were brownfield sites.

The second phase consisted of a comparative evaluation of the candidate sites using specific site evaluation criteria. One of the Functional Criteria was the avoidance of contaminated soils. One of the Health and Safety criteria was avoiding existing hazardous materials areas and waste areas (i.e. Waste Area Groups and RCRA sites). Again, these criteria were included to avoid the increased risk to construction workers and the increased costs and schedule delays associated with placing a large scale construction project at a site with contaminated soils or hazardous materials.

LOCATION OF EIS REVISION(S): Sections S 1.4.2 and 3.2.4.2

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COMMENT CODE
P-1-2

Another area of concern that is not clearly addresses in the EIS is the topic of karst formations associated with the siting of the SNS.

The region is noted for its karst formations, which have the potential to dramatically impact the construction of new facilities. The Copper Ridge area has been known to contain sink-holes and caves. Perhaps the White Wing Scrap Yard site is better suited from a karst standpoint and is less likely to have these impacts.

RESPONSE
The site-selection study for the proposed SNS at ORNL is presented in its entirety in Appendix B of the EIS. As indicated in this study, karst formation (solution-conduit groundwater flow) was not used as a specific criterion for evaluation of the ORNL candidate sites. However, during the site-selection process,

the Reservation Management Organization (refer to first memorandum in Appendix B, Exhibit 3) raised possible karst formation beneath the proposed Chestnut Ridge site as a potential issue for SNS construction. Consultations between the Reservation Management Organization and SNS project resulted in resolution of this issue (refer to second memorandum in Appendix B, Exhibit 3). The content of the resolution is described in this response.

Present information about foundation stability requirements for the proposed SNS, preliminary foundation design work, preliminary core borings, and shock test data from ORNL indicate that implementation of the proposed action on the Chestnut Ridge site would not be a problem, if it is correctly approached. Furthermore, it should be noted that construction on karst topography is not uncommon in the Knoxville area or on the ORR. Additional geological studies have been planned to further confirm this resolution of the karst issue prior to construction on the site.

Approximately 90 percent of the White Wing Scrap yard is underlain by the Chickamauga Supergroup, a sequence of gray limestones and red mudstones overlying the dolostones of the Knox Group. Evidence for karst development has been documented in the Chickamauga Supergroup.

A thrust fault line runs through the southwest corner of the White Wing Scrap Yard. The area immediately south of this fault line, including the remaining 10 percent of the scrap yard, is underlain by the Rome Formation. Karst development is not characteristic of this formation.

The footprint of the proposed SNS would be much larger than the White Wing Scrap Yard. This would result in constructing large portions of the facility on the Rome Formation and the Chickamauga Supergroup. As is the case with the Chestnut Ridge site, DOE does not view the karst potential of the latter group as an impediment to construction of the proposed SNS. However, as noted in the response to Comment P-1-1, other environmental characteristics of the White Wing Scrap Yard make it an undesirable location for the proposed SNS.

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COMMENT CODE
P-2-1

Before documenting my comments, I want to make it clear that I fully support the mission of the SNS and its siting in Oak Ridge. My comments are made not to disparage or negate the importance of the SNS to the future of neutron-based research in the U.S. or at Oak Ridge but to assure that all-important issues potentially affecting public welfare are adequately and sufficiently addressed. The issues raised in the comments and recommendations that are provided below are just as valid for public consideration and for DOE or other official resolution not matter where the SNS is sited. I strongly recommend that Oak Ridge be the selected site for SNS.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
P-2-2

Comment: SNS EIS Sects. 6.1.3, 6.1.4, 6.1.10, and 6.1.11 and SNS CDR Sects. 8.8 and 9.1 fail to define the legal bases for how the SNS radioactive wastes are to be classified and regulated for disposal. Both sets of cited sections fail to indicate under which statutes or laws and under which regulatory authorities the SNS radioactive wastes are to be regulated, and both sets use terminology (specifically, "mixed-waste") without further clarifying why the statutory definition of the term does not apply to SNS-generated radioactive wastes. Lack of clarity and specificity is unacceptable because the disposal of radioactive wastes from the SNS involves complex and conflicting statutory and regulatory matters that have not been resolved by the government previously (see U.S. Nuclear Regulatory Commission, NRC, documents NUREG-1310 and SECY-92-325). If DOE at this juncture does not properly address this situation, there is confusion as to who is the legally empowered regulator for such wastes and what are the proper regulatory requirements. The fact is that the replaceable metallic components in the SNS target will under proton-neutron irradiation become as highly radioactive as any power reactor component irradiated in the core where such reactor-irradiated material would be classified as Greater-than-Class-C Low-Level Radioactive Waste (GTCC LLRW) under NRC regulations at 10 CFR Part 61 and would require ultimate permanent disposal in a geologic repository unless the NRC approves an alternative disposal. In the DOE system, however, appropriate regulatory requirements for disposal of these wastes have never been defined. The authors of both the EIS and the CDR do the public a disservice by failing to present this problem in a clear and straightforward manner. Although SNS EIS Sect. 6.1.2 alludes to one key aspect of the problem in the context of radioactive materials affecting water quality in site effluents, the issue is never detailed in the context of radioactive waste management and classification.

The reason that an issue exists is because SNS-generated radioactive materials do no (*sic*) meet the statutory definitions of source material, special nuclear material (SNM), or by-product material as defined in the *Atomic Energy Act of 1954* (AEA), as amended, and codified at 42 *U.S.C.* 2014. Thus, in a strict legal sense, SNS-generated radioactive wastes appear to fall solely under the *Resource Conservation and Recovery Act* (RCRA) as meeting the definition for "solid waste" codified at 42 *U.S.C.* 6903(27), are tehreby (*sic*) excluded both from the definition of "mixed waste" codified at 42 *U.S.C.* 6903(41) and from the DOE mixed waste reporting requirements at 42 *U.S.C.* 6939c, and should be regulated only as "hazardous waste" under the definition at 42 *U.S.C.* 6903(5) by the Environmental Protection Agency (EPA) and by the states under the *Federal Facilities Compliance Act* (FFCA). Therefore, SNS-generated highly radio-toxic or high-hazard radioactive wastes are subject to listing as hazardous waste under 42 *U.S.C.* 6921 and subject to all the standards and permitting requirements at 42 *U.S.C.* 6922, 6924, and 6925. Since EPA and the states (except perhaps for Illinois) have not promulgated land disposal restrictions previously for this type waste, it is expected that new EPA and/or state rulemaking, additional Federal EISs, and public meetings are required to bring closure by defining proper statute-based regulatory controls for the handling and disposal of SNS radioactive wastes. The draft EIS addresses none of this. There is no mention in the draft EIS that the SNS radioactive wastes fall into a category of wastes that NRC indicates in NUREG-1310 that Congress refers to as "orphan wastes," that DOE has itself called "unregulated wastes" (*Federal Register*, *60*, pp. 13424-13425, March 13, 1995), and for which EPA has failed to take regulatory ownership in spite of the law.

DOE has previously acknowledged EPA authority over accelerator-generated (non-by-product) radioactive materials. This previous DOE acknowledgment of EPA authority has been (1) implicit both in 10 CFR Part 962 and in Definitions 3.a and 27 of DOE 5820.2A that respectively delineate the demarcation of authority between the AEA and RCRA and (2) explicit in Chapter IV of DOE 5820.2A that specifies that accelerator-generated radioactive materials are to be regulated under RCRA and/or as "residual radioactive material" under 40 CFR Part 192, where the latter EPA regulation is not really applicable. It is noted that the recent draft DOE O435.1 attempts to redefine DOE authority under the AEA-based oversight of radioactive wastes to include accelerator-generated radioactive wastes, but I have noted to DOE in separate correspondence that this proposed revision to DOE 5820.2A requirements is not advisable because (1) there is an absence of clear statutory authority and (2) DOE needs to issue regulations not directives to manage radioactive wastes in an acceptable and enforceable manner. Thus, notwithstanding the broad regulatory authority granted both DOE and NRC at 42 *U.S.C.* 2201(i)(3) and (p) and with due consideration to the DOE General Counsel's interpretation of this authority with regard to the regulation of radiological hazards (Sect. B.1, *Federal Register*, *61*, pp. 4209-4910, February 5, 1996), the AEA and RCRA appear to be very clear when considered in combination that the types of waste to be generated in SNS are not subject to DOE regulatory authority. It is also noted that DOE has used the terms "unregulated waste" and "special case waste" (*Federal Register, 60*, pp. 13424-13425, March 13, 1995) to refer to certain types of non-AEA radioactive wastes, that is, "unregulated" wastes that pose the same hazards as GTCC LLRW are to be treated as "special cases" under Sect. III.3.i(4) of DOE 5820.2A. However, DOE is understood to be dropping the "special case waste" terminology. This change in terminology is presumably due to the criticism stemming from the multiple findings of DOE activities involving the production or storage of special case waste with no clear path forward to disposal. These findings are documented in the DOE report, "Complex-Wide Review of DOE's Low-Level Waste Management ES&H Vulnerabilities," May 1996, submitted in response to Defense Nuclear Facilities Safety Board Recommendation 94-2. Finally, in the context of possibly considering DOE regulatory oversight of radioactive wastes, it is noted that DOE's issuance of regulations to implement the *Price-Anderson Amendments Act of 1988* is way behind schedule, is in abeyance, and has never proposed nor attempted to implement consistent rulemaking for radioactive waste classification and management analogous with and equivalent to that of the NRC regulations at 10 CFR Parts 60 and 61 for AEA-regulated materials. Thus DOE appears to have neither the statutory nor the regulatory track record to provide the regulatory structure needed to control the classification, treatment and disposal of SNS hazardous radioactive wastes.

It is noted that the statutory issue could be resolved if Congress would amend the definition of by-product material as it appears in 42 *U.S.C*. 2014(e)(1) from reading "any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material" to read instead "any radioactive material (expect special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing *atomic energy or* special nuclear material." This wording change would adapt the intent of the words used in 42 *U.S.C*. 2013(c) regarding the purpose of the AEA and make by-product material consistent with the definitions both of "atomic energy" in 42 *U.S.C*. 2014(c) as being "all forms of energy released in the course of nuclear fission or nuclear transformation" and of "utilization facility" in 42 *U.S.C*. 2014(cc)(1) as being "any equipment or device, except an atomic weapon, determined by rule of the Commission to be ... peculiarly adapted for making use of atomic energy in such quantity as to be of significance to the common defense and security, or in such manner as to affect the health and safety of the public." The recommended amendment would permit radioactive materials produced by particle accelerators and nuclear fusion devices to be classified as by-product material and thus subject to regulation by DOE and NRC but would exclude naturally-occurring radioactive materials except those covered under 42 *U.S.C*. 2014(e)(2). This change would permit NRC to license the use of such materials under 42 *U.S.C*. 2111 and thereby obviate the NRC's reluctance to assert licensing and regulatory authority, including waste classification, over this type of radioactive waste by meeting the "consistent with existing law" provisions at 42 *U.S.C*. 2021(b)(9)(B) and 10101 (12)(B) and (16)(B). Therefore, if this amendment were enacted, the regulation of the radio-toxicity of SNS-generated radioactive wastes and the safe disposal of these wastes would fall under the statutory provisions of the AEA, the *Nuclear Waste Policy Act* and the *Low-Level Radioactive Waste Policy Act* as opposed to RCRA only as is the case without the amendment. However, the proposed amendment would place the production and use of all radioactive medical therapy and diagnostic isotopes that are produced in small accelerators in hospitals under NRC regulations, but this control would in most cases simply be delegated back to the states, which already regulate such isotopes by default, by the NRC under 42 *U.S.C*. 2021(b)(1). The states would thus have enhanced authority under Federal law since litigation of contested violations could be referred to Federal courts if needed.

Finally, SNS EIS Sect. 6.1.11 states: "The Toxic Substances Control Act (TSCA) regulates the manufacture, use, treatment, storage, and disposal of certain toxic substances not regulated by RCRA or other statues." While this statement is true with respect to the AEA as provided at 15 *U.S.C.* 2602(2)(B)(iv), this statement implies incorrectly that the treatment, storage, and disposal of certain hazardous materials are not subject to RCRA. Please note that the treatment, storage, and disposal of all hazardous materials except AEA-defined materials are covered under RCRA; that TSCA provides the statutory basis for implementing by regulation additional treatment, storage, and disposal requirements as may be appropriate for certain toxic substances generated for commercial purposes and regulated under TSCA; but that, as provided at 15 *U.S.C.* 2608(b) and 42 *U.S.C*. 6905(b), TSCA and RCRA are fully coordinated as the statutory bases for regulating the treatment, storage, and disposal of hazardous materials including toxic substances regulated under TSCA. Obviously, if this were not the case, TSCA regulations at 40 CFR Subchapter R would contain treatment, storage, and disposal requirements that are instead given in 40 CFR Subchapter I. It is also noted that in this regard that the NRC has taken the position in SECY-92-325 that accelerator-generated radioactive materials that are produced for commercial purposes without using source material, special nuclear material, or by-product material are not subject to the AEA but are subject to regulation by the states and by the EPA under TSCA. This basis for the NRC's position applies to any radionuclides produced for commercial purposes in the SNS. This will not change unless Congress changes the AEA such as by redefining by-product material as noted above or makes some other set of changes to TSCA.

<u>Recommendations</u>:

1-1 The above-cited sections in the SNS EIS and CDR should be revised to indicate that all SNS radioactive wastes are subject to regulation by EPA and the state of siting under RCRA and FFCA. The inapplicability of the AEA to the regulation of SNS radioactive wastes should be clarified and explained. The use of the term "mixed wastes" should be deleted. The planned path forward should be outlined as to how DOE intends to obtain EPA and state rulemaking to define appropriate land disposal restrictions for SNS radioactive wastes.

1-2 The SNS EIS should clarify that any radionuclides produced for commercial purposes in SNS without using source material, special nuclear material, or by-product material will be regulated by the state of siting or by the EPA under TSCA and that disposal of such commercial products when no longer used will be in accordance with TSCA/RCRA regulations or appropriate state regulations. The SNS EIS should commit that DOE will obtain TSCA permits for the production of any radionuclides in SNS for commercial purposes consistent with the NRC's position given by SECY-92-325.

1-3 SNS EIS Sect. 6.1.11 should be revised to correct the implication that TSCA and RCRA are not coordinated laws.

1-4 As an alternative to Recommendations 1-1 and 1-2 above, the SNS EIS could indicate the steps planned (1) to obtain an amendment to the AEA by Congress that will redefine by-product material to include SNS-generated radioactive materials and (2) for DOE and NRC to work together with the NRC agreement states to implement appropriate regulations under the amended AEA and related legislation.

<u>RESPONSE</u>
DOE believes that it has properly and adequately described its authority to build and operate the proposed SNS, including the rules, order, and policies governing the management of products and waste the SNS might generate.

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<u>COMMENT CODE</u>

P-2-3

Comment: In reviewing the draft EIS and the CDR, I have attempted to understand the bounding or worst case accidents so as to understand the degree of need for active prevention and mitigation features and the reliance if any that can be placed on inherent and passive features to prevent accidents and to mitigate the consequences of accidents. Although Sect. 3.1.2 of Appendix A to the draft EIS acknowledges the importance of the beam trip, I find that the "structured" process for defining the accident source terms, as given in Appendix A to the draft EIS, obscures key assumptions about the human factors in the assumed operability of safety systems and the high dependence of success paths both upon a safety culture that is yet to be created and upon institutional controls that have yet to be defined or specified. This situation is also obscured in CDR Chapters 7 and 8 so that safety-system top-level requirements are never well defined.

I do readily acknowledge that the total radioactive source term in SNS is very, very small in comparison to a large research or power reactor and that, during normal operation, the thermal margins in terms of temperature appear quite substantial to conditions that would fail the target vessel and the vessel confinement. However, unlike an NRC-licensed nuclear research reactor that would be designed and regulated under 10 CFR Part 50 Appendix A to meet NRC General Design Criterion (GDC) 11, "Reactor inherent protection," the SNS accelerator and target apparently lack any inherent protective or mitigative feedback mechanism to control the rate at which thermal energy is deposited in the target mercury by the proton beam. The singular importance of this fact is significant but has not been emphasized in the limited safety analysis presented in the EIS.

Thus, in SNS, the control of target heating during normal operation or upset conditions relies totally upon either the human operator or automatic detection and actuation systems that are designed, fabricated, constructed, configured, maintained, and tested by humans. The structures around the target provide the only inherent features that can passively prevent or mitigate a release of radioactive materials in the event of a worst case accident in which the target is vaporized. However, the functional integrity of the confinement structures to prevent or mitigate a release of radioactive materials will be maintained and not bypassed only if conditions in the confinement, including the effects of an untripped beam, do not present a serious challenge to the confinement structure and particularly to the less massive barriers that would be in place if active mitigation features fail to operate during an upset to secure experimental access to the target as needed during operations to extract the neutron beams.

The fragility of relying solely on human operators and automatic prevention and mitigation systems, which can be bypassed by human operators, in a nuclear system that lacks inherent protective or mitigative feedbacks was illustrated most dramatically and notoriously in the accident at Chernobyl Unit 4. While the possible consequences and therefore the risk of a worst case accident in SNS is in no way comparable to what happened at Chernobyl, it must be remembered that the SNS mercury target is not merely a jar of radioactive liquid sitting in a hot cell where the standard practice is not to load hot cells containing radioactive materials with large quantities of highly flammable or explosive materials nor to place the jar in the path of an explosive or incendiary projectile. Instead the SNS target might better be characterized as an actively-cooled jar of radioactive liquid sitting in a hot cell with access ports more similar to those of a glove box and where the jar is heated by a device that is technically similar to the directed energy weapons regulated in international trade by the U.S. Department of State on the United States Munitions List at 22 CFR 121.1, Article XIII(h). An extended failure to trip the beam in an accident that is initiated by target under-cooling can lead to the vaporization of the target and adjacent target structures and potentially lead to energetic interactions with confinement structures and barriers contributing to loss of confinement integrity. The presence of cooling water systems nearby the target could lead to steam explosion of confinement over-pressurizations.

The SNS accelerator beam may also be potentially classifiable as the energizing or effecting mechanism in a large "utilization facility" that effects "nuclear transformations" and satisfies the portion of the definition for utilization facility in the AEA at 42 *U.S.C.* 2014(cc)(1) as being "any equipment or device, except an atomic weapon, determined by rule of the Commission to be ... peculiarly adapted for making use of atomic energy ... in such manner as to affect the health and safety of the public" Although NRC has elected to classify even the smallest nuclear reactor as a utilization facility subject to a "minimum" set of health and safety regulations at 10 CFR Part 50, no such equivalent determination has ever been made by the NRC with respect to the utilization of atomic energy through the nuclear transformations that are induced by the accelerator beam in the target of an accelerator facility. Perhaps this is because the radioactive materials produced in an accelerator target are not AEA-regulated materials or perhaps because to date most commercial particle accelerators have been very small and with very low-power beams compared to what is envisioned for SNS. The historical safety and health physics performance of small accelerators is summarized only in the DOE report SLAC-327, *Health Physics Manual of Good Practices for Accelerator Facilities*, April 1988. In Sect. 2.6, "Beam Containment," pp. 28-30 of this report, examples are given of how failures to control the beam in small accelerators can lead to melting or vaporization of that portion of the target or other structures exposed to the uncontrolled beam. The substantial radiation hazard posed by the irradiated non-fissionable, heavy-metal targets in the larger DOE accelerators is also a matter of record (See Occurrence Report Number ALO-LA-LANL-RADCHEM-1996-0010, "Unposted High Radiation Area on the Rooftop above TA-49-1 Hot Cells," 10/11/1996).

As implied in Sect. 3.1.2 of Appendix A to the EIS, the bounding accident for the SNS would be the failure of target cooling with simultaneous failure to trip the beam for an extended period of time. However, Sect. 3.17 Table 3.7 and Exhibit F Table F.1 of Appendix A to the draft SNS EIS indicate that one of the two bounding "beyond design basis accidents" analyzed in the draft EIS is the failure of target cooling with the failure of two out of three beam trip mechanisms such that there is a slightly delayed beam trip but the delay causes beam window failure leading to a mercury spill. The so-called bounding accident addressed in the draft EIS assumes that both the Target Protection System (TPS) and the Beam Permit (BP) fail but that the Personnel Protection System (PPS) operates quickly either automatically or in response to an operator action. This accident is indicated in the EIS to be beyond design basis because the estimated combined frequencies of component failures produces an event sequence frequency that is greater than 10^{-8}/year but less than 10^{-6}/year. The assumption of a simultaneous failure of the PPS is indicated in a footnote in Table 3.7 of Appendix A to have a frequency of occurrence that is less than 10^{-8}/year.

However, the accident failure frequencies used in the draft EIS are, according to Sect. 1.2 (P. A-14) of Appendix A, "based on experience and on engineering judgement considerations." In other words at this stage of the conceptualization of an as yet unbuilt and non-prototyped facility, the failure frequencies are based on unreviewed and non-validated guesses. It is highly likely that these guesses were developed by nuclear engineers with the tacit assumption that the typical regulated institutional controls of NRC-licensed nuclear systems will apply to SNS (that is, a continuously updated safety analysis report, technical specifications, a quality assurance program, configuration management and the associated procedural controls that are regulated by NRC against commitments made in the safety analysis report).

Although I am a proponent of the usefulness of risk-based regulation for nuclear systems when used as a guide to better understand the margins and conservatism in deterministic accident analyses and to address risk cliffs that may lurk beyond the design basis, it is noted that SNS lacks a key defense-in-depth component available in nuclear reactors by not meeting NRC GDC 11 and that there is no guarantee that SNS will be subject to equivalent institutional controls since, historically within DOE, accelerator facilities have received a much reduced level of regulation and external oversight compared to reactors. In general, copies of the safety assessment documents for DOE accelerators are not available to persons outside the facility and are not maintained available for outside review either by the public or by DOE safety oversight organizations.

Thus, I find fault with the underlying assumptions of the risk assessment in the EIS at this early stage of SNS design and with the failure to address a deterministic worst case scenario for assessing defense-in-depth. One cannot rely on hand-waving risk analyses for non-existent systems for which there is no data base for making integral estimates of system reliability that account for as-built configurations and the impacts of institutional controls. In this case, you must be deterministic and bounding in any accident or health-risk analysis.

Consistent with NRC's requirements for deterministic safety analyses of anticipated transients without scram (ATWS) for reactors, which have inherent feedbacks to mitigate such accidents, and consistent with NRC's treatment of operator actions wherein it is typically assumed that the operator takes no action or the wrong action for the first 10 minutes of a transient, it would appear to be more prudent and bounding if the SNS EIS addressed loss of target cooling with failure to trip the beam for a period of time up to 10 minutes. Since water-cooled systems are nearby, the potential for steam explosion or over-pressurization of the confinement should also be assessed under the worst case assumptions. More simply, it may be best to assume that all radioactive materials in the target environs are vaporized and released to the atmosphere similar to the conservative and bounding assumptions in NRC report NUREG-0396 that was used to establish the bases for 10 CFR Part 50, Appendix E, "Emergency Planning and Preparedness for Production and Utilization Facilities." It should be sufficient to determine for the most adverse weather conditions the boundaries of the zone around the SNS site where such an accident would lead to doses that exceed the EPA minimum guidelines for sheltering and evacuation (that is, 1 Rem whole body and 5 Rem thyroid). Beyond that boundary, which would hopefully be shown not to pass beyond the one-mile exclusion zone for the site, the SNS can be considered to be passively safe no matter what mistakes the operators might make. This is analogous to the approach proposed for the Modular High-Temperature Gas-Cooled Reactor that was being designed to incorporate numerous diverse and redundant, inherent and passive safety features that have no equivalent in the SNS.

Since my home in Oak Ridge is located on a hill about 10 miles Northeast of the proposed site for SNS, as a professional nuclear engineer, I am most interested in knowing the results of such a bounding accident analysis in which no optimistic assumptions are made about the performance of systems and operators. I prefer knowing that no matter what mistakes are made by the operators on site I have no need to be concerned off-site; I assume that my fellow residents of Oak Ridge and surrounding areas feel the same way. Of course, my requirements stem from treating SNS as a nuclear facility. Since the radio-toxic substances in the SNS target are not AEA-regulated materials, other bounding accident scenarios may be posed more analogous to the types of accident and emergency response situations that can occur in industries regulated by EPA and the states. However, whether one draws upon historical worst-case precedents at Chernobyl or Bhopal, the fragility of relying on the human operator and the importance of institutional controls must be addressed in setting the bounding case for public risk. My assumption is that it can be shown that no substantive risk exists; I expect that the final EIS will provide the substantive documentation to validate this assumption and not confuse the issue with hand-waving discussions about reliabilities for untried and nonexistent systems, operators, and procedural controls. While this approach will establish the hazard or bounding consequences for public health off-site, a similar approach is recommended for establishing the hazard or bounding consequences for both occupational safety and health and environmental insult on-site. It appears that the SNS approach used to date to evaluate hazards under DOE 5480.23 and DOE-STD-1027-92 always gets shortcut by the assumption that the target is never vaporized so the assumed release fractions for non-volatile radioactive materials are always much less than 1.0. Thus the strict requirements of Sect. 8.c of DOE 5480.23 and Sects. 3.1.2 and 4.1.1 of DOE-

STD-1027-92 seem to be violated by the fatal logic flaw of assuming that which you want to prove. Such logic may unfortunately be taken as further proof by some persons that DOE is inherently incapable of honest self-regulation. I hope that this is not the case.

Recommendations:

1-1 The SNS draft EIS and CDR should be revised to indicate that equipment relied upon to perform safety functions will be classified as safety-related and that DOE is committed to assuring that all safety-related equipment is subject to both technical safety requirements and configuration management controls as required for the DOE research reactors. This includes the TPS, BP and PPS.

2-2 The accident scenario for the beyond-design-basis event to be provided in the final EIS should address the consequences of the untripped beam (up to 10 minutes) as it affects the target and confinement. Consistent with NRC's treatment of ATWS, the failure to trip the beam should be applied to all events in the which cooling is lost to the target both loss of coolant and loss of flow. The treatment of the accident upon which emergency planning is to be based should be as conservative as the NRC assumption underlying 10 CFR Part 50, Appendix E (namely, total loss of target integrity and total loss of confinement integrity).

RESPONSE

As discussed in Appendix C (page A-16) of the DEIS, the SNS Target Facility has received initial designation as a Hazard Category 2 (HC-2) nuclear facility. The safety of the SNS Target Facility will be evaluated and documented in accordance with DOE Order 5480.23, Nuclear Safety Analysis Reports, and other related orders. Hazard evaluation and safety analysis will be done under the guidance of DOE-STD-3009-94, Preparation Guide for U. S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports (SAR). One of the major purposes of the SAR is to justify and document which systems are necessary to maintain the high degree of safety and defense in depth against environmental releases necessary for DOE facilities. After DOE approves the preliminary SAR for the facility, the SNS may be constructed, and after the final SAR is approved, it may be operated. Since the purpose of the SAR is to address concerns such as those voiced in this comment and since the SAR for the SNS will not be a classified or restricted document, the preliminary SAR would be available to the public following approval by DOE.

The SAR designations of safety-related equipment result in a graded scale of higher design, operational surveillance, and configuration control. The requirements regarding safety-related equipment, as documented in the SAR, are expressed concisely in a related document called Technical Safety Requirements (TSR). This document sets down the conditions under which the facility will be authorized to operate. The DOE requirements for TSR are specified in DOE Order 5480.22. The SAR/TSR process, developed and refined by DOE over the past decade with its many nonreactor DOE nuclear facilities, will ensure that SNS safety-related structures, systems, and equipment, including beam cut-off systems, are appropriately designated, configured, operated, and maintained.

The beyond-design-basis accident presented in the DEIS is sufficiently representative of very-low-probability accident scenarios. The reference in Recommendation 2-2 to the anticipated transients without scram issue in power reactors is not relevant because of the many physical and conceptual differences between reactors and accelerators. For example, one of the reasons the anticipated transients without scram cases are analyzed for reactors is that reactors have only mechanisms for accomplishing rapid shutdown (i.e., insertion of control rods). By contrast, three automatic systems would be available to cut off the beam for the SNS, and the control room operators would act as a back up to the three fast-acting automatic systems. The simultaneous failure of all these for any significant time, even 10 minutes, would go beyond what is intended for the beyond-design-basis category and what is reasonable for the SNS. The design, configuration control, and maintenance requirements that will be in place for safety-related systems, such as the Target Protection System and the Personnel Protection System, via the SAR and TSR are discussed above. These will be high-integrity systems that employ multiple sensors and logic channels to achieve the desired high reliability. The SNS study of the operator action to effect beam cut off in the event of severe target abnormalities showed that operator action within a 1-minute period would be highly probable.

The second part of Recommendation 2-2 concerns emergency preparedness. The SAR being prepared for the SNS is required by DOE Order 5480.23 to address emergency preparedness. The SAR will document facility compliance with DOE emergency preparedness requirements. The emergency planning provisions for protection of the public and workers will be based upon the SAR hazard evaluations and accident analysis of design-basis and beyond-design-basis accidents.

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COMMENT CODE
P-2-4

3. Recommendations based on Other Considerations:

Comment: Sect. 1.2 (p. 1-7) of the draft SNS EIS indicates that the construction of SNS is a “global concern” from the standpoint of filling a “neutron gap” in research capabilities. The SNS is proposed to be a U.S. research facility, but it is inferred that SNS will be open to international research collaborations. The significance of SNS in the context of intentional collaborations and the sharing of its technology advances and advantages is not addressed in the draft EIS.

In particular, an issue that is not addressed in the SNS draft EIS is that which is addressed briefly in Sect. 1.6, “Non proliferation,” of DOE/EIS-2070D, December 1997, which is the draft EIS for locating the Accelerator Production of Tritium (APT) at the Savannah River Site. Sect. 1.6 of DOE/EIS-0270D asserts that “accelerator technology has been in use for more than 75 years,” that “the possibility of producing special nuclear material (i.e., plutonium) using an accelerator was recognized several decades ago,” and that the “APT is the first known accelerator proposed for a mission to produce weapons materials in a sustained production operating mode.” The latter statement is simply not true since the formerly-classified Materials Test Accelerator pursued by the Atomic Energy Commission in the late 1940s and early 1950s was a project dedicated to developing an accelerator-driven system to produce weapons plutonium as an alternative to constructing large production reactors. Sect. 1.6 of DOE/EIS-0270D also indicates that using “an accelerator to produce special nuclear materials in quantities which could be a proliferation concern requires a particle beam power of approximately 1 megawatt or greater” and that “research accelerators with beam powers in the 1 megawatt range have been viable for at least 20 years.” As noted in the SNS draft EIS, SNS is to use a 1 MW beam initially and upgraded to 4 MW later.

Article III of the *Treaty on the Non-Proliferation of Nuclear Weapons* stipulates that “Each State Party to the Treaty undertakes not to provide:” ....(b) equipment...especially designed or prepared for the...production of special fissionable material, to any non-nuclear-weapon State for peaceful purposes, unless the source of special fissionable material shall be subject to the safeguards required by this Article.” However, there are currently no U.S. safeguards requirements or export controls placed on particle accelerators that DOE/EIS-0270D acknowledges are a potential proliferation risk at the beam power levels of the SNS. It is noted that the U.S. is a member of an international body called the Nuclear Suppliers Group (NSG) composed of signatories of the Nonproliferation Treaty. The guidance formulated by the NSG on issues of export controls includes the “Trigger List,” which triggers safeguards, and the

"Dual Use List." Based on an earlier international agreement on safeguards, the Trigger Lists starts with export controls for reactor equipment for a facility that can produce as little as 100 grams of plutonium annually. This international standard has implications for accelerators operating with beam powers much, much less than 1 megawatt. These agreements, guidelines and lists are published in the International Atomic Energy Agency (IAEA) Information Circulars. A logical question that arises is that, in the absence of clear controls to prevent the diversion of accelerator technologies for purposes of nuclear weapons proliferation, how can one be sure that any international collaboration on SNS will not lead to the uncontrolled transfer of technology that can be used to promote the illegal production of special nuclear materials for nuclear explosive purposes. What pro-active measures does DOE intend to take to prevent or mitigate the risk of nuclear proliferation arising from the construction and operation of SNS? Sect. 1.6 of DOE/EIS-0270D indicates only that DOE is considering changes to its regulations at 10 CFR Part 810 that implement its authority under 42 *U.S.C.* 2077(b) although it is now one year since these words were published for public consumption and no such rulemaking has been proposed to the public. However, how does DOE intend to coordinate its actions on SNS effectively with the NRC and the Department of Commerce that have the primary responsibility for nuclear-related export controls under 42 *U.S.C.* 2139 and 2139a? How does DOE intend to coordinate its activities on SNS effectively with the Department of Commerce under its authority provided in Sect. 3(d) of Presidential Executive Order 12938 of November 14, 1994, "Proliferation of Weapons of Mass Destruction," "to regulate the activities of United States persons in order to prevent their participation in activities that could contribute to the proliferation of weapons of mass destruction?"

Also, 22 CFR 121.1(a) stipulates that "The following articles, services and related technical data are designated as defense articles and defense services pursuant to sections 38 and 47(7) of the Arms Export Control Act (22 U.S.C. 2778 and 2794(7))." Further, 22 CFR 121.1, Article XIII(h) lists "Devices embodying particle beam and electromagnetic pulse technology and associated components and subassemblies (e.g., ion beam current injectors, particle accelerators for neutral or charged particles, beam handling and projection equipment, beam steering, fire control, and pointing equipment, test and diagnostic instruments, and targets) which are specifically designed or modified for directed energy weapon applications." While the SNS accelerator is not "specifically designed or modified for directed energy weapon applications," how can one be sure that any international collaboration on SNS will be used to promote the illegal transfer of "services and related technical data" that could be diverted for purposes of developing directed energy weapon applications? What pro-active measures does DOE intend to take to prevent or mitigate the risk of the proliferation of enabling technology for directed energy weapon applications arising from the construction and operation of SNS? How does DOE intend to coordinate its activities on SNS effectively with the Department of State to preclude inadvertently violating the intent of the *Arms Control Export Act* by allowing the export of enabling technology?

Notably, high-energy particles such as those used in the beam of SNS release secondary energetic particles and radiations from collisions with target atoms through the process of nuclear spallation, which is a form of "nuclear transformation." Energy released from the process of nuclear transformation is defined at 42 *U.S.C.* 2014(c) to be "atomic energy." Per 42 *U.S.C.* 2014(d): "The term 'atomic weapon' means any device utilizing atomic energy, exclusive of the means for transporting or propelling the device (where such means is a separable and divisible part of the device), the principal purpose of which is for use as, or for development of, a weapon, a weapon prototype, or a weapon test device." Thus, any directed energy weapon utilizing a particle beam energetic enough to induce nuclear transformation by effecting spallations in the target materials may apparently be inferred legally to be an atomic weapon if not a "weapon of mass-destruction." None of the existing regulations specifically address this notable aspect of SNS-related technologies. Does DOE intend to address this aspect of SNS and its implications on how SNS technologies are to be regulated in international collaboration?

Recommendations:

3-1 DOE needs to revise the SNS EIS (1) to assess the risks posed by SNS to the proliferation of the capability to produce special nuclear material without safeguards and thereby to produce weapons of mass destruction and (2) to specify the active measures to be taken by DOE in coordination with the NRC, the Department of Commerce, and the NSG to prevent or mitigate such risks. In particular, DOE might indicate when the previously-indicated rulemaking for 10 CFR Part 810 can be expected.

3-2 DOE needs to revise the SNS EIS to assess the risks posed by SNS to the proliferation of directed energy weapons and to specify the active measures to be taken by DOE in coordination with the Department of State to prevent or mitigate such risks arising from international collaborations that might lead to the export of SNS technologies. DOE also needs to explain why directed energy weapons using beam energies comparable to SNS and incorporating technologies very similar to that used in SNS do not need to be regulated as atomic weapons.

RESPONSE

Fundamental particle accelerator technology to be used in the SNS facility is openly available around the world in both text and hardware. As pointed out in preface material to this comment, Article III of the Treaty on the Non-Proliferation of Nuclear Weapons discusses facilities "especially designed or prepared for the...production of special fissionable material." The SNS facility is not "especially designed" for production of fissionable material, and its supporting research activities are focused on the nuances of creating sharply defined pulses of high energy particles - effectively reducing the potential integral particle flux and potential application to fissionable material production. Thus, the SNS facility would not create new special nuclear material production technology useful for the manufacture of weapons of mass destruction; therefore, the project adds no incremental proliferation risk. In the absence of incremental proliferation risk, DOE plans no antiproliferation actions associated with the SNS project. Regarding the reference to rulemaking for 10 CFR 810, draft rulemaking under consideration would address the use of accelerators for production of special nuclear materials. If such rules were enacted and if SNS technology were deemed to be important to special nuclear materials production, then approval by the Secretary of Energy would be required before its export. However, such rules are not currently in force, and the promulgation of regulations is outside the scope of this EIS for the proposed action to construct and operate an accelerator-based neutron research facility.

The SNS accelerator system generates proton ion beams, both negatively and positively charged, at up to the 1 GeV energy level. Such beams would be rapidly attenuated in air; therefore, they are of no practical application for a ground-based directed energy weapon. The specific technology used in this project is for equipment and facilities that are massive; therefore, they are not practical for space-based directed energy weapons. Thus, the SNS facility would not create new technology useful for the manufacture of directed energy weapons, and it is not subject to regulation as any form of a weapon.

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COMMENT CODE

P-3-1

I support the NSNS project as an important scientific endeavor, as an opportunity for Oak Ridge National Laboratory to maintain it's world-class ranking in this field of research, and as a significant economic activity that will benefit Oak Ridge and the surrounding communities for many years into the future. Siting of the NSNS within the Oak Ridge Reservation (ORR) is consistent with the purpose and mission of the ORR.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
P-3-2

I am concerned that the preferred location for the NSNS on Chestnut Ridge -- at the center of the National Environmental Research Park and the Southern Appalachian Biosphere Reserve -- together with the planned location of the Joint Institute for Neutron Science, will significantly contribute to the increasing forest fragmentation in this nationally and internationally important habitat for rare and endangered species.

RESPONSE
The selection of the Chestnut Ridge site for construction of the SNS at ORNL is discussed in Appendix B of the DEIS. DOE agrees that removal of the trees on the Chestnut Ridge site would contribute to forest fragmentation; however, the area around the proposed site would remain forested. Construction plans call for a minimum of forest clearing, which would help minimize the fragmentation effects of clear cutting. The 110-acre site represents less than one-half percent of the total forested area on the ORR (see Section 5.2.5.1 of the EIS).

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COMMENT CODE
P-3-3

I am also concerned about likely and possible impacts of the NSNS on long-term research projects that have been collecting scientific data on the forest and stream ecosystems in the Walker Branch watershed for three decades.

RESPONSE
The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.311, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
P-3-4

The draft EIS fails to adequately address cumulative impacts on the ORR and in particular on its biodiversity. It does not even include in its assessment such major impacts from the immediate past and from present activities as the development of the ED1 parcel. Indeed, the document's discussion of cumulative impacts is essentially limited to the construction and operational phases of the NSNS project, and its anticipated future expansion. Thus this EIS does not meet the requirements detailed in 40 CFR 1508.7 of assessing cumulative impacts, which requires the inclusion of "other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."

RESPONSE
When discussing the potential impacts of construction of the SNS, DOE assessed the impacts against "background" conditions or the existing conditions taking into account past and present activities at each of the potential sites. Discussions in Section 5.7, Cumulative Impacts, center on the potential effects of reasonably foreseeable future actions in conjunction with the potential effects of SNS construction. The discussion for ORNL specifically included Parcel ED-1. Section 5.7.1.5.1 indicates that development of Parcel ED-1 would require clearing of approximately 500 acres of land. The potential impacts are judged to be minimal because the total acreage of forest on the ORR would be reduced by approximately 2.5 percent. This reduction includes land cleared for Parcel ED-1, the CERCLA Waste Disposal Facility, the Joint Institute for Neutron Science, and the SNS.

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COMMENT CODE
P-3-5

Also, the draft EIS does not assess in sufficient detail mitigation measures that might be taken to minimize the environmental impacts of the NSNS, such as DOE long-term commitments to preserving the integrity of the National Environmental Research Park and alternative technologies for cooling the NSNS.

RESPONSE
The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.311, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
P-3-6

-involve local stakeholders in the design and analysis of mitigation measures

RESPONSE
DOE does plan on holding additional public information meetings concerning the SNS project after publication of the Record of Decision. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision. DOE will solicit input from local stakeholders concerning various aspects of the project, including proposed mitigation measures.

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COMMENT CODE
P-3-7

-hold another, well-publicized, public comment period and hearings on the FEIS before decisions on the final design of the NSNS are made and any construction begins.

RESPONSE
DOE does plan on holding additional public information meetings concerning the SNS project after publication of the Record of Decision and before construction begins. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision.

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COMMENT CODE
P-3-8

I also ask you to extend the comment period for the draft EIS because I know of several organizations that have not had enough time to study this document and to come to a decision about their responses.

RESPONSE
While DOE did grant specific requests to extend comment receipt, there were so few of these (2) that a general extension was not considered necessary or warranted. DOE incorporated comments received after the close of the formal comment period to the extent possible, preceding the printing of the FEIS.

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COMMENT CODE
P-4-1

I support the selection of the Preferred Alternative; locate the SNS in Oak Ridge to be operated by the ORNL. I recognize the importance of the research the SNS enables.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
P-4-2

The draft EIS does a good job of documenting the concerns and issues raised at the scoping meeting -- except for one -- the lack of public involvement in selecting the actual, physical site. The draft EIS and associated public meetings are the first such opportunity since then. An informal, interactive work session earlier in the process would have been desirable. Unfortunately it may now be too late in the process to affect the outcome for actual adjustment of the site.

RESPONSE
The siting of the proposed SNS facility was determined based upon a site selection process that is presented in Appendix B of the DEIS. The site selection process included an evaluation of several potential sites within the ORR. DOE has held additional public information meetings concerning the SNS project and will continue to do so. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision.

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COMMENT CODE
P-4-3

The document does NOT give all the environmental impacts. The site plan shown on page 3-12 and elsewhere does not show the retention basin. This basin is discussed on pages 5-20, 21, 30 and elsewhere but its size and location are never given.

RESPONSE
The retention basin is not shown on the site plan (Figure 3.2.1.5-1) on page 3-12 because it is meant to show a generic site plan illustrating the facility. The placement of a retention basin is site specific and will vary in location according to the site. The figures showing the specific SNS site location for each of the four alternative locations have been modified to include the retention basin. The text of the EIS

concerning the retention basin has been clarified. At the Conceptual Design stage of the project, the size of the retention basin required was approximated at 2 acres.

LOCATION OF EIS REVISION(S): Figures 4.1-1, 4.2-1, 4.3-1, and 4.4-1; Sections 3.2.2.3, 3.2.3.6, 5.2.2.1.2, 5.2.5.2, 5.3.2.1, 5.3.5.2, 5.4.2.1, 5.4.5.3, 5.5.2.1, 5.5.5.2, 5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.11.1, and 5.11.3

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COMMENT CODE
P-4-4

Page 5-37, last paragraph mentions construction of improvement of utility corridors and a southwest access road not assessed at the time of the draft EIS; these should be included in the final EIS and not just for cultural resources.

RESPONSE
The CEQ regulations (40 CFR 1501.2) require integration of the NEPA process with other planning for proposed actions "…at the earliest possible time…" In the DOE system, this means that an EIS is typically initiated during the Conceptual Design phase of a proposed action. This is a most general level of design. The full details of a proposed action are not generally established until the completion of Title I and Title II (preliminary and detailed) design at a later date.

This EIS was initiated during the Conceptual Design phase of the SNS project. Title I and II design for the project have not been completed. As a result, all of the final design details for the proposed SNS have not been established. For example, the final routes of access roads and utility corridors to the proposed SNS sites at the four national laboratories are not fully known. In addition, the final locations of the retention basin are uncertain. Consequently, the potential effects of construction and operation of these utility corridors and retention basin on the environment are considered to be within the bounds of the overall site assessment in this EIS.

The locations of the retention basin, roads, and utility corridors would be firmly established at the host national laboratory after publication of the Record of Decision. To the maximum extent possible, these areas would be established to avoid effects on sensitive environmental features such as cultural resources, wetlands, and natural areas. In addition, the potential effects of the proposed action on the environment in these areas would be assessed. DOE will prepare a Mitigation Action Plan to explain how and when mitigation measures would be implemented and how DOE would monitor the mitigation measures over time to ensure their effectiveness. The assessment and mitigation measures would be implemented prior to the initiation of ground-disturbing activities at these locations.

LOCATION OF EIS REVISION(S): Chapter 5 (Introduction)

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COMMENT CODE
P-4-5

The EIS does not do a good job of showing the intrusion of the SNS into environmentally sensitive areas in a way the public can easily see. In contrast, for example, the CERCLA Waste Disposal RI/FS (DOE/OR/02-1637&D2 in figures 7.2, 7.3 and 7.4) show in detail, the sensitive areas and the proximity to the candidate sites. I have used these in studying the SNS site. The inclusion of a figure similar to Figure 7.4 in section 4.1.5 or 5.2.5.4, along with the figure found on page B43 of this document, is recommended.

RESPONSE
An additional figure showing environmentally sensitive areas on and adjacent to the proposed SNS site has been included in the FEIS. The other figure mentioned by the commenter is considered to already be part of the EIS (Volume II, Appendix B, page B-43). This figure shows BSR areas relative to the proposed SNS site on the ORR. A new paragraph referring the reader to these figures has been included in the text of the FEIS.

LOCATION OF EIS REVISION(S): Section 4.1.5.4, Figure 4.1.5.4-2 (new)

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COMMENT CODE
P-4-6

In addition, an outline of the SNS footprint should be shown on Figures 4.1.5.4-1 and 4.1.5.4-2.

RESPONSE
Figures 4.1.5.4-1 and 4.1.5.4-3 (renumbered) have been revised to include an outline of the SNS footprint.

LOCATION OF EIS REVISION(S): Figures 4.1.5.4-1 and 4.1.5.4-3 (renumbered)

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COMMENT CODE
P-4-7

Figures 4.1.8.3-1 and 4.1.8.3-2, found on pages 4-54 and 4-55 are not readable; an expanded view of the affected area would be an improvement.

RESPONSE
The base map for Figure 4.1.8.3-1 was originally done in multiple colors. It was translated into a black and white format for use in the DEIS. Prior to issuance of the draft document, several attempts to improve the quality of this figure were undertaken with limited success. However, the relationship of the BSR areas to the proposed SNS site is shown in another figure in the EIS. This figure, which provides an expanded view of the affected area, is in Volume II, Appendix B, page B-43.

An attempt has been made to improve the quality of Figure 4.1.8.3-2, particularly on the legend bars.

LOCATION OF EIS REVISION(S): Figure 4.1.8.3-2 (renumbered as Figure 4.1.5.4-3)

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COMMENT CODE
P-4-8

The Draft EIS also does a good job of stating the impact of the SNS on the research being done in the Walker Branch Watershed. The work being done here is very important to the Nations Global Change Program. It is extremely important to mitigate such impacts. For example, in addition to the potential replacement of natural gas boilers with electric heat pumps mentioned on page 5-41, the use of an electric shuttle bus to transport people to the site during the operations period would reduce both runoff by eliminating the need for parking lots as well reducing carbon dioxide emissions from conventional vehicles.

RESPONSE
The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2

and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.311, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
P-4-9

There needs to be a COMMITMENT to mitigation measures BEFORE construction begins!

RESPONSE
DOE is committed to the identification and implementation of appropriate mitigation measures prior to the beginning of construction on the proposed SNS at the site selected in the Record of Decision. DOE will prepare a Mitigation Action Plan for the selected site (see Sections S 1.4.4 and 1.4.3).

....

COMMENT CODE
P-4-10

A better decommissioning plan is needed. Page 5-43 (2nd paragraph) states: “Current plans call for in-situ decommissioning of the SNS when its operational life cycle is completed.” This is unacceptable. Is a 30 year operational life (page 5-19) realistic?

RESPONSE
DOE will prepare a decommissioning plan for the SNS at the selected site after release of the Record of Decision and before the start of construction. This plan will include estimates of the amount of scrap and wastes that would be generated during decommissioning of the facility. At present, DOE estimates the cost of decommissioning the facility to be 150 million dollars (year 2006 dollars) (Spallation Neutron Source Project Execution Plan; SNS/97-1). DOE has also committed to prepare the appropriate NEPA documentation prior to decommissioning the facility.

The SNS is being designed to operate for 40 years beginning in 2006. DOE estimates that the facility will be producing neutrons for scientific research approximately 75 percent of this time, or 30 years. Thus, 30 years was used in the DEIS to determine the amount of activation products produced. Advances in design and technology over the next 46 years may allow the life of the facility to be extended past 40 years, provided there is a continued need for the facility.

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COMMENT CODE
P-4-11

1. Page 4-19 (3rd paragraph) states that one wetland area in the area of BCV south tributary 4 will be affected. However Table 4.1.5.2-1 and Figure 4.1.5.2-1 show BCST2.

RESPONSE
The paragraph identified in the comment is not intended to indicate that wetland BCST2 would be affected by the proposed action or the no-action alternative. This paragraph simply identifies the wetlands in the vicinity of the proposed SNS site at ORNL. The wording "…Bear Creek south tributary 4…" in the DEIS has been changed to read "…Bear Creek south tributary 2…"

LOCATION OF EIS REVISION(S): Section 4.1.5.2

....

COMMENT CODE
P-4-12

2. On page 5-48 in the 2nd paragraph of the 2nd column the annual dose to members of the public, inside and outside the controlled area appear to be reversed.

RESPONSE
The dose limits are correct as stated. The SNS shielding policy is based on the requirements of 10 CFR 835 and is intended to simplify radiation monitoring of individuals at the facility. The dose to members of the public is limited to 100 mrem/yr both inside and outside the controlled area; however, 10 CFR 835.402(a)(3) and 835.402(c)(3) require individual radiation monitoring for minors and members of the public inside the controlled area that would be likely to receive external or internal exposures of 50 percent of the annual limit. By limiting potential exposure to such individuals to no more than 50 mrem/yr, the SNS shielding policy eliminates the need to issue individual radiation monitors to visitors. Such monitors are not required for individuals outside the controlled area.

....

COMMENT CODE
P-4-13

3. On page 5-38 in the 1st column, 40RE488 is discussed in both prehistoric and historic resource section, there appears to be an error.

RESPONSE
Sections 5.2.7.1 and 5.2.7.2 are not in error, but the comment indicates the need for some clarification of the DEIS text. This need for clarification rests on the meaning of the term "component," as it is typically used in American archaeology.

Many archaeological sites contain the separate and distinctive material remains of occupations by different cultural groups. Each of these occupations may be associated with a particular period in time, and the individual occupations may be separated from each other in time by thousands of years. In

American archaeology, each culturally and temporally distinctive occupation of a single site is referred to as a component. One archaeological site may have a single component, but another may have numerous components. Sites with more than one component are referred to as multicomponent sites. Site 40RE488 is a multicomponent site. It contains archaeological remains indicative of a prehistoric occupation, and it was also the site of a late 19th or early 20th century Anglo-American occupation. Thus, in the DEIS, potential effects on the prehistoric component at this site are appropriately assessed under Section 5.2.7.1, Prehistoric Resources, and potential effects on the Anglo-American component are appropriately assessed under Section 5.2.7.2, Historic Resources.

The text of the DEIS has been revised to more clearly indicate that 40RE488 has both a prehistoric component and a historic component. This includes the insertion of an explanatory text box in Chapter 5.

LOCATION OF EIS REVISION(S): Sections 4.1.7.2; 5.2.7.1 and 5.2.7.2 (new text box)

....

COMMENT CODE
P-4-14

4. On page 4-5 the figure is mislabeled, it should be 4.1.1.1-3 (as referenced on page 4-7). In addition, the four borings discussed should be identified.

RESPONSE
The incorrect figure number on page 4-5 in the DEIS has been changed to Figure 4.1.1.1-3. The boreholes discussed in Section 4.1.1.4 are B-1, B-5, B-8, and B-11. These boreholes have been identified in the text.

LOCATION OF EIS REVISION(S): Sections 4.1.1.1 and 4.1.1.4

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COMMENT CODE
P-4-15

5. Figures 1 and 2 in Appendix B are unreadable.

RESPONSE
Figures 1 and 2 in Appendix B of the EIS are part of a separate report on selection of the proposed site for the SNS at ORNL. The full text of this report is included in the EIS to document how this site was selected. In the original report, Figures 1 and 2 are highly complex color maps with subtle gradations in color from one area to another. Such maps are not very amenable to the reproduction of detail in the black and white format chosen for this EIS. Nonetheless, DOE believes it is necessary to include this report in the EIS. The color versions of these maps are available for public inspection and use in the DOE Reading Rooms. The locations of the reading rooms are provided in Volume 1, Section 1.5, page 1-17 of the EIS.

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COMMENT CODE
P-5-1

page 5-45 (Table S1.5.2-1) 9b. BNL Alternative
I believe 3.4 mrem is 34% of limit (not 3.4%).

RESPONSE
The commenter is correct. The 3.4% mrem figure has been changed to 34%.

LOCATION OF EIS REVISION(S): Table S 1.5.2-1, 9b – BNL Alternative, Table 3.5-1, 9b—BNL Alternative

COMMENT CODE
P-5-2

page 1-3 1st paragraph - it states that cold n° are slower than thermal n°; yet, the energies listed state otherwise. Units correct?

RESPONSE
The commenter is correct. The electron volts for thermal and cold neutrons have been corrected.

LOCATION OF EIS REVISION(S): Section 1.1

COMMENT CODE
P-6-1

Hello, My name is Bonnie Bonneau, I'm on your list. I'm at Box 351, El Prado, NM. I have been pretty busy, but I am real concerned about this issue and I don't think you should make one of those neutron, spallation source, facilities at all, it sounds really dangerous. I was really impressed with your catalogue accident scenarios, but of course I suspect there is probably one where something could really go wrong and people could really get hurt.

RESPONSE
DOE shares the commenter's concern for human safety issues potentially associated with the proposed construction and operation of the SNS. As a reflection of this concern, DOE considered a full range of accident scenarios in the DEIS, including those that realistically could occur and those with a very low mathematical probability of occurrence. This represented a conscientious attempt to identify and analyze that one accident "…where something could go wrong and people could really get hurt." It should also be noted that DOE plans to perform additional, highly detailed analyses of facility safety prior to construction and operation of the proposed SNS. More information on these planned analyses is provided in the response to Comment P-2-3.

COMMENT CODE
P-6-2

I don't like this accident, it makes a whole lot more of poisonous wastes that we don't have any way to deal with.

RESPONSE
As indicated in Sections 5.2.11, 5.3.11, 5.4.11, and 5.5.11 of this FEIS, DOE has the capacity to safely and effectively manage SNS-generated wastes in compliance with applicable federal and state environmental regulations for the foreseeable future. The issue of securing technology for the safe, long-term management of radioactive wastes from DOE facilities in general is beyond the scope of this EIS.

COMMENT CODE
P-6-3

I don't like the notion that where, the page you said that you wanted it set in bedrock, but karst would do, or you would maybe even put it, that was on page B-81, you would even put it at Los Alamos where there is not even karst, there is something called tuff which is a bunch of volcanic ash, and so putting it at Los Alamos is totally outrageous.

<u>RESPONSE</u>

The site-selection report for LANL is in Appendix B of the FEIS. Table 1 on page B-69 in this report indicates that the rock underlying the proposed SNS site in TA-70 has been determined to be an adequate substrate for the SNS facilities. This rock is the tuff mentioned by the commenter (refer to Section 4.2.1.1 of the FEIS). The stability of this rock for construction of the proposed SNS is further underscored by the discussion in Section 4.2.1.4.

<u>COMMENT CODE</u>

P-6-4

Putting it anywhere near a water table would be total ridiculous. And, you know, I don't like all that money.

<u>RESPONSE</u>

The commenter’s concern for the potential effects of the proposed SNS on groundwater is shared by DOE. In making its decision on a final site for the proposed SNS, DOE will consider the proximity of the alternative sites to the water table, the potential for groundwater effects at these sites, and the potential implementation of technologies that can prevent or significantly limit effects on groundwater. Information pertinent to these decision factors is provided in Chapters 3, 4, and 5 of the FEIS.

<u>COMMENT CODE</u>

P-6-5

But I have also say that your section of cumulative impacts is a terrifically sad understatement. Because a cumulative impact have to do with taking food from children, you know, depriving parts of our economy that really need help to do a bunch of weird stuff that is very dangerous. And, you know, not as useful as making sure children get decent nutrition and good educations. And I don't like, I think you are making a new generation of weapons, with a neutron bomb. I think you are trying to make a new generation of warfare, that you refuse to be nice to people and you just have this attitude of wanting to kill more and more and I think it is a bad way to go and I hope you hang it up and give up this project and all the ways of war. Thank you so much, good bye.

<u>RESPONSE</u>

The social issues mentioned in the comment are beyond the scope of this EIS.

<u>COMMENT CODE</u>

H-1-1

BARBARA WALTON: Okay. The main deficiency I found in the E.I.S. was it spoke of a retention basin, but it never showed it in the site plan. And it never said how big it was and whether it would fit in the footprint, and I would like to -- and I did notice in this color document, which I saw for the first time today, something that might be the retention basin.

Could you speak to the retention basin and just maybe answer some of my questions about the retention basin?

BARBARA WALTON: How will we find out the impacts of that then if it's not -- will it be in the Final E.I.S.?

BARBARA WALTON: This is the first I heard about a retention basin. How big is it?

The document then does not give all the environmental impacts because it does not include the retention basin.

Now, I got this as I walked in, and there appears to be a basin on the last document. I don't know whether the size is representative on this picture. I do know that it is located outside the footprint that was given in the E.I.S.

RESPONSE

The text of the EIS concerning the retention basin has been clarified. At the Conceptual Design stage, the size of the retention basin required was approximated at 2 acres. The approximate location of the retention basin has been added to the figures showing the SNS site location for each of the four alternative locations. The siting of the retention basin will occur after release of the Record of Decision and before the start of construction, during the Title I or Title II Design stage.

LOCATION OF EIS REVISION(S): Figures 4.1-1, 4.2-1, 4.3-1, and 4.4-1; Sections 3.2.2.3, 3.2.3.6, 5.2.2.1.2, 5.2.5.2, 5.3.2.1, 5.3.5.2, 5.4.2.1, 5.4.5.3, 5.5.2.1, 5.5.5.2, 5.8.1, 5.8.2, 5.8.3, 5.8.4, 5.11.1 and 5.11.3

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COMMENT CODE

H-1-2

BARBARA WALTON: I would like to start by saying that I agree with the need and the importance of the research that will be performed by the S.N.S. And I support the selection of the preferred alternative to locate it in Oak Ridge.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
H-1-3

I also would state that the Draft E.I.S. again does a good job of documenting the concerns and issues raised at the scoping meeting except for one, which is the lack of public involvement in selecting the actual, physical site.

There appear to me that there might be some other locations on Chestnut Ridge that might be better, but -- I would like to see an opportunity for the public to better understand this site and whether or not there might be a site less environmental and research impacted -- impact less areas.

and a commitment to involve the public. …

RESPONSE
The siting of the proposed SNS facility was determined based upon a site selection process that is presented in Appendix B of the DEIS. The site selection process included an evaluation of several potential sites within the ORR. DOE has held additional public information meetings concerning the SNS project and will continue to do so. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision.

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COMMENT CODE
H-1-4

… The other thing that really concerned me in addition to the impact of the research areas at Walker Branch. Now, I want to make a statement about that because I recognize the importance of that research.

…. This is very important research that's being done at Walker Branch. So I am very much concerned about it.

RESPONSE

DOE shares the commenter's concern for the potential effects the proposed SNS may have on long-term research projects in the Walker Branch Watershed on the ORR. These projects are described in Section 4.1.8.2, Section 4.1.8.3, and Appendix F of the EIS. The potential effects of the proposed action on short-term and long-term research projects in the Walker Branch Watershed are described in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2, and 5.8.1.

If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.311, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE

H-1-5

I got a little bit angry about one thing. And that is there appeared to be no commitment in the E.I.S. to mitigation. I mean, the words were there occasionally. Some mitigation measures were even mentioned in some areas, but there was no commitment to mitigation. And I think it's absolutely essential. I think the public needs to be involved. There needs to be a mitigation plan before construction begins.

And I would like to see a commitment to mitigation

We certainly also want to mitigate any impact on research being done in the Walker Branch area. For example, the cooling towers for gas fire. It did mention that you might be able to use heat pumps. Well, there should be a commitment to that if that's necessary.

Well, I say make your parking lot down below and use an electric bus to transport people to and from so that you can avoid the exhaust fumes once it's occupational. You probably can't do that during the construction phase.

But anything that you can do to mitigate should be done. And if you involve the public in helping to prepare a mitigation plan prior to construction beginning you will have a better facility. There will be less clean up needed in the future.

RESPONSE

The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.311, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
H-1-6

There must be a better decommissioning plan. On page 554, and the second paragraph states, and this is a direct quote. "Current plans call for in situ decommissioning of the S.N.S. branch operational life cycle is completed."

Now, for the purposes of the E.I.S. they used a thirty-year life, operational life. I don't know if that's realistic. It seems to me if you're putting a lot of money into a facility like that it might very well operate longer.
… But I don't know whether that thirty-year life is a reasonable life. And I would like to hear more about that in the Final.

RESPONSE
DOE will prepare a decommissioning plan after release of the Record of Decision and before the start of construction. DOE has also committed to prepare the appropriate NEPA documentation prior to decommissioning the facility.

....

COMMENT CODE
H-1-7

… They did a very poor job of showing its impact on the environment in a way that the public can understand. Most of the drawings show the whole reservation and are so small you can't see it.

And so I've tried to figure out where S.N.S. is by using those maps. That's not asking too much that that kind of map that is used in other decision-making documents be used. And I would like to see those kinds of charts in the final E.I.S. …

using a pristine area and developing a major facility that we avoid as much contamination, as much environmental impact, as possible.

RESPONSE
An additional figure showing environmentally sensitive areas on and adjacent to the proposed SNS site has been included in the FEIS. The other figure mentioned by the commenter is considered to already be part of the EIS (Volume II, Appendix B, page B-43). This figure shows BSR areas relative to the proposed SNS site on the ORR. A new paragraph referring the reader to these figures has been included in the text of the FEIS.

The base map for Figure 4.1.8.3-1 was originally done in multiple colors. It was translated into a black and white format for use in the DEIS. Prior to issuance of the draft document, several attempts to improve the quality of this figure were undertaken with limited success. However, the relationship of the BSR areas to the proposed SNS site is shown in another figure in the EIS. This figure, which provides an expanded view of the affected area, is in Volume II, Appendix B, page B-43.

An attempt has been made to improve the quality of Figure 4.1.8.3-2, particularly on the legend bars.

LOCATION OF EIS REVISION(S): Section 4.1.5.4, Figure 4.1.5.4-2 (new), and Figure 4.1.8.3-2
....

COMMENT CODE
H-1-8

One, I rise to support the S.N.S. project and specifically it's location in Oak Ridge under the auspices of O.R.N.L.

Further, I think locating the S.N.S. at Oak Ridge gives it a chance to tie in …

Thank you for the opportunity to present some views on the S.N.S. And, again, as I said in my opening, I rise to support both the S.N.S. project and the location at Oak Ridge under the auspices of Oak Ridge National Lab. Thank you.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
H-1-9

Three, I think the socioeconomic aspects of the project should be noted with great importance because the D.O.E. has projected the loss of two thousand jobs in the next five years and five thousand jobs in the five years after that.

… So from socioeconomic points of view this is a much appreciated facility.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
H-1-10

Indeed, I am opposing Oak Ridge State of -- the World's first future demonstration plant as the follow-up to this to take off about five thousand construction jobs in five to ten years from now, era.

RESPONSE
DOE appreciates the comment; however, the loss of construction jobs in Oak Ridge is not within the scope of this EIS.

....

COMMENT CODE
H-1-11

I wanted to comment now about the E.I.S. for multiple sites versus having D.O.E. headquarters make the decision to use Oak Ridge, 4.1.

But I feel that if headquarters could make the decision on sound technical grounds that Oak Ridge was the preferred location, then there should have been an E.I.S. for Oak Ridge as the site without looking at the other three sites. …

But in this comment I don't think the S.N.S. E.I.S. should be the decision-making basis for Mr. Secretary Richardson, as compared with the acting manager Richardson, of Oak Ridge.

But rather D.O.E. headquarters should make the decision Oak Ridge is the preferred site and the Environmental Impact Statement should be limited to Oak Ridge with a brief synopsis of the other three sites without repeating the other three sites and saving at least some money in the preparation of the Final E.I.S.

I would like to see in the final analysis the current site that you're looking at and at least one other site for a comparison within the Oak Ridge area.

I would suspect perhaps something closer to Bethel Valley Road, which among other things would save on the cost

I am concerned that the Oak Ridge Reservation is a prime environmental research area, and you're kind of sticking yourself right in the middle of -- over here of this prime area. …

If we have thirty thousand acres, I'm sure there could be an alternate site that isn't quite as intrusive as what you have in roughly the center of this whole wilderness expanse.

RESPONSE
The site-selection study for the proposed SNS is presented in its entirety in Appendix B of the EIS. The intent of DOE is to select the best location for the proposed SNS based upon certain criteria that are outlined in this study. Based upon these criteria DOE narrowed down their selection of potential sites to the four (ORNL, ANL, LANL, and BNL) identified in the EIS. The purpose of the EIS is to assess the environmental impacts that would result from implementing the proposed action at any of the four alternative sites. This information will enable DOE to make a well-informed location decision, which will be published in the Record of Decision.

....

COMMENT CODE
H-1-12

… I don't know how much it costs and I would like to get that information if I can to prepare a full in force site E.I.S.

RESPONSE
The cost of preparing the EIS for the SNS will be approximately 2 million dollars.

....

COMMENT CODE
H-1-13

I want to make another comment now, five. I was very pleased to see the very clear graphics on this color photo. Your slides have a dark background which make it hard to see. I hope you will redo the slides, even for tonight's presentation if possible.

… The light background is far superior and I hope you will change some of your documentation as quickly as possible.

RESPONSE
DOE appreciates the comment, however, the brochures that are being referred to are not in the scope of the EIS.

....

COMMENT CODE
H-1-14

In this regard, number seven, regardless of where you put it on the reservation I would like you to add some biological environmental research capability as an adjunct to your facility because it is located, as shown here, so close to the center of the relative wilderness areas.

… But I think for the environmental researchers it would be very helpful to them to have some small buildings supplemental to your facility to be looking at.

RESPONSE
DOE appreciates the comment; however, site-specific biological environmental research is not contained in the programmatic mission of the SNS or the EIS.

....

COMMENT CODE
H-1-15

Eight, do you have -- I know they're talking -- the State of Tennessee is talking of the visitor's house. And I think you showed Joint Institute for Neutron Science -- incidentally, where will that be relative to the site?

DANIEL AXELROD: I would hope that the JINS will be not only for the visiting scientific community, but also will have a visitor's area as well. We, of course, have a visitor's area at the X-10 historic site, the graphite reactor.

… So I would ask that you -- as I may, put in provision for a visitor's facility. It needn't be very large. …

… I propose the library accessibility to the public at Bethel Valley Road by the pond near the entrance to the laboratory.

DANIEL AXELROD: This would also be another useful reason for the visitor facility near the JINS …

So if it turned out to be a multi-function facility that visitors, public information, news media releases, and emergency headquarters, and also visitor control.

RESPONSE
Discussions regarding a visitor center/facility in the area of the Joint Institute for Neutron Science and/or the proposed SNS site have been held. However, at this time nothing has been finalized due to the early state of both projects and attendant uncertainties.

....

COMMENT CODE
H-1-16

This JINS facility with its visitor's facility might also well -- a restaurant or tie in your visitor facility with the overlook to O.R.N.L. …

RESPONSE
Discussions regarding a visitor center/facility in the area of the Joint Institute for Neutron Science and the proposed SNS site have been held. However, at this time much uncertainty exists for both projects, and because the Joint Institute for Neutron Science is a Tennessee state initiative, DOE cannot appropriately comment on its prospective capabilities. At the appropriate time visitor facilities, including such things as overlooks and restaurants, may be examined.

....

COMMENT CODE
H-1-17

… but it seems the real problem here is the Walker Springs.

What we need is an E.I.S. for Walker Springs, incorporating environmental studies. I'm essentially at the end, but is there something in existence that would allow the prediction of needs, possible interferences with the environmental studies for future time?

Now, I'm asking -- well, I'm asking anyone who has a feel. But it would have been better if the designers of S.N.S. could have looked at what's required to maintain the environmental study and not interfere. …

FRED MAIENSCHEIN: Is there another Walker Springs that will interfere with the next project to be established? Can we ascertain that in advance?

RESPONSE

The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

In accordance with 10 CFR 1021.311, DOE will make copies of the mitigation action plan available for public inspection in the DOE reading room in Oak Ridge (refer to Section 1.4 of this FEIS), and copies will also be available upon written request to DOE. In addition, DOE plans on holding public information meetings concerning the SNS project after publication of the Record of Decision and before the beginning of SNS construction. One of these meetings will include an opportunity for public comment on the contents of the mitigation action plan. The time, location, and agenda for such meetings will be announced through the normal public communications practices of DOE-ORO.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

COMMENT CODE
H-1-18

If indeed S.N.S. is going to change what happens on Walker Branch because of atmospheric emissions, then I guess I agree with Barbara that the mitigation plan has to be carefully constructed to avoid those kinds of impacts on the Walker Branch watershed and the scientific research that's been going on there for so many years.

RESPONSE
The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

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LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

COMMENT CODE
H-1-19

On page S-27, the table that says an estimated total of three hundred thousand curies will be deposited …

It seems to me like these really won't comment on just what that three hundred thousand means and how long it's going to be there and that kind of stuff.

RESPONSE
Table S 1.5.2-1 is meant to merely be a summary outline of the impacts associated with the operation and construction of the proposed SNS. A more detailed assessment of the impacts found on this table, including those on geology and soils (page S-27, 1b), can be found in Sections 5.2.1.3, 5.3.1.3, 5.4.1.3, and 5.5.1.3.

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COMMENT CODE
H-1-20

And I don't have any prepared comments, but I would like to say that I strongly support location of the Spallation Neutron Source in Oak Ridge.

… And I think you'll find that the Greater Oak Ridge Community has repeatedly expressed its support of the project, and we would like to see it go forward in Oak Ridge.

RESPONSE
DOE appreciates the comment.

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COMMENT CODE
H-1-21

I'd also like to say that I agree with many of the concerns expressed earlier by Barbara Walton and some of the other members of the audience about the impacts to the research on Walker Branch.

We don't want to have to trade off one research project for another. …

RESPONSE
DOE is in agreement with the conclusion that one important research project on the ORR should not be traded off in favor of another. The agency has no proposed plans to do this. Instead, DOE believes that the potential effects of the proposed action on the research projects in the Walker Branch Watershed can be mitigated to maintain the integrity of these projects.

The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

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LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
H-1-22

… I think that it would behoove Oak Ridge to reexamine the site.

My own background involves geology and land use issues. In just a brief examination of a map you can find other ridge top sites, particularly to the southeast along Chestnut Ridge, that have good access to power and potential for decent roadways.

Maybe they're a little bit farther from Oak Ridge National Laboratory, but you're talking about making a variety of compromises anyway. And it may be a better compromise to put the facility on a suitable location that is farther away from the lab than to compromise the research going on in Walker Branch.

and I don't know whether it's a specific NEPA group or Energy Research Organization coming to the public after significant decisions are apparently already made in Oak Ridge.

I think that for big scientific projects like this that are going to be supported by the community because they will be, you will have less controversy if you involve the public early on in decisions; such as, where exactly on the reservation would we propose to locate such a facility.

And I would encourage you to take that as a lesson learned for next time. …

RESPONSE

The siting of the proposed SNS facility was determined based upon a site selection process that is presented in Appendix B of the DEIS. The site selection process included an evaluation of several potential sites within the ORR.

DOE has held additional public information meetings concerning the SNS project and will continue to do so. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision.

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COMMENT CODE

H-1-23

DANIEL AXELROD. Mr. Daniel Axelrod. I spoke before. You indicated a .40 mrem, M.E.I., maximally exposed individual, on an annual radiation dose. Could you state what the boundary was for this individual? And is one of the reasons for locating at Chestnut Ridge as compared to closer to Bethel Valley Road to give yourself a buffer space from the radiation point of view?

So what was the basis for the M.E.I., maximum exposed individual?

DANIEL AXELROD: What amount of time per year and hours per year were you assuming?

DANIEL AXELROD: So this accident scenario might be anywhere from eight to forty-eight hours, for example, on the access road?

RESPONSE

A complete analysis of the information found in the Summary on page S-45, Impacts on Human Health, can be found in Section 5.2.9.2.1 and Appendix G of the EIS. In addition, the SNS Shielding Policy, which specifies maximum allowable radiation exposure rates for various areas inside and outside the SNS, can be obtained from the DOE Reading Rooms. The locations of the reading rooms are provided in Volume I, Section 1.5, page 1-17 of the EIS.

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COMMENT CODE

H-1-24

DANIEL AXELROD: Have you written in operational aspects to clear the road in the event that an accident was determined to be taking place?

RESPONSE

The safety of the SNS facility will be evaluated and documented in accordance with DOE Order 5480.23, SAR, and other related orders. Hazard evaluation and safety analysis will be done under the guidance of DOE-SD-3009-94, Preparation Guide for U.S. Department of Energy Nonreactor Nuclear Facility Safety Analysis Reports. The SAR being prepared for the SNS is required by DOE to address emergency preparedness. Clearing the road during an accident would fall under emergency preparedness and planning. The SAR will document facility compliance with DOE emergency preparedness requirements. The emergency planning provisions for protection of the public and workers will be based upon the SAR hazard evaluations and accident analysis of design-basis and beyond-design-basis accidents.

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COMMENT CODE

H-1-25

… On page 5-48 -- I don't know if you have a copy of the document convenient -- it's talking about doses to the public again.

The second paragraph in the second column, I think maybe the numbers have been reversed. Let me read you the statement. It sounded like they might be backwards.

"Under this policy the annual dose to members of public, including site visitors, would not exceed one hundred milligrams outside the control area or fifty milligrams inside the controlled area." I would think you would have higher dosage inside the controlled area than outside.

BARBARA WALTON: Well, I would ask in the Final that some clarification be given to statements like that.

RESPONSE

The dose limits are correct as stated. The SNS Shielding Policy is based on the requirements of 10 CFR 835 and is intended to simplify radiation monitoring of individuals at the facility. The dose to members of the public is limited to 100 mrem/yr both inside and outside the controlled area; however, 10 CFR 835.402(a)(3) and 835.402(c)(3) require individual radiation monitoring for minors and members of the public inside the controlled area that would be likely to receive external or internal exposures of 50 percent of the annual limit. By limiting potential exposure to such individuals to no more than 50 mrem/yr, the SNS shielding policy eliminates the need to issue individual radiation monitors to visitors. Such monitors are not required for individuals outside the controlled area.

In addition, for clarification purposes, the SNS Shielding Policy which specifies maximum allowable radiation exposure rates for various areas inside and outside the SNS can be obtained from the DOE Reading Rooms. The locations of the reading rooms are provided in Volume I, Section 1.5, page 1-17 of the EIS.

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COMMENT CODE

H-1-26

UNKNOWN SPEAKER: Could you give the job title or the functions of the individuals, the other three?

RESPONSE

The job titles and functions of the three individuals representing DOE's interests at the public comment meeting are as follows: Clarence Hickey, functioning in a staff role for environmental matters for the Office of Science; David Bean, prime contractor representative with Enterprise Advisory Services, Inc., responsible for the preparation of the EIS document; and Bill Fleming, subcontractor to Enterprise Advisory Services, Inc., responsible for portions of the preparation of the EIS document.

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COMMENT CODE
H-2-1

First, I want to say that I and the city council strongly endorse the location of the Spallation Neutron Source in Oak Ridge. I believe we understand the significance and the benefits this project will provide to the community, to the state, and to the nation.

The council has previously supported past resolutions in support of the Spallation Neutron Source, and I will read a resolution that I will present for council approval at our next meeting Monday night, February the 1st, …

Now, therefore, be it resolved by the mayor and the councilmen of the City of Oak Ridge that the City of Oak Ridge supports and endorses the Department of Energy's preferred alternative to construct and operate the Spallation Neutron Source at the Oak Ridge National Laboratory.

RESPONSE
DOE appreciates the comment.

COMMENT CODE
H-2-2

Second, I want to say that the citizens of this community strongly support the location of the Spallation Neutron Source in Oak Ridge. This was evident in a recent city-wide survey that was conducted in September of 1998 where a survey was mailed to every household in the city and it consisted of thirteen questions.

So I think I can truly say that the citizens of the community strongly support the location of the Spallation Neutron Source in the City of Oak Ridge.

RESPONSE
DOE appreciates the comment.

COMMENT CODE
H-2-3

I strongly support the need for a Spallation Neutron Source, which I think is a scientific and international need, and I believe that Oak Ridge National Laboratory is an excellent institutional setting for this new facility.

RESPONSE
DOE appreciates the comment.

COMMENT CODE
H-2-4

What I question is the precise location in the heart of the National Environmental Research Park at the Southern Appalachian biosphere reserve. This is certainly -- I can't see in the draft EIS any reasoning or justification why this facility needs to be presented in the Environmental Research Park.

I also didn't see any evaluation of alternate sites within the Oak Ridge Reservation that are not in the actual -- or at least not in the middle of the research area, and I would really like to see more information in the final EIS that justifies if there really is no other location that's suitable in Oak Ridge.

RESPONSE
The siting of the proposed SNS facility was determined based upon a site selection process that is presented in Appendix B of the DEIS. The study shows how the entire reservations was assessed, using exclusionary criteria, to identify the Chestnut Ridge site as the best alternative.

DOE has held additional public information meetings concerning the SNS project and will continue to do so. The time, location, and agenda for these meetings will be announced through normal public communication processes at the site selected in the Record of Decision.

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COMMENT CODE
H-2-5

And in terms of mitigation, if it should turn out that this is the only suitable location for the Spallation Neutron Source, mitigations should address concerns of the integrity of the National Environmental Research Park.

RESPONSE
The major impact of the proposed action on the National Environmental Research Park involves disturbance of current and planned environmental research projects in the Walker Branch Watershed research area. The potential effects of the proposed action on NOAA monitoring and ORNL-ESD ecological research projects in the Walker Branch Watershed are assessed in Sections 5.2.8.1.1, 5.2.8.2.1, 5.7.1.8.1, 5.7.1.8.2 and 5.8.1 if the FEIS. If the ORR site is selected for the SNS, DOE is committed to preparation of a formal mitigation action plan to address these effects. In the mitigation action plan, DOE will identify potential mitigation measures and evaluate them for effectiveness. The measures to be evaluated would include heating the proposed SNS with electric heat pumps or heat recovered from the SNS cooling system instead of the currently proposed natural gas boilers. Such measures could mitigate the effects of CO_2 emissions from SNS operations. To further mitigate the effects form CO_2 emissions, DOE would also evaluate the use of electric or ultra-low-emission vehicles to transport workers to the SNS site from remote parking lots. These evaluations would also include relocating the current NOAA/ATDD monitoring tower to a new location less susceptible to CO_2 and water vapor emissions from the proposed SNS or construction of a new tower at this new location. Based on the results of its evaluations, DOE will select and commit to the implementation of particular mitigation measures in the mitigation action plan. The mitigation action plan will be completed after publication of the Record of Decision and prior to construction of the proposed SNS.

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The development and implementation of long-term policies, plans, and procedures to preserve the integrity of the National Environmental Research Park are beyond the scope of this EIS. While DOE remains sensitive to providing reasonable protection for the National Environmental Research Park, it should be noted that the use of ORR land for primary DOE missions and other DOE programmatic initiatives takes precedence over land use for environmental research, forestry, and wildlife management. The National Environmental Research Park was established to make DOE's land resources available for environmental research but not to impede or prevent the use of ORR land for DOE mission purposes.

LOCATION OF EIS REVISION(S): Sections 1.4.4 and 5.2.8.1.1

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COMMENT CODE
H-2-6

The draft EIS mentions as one of the problems that this will increase defragmentation of the park, and sort of in the same sense it brushes that under the rug and says, well, there will be a wildlife corridor.

A lot of the EIS concentrates on individual species and doesn't look at the reserve as an entity, and its integrity and the designation of it as a biosphere reserve is one indication that this is a national asset and even an international asset.

A recent scientific survey by the National Conservancy has identified this as a big, important area because it is the only remaining large unfragmented or moderately unfragmented area within the region valley province that has mature forests, or mixed forests, and large amount of interior forest. So that is an important national mission of the research park, and I don't see that addressed in the draft Environmental Impact Statement.

RESPONSE
Identification of the Chestnut Ridge site for potential construction of the SNS at ORNL is discussed in Appendix B of the DEIS. DOE agrees that removal of the trees on the Chestnut Ridge site would contribute to forest fragmentation. However, the area around the proposed site would remain forested. Construction plans call for a minimum of forest clearing, which would help minimize the fragmentation

effects of clear cutting. The 110-acre site represents less than one-half percent of the total forested area on the ORR (see Section 5.2.5.1 of the FEIS).

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COMMENT CODE
H-2-7

Also, in terms of addressing human impacts, it doesn't do a good job at looking at past or present and reasonably foreseeable future impacts, which is really a requirement for a good EIS. It treats the accumulative impact as the impact of the construction phase and the operational phase, and it really stops at that without looking into all the other proposals and interests that exist in taking out other chunks of the Oak Ridge Reservation for different purposes. So these future impacts should be looked in their entirety and need to be assessed. …

RESPONSE
When discussing the potential impacts of construction of the SNS, DOE assessed the impacts against "background" conditions, or the existing conditions taking into account past and present activities at each of the potential sites. The discussion in Section 5.7, Cumulative Impacts, centered on the potential effects of reasonably foreseeable future actions in conjunction with the potential effects of construction of the SNS.

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COMMENT CODE
H-3-1

That the City of Oak Ridge supports and endorses the Department of Energy's preferred alternative to construct and operate the Spallation Neutron Source at the Oak Ridge National Laboratory.

RESPONSE
DOE appreciates the comment.

....

COMMENT CODE
H-4-1

But the only reason I wanted to make a comment is because you guys need to have some good kudos, not just people who like to raise Cain …

But anyway, I have been reading a lot of the DOE environmental impact statements, the programmatic and dual access and the SWEIS, and this one, and I would have to say the art of making these documents has really improved, and it's more of a science as well as an art.

I enjoyed this particular one because it had a chance to put in details about four different sites, Obviously I'm not a neutron scientist, you don't have to be to be involved in this process, but I was really impressed how in a relatively short time, 18 months, they could put together all the technical stuff and all the things that could go wrong and all that, and they have to use the worst case because that's for planning purposes.

So I would have to say that besides the programmatic thing for stockpile stewardship and all, this is the first time I ever saw such a thing in depth for four different places, and not only are we looking at four different sites in four different states, each state, you know, Oak Ridge looked at four different places, four places besides the Chestnut Ridge or whatever it is. Right here at Los Alamos they looked at four different places, and they did other places. So you're talking about 16 or 17 different sites that are being evaluated, and I thought that was impressive.

If I were somebody that was going to be living wherever they build it, whether it be Oak Ridge or here or wherever, I would know that somebody did their homework, and they made all these evaluations and all these calculations with worst case and that if everything goes right, and then they figure out all the different things that can go wrong and stuff, …

… And I appreciate the fact that DOE has spent the time and the money not only on the research but doing all the calculations that show that things can be right and that there shouldn't be too many things that haven't been foreseen.

RESPONSE

DOE appreciates the comment.

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COMMENT CODE

H-7-1

MR. ZIZEK: My name is Russell Zizek. I'm a homeowner. I live on Kearney Road directly outside this facility, second house outside the facility. Being situated there, I dare to object on record against this project being put in this location. There are several criteria which you mentioned, and I've read them in your vast information here. And it seems like there's a lot of criteria brought up by the Department of Energy that's been either overlooked or ignored. Perhaps you operate by leaving this go 'til after this particular part of the function and then taking a name off the table. However, I would hope that with all of the criteria failing, Argonne would have already been taken off.

Brings me to the question I asked myself: Why are we even here? The first criteria: There's a one-mile buffer around the site that's your criteria. There's no way 1500 acres of land, which it states in here somewhere, that Argonne possesses can create a one-mile buffer around any point on the facility. Can't do it.

… And the main thing which makes me wonder why we're here is this, seems to me, total disregard of the DOE's own criteria. I've already stated the one-mile buffer; no way you can meet that. And that's been overlooked. And it seems to me that should have been an initial move to pull Argonne out of the mix.

And then later on, there's another, a criteria of 500 meters to any existing occupied structure. Well, I'm not a scientist, but I think 500 meters is 1500 feet. And 1500 feet from the current crossroads of -- I wouldn't say the current crossroads -- from your map showing where this site ends, the northerly portion of the site, is 1300 feet to occupied residents. And I'll even go so far as not to lie to you. It's not occupied right now. In fact, the house is empty because it's been sold. And it's already been rezoned to build thirteen single-family houses there. So, they're gonna be within your 500-meter lower criteria.

MR. ZIZEK: 750 feet from the northwest corner of your footprint is where the 115 townhouses, 64 condominiums and so forth are located.

Kearney Road has three, four houses along it between the forest preserve property and frontage road. And there's a new house built there, which is now in Darien. They get city water, however. There's another street to the west. Ruth Drive has about ten houses.

They all have well water. And they're within the same, within the 1500-foot criteria.

In addition, between our houses is the forest preserve. And the forest preserve has a designated hiking, riding, recreation pact which is 250 feet only from your fence. And your fence would be maybe, I would guess, 400 feet from the end of this footprint to your new facility. So, it seems like you set up these criteria, and you stumble over them, but you never recognize them. I hope you're gonna recognize them now sometime in the very near future and agree that this shouldn't be built here at Argonne.

RESPONSE

In an attempt to narrow down the selection of candidate sites for the SNS, many of the general criteria were originally established from offsite offices with lack of detailed knowledge of the facilities. The 1-mile buffer zone was one of four general exclusionary criteria that DOE used to identify major suitable DOE facilities during the initial screening process (Appendix B). The definition of a 1-mile buffer zone that DOE used as a requirement for a site was that there be a 1-mile buffer between any portion of the facility and permanent residential areas. The buffer zone could include land other than that, which is owned by the DOE. In their initial alternate site analysis process, ANL was identified as being such a site. The 500-meter buffer criterion was established at a later time when the four candidate sites were evaluating their specific site for locating the SNS facility. Given this 500-meter buffer criteria, along with many others, ANL made their best effort to site the proposed SNS in a location to meet as many of the required criteria as possible in order to determine if this site was a viable choice. Although it is geographically possible to place the facility here and have a mild buffer between it and existing occupied structures, it may not be the optimum choice for locating the SNS facility. This step is part of the process to identify the realities of the situation so that the decision-makers can make a well-informed decision.

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COMMENT CODE

H-7-2

Another point I object to is the possible contamination of ground water. In your EIS Statement, it says that drinking water is taken not from the upper ground water which is, I believe, 65 feet; and that's the point at which you believe the contamination will get down to. Below that, you don't believe -- again, according to the EIS -- that it will reach the lower level of about 165 feet due to the clay and so forth above it.

However, you do state that it's not a hundred percent sure that that won't happen due to the various types of materials in the ground. So, in a way, you're saying it won't happen. But you're saying you can't be sure of that. I drink well water. There's 35 homes -- I live in the area between I-55 and Argonne and between Lemont Road and Cass Avenue. In that area, there's 35 original houses, I'll call them. Let's say they're 30 years old or better.

RESPONSE

Section 3.2.2.9 presents the shielding design for the linear accelerator and accumulator rings. The design is an engineered earthen berm designed to isolate the activation products generated by the particle beam. In Chapter 5 the potential impacts to groundwater are presented. These impacts are based on very conservative assumptions concerning groundwater travel times, dilution, and levels of radionuclides in the earthen berm. The results of this analysis present a bounding estimate of the potential impacts. This bounding estimate becomes the design goal for Title I and Title II design, that takes place after the publication of the Record of Decision. It is true that DOE can not be absolutely certain at this point that activation products would not reach the deep aquifer. However, if during the investigations of the selected site, it is found that soil conditions and groundwater travel times do not agree with the assumptions used in the EIS, the design of the earthen berm would be modified to assure that the severity of the impacts to groundwater would not be greater than expressed in the FEIS.

A discussion of transport of radionuclides for each of the four alternative sites is presented in Chapter 5 of the DEIS (Sections 5.2.2.3, 5.3.2.3, 5.4.2.3, and 5.5.2.3). Because of the uncertainties in the amount of soil activation products and uncertainties about the groundwater at each of the four sites, these analyses are based on very conservative assumptions. The results of these analyses present what DOE considers to be an upper limit of releases to groundwater. After publication of the Record of Decision, characterization of the selected site would determine if additional design features are necessary to achieve the groundwater protection levels presented in the EIS.

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COMMENT CODE

H-7-3

In addition to those houses, there's a project which is going to be located 750 feet from the site of this SNS, which is gonna contain 115 townhouse units, 64 condominium units, a hotel, and a gymnasium. They are on Lake Michigan water, as you are. So, I guess as far as the water issue is concerned, they're protected from that. But those of us who have wells, the only way we can get Lake Michigan water is to genuflect in front of the Mayor of Darien and ask him if we can please have some Lake Michigan water. They tried that with Argonne; and Argonne, I guess, told them they would take other ways. And they got it directly from the County. We all would appreciate Argonne using that same maneuverability to get Lake water for us without going through Darien since we are in this no-man's land of water situation.

MR. ZIZEK: As far as the water, I quite frankly don't trust the water anymore. I've been buying water in the store for 20 years. Feel like sending the bills to Argonne for that. But the LCF's don't thrill me

RESPONSE

DOE appreciates the comment; however, the issue of obtaining water from Lake Michigan for local residents who have wells is not within the scope of this EIS.

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COMMENT CODE

H-7-4

The other impact is on human health. I went through all the tables as comparisons of the different laboratories. And it's shown on one page, "Operation would result in 1.3 LCF's." I don't know what "LCF" meant. But, anyway, it would result in something in the offsite population attributed to the SNS.

On the next page, it showed, "Anticipated effects to offsite population would be 1.3 excess LCF's over 40 years." And then it addresses one anticipated accident resulting in 2.1 LCF's. Well, this I read in a summary, and the summary didn't contain the definitions for the acronyms. But then later, I got the full manual, and I discovered "LCF" means latent cancer fatalities. Well, I don't know -- You know, there's a lot of tradeoffs in life. And I imagine the community that you people live in maybe feel this is not a significant number. But I'm sure if you were one of the two LCF's, 17 it would be rather significant.

RESPONSE
Latent cancer fatality (LCF) is the parameter DOE uses in EISs to evaluate and compare the radiological consequences of its proposed actions. LCFs are estimated by applying a dose-to-risk conversion factor to an estimated radiation dose. There are many conservative assumptions, designed to make the assessment as rigorous as possible, involved in the derivation of these conversion factors and in their use in an EIS. As a result, LCF values in an EIS are intended primarily to provide a means of comparing potential radiological consequences of alternative actions evaluated in the EIS (i.e., the alternative sites for the SNS) rather than to predict future events.

Potential radiation exposures from SNS activities are low-dose, low-dose-rate exposures. Scientific studies have yet to establish whether, in fact, such exposures could result in latent cancer fatalities. The dose-to-risk conversion factors for low-dose, low-dose-rate exposures used by DOE have been derived from observations of the consequences of high-dose, high-dose-rate exposures based on conservative assumptions that make it unlikely that consequences would be underestimated. Since it is presently unknown whether there is some threshold dose for induction of latent cancers, dose-to-risk conversion factors are applied based on the assumption that any radiation exposure, no matter how small, could result in latent cancer fatality.

DOE applies dose-to-risk conversion factors to both populations and to individuals. The 1.3 LCFs over 40 years reported for the ANL alternative is equivalent to an average individual cumulative dose of 0.314 mrem (0.008 mrem/yr) to each of the approximately 8.2 million people within 50 miles of the proposed SNS site at ANL. Based on a dose-to-risk conversion factor of 0.0005 LCFs per person-rem, the average individual in the population would have 1 chance in 5,000,000 of dying of cancer as the result of exposure to SNS emissions for 40 years. Under the same conditions, the maximally exposed individual assumed to live at the ANL site boundary would have 1 chance in 5,000 of dying of cancer as the result of exposure to SNS emissions for 40 years. The methods used to estimate the magnitude of these emissions and their movement through the environment are both conservative so that the actual risks are likely to be less.

The maximally exposed individual is a hypothetical member of the public assumed to live at the boundary of the DOE-owned land for 8,760 hours per year and to produce their entire food supply at this location. For the ORNL alternative, this is the boundary of the Oak Ridge Reservation. For the LANL, ANL, and BNL alternatives, this is the boundary of the laboratory.

The off-site population consists of all individuals residing outside the ORR boundary within 50 miles (80 km) of the site and is assumed to be present for 8,760 hr/yr.

The same type of analysis can be applied to the "anticipated" accident with 2.1 LCFs at an SNS power level of 4 MW and would yield similar, but slightly higher, results. Section 5.2.9.3.3 discusses changes in assumptions for the accident scenario that could reduce its probability of occurrence and/or reduce its consequences.

LOCATION OF EIS REVISION(S): Section 5.1.9.4
....
COMMENT CODE
H-7-5

23 … I think it would be enlightening and maybe

a little more neighborly if in any future charts of this type, maybe once a page you would spell out what these acronyms mean. A lot of people, they read things -- and especially laymen like myself -- you read something, you don't understand it, you say, "Well, it can't be too bad." It just means something. Inside joke. So, you go over it.

RESPONSE
DOE agrees that the use of acronyms can be confusing. The first time an acronym is used in a chapter of this EIS, it is defined. The definitions of all acronyms used in this EIS can be found in "Acronyms and Abbreviations", beginning on page AACC-1 of the document.

....

COMMENT CODE
H-7-6

MR. ZIZEK: All right. Thank you for that. I thank you for listening to me. I would also ask, though, in the future -- I discussed with various neighbors in the area. And no one, I don't believe, has received any information on this. Maybe they refused it if they were asked if they wanted it. But I would say a very small portion of the 35, 40 houses in the area received any information on this proposed project. I think it would be far more correct if when Argonne was contemplating anything that would change drastically their operation, that the public around the facility be informed to participate in meetings such as this. If they're not informed, they can't participate.

MR. ZIZEK: What I was speaking, though, was prior to this meeting so that they would have a chance to also participate. You know, maybe they don't have the same view as I do. Maybe you would benefit from something they might say, too. But in County procedures, when a simple thing like zoning is changed, they have to by law notify everyone in the immediate area that owns property so that they know what's going on and participate. And if I'm not mistaken, I believe some air and water permits from the EPA require large facilities to keep the public informed as to what's going on in their facilities. So, that might be an idea. I would hope it would be, that it would be more an automatic thing to give the information to the local people rather than make them seek it out. …

RESPONSE

DOE announced the availability of this EIS and the time and place of the public meeting several ways. DOE mailed a pamphlet to stakeholders on a mailing list from the DOE Chicago Area Office. The pamphlet offered the recipient a copy of the entire DEIS or a copy of the summary. DOE also announced the public meeting in the cover letter transmitting the DEIS and in several local newspapers.

APPENDIX B

REPORTS ON THE SELECTION OF ALTERNATIVE SITES FOR THE SNS

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B. REPORTS ON THE SELECTION OF ALTERNATIVE SITES FOR THE SNS

This appendix includes the *National Spallation Neutron Source Project Alternate Site Selection Report*, prepared by the U.S. Department of Energy, Office of Energy Research, which explains the site selection process for the proposed Spallation Neutron Source (SNS) project. It identifies the four national laboratory sites resulting from the analysis, that represent reasonable alternatives for detailed analysis for site selection of the SNS. Each of the four laboratories, Oak Ridge National Laboratory, Los Alamos National Laboratory, Argonne National Laboratory, and Brookhaven National Laboratory, were tasked with conducting an analysis to identify alternate sites within their complex for the location of the proposed SNS. This appendix also includes the four reports submitted by the laboratories that address their site specific selection process.

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NATIONAL SPALLATION NEUTRON SOURCE
SITE SELECTION REPORT

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NATIONAL SPALLATION NEUTRON SOURCE PROJECT
ALTERNATE SITE SELECTION REPORT
Rev. 6

U.S. Department of Energy
Office of Energy Research

July, 1997

Table of Contents

LIST OF TABLES

LIST OF ACRONYMS AND ABBREVIATIONS

ANL	Argonne National Laboratory
ANS	Advanced Neutron Source
BES	DOE Office of Basic Energy Science
BESAC	DOE Basic Energy Science Advisory Council
BNL	Brookhaven National Laboratory
CFR	U.S. Code of Federal Regulations
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
EIS	Environmental Impact Statement
ER	DOE Office of Energy Research
ES&H	Environment, Safety and Health
FEMA	Federal Emergency Management Agency
LANL	Los Alamos National Laboratory
NAS	National Academy of Science
NEPA	National Environmental Policy Act
NRHP	National Register of Historic Places
NSNS	National Spallation Neutron Source
ORNL	Oak Ridge National Laboratory
ORO	Oak Ridge Operations

1.0 INTRODUCTION

Over the past 40 years, the use of neutrons for research purposes, a technology which was invented by the US at Oak Ridge National Laboratory (ORNL), has played an invaluable role in advancements in the fields of fundamental science, technology, and medicine. Neutrons provide critical investigative techniques to obtain information that is impossible to acquire by any other means. However, in the last 20 years, the U.S. has fallen behind the European scientific community in the availability of state-of-the-art neutron sources and instrumentation because of aging U.S. facilities, and because the European community has continually upgraded and added new neutron science facilities. Since the 1970's, numerous assessments have firmly established the need for new neutron sources and instrumentation in the U.S (NAS, 1984b).

Existing U.S. reactor-based neutron sources were built in the U.S. over 25 years ago. The existing spallation sources were built in the early 1980's and are based on aging accelerator facilities (DOE, 1993). These facilities have had minimal upgrading and modernization, and are not well suited to the specific areas of research to which scientific investigation has evolved. The need for a new neutron source has been recognized by every national panel investigating the status of neutron sources and science in the U.S. since the NAS study in 1977 (DOE, 1993; NAS, 1977). After reviewing the situation regarding all major domestic facilities for materials research, an NAS' panel (1984a) recommended:

1. Construction of a new high-flux, reactor-based neutron source, and;

2. Development of a plan leading to the construction of a major accelerator-based spallation neutron source.

These recommendations were reaffirmed in 1993 by the U.S. Department of Energy's (DOE) Basic Energy Science Advisory Committee (BESAC) Panel on "Neutron Sources for America's Future" (DOE, 1993). Although a reactor-based Advanced Neutron Source (ANS) Project was proposed in fiscal years 1994 and 1995, the project was not pursued in the fiscal year 1996 budget process, primarily due to the high cost (about $3 billion) of the total project. However, the need for a viable new neutron source continues, and the emphasis has shifted to a lower cost option of the proposed accelerator-based National Spallation Neutron Source (NSNS) program. According to the March 10, 1996 BESAC advisory committee recommendations (Lineberger, 1996), "there is an urgent need to build a short pulsed spallation source in the 1 MW power range dedicated to neutron scattering with sufficient design flexibility such that it can be operated at a significantly higher power in a later stage."

Design and construction of the proposed NSNS Project is a major component of the DOE Office of Energy Research's (ER) efforts to meet these goals. Such a facility would allow for advanced research in the U.S. by producing a high flux of neutrons for experiments in the physical and biological sciences for industrial application and medical research. It would provide the U.S. with a facility that meets many of the long-term needs for neutron research by the scientific community over a wide-range of disciplines, and it would be available to government, educational, and industrial users.

In the 1996 "Energy and Water Development Appropriations Bill", Congress committed funding for DOE to pursue research, design and conceptual design activities for a spallation neutron source. The preferred alternative site for this spallation source was identified as Oak Ridge National Laboratory (ORNL), "... to maximize the use of the expertise already developed through preparation of the advanced neutron source design and to take advantage of the laboratory's experience in operating particle accelerators and conducting neutron scattering research...". (Congressional Record, 1995).

2.0 THE PROPOSED NSNS PROJECT ALTERNATE SITE SELECTION PROCESS

In 1995, DOE decided to move forward with a conceptual design for the proposed NSNS Project. Accordingly, DOE ER made the determination to prepare an EIS which led to a programmatic site selection process to logically identify suitable alternatives to the DOE's "preferred alternative" (ORNL) for the proposed NSNS Project. This process consisted of a tiered, or multi-phased approach, including:

1) Identification of the basic technical/logistical requirements or needs for meeting the NSNS Project mission goals;

2) Decision to limit potential NSNS Project sites to existing DOE facilities; and

3) Preliminary exclusionary screening of DOE alternate sites based on "fatal flaws".

2.1 Technical/Logistical Requirements

The initial task in the site-selection process involved the definition of specific project requirements. This information was used to develop the various levels of technical/logistic site exclusionary criteria.

For the NSNS Project, the following basic technical and logistical requirements are necessary to meet the mission goal of supporting neutron science research, and providing neutrons for materials research:

1) A minimum 110-acre site that has a rectilinear footprint to accommodate the length of the proposed linear accelerator and possible future expansion of the facility.

2) a one-mile buffer zone around the proposed NSNS Project facility site
   - to restrict uncontrolled public occupancy
   - to insulate the public from the consequences of a postulated accident at the facility.

3) availability of/proximity to source of adequate electric power
   - regional power grid able to supply 40 megawatts of power during periods of operation
   - within one-quarter to one mile of existing transmission lines to minimize collateral construction impacts and costs.

4) presence of existing neutron science programs to provide
   - a pool of existing neutron science expertise and experience to meet the mission goals
   - major, in-place facilities and programs utilizing neutron scattering techniques.

2.2 Use of Existing DOE Facilities

In assessing potential candidate sites in the U.S., the opportunities fall into three categories:

1) existing DDE sites;

2) DOE acquisition and development of other federal property, or a new, privately-owned site; or,

3) joint use of a non-federal site (i.e., an academic facility)

The DOE is the third largest land-owner within the federal government, behind the Department of Defense (DOD) and the Department of the Interior (DOI), and is responsible for the management and/or control of 2,367,818 acres nation-wide. Although not limiting from a geographical standpoint, this approach provides an estimated 2.37 million total acres and many facilities nation-wide from which to select candidate sites (Nettle, 1996; DOE, 1996). This would include DOE Operations Offices, Site Offices, Power Administrations, and Special Purpose Offices that are not really suited to development of the proposed project, as explained later in this report. Several DOE facilities appear to meet all of the basic requirements necessary to meet the NSNS mission goal so the search within the DOE was limited primarily to facilities like national laboratories, which would likely have sufficient land holdings to accommodate the proposed project.

Other existing federal sites would include non-DOE sites such as DOD facilities (closed U.S. Air Force bases, for example), or lands managed by other federal agencies such as the DOI. The DOE could also acquire a new site that is presently privately-owned through purchase, trade or possible condemnation. Acquisition of these types of properties would require lengthy, costly, and more detailed site selection, environmental compliance, and jurisdictional transfer processes. In addition, while some of these types of candidate sites might offer some of the physical and power requirements needed to meet the NSNS Project mission goals, none of these types of sites can offer the neutron science and infrastructure support requirements. Finally, as the general public continues to express its concerns on limiting the growth of the federal government, it is unlikely that the public would support the acquisition or transfer of new lands from private or public use to simply duplicate facilities, resources, support structures, and uses available at existing DOE facilities.

A final candidate site category includes co-location of the NSNS facility at a non-federal location, such as an academic center or private research facility. This category was dropped from further consideration because, again, few if any of the non-DOE facilities can offer all of the required neutron science and infrastructure support requirements. Also, to establish a facility of the magnitude of the proposed NSNS Project would, in essence, create another national laboratory-type facility. It would not maximize the use of existing federal and/or DOE resources, would not be cost efficient, and could duplicate existing DOE missions. This would be in direct conflict with current DOE initiatives, as defined in several recently released studies and reports (DOE, 1994; DOE,1995a; DOE, 1995).

It is therefore appropriate not only to limit the designated alternate site search to federal properties, but also to further limit the proposed site search to specific types of DOE facilities (i.e. national laboratories), only.

2.3 Exclusionary Screening of Alternate Sites

After the minimum technical and logistic requirements were identified and reviewed to determine the basic aspects of the project that are all required to meet the mission goals without incurring unacceptable costs, these factors were used to define "fatal flaw," ("go-no go") or preliminary exclusionary criteria. The four requirements carried forward as exclusionary or "fatal flaw" criteria included:

1) enough space for a 11D-acre, rectilinear site footprint

2) a 1-mile buffer

3) power availability/proximity

4) existing neutron science capability

Of the major DOE facilities that are DOE-owned or -operated facilities, most were immediately eliminated from serious consideration due to the nature of the site or uniqueness of the programs carried out at the site. For example, DOE Operations Offices were excluded from the list of considered facilities because they are typically located in office buildings, in or near downtown population areas, and lack sufficient land to meet project objectives. The DOE Power

Administration Offices and most Special Project Offices are so specialized that they do not have the necessary program experience or the necessary infrastructure to support an NSNS Project-type of effort. Examples would include DOE facilities such as the Petroleum Reserves in California and Louisiana, and the Oilshale Reserves in Colorado and Wyoming.

Based on these preliminary DOE facility screening criteria, 39 DOE facilities were carried forward as the "universe" of potentially available sites. These sites are shown in Table 2.1, "NSNS Alternate Site Analysis Matrix."

After reviewing each DOE facility against the four "fatal flaw" exclusionary criteria, four national laboratory sites were carried forward to the next level of analysis. As stated above, a "no" response in any of the four criteria categories resulted in the elimination of the site from further consideration. As indicated in Table 2.1, the potential sites resulting from this analysis that represent the array of reasonable alternatives for detailed analysis in the EIS are:

- Argonne National Laboratory (East) (ANL); Argonne, Illinois
- Brookhaven National Laboratory (BNL); Upton, New York
- Los Alamos National Laboratory (LANL); Los Alamos, New Mexico
- Oak Ridge National Laboratory (ORNL); Oak Ridge, Tennessee

This information was then factored into the development of the alternatives to be considered in the EIS, including:

1) The Proposed Action: siting/construction/development of the proposed NSNS Project at a DOE facility

   a) The DOE's Preferred Alternative: siting/construction/development of the

   b) Other Potentially Acceptable Siting Alternative(s): ANL; BNL; LANL

2) The No Action Alternative: no new NSNS Project; maintain the "status quo"

3) Other Alternatives To Be Considered:
   - technological alternatives (reactors/accelerator technology)

3.0 CONCLUSIONS AND RECOMMENDATIONS

Through a series of meetings, culminating in a meeting on June 22, 1996, DOE ER, BES, and Oak Ridge Operations (ORO) developed a programmatic alternate site and site location identification and selection process to logically select a suitable site. This analysis yielded identification of the preferred site (ORNL) and alternate sites (ANL, LANL, and BNL) for further evaluation. Subsequently, on March 13, 1997, BNL requested to be withdrawn as a potential alternative for the NSNS project due to a number of environmental issues the Laboratory is facing on Long Island. However, it was determined that BNL had to be evaluated because it met the programmatic screening criteria.

It is recommended that these alternatives be carried forward for use in developing the NSNS Project EIS Implementation Plan and Notice of Intent, and ultimately, in the preparation of the NSNS Project EIS.

Table 2.1
National Spallation Neutron Source
Alternate Site Analysis Matrix

Selection Criteria / Department of Energy Facilities	Ames Laboratory; Ames, IA	Argonne National Laboratory (East); Argonne, IL	Argonne National Laboratory (West); Idaho Falls, ID	Battelle Columbus Laboratories; Columbus, OH	Bettis Atomic Power Laboratory; West Mifflin, PA	Brookhaven National Laboratory; Upton, NY	Continuous Electron Beam Accelerator Facility; Newport News, VA	Energy Technology Engineering Center; Canoga Park, CA	Environmental Measurements Lab; New York, NY	Fernald Environmental Management Facility, Fernald, OH	Fermi National Accelerator Laboratory; Batavia, IL	Hanford Site; Hanford, WA	Idaho National Engineering Laborоratory; Idaho Falls, ID	Inhalation Toxicology Research Institute; Kirtland AFB, NM	Kansas City Plant; Kansas City, MO	Lawrence Berkley National Laboratory, Berley, CA	Lawrence Livermore National Laboratory; Livermore, CA	Los Alamos National Laboratory, Los Alamos, NM	Morgantown Energy Technology Center; Morgantown, WV	Mound Plant; Miamisburg, OH	National Renewable Energy Laboratory; Golden, CO
Selection Criteria No. 1: 110-acre Rectilinear Site Footprint	Y	Y	N	N	(?)	Y	N	(?)	N	Y	Y	Y	Y	N	N	Y	Y	Y	N	N	N
Selection Criteria No. 2: 1-mile Buffer	N	Y	Y	N	(?)	Y	N	(?)	N	Y	Y	Y	Y	N	N	Y	Y	Y	N	N	N
Selection Criteria No. 3: 40 MW Power Availability/Accessability	Y	Y	Y	Y	(?)	Y	Y	(?)	N	Y	Y	Y	Y	Y	Y	Y	(?)	Y	N	N	(?)
Selection Criteria No 4: Existing Neutron Science Capability	N	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N

DRAFT NSNS Project Alternate Site Selection Report 7/9/97

Table 2.1
National Spallation Neutron Source
Alternate Site Analysis Matrix

Selection Criteria / Department of Energy Facilities	Nevada Test Site; Mercury, NV	K-25 Plant/Site, Oak Ridge, TN	Oak Ridge national Laboratory; Oak Ridge, TN	Y-12 Plant; Oak Ridge,TN	Pacific Northwest National Laboratory; Richland, WA	Paducah Gaseous Diffusion Plant; Paducah, KY	Pantex Plant; Amarillo, TX	Pinellas Plant; St. Petersburg, FL	Pittsburgh Energy Technology Center; Pitsburgh, PA	Portsmouth Gaseous Diffusion Plant, Piketo, OH	Princeton Plasma Physics Laboratory; Princeton, NJ	Rocky Flats Environmental Technology Site; Golden, CO	Sandia National Laboratory/California; Livermore, CA	Sandia National Laboratory/New Mexico, Albuquerque, NM	Savannah River Site; Aiken, SC	Stanford Linear Accelerator Center; Stanford, CA	Waste Isolation Pilot Plant; Carlsbad, NM	West Valley Demonstration Site; West Valley, NY
Selection Criteria No. 1: 110-acre Rectilinear Site Footprint	Y	N	Y	N	(?)	Y(?	Y	N	(?)	Y	N	N	N	Y	Y	N	Y	(?)
Selection Criteria No. 2: 1-mile Buffer	Y	Y	Y	Y	(?)	(?)	Y	N	(?)	Y	N	N	N	Y	Y	N	Y	(?)
Selection Criteria No. 3: 40 Mw Power Availability/Accessability	(?)	Y	Y	Y	Y	Y	(?)	Y	(?)	Y	Y	Y	Y	Y(?	Y	Y	(?)	(?)
Selection Criteria No 4: Existing Neutron Science Capability	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

DRAFT NSNS Project Alternate Site Selection Report

7/9/97

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OAK RIDGE NATIONAL LABORATORY
SITE SELECTION REPORT

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SPALLATION NEUTRON SOURCE
OAK RIDGE NATIONAL LABORATORY
SITE SELECTION REPORT

Prepared for the
United States Department of Energy/
Oak Ridge Operations Office

October 1998

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1.0 INTRODUCTION

In 1996, Congress provided funding for the Department of Energy (DOE) to pursue the development of a short-pulsed spallation neutron source. DOE identified the Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, as the preferred site for the Spallation Neutron Source (SNS) facility (*1996 Energy and Water Development Appropriations Bill*). The three alternative locations considered for the facility were Los Alamos National Laboratory (LANL), Argonne National Laboratory (ANL), and Brookhaven National Laboratory (BNL).

The conventional facilities design team for the SNS project was tasked to identify candidate sites for the SNS on the Oak Ridge Reservation (ORR) and designate one of these sites as the preferred location through a comparative evaluation of the candidate sites. The conventional facilities design team developed a list of siting criteria that represented the physical and sociological requirements for the facility and included functional, environmental, programmatic, health and safety, and safeguards and security criteria.

The process for selecting a site for the SNS facility on the ORR has evolved over a two-year period. The purpose of this report is to provide information used in the evaluation of potential sites and to outline the decision-making process for siting the SNS on the ORR. The site identified as the preferred site on the ORR for the SNS will be compared with potential sites at LANL, ANL, and BNL in an Environmental Impact Statement (EIS).

2.0 ORR SITE SCREENING

With the establishment of definitive criteria, the SNS project contracted with the Site and Facilities Planning (SFP) Group of Lockheed Martin Energy Systems to perform a comprehensive screening of all areas on the ORR that should be considered for placement of the SNS. The SFP Group was the organization responsible for development planning on the entire reservation. As such, SFP developed and maintained technical site information, primarily electronic maps, addressing all of the five categories of criteria developed for the SNS by the project team. The three required criteria, functional, environmental, and health and safety were mapped electronically by SFP to screen the entire ORR and rule out those areas that clearly did not meet the project requirements. These were defined as areas that should not be carried forward for evaluation of specific site characteristics. These areas were essentially “fatal flaw” areas that would preclude development of the project as currently defined because of conservation, waste management, or other land use/environmental issues.

An Intergraph MGE Geographic Information System (GIS) overlay map was created using the most current information and a report entitled, *“Candidate Site Identification for the National Spallation Neutron Source Facility,”* was prepared by SFP and issued in August 1996. Table 1 lists the data sets used for the GIS analysis, along with the information sources that were used for the most current data that was mapped. Figure 1 is the map that was included in this report; the white areas are those that could be considered as candidate areas. Because of the general nature of overall ORR mapping information, minimal data sets were input. For example, the GIS recognizes contingent areas but cannot evaluate configurations such as the hammerhead shape of the SNS. Although steep slopes may not be desirable over large areas, a confined area of steep slope within the facility footprint could be tolerated if properly configured. Therefore, these areas were not excluded from consideration at this point.

Table 1. SNS Candidate Site Identification Data Sets

Data Set	Information Source
Conservation Issues	
Natural/aquatic/reference areas, sinkholes, and a 200-foot buffer	Pat Parr, Environmental Sciences Division, ORNL
BSR2 areas and a 200-foot buffer	The Nature Conservancy, Primary Conservation Sites map (5/24/95)
Wetlands and a 200-foot buffer	Pat Parr, Environmental Sciences Division, ORNL
Environmental sciences research sites	Pat Parr, Environmental Sciences Division, ORNL
Waste Management Issues	
Waste area groupings	Nonradioactive Storage Area (NRSA)
Source control operable units (Environmental Restoration projects)	NRSA
Waste management areas	ORR Technical Site Information (MMES 1994)
Other Issues	
Historic/cultural/archaeological resources and a 200-foot buffer	Peter Souza, Office of Environmental Compliance and Documentation, ORNL
Existing structures and a 1640-foot buffer	Tennessee Valley Authority (TVA), Oak Ridge Area S-16A quadrangle map, 1994 ORR SDP/TSI updated information
Surface hydrology and a 50-foot buffer	TVA, Oak Ridge Area S-16A quadrangle map
500-year floodplains	Richard Durfee, Geographic Information Science and Technology Group, ORNL
Primary roadways and a 100-foot buffer	TVA Oak Ridge Area S-16A quadrangle map

Source: LMES 1996.

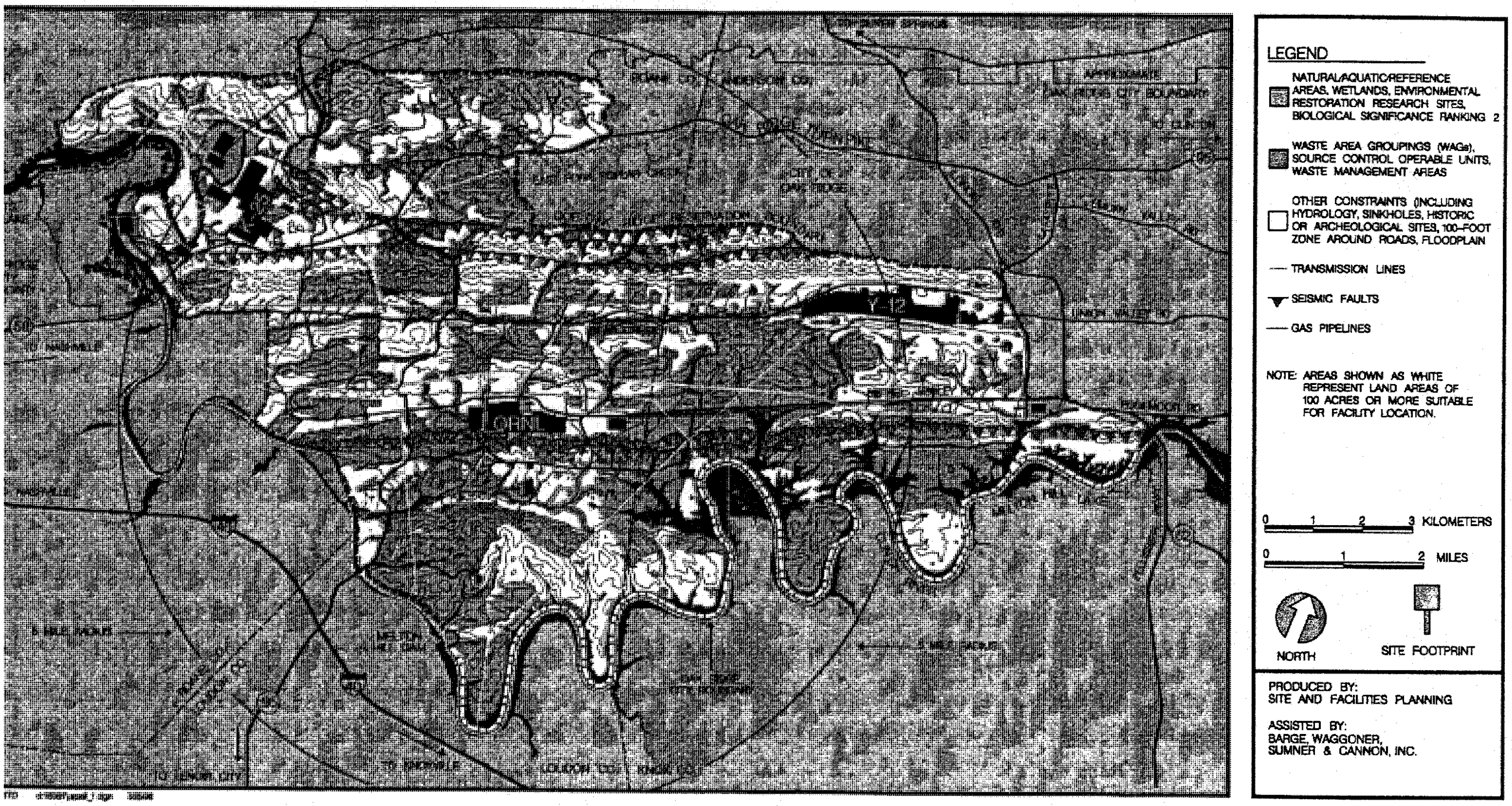


Figure 1. Spallation Neutron Source Candidate Site Map (LMES 1996).

Two other maps were included in the GIS report, one indicating Environmental Restoration watershed projects and the other indicating the current National Environmental Research Park boundaries and the proposed expansion of those boundaries to encompass virtually the entire ORR, except for the existing three plant sites. These maps were included in the GIS report as informational data only and are shown in Figures 2 and 3.

An augmented analysis was then made of the screened areas identified in the report. Using the SNS footprint criteria, general size, shape, and terrain, the ORNL site selection team identified four candidate site areas that exhibited the most favorable characteristics. A fifth area, the previously developed Clinch River Breeder Reactor (CRBR) site, was added by the SNS project even though the mapped data were not available for the GIS analysis. This site had previously been favored and studied in detail, but the property was not owned by the DOE. Figure 4 identifies the five sites selected for further evaluation.

These candidate sites include: Alternative 1 - the area south of the High Flux Isotope Reactor (HFIR); Alternative 2 - the area east of the Health Physics Research Reactor (HPRR); Alternative 3 - Freels Bend; Alternative 4 - the Chestnut Ridge site; and the CRBR site to be revisited.

3.0 CANDIDATE SITE EVALUATION

Using the original SNS general requirements, the selection team grouped the various criteria into five topical groups. These five topical groups were derived from the original requirements to be more site specific than the general criteria and provided more detailed and consistent criteria for the second phase of the evaluation. The SNS footprint was superimposed on each candidate site area and each was evaluated using the following criteria:

- **Constructibility.** The suitability of a given site to meet specified conditions for construction of the facility without exorbitant cost or effect on the environment. Here, steep slopes within the construction boundary were evaluated accordingly to the positive and/or negative impacts they may have on construction. The bulk of the original criteria fall in this group, therefore, these criteria are the most important. The key considerations under this category are:

    - site gradient and how the site contour conforms to the SNS footprint
    - utility access
    - primary and secondary road access
    - soils suitability and seismicity
    - overlapping and adjacent environmental areas such as nature areas or biological significance rated (BSR) areas
    - presence and proximity to contaminated sites
    - land use/ownership
    - security notification zones
    - distance to aquifers

Figure 2. Spallation Neutron Source Candidate Site Map with Environmental Watershed Projects (LMES 1996).

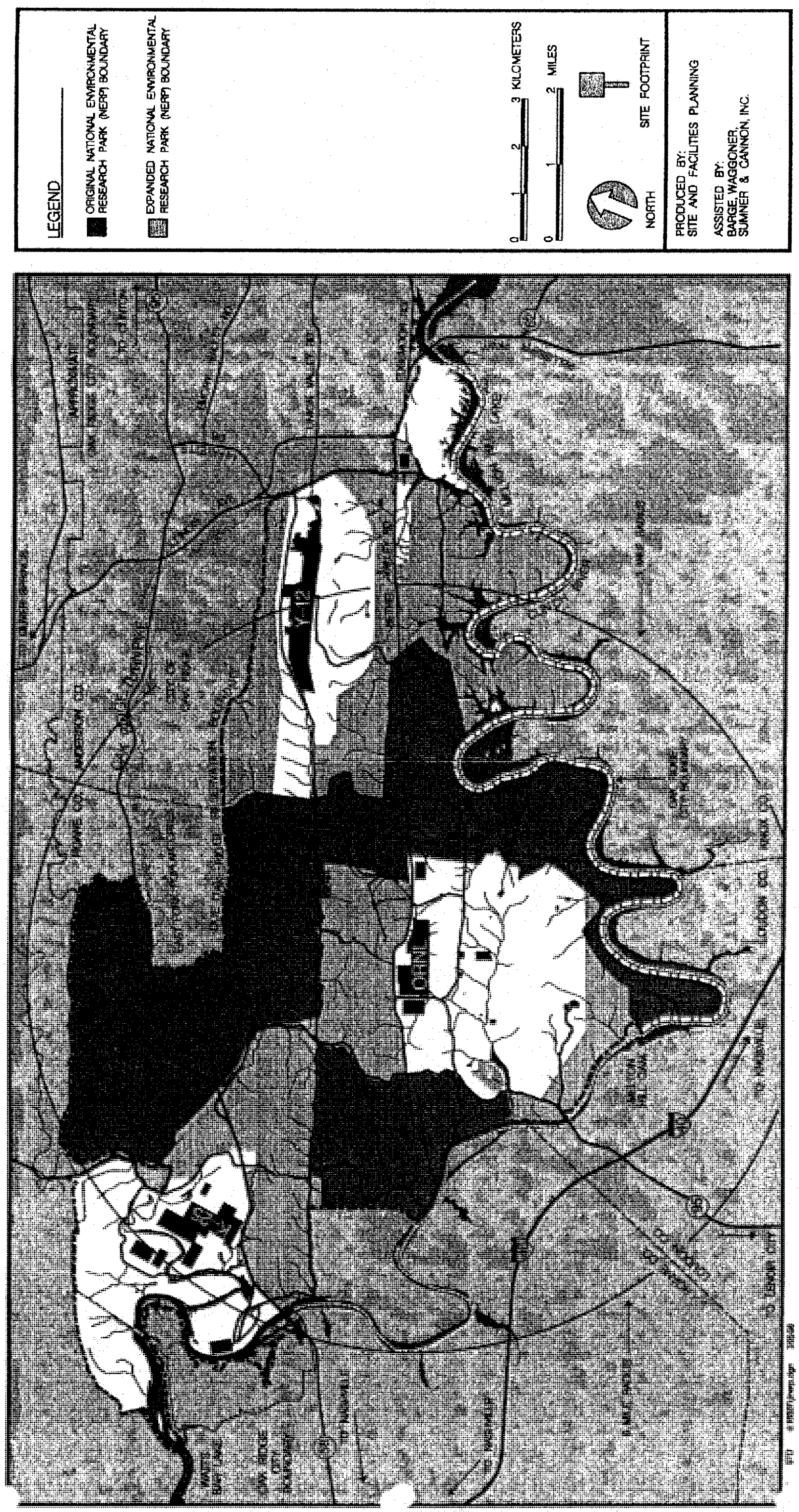


Figure 3. National Environmental Research Park (LMES 1996).

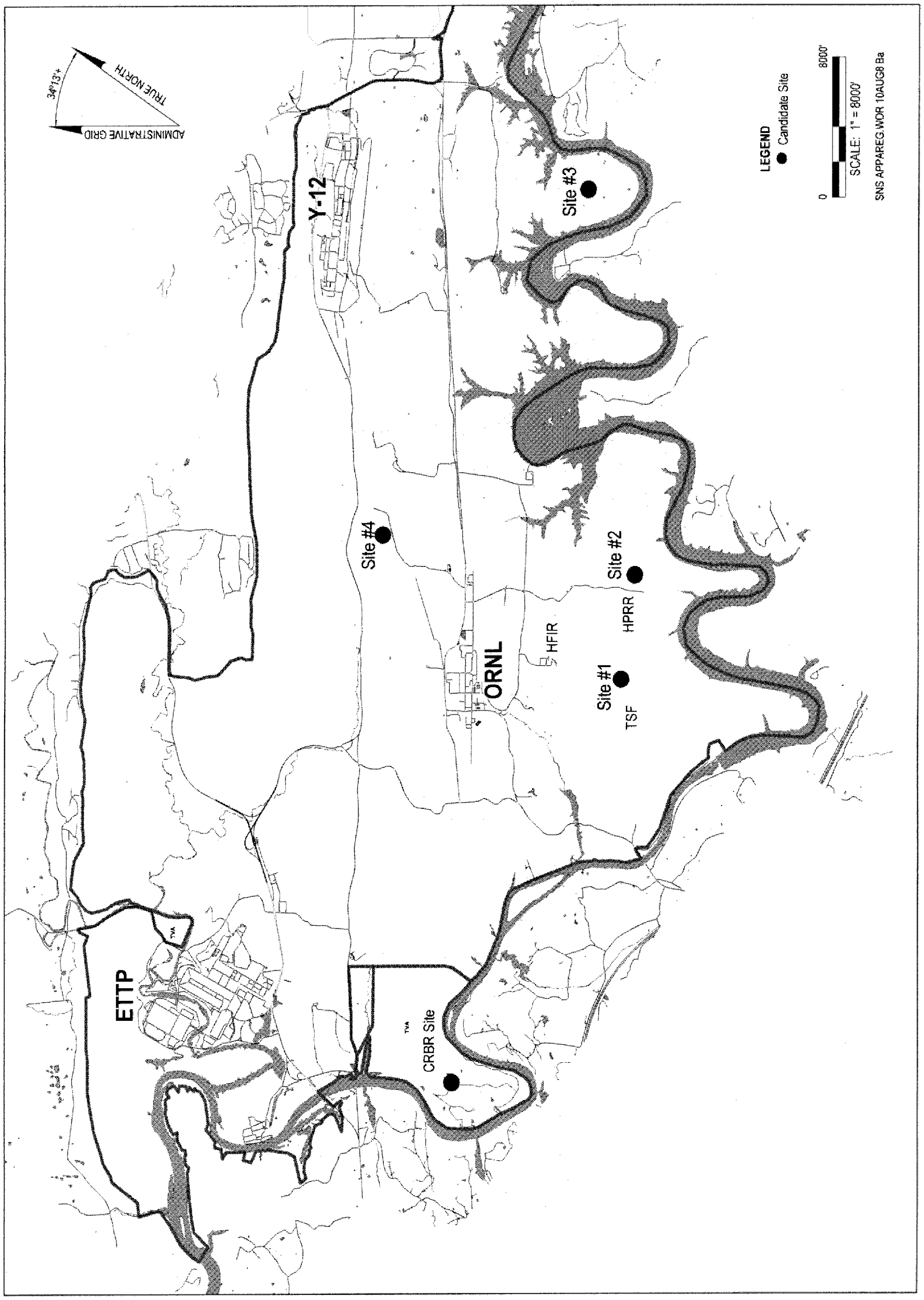


Figure 4. Location of Candidate ORNL Area Sites.

- **Flood Potential.** The likelihood of the site being affected by flooding, given that these areas are not within the 500-year flood plain, but could be adversely affected by localized flooding.

- **Proximity of Occupied Buildings/Areas.** An original criterion required a 500-meter buffer from occupied buildings. The relative closeness to permanent residential areas in comparison to the other candidate sites was considered.

- **Proximity to Historic Resources.** The relative closeness of historic resources considered limited and nonrenewable because of their association with historic events, persons, or social or historic movements. The impact that site grading may have on these sites beyond the actual SNS footprint was compared among sites.

- **Distance from ORNL/HFIR.** The GIS map indicated an approximate 5-minute-travel-distance circle as a preferable criterion. The relative proximity of each site was evaluated against the other sites.

These criteria were used for the comparative evaluation of the potential sites. Where candidate areas offered more than one potential site, only the prime site was carried forward. Desirable criteria, as well as required criteria, were considered. Table 2 presents the summary evaluation of the five potential candidate sites according to the aforementioned site-specific siting criteria. Summary descriptions of the five sites are presented below:

Area South of HFIR (Alternative 1). This site meets three of the five specific criteria groups. The site is not in danger of flooding, it is extremely close to ORNL/HFIR, and it is not in close proximity to occupied areas. However, two of the main criteria, constructibility and proximity to historic sites, were not met. The site has slopes of greater than 25 percent in areas that would not conform to the SNS footprint requirements. Much of the area is classified as fragile land, land defined in the technical site information document as best reserved for natural areas and not suitable for construction. Only electric utilities are nearby and road access is poor at best. Several areas within close proximity to this site have historical value, and the site is completely within a Biodiversity Significance Ranking (BSR) 2 area, the significance area ranked highest on the ORR by the Nature Conservancy (no BSR1 areas are present on the ORR). Use of the Alternative 1 site would involve additional expense to extend adequate utilities, improve road access, conduct assessments of historic areas, and perform grading to provide an adequately sized pad and overall site for the SNS facility.

Area East of HPRR (Alternative 2). This site also meets three of the five specific criteria groups. The site is not in danger of flooding, it is extremely close to ORNL/HFIR, and it is not in close proximity to occupied areas. The remaining two are not met, however, because this site also has slopes of greater than 25 percent in areas that would not conform to the SNS footprint requirements. Much of the area is classified as fragile land. Only electric utilities are nearby, and road access is poor. Several areas within close proximity to this site are classified as historical sites. This site, which is similar in characteristics to Alternative 1, would require additional expense to extend adequate utilities, improve road access, conduct assessments of historic areas, and perform grading to provide an adequately sized pad and overall site for the SNS facility.

Freels Bend Site (Alternative 3). This site does not meet any of the five key, site-specific criteria used in this phase of the evaluation. It has poor constructibility because there are no major utilities close by and road access is poor. It lies outside the 5-minute arc on the GIS map and could potentially be blocked

Table 2. Evaluation of Siting Criteria at Five Candidate ORNL Area Sites.

GENERAL CRITERIA	SPECIFIC CRITERIA	SITE CHARACTERISTICS				
		ALTERNATIVE 1	**ALTERNATIVE 2**	**ALTERNATIVE 3**	**ALTERNATIVE 4**	**CRBR SITE**
Functional Criteria	**Constructibility**	Slopes >25%	Slopes >25%	Slopes >25%	Slopes <25%	Slopes <25%
	Constructibility	Knox Group/Knox Residuum soil	Knox Group/Knox Residuum soil	Knox Group/Knox Residuum soil	Knox Group/Knox Residuum soil	Knox Group/Knox Residuum soil
	Constructibility	Pleistocene alluvium	Pleistocene alluvium	Pleistocene alluvium	Holocene/recent alluvial	
	Constructibility	Fragile land classification	Fragile land classification	No classification	No classification	No classification
	Constructibility	Limited utilities (electric only)	Limited utilities (electric only)	Limited utilities (gas and electric only)	Close proximity/access to utilities (gas, electric, water)	Close proximity to utilities (gas, electric, water)
	Distance from ORNL/HFIR	Close proximity to ORNL/HFIR	Close proximity to ORNL/HFIR	Not within close proximity to ORNL/HFIR	Close proximity to ORNL/HFIR	Not within close proximity to ORNL/HFIR
	Constructibility	Poor proximity to primary and/or secondary paved roads	Poor proximity to primary and/or secondary paved roads	Poor proximity to primary and/or secondary paved roads	Good proximity to primary and/or secondary paved roads	Good proximity to primary and/or secondary paved roads
Environmental Criteria	**Constructibility**	Completely within BSR2 Area	Within BSR3 Area	Close proximity to BSR3-7 and BSR3-13 areas	Within BSR3-16 area; Close proximity to BSR2-10	Within BSR2 area
	Constructibility	Close proximity to a contaminated site	Close proximity to a contaminated site	Close proximity to a contaminated site	Not in close proximity to a contaminated site	Relatively close proximity to a contaminated site
	Historic Site Proximity	Close proximity to historic sites	Close proximity to historic sites	Within and in close proximity to historic sites	Not in close proximity to historic sites	Not in close proximity to historic sites
	Constructibility	Knox Aquifer at surface	Knox Aquifer at surface	Knox Aquifer at surface	Knox Aquifer at surface	Knox Aquifer at surface
Safeguards & Security Criteria	**Constructibility**	Within security administration zone (controlled area)	Within security administration zone (controlled area)	Within security administration zone (Y-12 229 area)	Within security administration zone (restricted area)	Within security administration zone (restricted area)

Table 2. Evaluation of Siting Criteria at Five Candidate ORNL Area Sites (continued).

GENERAL CRITERIA	SPECIFIC CRITERIA	SITE CHARACTERISTICS				
		ALTERNATIVE 1	**ALTERNATIVE 2**	**ALTERNATIVE 3**	**ALTERNATIVE 4**	**CRBR SITE**
Safeguards & Security Criteria (continued)	**Constructibility**	Within immediate notification zone	Within immediate notification zone	Not within immediate notification zone	Within immediate notification zone	Within immediate notification zone
	Constructibility	Within 5-mile emergency planning sector	Within 5-mile emergency planning sector	Within 5-mile emergency planning sector	Within 5-mile emergency planning sector	Within 5-mile emergency planning sector
	Constructibility	Within 2-mile public immediate notification zone	Within 2-mile public immediate notification zone	Outside 2-mile public immediate notification zone	Within 2-mile public immediate notification zone	Within 2-mile public immediate notification zone
Programmatic Criteria	**Constructibility**	Existing land use is natural area	Existing land use is natural area	Existing land use is natural area	Existing land use is multipurpose research and development area	Existing land use is industrial
	Constructibility	Site owned by DOE	Site owned by DOE	Site owned by DOE; Recent land request from City - parcel identified as self-sufficiency parcel	Site owned by DOE	Site owned by TVA
Health & Safety Criteria	**Constructibility**	No geological faults within area	No geological faults within area	No geological faults within area	No geological faults within area	No geological faults within area
	Flood Potential	No flood danger	No flood danger	Probable maximum flood area	No flood danger	No flood danger
	Residential Proximity	Not in close proximity to residential area	Not in close proximity to residential area	Close proximity to residential area	Not in close proximity to residential area	Close proximity to residential area

off in a probable maximum flood event. Freels Bend is just across the river from a lakefront residential district and has many historic sites indicated by mapping data.

Chestnut Ridge Site (Alternative 4). This site meets or exceeds all of the five topical criteria groups. The constructibility of the site is good because the site offers all required utilities close by. The lay of the land, although containing slopes greater than 25 percent, meets SNS footprint criteria with reasonable grading. Chestnut Ridge Road currently crosses the site and ties to Bethel Valley as well as Bear Creek Roads. The site is not in danger of floods, is not close to any occupied structures or residential areas, is close to ORNL and HFIR, and encroaches on no historic sites. In addition, the existing land use characterization of this site is multipurpose research and development.

Clinch River Breeder Reactor (CRBR) Site. This site meets three of the five key evaluation criteria. The constructibility of the site is favorable because of the low slopes. It has close access to gas, water, and electricity. Road access via existing roads is good. No flood danger is associated with the site. No historic sites are located in the way of construction. However, the proposed site is not in close proximity to HFIR and lies across the river from a residential area, which is closer than such areas are to three of the other sites. Most importantly, although this site was considered as an alternative with favorable conditions for siting the SNS, DOE does not own it. Acquisition of the property from TVA would increase the time for development of the SNS by an unknown amount.

The results of the comparative evaluation of candidate sites against the siting criteria, and more specifically the five key criteria, show that the Chestnut Ridge site (Alternative 4) offers the best overall potential of the five alternative sites reviewed by the SNS site selection team. Maps with site-specific criteria used during these evaluations are included in Exhibit 1.

4.0 RECOMMENDATION OF THE PREFERRED SITE

The SNS Project Group presented a preliminary summary of the candidate site evaluation process and its results to the Reservation Management Organization (RMO) for the ORR in late 1996. During this presentation, the Chestnut Ridge site (Alternative 4) was first identified as the preferred site for the SNS. All SNS design layouts and estimates for land improvements were to be based on this site.

A more thorough presentation of the candidate site evaluation process was delivered at an RMO meeting on April 3, 1997. During this presentation, the SNS Project Group formally designated the Chestnut Ridge site as its preferred location for the SNS at ORNL. This preference was based on the results of the candidate site evaluation process. Furthermore, the SNS Project Group requested that the RMO formally recommend this site to the Federal Property Management Committee as the preferred site for construction of the SNS.

The RMO reviewed the content of this presentation and issued review comments on June 25, 1997. These comments focused primarily on environmental concerns associated with siting the SNS on the Chestnut Ridge site and at Alternatives 1, 2, and 3. The concerns with the Chestnut Ridge site included karst topography and hydrologic transport related to this topography. They also included potential impacts of the SNS on White Oak Creek and research efforts in the nearby Walker Branch Watershed (WBW). The WBW research is being conducted by the National Oceanic and Atmospheric Administration/Atmospheric Turbulence and Diffusion Division (NOAA/ATDD) and the Environmental Sciences Division (ESD) at ORNL. In addition, the comments included a recommendation to consider use of the CRBR site for the SNS. The complete comments are presented in Exhibit 2.

A key SNS Project Group representative met with the RMO on August 7, 1997, to address the environmental and alternative siting issues raised in the review comments. Two major issues regarding the Chestnut Ridge site were addressed, (1) karst topography, and (2) potential adverse impacts on environmental science research in the WBW area. In close consultation with the RMO members, resolutions to these issues were mutually agreed to by the SNS Project Group and the RMO. The karst topography proved not to be an issue since large structures have been successfully built on karst topography, such as most of Knoxville proper, including the University of Tennessee. Experts in this area are currently on board and will continue to be involved in the SNS siting process to ensure that karst topography does not impact the initial construction of the SNS nor create any environmental concerns (i.e., hydrologic transport) after construction of the facility. The SNS Project Group responded to the issue concerning the WBW by acknowledging it was aware of the potential effect construction of the SNS could have on the WBW. Every possible action will be taken to minimize effects on this area. Based on these resolutions, the RMO formally recommended the Chestnut Ridge site as the preferred location for the SNS on August 15, 1997. In making this recommendation, the RMO cited four reasons why it considered the Chestnut Ridge site to be the “best site” for the SNS:

- Cost-effectiveness, based on several factors (near existing roads, utilities, and construction borrow areas; best situation for waste transport and use of ORNL shops, security, and facilities; and most advantageous topographical configuration for site excavation and construction of berm shielding).

- Least potential impact on the environment and public, because the site avoids wetlands, blue line streams, historical sites, threatened and/or endangered species, and other environmental impacts as well or better than the alternative sites. It is the most remote of the evaluated sites from public access areas.

- Best location for supporting ORNL neutron science programs.

- Located in close proximity to the preferred site for the Joint Institute for Neutron Sciences (JINS). This proposed facility would support neutron science programs at ORNL, HFIR, and the SNS.

The resolutions of the issues raised in the review comments on the site evaluation process are documented by the memorandum in Exhibit 3. The formal recommendation of the Chestnut Ridge site as the preferred site for the SNS at ORNL is also contained in this memorandum.

5.0 REFERENCES

LMES (Lockheed Martin Energy Systems, Inc.), 1996, *Candidate Site Identification for the National Spallation Neutron Source Facility*, ES/EN/SFP-47, August, prepared for the Department of Energy, Oak Ridge Operations, Oak Ridge, Tennessee.

MMES (Martin Marietta Energy Systems, Inc.), 1994, *Oak Ridge Reservation Technical Site Information*, ES/EN/SFP-23, August, prepared for the Department of Energy, Oak Ridge Operations, Oak Ridge, Tennessee.

EXHIBIT 1

SPALLATION NEUTRON SOURCE SITE EVALUATION CRITERIA AND CANDIDATE SITES

SPALLATION NEUTRON SOURCE SITE EVALUATION CRITERIA

Functional Criteria - These criteria relate to the physical parameters of the site, including the transportation and utility systems required for construction and operation.

- Site area requirement: 500 meters × 500 meters (1640 feet × 1640 feet) with a 100 meter × 500 meter (328 × 1640 feet) tail centered on the main square (hammer-head-shaped), all at the same elevation after excavation and preferably founded on solid rock. However, karst formations are not to be eliminated.

- Must have a stable foundation (capable of supporting 15,000 lbs/ft^2) that permits beam alignment along the entire beam line path.

- Must have an adjacent area, which can be at different elevations, measuring 100,000 square meters (24.7 acres) for support facilities, roads, buffer, etc.

- Reasonable proximity to a borrow area capable of supplying sufficient fill material for earthen shielding and a spoils area for storage or disposal of excess excavation material.

- Close proximity to ORNL (within 5 road minutes of ORNL proper)/HFIR.

- Avoid contaminated soils.

- Avoid relocating significant overhead and underground utilities (e.g., power lines, water line mains, and gas transmission lines).

- Minimize surface water runoff to or through the site.

- Proximity/access to existing utility systems:
  - 30 MW power required
  - Potable water required
  - Compressed air, natural gas, sanitary sewer, steam, and chilled water desirable but can be provided by on-site facilities
  - Availability of construction power within one mile strongly desirable

- Proximity to primary and/or secondary paved roads for users, researchers, materials, supplies; target transport; and waste and irradiated material removal.

Environmental Criteria - These criteria are used to minimize the effect of a site's development on the environment.

- Avoid disturbance of wetlands and streams.

- Avoid locations with a high significance ranking of threatened or endangered animal or plant species, specifically BSR 1 and 2 areas. (The Nature Conservancy BSRs are from a high of 1 for outstanding significance to a low of 5 for general biodiversity interest. BSR 1 and 2 areas are more critical and have a higher priority than BSR 3, 4, and 5 areas.)

- Avoid historic, cultural, or archaeological resources.

- Minimize impacts on natural reference and natural research areas in the National Environmental Research Park.

Safeguards and Security Criteria - These criteria relate to the ability of the site to provide physical safeguarding and security of the facility.

- Site maximizes use of existing physical security systems.

- Site maximizes use of existing programmatic security systems.

Programmatic Criteria - These criteria are used to ensure that the site considers appropriate site development and land use plans.

- Site maximizes use of existing land use areas.

- Site conforms to site development plans.

Health and Safety Criteria - These criteria provide a basis for candidate site selection in terms of protecting the public, facility personnel, and the facility from hazards during both construction and operation of the facility.

- Site construction and operation should minimize adverse impacts on traffic flow and traffic hazards adjacent to the site.

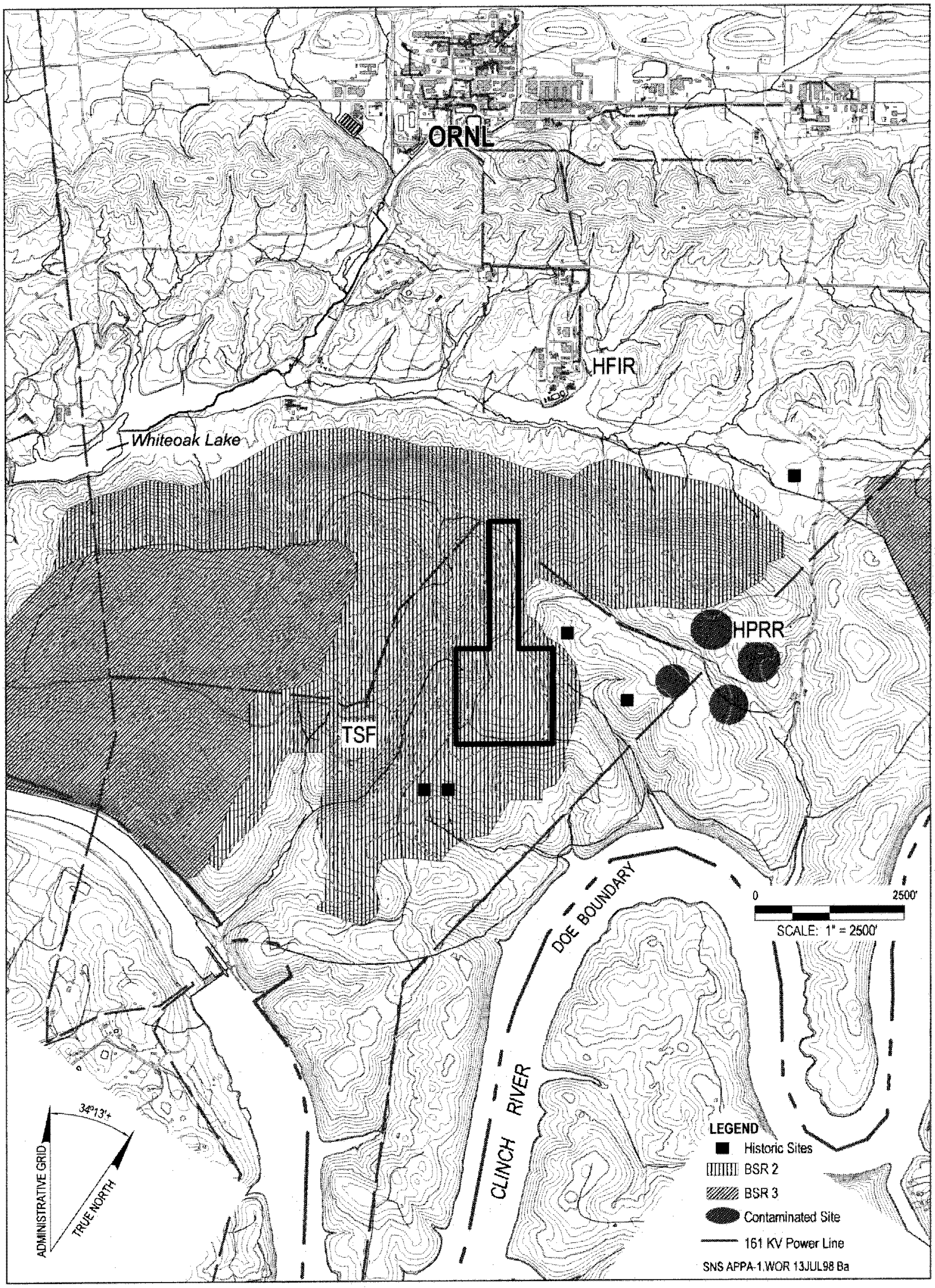
- Site should minimize adverse impacts on existing streams and groundwater.

- Site must not be located within the 500-year floodplain elevation.

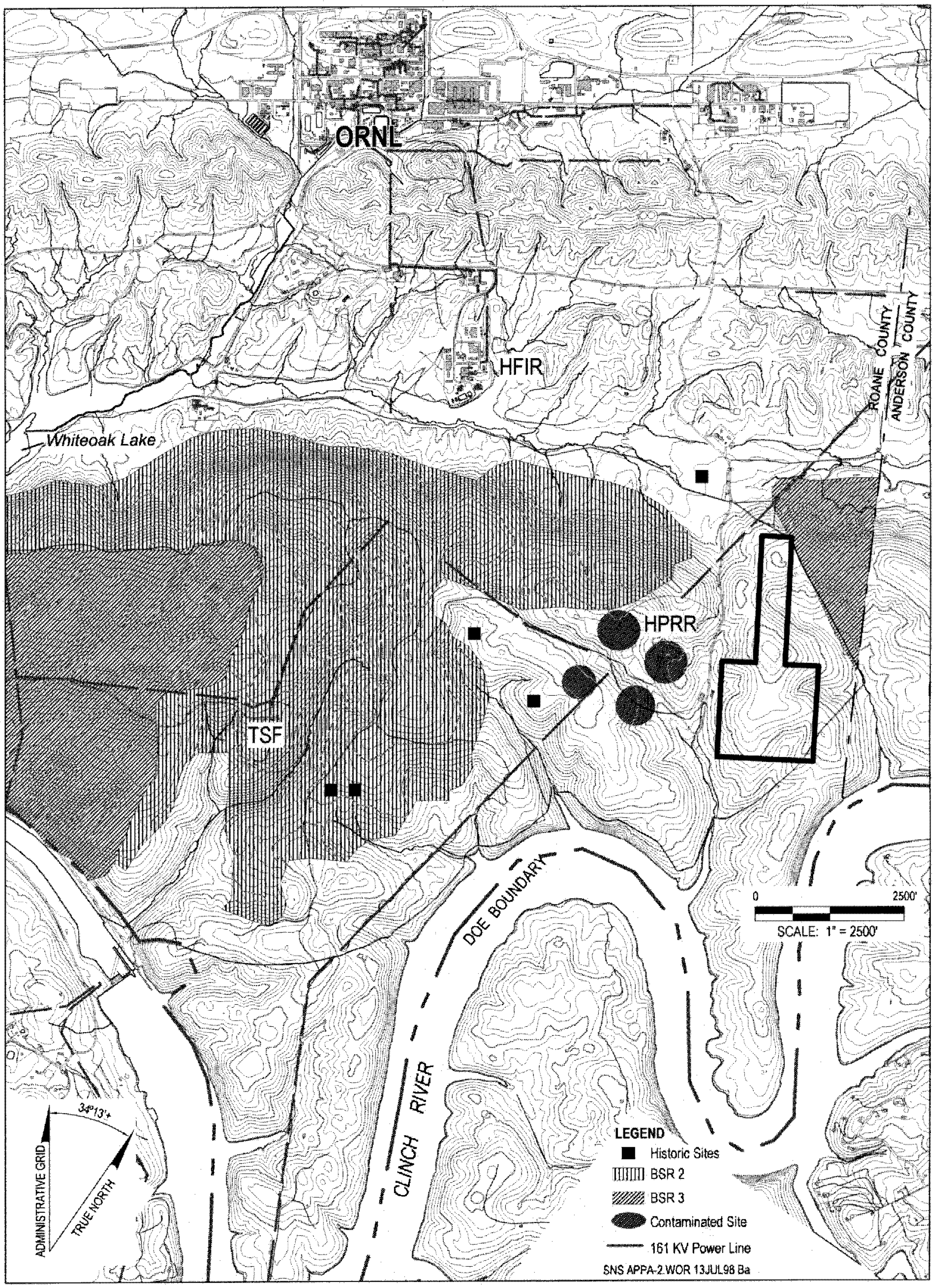
- Site avoids existing hazardous materials areas and waste areas [i.e., Waste Area Groups (WAGs) and Resource Conservation and Recovery Act (RCRA)].

- Site must not be on a geologic fault (seismic).

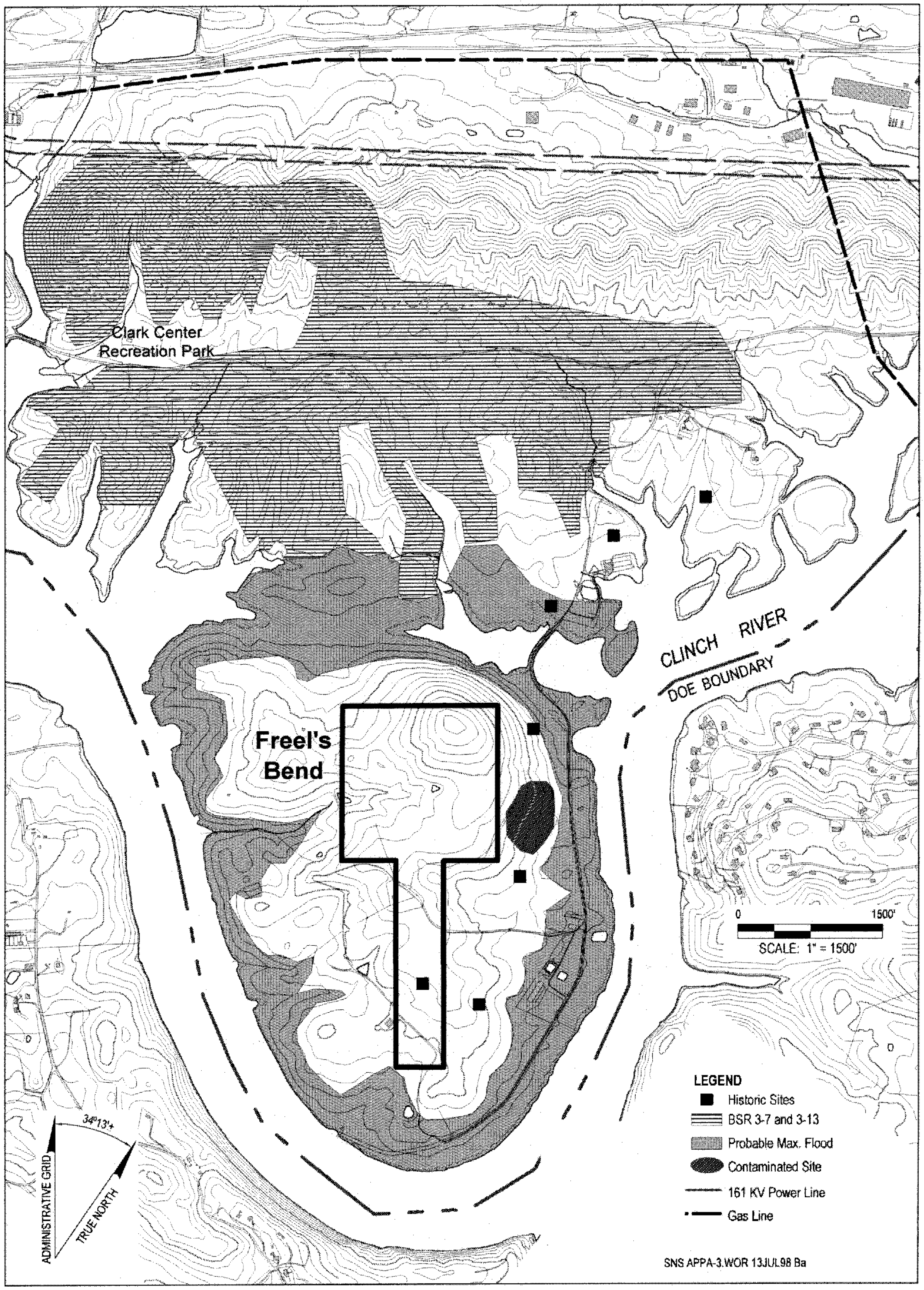
- Site provides a minimum 500-meter (1640 feet) separation from existing occupied structures (1000 meters desirable). Avoid close proximity to residential areas.



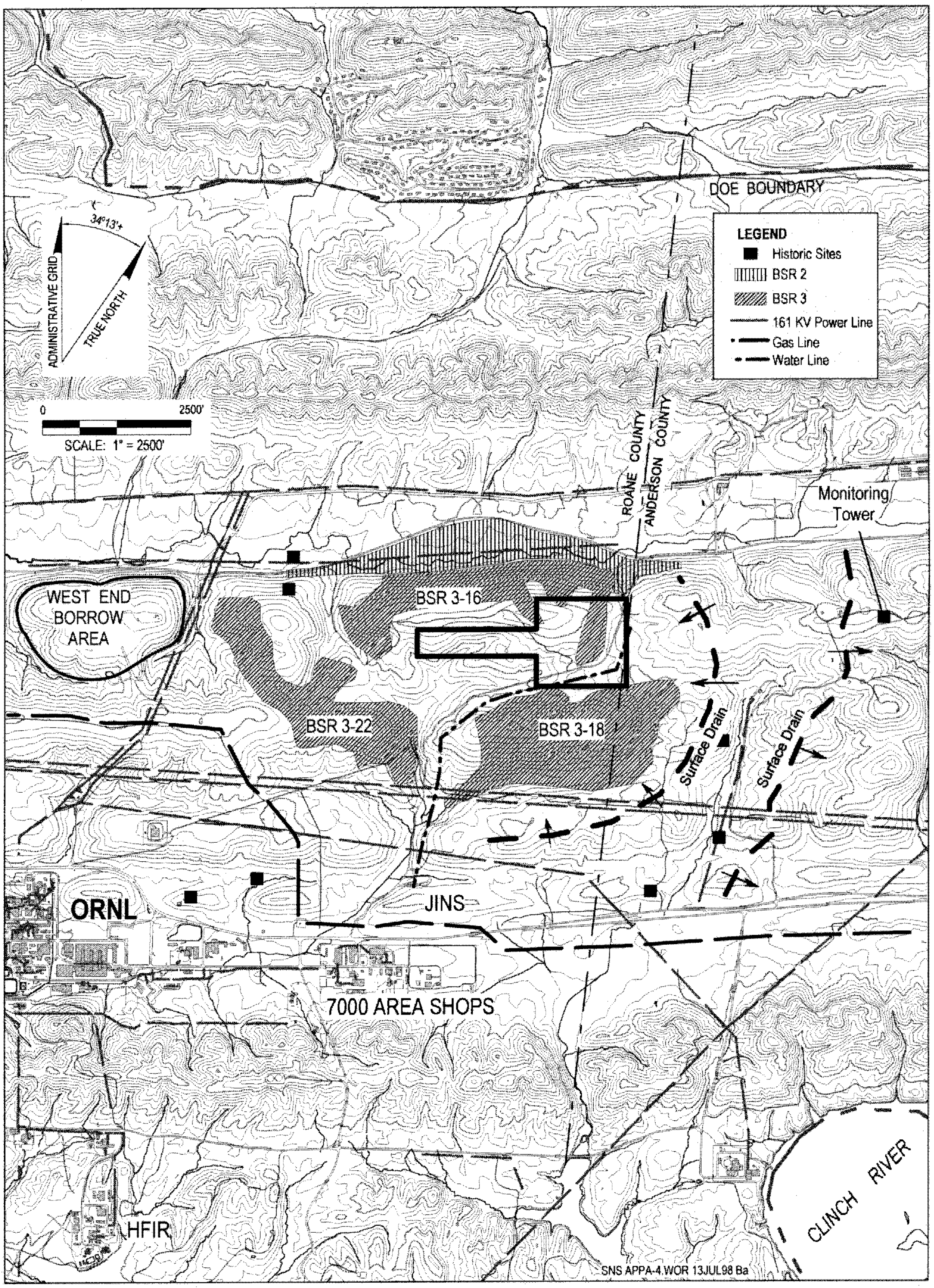
Area South of HFIR (Alternative 1)



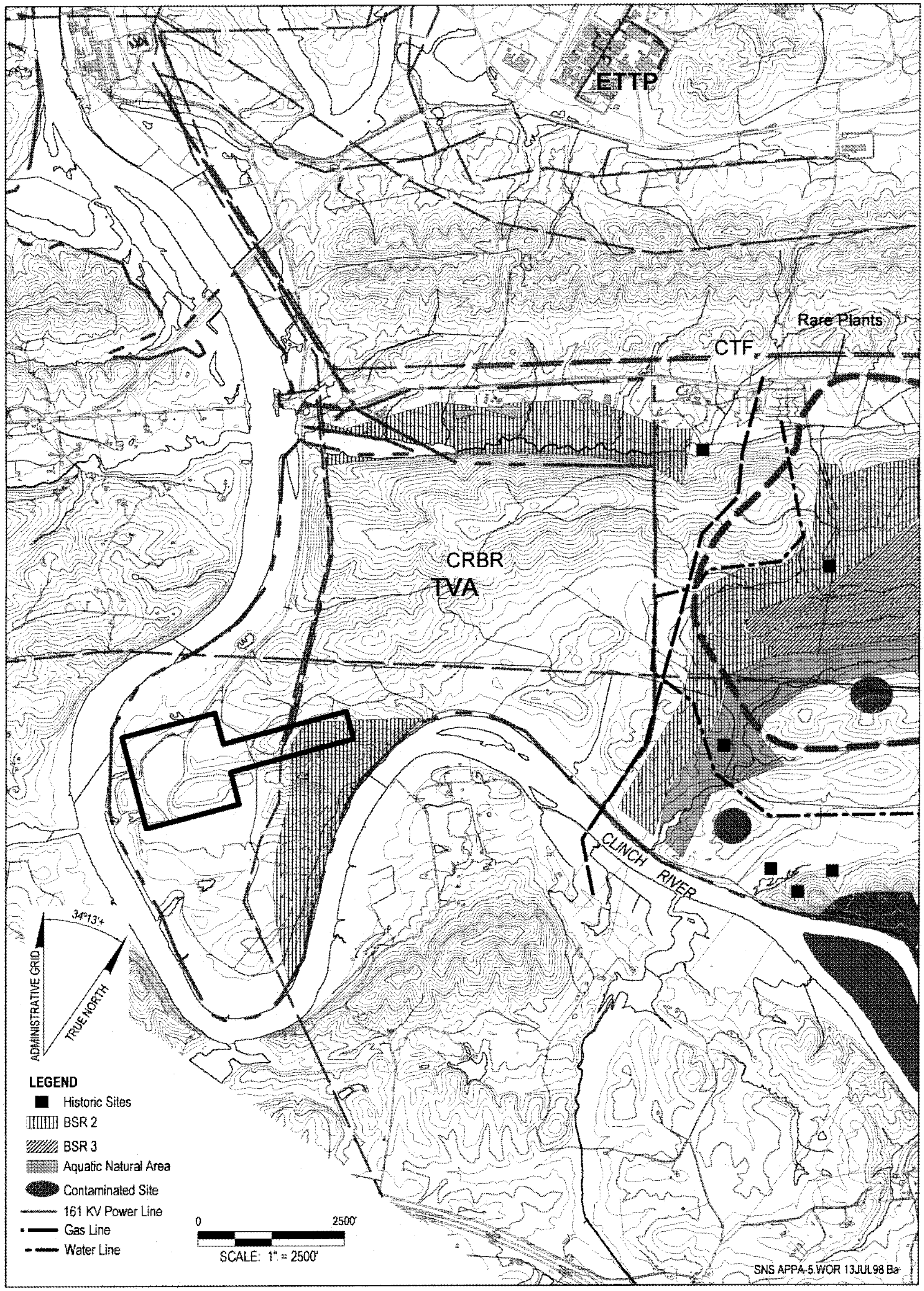
Area East of HPRR (Alternative 2)



Freels Bend Site (Alternative 3)



Chestnut Ridge Site (Alternative 4)



Clinch River Breeder Reactor (CRBR) Site

EXHIBIT 2

RESERVATION MANAGEMENT ORGANIZATION REVIEW COMMENTS ON THE SNS FACILITY SITING STUDY

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LOCKHEED MARTIN

Memorandum

Date: June 25, 1997

To: Fred R. Mynatt

c: H. M. Braunstein, J. B. Bussell (ETMC), T. R. Butz, R. Cox (ORAU), J. E. Cleaves, L. T. Cusick, S. G. Garland, R. P. Hosker, Jr. (NOAA/ATDD), D. T. Kendall, F. C. Kornegay, J. M. Loar, A. R. Medley, J. R. Newman, J. B. Overly, K. K. Baksa, P. D. Parr, J. D. Peebles, R.C. Peters, J. G. Rogers, W. K. Simon, D. S. Shriner, W. W. Thompson, Jr.

From: W. W. Teer, Jr., 1009COM, MS-8320 (6-0102)

Subject: **Reservation Management Organization (RMO) Review of Siting Study - National Spallation Neutron Source Facility**

On April 3, 1997, Mr. John E. Cleaves, Project Manager, National Spallation Neutron Source (NSNS) Facility presented the subject siting study (attached as Exhibit "1") to the RMO for review and comment. The RMO's review of the siting study has been completed and its' comments and recommendations concerning the four proposed sites (one preferred and three alternates) are summarized below:

GENERAL COMMENTS

1. The RMO recognizes the importance of the NSNS project to the Oak Ridge area and supports it.

2. Significant geologic concerns have been raised questioning the karst topography and related hydrologic transport on the preferred Chestnut Ridge Site. Flow paths from releases at this site have been traced to springs along Scarboro Creek and to the west of the site. The RMO strongly recommends a similar confirmation of flowpaths.

3. A detailed and time consuming preliminary analysis was done by the National Oceanic and Atmospheric Administration (NOAA) to evaluate potential impacts of the NSNS siting on their research site adjacent to Walker Branch Watershed resulted in prolonged response time for this RMO review.

This preliminary analysis indicates that NOAA measurements will be impacted by the siting of NSNS adjacent to their monitoring facility. The level and significance of this impact, however, has not yet been determined. NOAA has made a request for additional information and time to complete more detailed modeling analyses.

The RMO recommends that NSNS project personnel work directly with NOAA researchers to minimize/mitigate any potential impacts to their research and monitoring programs if the preferred Chestnut Ridge site is selected.

Fred R. Mynatt
June 25, 1997
Page 2

4. The RMO recommends that the CRBR site be considered. This site has many advantages over the proposed alternatives: it has been studied in detail (has an Environmental Impact Statement); it would avoid impacts to the resources on the ORR; it would provide ample space for all facilities; it would afford expansion, if desired; it is close enough to ORNL; and it apparently meets many of the NSNS site selection criteria.

CHESTNUT RIDGE (PREFERRED SITE)

Geologic and Hydrologic Concerns

Karst development and conduit-related flowpaths are most developed along the Knox outcrop belt. These are sensitive areas from a hydrology perspective since any releases are rapidly transported through the system and there is little potential for remediation after-the-fact. In this case, both the primary and secondary sites are directly atop the Knox dolomite. This unit is known to have well developed karst and this is documented in karst inventory work recently completed. Further, if one considers the potential for collapse (such as is evidenced in the Mona Lane case in Oak Ridge), structural stability is questionable and the highest occurrences of collapse occurs in the Knox. Thus if there is any need for structural integrity, NOT documented in the siting needs list, these sites are possibly poorly situated. The most favorable locations would lie in outcrop belts of the Conasauga group or Rome formation, such as Pine Ridge, Haw Ridge, Melton Valley. It would also seem that in the case of Melton Valley, there is a wealth of information and monitoring network which would allow for release detection, etc. Given that one of the criteria was the potential for anchoring into sound bedrock, the question arises as to how these sites emerged at all.

Based upon ORNL karst inventory work, there are a number of sinkholes which form a linear trend that persists all along the ridge line. There are a number of documented sinkholes that exist along the south slope of the primary site location. This suggests a well developed conduit network (to have accommodated removal of the soil/overburden mass from these sinkholes).

Further, though the candidate site is located atop a relatively flat hilltop in the Knox with incised drainages on two sides, this also suggests potential for radial releases of any contaminants should this occur. Flow in bedrock is typically strike-parallel which would either be to some of the springs that exist along westerly bounding drainage (which flows north towards Y-12) or the southerly bounding drainage (which flows towards Bethel Valley), if not beyond these. Based upon dye tracer work at the Y-12 Security Pits site located directly along strike to the east, flow paths from releases at this site have been traced to springs along Scarboro Creek and to the west of the site.

The accompanying proposal text cites a minimal demand for containing groundwater "runoff" due to its limited 'encatchment' area. In karst settings, topographic expression in no way delineates watershed and thus catchment areas. Further, as evidenced from similar settings along Black Oak Ridge, the overburden developed above the cherty Knox group bedrock consists of silty clay and gravel zones the latter of which are laterally end vertical extensive relict chert bedding zones. These zones can be shown to 1) serve as primary, quick routes of transport of contaminants to the underlying

Fred R. Mynatt
June 25, 1997
Page 3

bedrock and 2) serve as pressure relief valves for the underlying karst network such that water from the conduits is transmitted to shallow depths along these features (sort of like fingers of higher heads extending above the average water table). This may impact shallow construction.

The criteria of encountering sound rock within reasonable depth of cut is questioned. Typically, the thickest overburden is encountered on hilltops over the Knox, such as in these two sites. Depth to rock may easily reach 60-80 ft on the ridgetop.

One resource representative has suggested that an alternate site that should possibly be considered from a hydrologic/geologic perspective (not necessarily based upon existing infrastructure elements). This alternate site would be in the relatively flat area in the 8000 area of ORNL near the Clinch River. This area is underlain by less permeable Conasauga group clastic bedrock overlain by alluvial deposits. Groundwater flow in this suggested alternate site is much more predictable and monitorable, there is electric power service, more structurally competent bedrock, and relatively good/easily improvable access from Highway 95.

Potential Research and Monitoring Impacts

A preliminary analysis by NOAA/Atmospheric Turbulence and Diffusion Division (ATDD) indicates that NOAA measurements will be impacted by the siting of NSNS adjacent to their monitoring facility. The level and significance of this impact, however, has not yet been determined. NOAA has made a request for additional information and time to complete more detailed modeling analyses.

A May 30, 1997 memorandum from Dr. R. P. Hosker, Director of NOAA/ATDD is included at the end of this response. See Exhibit 2.

At this point, there is no information on chemicals that would be used during operation of the facility, although researchers could possibly bring such things with them. Also there are no plans for a steam plant, but if one were needed it would probably be gas-fired.

Evaluation of impacts to on-going or potential future ORNL Environmental Sciences Division ecological research has concluded that the probability for negative impacts is minimal, however, geologic/hydrologic review of subsurface transfers is recommended to ensure that the Walker Branch Watershed 30-years hydrologic record is not compromised. A subsidiary issue which would impact the National Precipitation and Dry Deposition Monitoring Netword site on Walker Branch Watershed, at a minimum, would be the use of chemical biocides in cooling tower waters.

Environmental Regulatory Impacts

An ORNL regulatory monitoring station, which is a reference sampling station for NPDES surface water monitoring as well as radiological parameters, is located on White Oak Creek. The station is located at the headwaters, which are on the crest of Chestnut Ridge quite close to the proposed NSNS site. Data collected at the station provide background information at a "clean" site, against which other data is compared for evidence of contamination. Care would be required during construction on the ridge to protect the monitoring station and keep it "clean."

Fred R. Mynatt
June 25, 1997
Page 4

Many other small streams that drain the ORR, including Chestnut Ridge, have recently been added as surface water sampling sites. These include Grassy Creek, Ish Creek, Northwest Tributary, and Raccoon Creek. It will be important to prevent soil erosion during construction on the ridge to protect all streams and creeks from compliance violations due to excessive suspended solids (i.e., sedimentation). In addition, these streams could be in violation of compliance limits subsequent to construction as a result of runoff from landscaped areas and roads and parking lots.

The preferred site is located in the Bear Creek watershed, and covered under the Y-12 NPDES Permit. Currently, only storm water type discharges are permitted in this area. Any process type discharges would have to be negotiated with state or local regulatory authorities. Several options are possible regarding the treatment/discharge of waste waters, some options could require a modification to the NPDES Permit.

Y-12's NPDES monitoring point S-24, rad monitoring point 304, and spring SS-5, could potentially be affected by the construction and operation of this 100 acre facility.

More information would be needed to fully assess other permitting needs, including air permitting, however, this need not be a problem.

Potential Impacts to Streams and Wetlands

No federal jurisdictional wetlands were identified in the site characterization area, consisting of the proposed boring locations and drill rig access paths, in a survey of the site conducted on March 11, 1997. Based on surveys in many areas of the ORR, ridge tops are considered to be highly unlikely locations for wetlands, with the possible exception of sinkholes and depression contours.

Adverse impacts to offsite wetlands and headwater tributaries of White Oak Creek immediately southeast of the site can occur unless effective erosion control measures are implemented prior to construction to prevent runoff and siltation of these important habitats. Care must also be taken to avoid erosion due to access path clearing and boring (e.g., escape of drilling muds) during any characterization activities.

A major spring just north of the site provides significant flow to Bear Creek, which has the Tennessee dace, a species listed as in need of management by the Tennessee Wildlife Resources Commission. Effective measures must be taken to prevent siltation of this headwater spring. Likewise, any long-term impact to the ecologically fragile seep-fed wetlands in the Bear Creek Spring Area at the base of Chestnut Ridge must be avoided.

A critical concern regarding the development of Chestnut Ridge is the long-term impact to the ecologically fragile seep-fed wetlands in NA52 (Bear Creek Spring Area) at the base of Chestnut Ridge. Adverse impacts which would over time destroy or degrade this sensitive habitat include: changes to the local hydrology and drainage patterns as a result of up-slope grading, construction and paving; increased erosion and siltation/sedimentation as a result of up-slope grading and construction; and chemical run-off from landscaped areas (fertilizers and pesticides) and roads (petrol-chemicals and salts).

Fred R. Mynatt
June 25, 1997
Page 5

Potential Impacts to Ecologically Sensitive Areas

The NSNS site overlaps several environmentally sensitive areas, including a National Environmental Research Park Natural Area (NA52; Bear Creek Spring Area) and three Preliminary Conservation Sites recommended for protection by The Nature Conservancy (BSR2-10, BSR3 16, and Landscape Complex 1). Additionally, the oak-hickory forest area on the southeast facing slope of Chestnut Ridge drains toward ecologically sensitive streams and wetlands in NA55 (Chestnut Ridge Springs Area), ARA6 (Upper White Oak Creek), BSR3-22, and BSR4-3. This forest provides significant landscape connectivity between NA52 and NA55. Parts of this forest should be protected (due to drainage effects) for increased natural area viability. Potential adverse impacts to environmentally sensitive areas include (1) reduction in T&E species habitat quality; (2) introduction or spread of exotic species; and (3) forest fragmentation and reduced landscape connectivity between Natural Areas.

Potential Impacts to T&E Wildlife and Plant Species

Although no extensive surveys for T&E wildlife have been conducted in the Chestnut Ridge area, a reconnaissance was conducted recently and several state-listed birds could occur there. Also, the Chestnut Ridge area of the ORR exemplifies the unfragmented hardwood habitat that is so increasingly scarce in the region. Protection and enhancement of such habitat would help protect interior forest species, such as bats (e.g., Rafinesque's big-eared bat and the Indiana bat) and neotropical migrant songbirds (e.g., Cerulean warbler).

The following three Tennessee-listed vascular plant species and an additional species which is highly ranked by The Nature Conservancy were determined to be present in the surrounding area during previous surveys, and potential habitat for these species exists onsite:

- Pink lady-slipper (Cypripedium acaule) / TN-Endangered
- Golden seal (Hydrastis canadensis) / TN-Threatened
- Ginseng (Panax quinquefolius / TN-Threatened
- Whorled horsebalm (Collinsonia verticillata) / The Nature Conservancy global ranking-High

Potential Impacts to Borrow Area

The NSNS Site Selection dialogue indicates the need for a storage area for backfill material and for spoils material, and that the "now exhausted Chestnut Ridge borrow area" could serve in that capacity. This conflicts with recent information obtained by the Environmental Restoration organization, where surveys have shown a large amount of soil for closure activities and other borrow material needs. Since this borrow area (a.k.a. West Borrow Area) is the only active borrow area on the ORR, consideration should be given to 1) selecting another soil storage area, possibly adjacent to the NSNS Site or, 2) selecting a replacement area with suitable clay to serve the regular needs of the ORR for closure/borrow material.

Fred R. Mynatt
June 25, 1997
Page 6

Potential Impacts to Cultural Resources

A preliminary cultural resource literature review indicates that there is at least one pre-1942 homestead near the west boundary of the Chestnut Ridge site. To comply with the National Historic Preservation Act, a Section 106 survey would be required for all of the 100 acres proposed for construction. No major archeological or historical sites are anticipated in this area however.

Other Considerations

There is great potential for erosion during construction as well as during operation of the facility. Both sides of the ridge are steep and may be very difficult to stabilize after clearing trees.

Soil data is available electronically (GIS) and should be useful in evaluating the site.

The site selection included karst rock formation, but excluded sinkhole areas. All karst areas have the potential for future sinkhole formation and underground caves. Sinkhole survey information is also available.

Part of the Aerial Survey program conducted by Environmental Restoration Program included the use of remote sensing magnetometers, etc. that might help identify more details associated with near surface caves, etc. (e.g., something less than solid rock). Richard Durfee's GIS group may have that data.

All environmental issues would be examined during the required NEPA review.

There do not appear to be any security consideration for this or any of the other potential sites. During the design phase, PSO needs to be involved to patrol guidance on elements such as barriers, property protection, access control, and Protective Force and Fire response.

From a radiological control perspective, there are no substantive comments on the identification of this or any of the other potential sites at the ORR. Obviously, the design of the facility will require consideration for shielding and dose control to workers, but that will occur later if project proceeds.

SOUTH OF HFIR AND EAST OF TSF (ALTERNATIVE #1)

Potential Impacts to Cultural Resources

This area includes the Gravel Hill Cemetery and several standing structures that made up the Gravel Hill Community, once supporting a school for that portion of Roane County. Recent surveys have shown that some of these sites are individually eligible for the National Register of Historic Places (NRHP), and collectively the area is eligible as a historic district. Additional surveys and considerable mitigation would be required to develop this area.

Fred R. Mynatt
June 25, 1997
Page 7

Potential Impacts to T&E Species

The following TN state-listed species was determined to be present in the surrounding area and may be present within the site: Ginseng (Panax quinquefolius) / TN Threatened. This site encroaches on a Preliminary Conservation Site recommended for protection by The Nature Conservancy (Landscape Complex 2). Without more detailed mapping of this site, it is not possible to identify any other encroachments on Environmentally Sensitive Areas.

Other Potential Environmental Impacts

Measures must be taken to avoid impacts on the extensive Copper Ridge Cave Reference Area system.

EAST OF HPRR (ALTERNATIVE #2)

Potential Impacts to Cultural Resources

This area includes some old home sites that recent surveys have documented as not eligible for the NRHP. An additional survey and little or no mitigation is likely for developing this area.

Potential Impacts to T&E Species

The following TN state-listed species were determined to be present in the surrounding area and may be present within the site:

- Ginseng (Panax quinquefolius) / TN Threatened
- Lesser ladies-tresses (Spiranthes ovalis) / TN Special Concern
- Appalachian bugbane (Cimicifuga rubifolia) / Federal Special Concern (former C2 candidate), TN Threatened

The following TN state-listed species were determined to be present in the surrounding area and may be adversely impacted by offsite effects of development (such as changes in local hydrology and drainage patterns, and increased erosion and sedimentation):

- Spreading false-foxglove (Aureolaria patula) / Federal Special Concern (former C2 candidate), TN Threatened
- Carey saxifrage (Saxifraga careyana) / TN Special Concern.

Potential Impacts to Ecologically Sensitive Areas

The site encroaches on a Preliminary Conservation Site recommended for protection by The Nature Conservancy (Landscape Complex 2). Without more detailed mapping of this site, it is not possible to any identify other encroachments on Environmentally Sensitive Areas.

Fred R. Mynatt
June 25, 1997
Page 8

The TN state-listed sharp shined hawk and yellow bellied sapsucker have been observed in the Park City Road area adjacent to the site. Also, this site is less desirable than the others because of the additional disturbance that would occur to meet road and other infrastructure requirements.

FREELS BEND AREA (ALTERNATIVE #3)

Potential Impacts to Cultural Resources

This area includes a valuable cultural resource, the Freels Cabin, listed on the National Register of Historic Places (NRHP). In addition, the site contains several archeological areas where Native American artifacts have been recovered. A considerable amount of investigation and evaluation, including consultation with the State Historic Preservation Officer, would be required for proposed projects in this area.

Potential Impacts to T&E Species

This site is the only site that has been surveyed for T&E wildlife. State listed in-need-of-management species on this site include: southeastern shrew, Sharp-shined and Cooper's hawks, great egret, northern harrier, yellow-bellied sapsucker, and grasshopper sparrow. The federally threatened bald eagle has been observed during the winter, and the state threatened osprey nests in the area. This is an excellent wildlife site, providing a mosaic of fields, hedgerows, woodlots, and water, an increasingly rare combination in the region. Development of this site would entail additional disturbance to wildlife habitat (compared to the preferred, TSF, or CRBR sites) for road improvement and other infrastructure development.

This site also encroaches on a Cooperative Management Area for T&E species (CMA 3), Lower Freels Bend Meadows. However, it is possible that the development of the NSNS at this site would be compatible with continued management of the surrounding area for T&E species.

Other Considerations

The mid-part of Freels Bend supports the Ecological and Physical Sciences Study Center, an important educational field resource for school children and teachers.

Hay grown on Freel's Bend is sampled and analyzed for radionuclides in compliance with the regulatory requirements in DOE Order 5400.1 to be incorporated into 10 CFR 834. The results are reported in the publicly available ORR Annual Site Environmental Report.

If you have any questions, please do not hesitate to contact me.

WWT:JRN:PDP:bsb

Attachments

EXHIBIT 3

RESERVATION MANAGEMENT ORGANIZATION RECOMMENDATION FOR SITING THE SNS FACILITY

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LOCKHEED MARTIN

Memorandum

Date: August 15, 1997

To: Richard K. Genung, Fred R. Mynatt

c: B. R. Appleton, K. K. Baksa, H. M. Braunstein. D. G. Lund (ETMC), T. R. Butz, J. E. Cleaves, R. Cox (ORISE), L. T. Cusick, S. G. Garland, R. P. Hosker, Jr. (NOAA/ATDD), D. T. Kendall, F. C. Kornegay. J. M. Loar, A. R. Medley, J. R. Newman, J. B. Overly, P. D. Parr, J. D. Peebles, R. C. Peters, J. G. Rogers, D. S. Shriner, W. K. Simon, W. W. Thompson, Jr., D. K. Wilfert

From: W. W. Teer, 1009COM, MS-8230 (576-0102)

Subject: **Reservation Management Organization Recommendation for Siting the National Spallation Neutron Source (NSNS) Facility**

Recommendation

The Reservation Management Organization (RMO) recommends the Chestnut Ridge Site on the southern slope of Chestnut Ridge immediately west of the Roane/Anderson County line and Chestnut Ridge Road as the preferred site for the National Spallation Neutron Source (NSNS). Issues of concern raised in the June review by the RMO (W. W. Teer, Jr. to F. R. Mynatt, June 25, 1997) have been adequately addressed. This site is shown as the "Primary Site" on the accompanying map. RMO approval of this does not preclude the need for National Environmental Policy Act (NEPA) documentation, Area Manager approvals, or other reviews as required.

Background

The NSNS project has developed requirements and criteria and has performed a selection process that identified Chestnut Ridge as the primary site. Several alternative sites have been identified. The RMO was informed of the NSNS project in November 1995, and the selection process was formally submitted to them on April 3, 1997.

Richard K. Genung, Fred R. Mynatt
Page 2
August 15, 1997

RMO representatives identified issues and provided comments and suggestions regarding the NSNS site selection. They were summarized in a memorandum from W. W. Teer, Jr. to F. R. Mynatt, dated June 25, 1997.

The Chestnut Ridge site is the best site for NSNS because:

a) It is the most cost effective site. It is near roads, utilities, and construction-borrow areas; it has the best situation for transport of waste and use of ORNL shops, security, and other facilities; and it has the most advantageous topological configuration for site excavation and construction of berm shielding.

b) It has the least potential impact on the environment and the public. The site avoids wetlands, blue line streams, historical sites, threatened and/or endangered species, and other environmental impacts as well or better than the alternative sites. It is also the most remote from public access areas.

c) It has the best location for supporting ORNL neutron sciences programs.

d) It will be located close to the site preferred for JINS, which will support neutron science programs at ORNL, High Flux Isotope Reactor (HFIR), and NSNS.

Issues and Resolutions

The major issues regarding the Chestnut Ridge site are that its karst topography could adversely impact construction, and the NSNS construction could adversely impact environmental science research at the Walker Branch Watershed (WBW) area located east of the site and the White Oak Creek headwaters south of the site.

Cognizant personnel from ORNL and the National Oceanic and Atmospheric Administrations (NOAA) were contacted to evaluate and resolve these issues. The issues addressed, and their corresponding resolutions, are described below.

<u>Construction on Karst Topology</u>

Present information about foundation stability requirements, preliminary foundation design work, shock test data from ORNL, and preliminary core borings indicate that construction on Chestnut Ridge will not be a problem if approached correctly. Further, construction on Karst topography is not uncommon in the Knoxville area and/or on the Oak Ridge Reservation.

Richard K. Genung, Fred R. Mynatt
Page 3
August 15, 1997

Further study of ORNL geological data from magnetometer measurements and much more core boring in FY 98 will be used to confirm the situation.

The NSNS project team will employ an integrated approach and/or plan that is generated with appropriate stakeholders and subject matter experts. A workshop with appropriate stakeholders and experts will define the issues and identify the technology available to measure, monitor, design, etc. Information from the workshop and existing ORNL data will be used to plan for core boring (including considering how bore holes might be used for monitoring wells and other items in the future), excavation, and lead into foundation design.

NOAA Research Issues

Dust from construction could affect the long-term monitoring of wet and dry deposition of key air pollutants. This potential impact will be of short duration (less than 1 1/2 years with most activity occurring in the first 7 to 8 months), and it is presently felt that this impact can be handled with normal dust control methods, possibly some additional measurements taken during construction, and other data protection means.

Carbon dioxide and nitrogen oxides from natural gas water heaters to generate building heat could affect studies of carbon dioxide uptake. This impact is not expected to be significant, and if it is, it can be handled by changes in the NSNS design (to provide heat a different way for example).

The heat and water vapor plume from the cooling tower could affect the measurement of air-surface exchange of momentum, heat, and water vapor. Modeling of the cooling tower will be performed in FY 98 to quantify the impact and examine the virtues of different cooling tower locations and arrangements to determine how best to mitigate the impact. This modeling will lead to an acceptable design. If not, a second research tower will be built at a suitable location far enough in advance of site excavation to calibrate it with respect to the existing tower and conditions.

White Oak Creek Impact

Construction on the Chestnut Ridge site could impact aquatic habitats and monitoring activities in the headwaters of White Oak Creek.

Technology to properly protect White Oak Creek from silt and other construction hazards is available. Proper planning and monitoring of construction activities will prevent adverse impacts.

Richard K. Genung, Fred R. Mynatt
Page 4
August 15, 1997

ORNL personnel will assist the NSNS team input requirements into conventional facilities requirements documents and the RFP for the Architect Engineer/Construction Manager contract. The NSNS project team will also conduct workshop(s) with experts in construction near sensitive areas to make sure that all the technology and tricks of the trade available are applied. This and plans, monitoring, and frequent meetings with the stakeholders during land survey, core boring, excavation, and other high activity times should provide acceptable results.

Construction Impact on Deep Subsurface Hydrology

NSNS site excavation could change the deep subsurface hydrology that very often exists with a karst topology to the degree that it causes an adverse impact on the WBW subsurface hydrology. This effect would occur primarily because the water table will be lowered when excavation occurs.

Well measurements during construction could be used to "recalibrate or adjust" the existing WBW data.

Assessment of potential impacts will be determined by performing drawdown and pump tests and examing magnetometer data. Based on drawdown and pump test results, tracer tests and, if warranted, modeling of the excavation design will be performed.

Consideration of Alternate Sites

The RMO suggested consideration of the Clinch River Breeder Reactor (CRBR) site (one of the alternative sites identified) and the Oak Ridge National Laboratory (ORNL) 0800 area across the Clinch River from Jones Island. The CRBR site is considered unacceptable because its location is too distant from other neutron sciences research facilities and the acceptable locations for the Joint Institute of Neutron Sciences (JINS) facility, and because it is owned by the Tennessee Valley Authority (TVA). Acquiring the site from TVA would likely cause an unacceptable cost and/or schedule impact to the NSNS project. The 0800 area is too small for NSNS construction and would cause adverse impacts to environmental sciences research in that area.

Summary

An NSNS project Design Team will have environmental components appropriately integrated (with representation, for example, from NOAA, Tennessee Wildlife Resources Agency, ORNL Environmental Sciences Division, National Environmental Research Park, etc.) This team will also pursue creative approaches for additional environmental research opportunities offered by the NSNS facility. Communication with RMO on implementation of these resolutions will be provided, and major changes in siting will be brought to the RMO for consideration.

Richard K. Genung, Fred R. Mynatt
Page 5
August 15, 1997

In conclusion, it is felt that Chestnut Ridge provides the most advantageous location for the facility, that solutions and fallback positions exist for the issues raised. Consequently, the RMO recommends that the Chestnut Ridge should be designated as the preferred site for NSNS construction.

If you have any questions or need additional information, please do not hesitate to contact m.

WWT:JRN:sgl

Attachment

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FAX (423) 241-3597
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LOS ALAMOS NATIONAL LABORATORY SITE SELECTION REPORT

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National Spallation Neutron Source
Los Alamos National Laboratory
Site Selection Report

Prepared for the
United States Department of Energy/
Oak Ridge Operations Office

Prepared by

The Planning Office of
Facilities Safeguards and Securities Six (FSS-6)
and Ecology Group (ESH-20)

Los Alamos National Laboratory
Los Alamos, New Mexico

March 28, 1997

NATIONAL SPALLATION NEUTRON SOURCE
LANL SITE SELECTION REPORT

Los Alamos National Laboratory
March 28, 1997

INTRODUCTION

This report evaluates four potential sites for construction of the National Spallation Neutron Source (NSNS) at Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. In 1995 the Department of Energy (DOE) determined that NSNS would require an Environmental Impact Statement (EIS). The DOE then developed a process to identify suitable alternatives to the DOE's "preferred alternative" at Oak Ridge National Laboratory (ORNL). The process evaluated 39 DOE sites, and LANL qualified as one of three alternative locations besides ORNL for the facility. The other two alternative locations were Argonne National Laboratory and Brookhaven National Laboratory. *(Draft National Spallation Neutron source Project, Alternate Site Selection Report; US Department of Energy, Office of Energy Research; prepared by Roy F. Weston, Inc., August 23, 1996)*

This report provides the NSNS program with a decision-making tool for selecting an alternative candidate site at Los Alamos National Laboratory for the NSNS facility. The site evaluation process uses the following steps for selecting a recommended site:

- List NSNS physical design parameters provided by the NSNS design team
- Inventory of candidate LANL sites
- Evaluation of each candidate site according to NSNS siting criteria
- Determination of the candidate site with the best attributes and least restrictions to accommodate the NSNS

Four candidate sites were identified from which the recommended site was determined to best meet the NSNS criteria: Technical Area* (TA-) 70, TA-33, TA-58 and TA-71. These areas and the project footprint are illustrated on the four maps presented at the end of this report.

NSNS SITE REQUIREMENTS

The NSNS site must accommodate several physical and environmental requirements. These requirements are categorized as functional, environmental, and programmatic and are listed below.

* LANL is divided into technical areas (TAs) that are used for building sites, experimental areas, waste disposal locations, roads, and utility rights-of-way. However, these uses account for only a small part of the total land area. Most land provides buffer areas for security and safety and is held in reserve for future uses.

Functional

- A site that accommodates a hammer-head shaped structure measuring 500 x 500 meters with a tail centered on the above square and measuring 100 x 500 meters
- A site that can be excavated to be level and founded on solid rock
- Additional space for support buildings and access roads requiring an additional 100,000 square meters
- Sufficient earth fill available on site or nearby to provide an average of 15 feet cover for shielding over the hammer-head shaped area
- Reasonable proximity to other facilities at LANL
- Reasonable access to a disposal area for rock and excess earth excavation
- Proximity to stockpile areas for earth excavation for covering and shielding the main structure
- Avoid significant overhead and underground utility relocation (e.g., power lines, water line mains and gas transmission lines, steam lines)
- Minimize runoff to, through and from the site
- Reasonable access to existing utility systems to include:
  - 40 MW electrical power
  - potable water
  - compressed air, natural gas, sanitary sewer, steam and chilled water (desirable, can be provided by on-site facilities)
  - availability of construction power within one mile
- Reasonable proximity to primary and/or secondary paved roads for users, researchers, materials, supplies; for target transport; for waste and irradiated material removal
- Buffer zone to avoid residential areas and large worker populations

Environmental

- Avoid construction in floodplain
- Avoid construction in or disturbance of wetlands
- Avoid locations with threatened or endangered plant or animal species
- Avoid Solid Waste Management Units (SWMUs) and Potential Release Sites (PRSs)
- Minimize impact on National Environmental Research Park (NERP)

Programmatic

- Conform with appropriate site development and land use plans
- Avoid existing recreation uses

INVENTORY OF CANDIDATE LANL SITES

Siting and construction of the NSNS facility is a major undertaking requiring a large site. While LANL covers 43 square miles, much of the terrain is rugged canyons separated by high mesas. Many sites are presently developed, and there are limited undeveloped sites of adequate size where the NSNS facility would have sufficient land. Of the total available sites some are too small in area or are isolated and/or geographically separated from major developed areas of the laboratory. Several sites are candidates for eventual transfer of ownership to Los Alamos County, nearby Pueblos or other entities.

There are only four sites that appear to meet the siting criteria and that are considered here for development of the NSNS facility. These sites are TA-70 (Alternative Site # 1); TA-33 (Alternative Site #2); TA-58 (Alternative Site #3) and TA-71 (Alternative Site #4). Each of these sites is evaluated according to the above siting criteria. Table 1 presents the summary evaluation of the four potential candidate sites according to the siting criteria for the NSNS facility.

Table 1. Analysis of Siting Criteria at Four Potential LANL Sites

Siting Criteria	TA-70, Alternative Site #1	TA-33, Alternative Site #2	TA-58, Alternative Site #3	TA-71, Alternative Site #4
FUNCTIONAL				
1. Physical accommodation of building footprint (500 m x 500 m with attached 100 m x 500 m addition) at same elevation and founded on sound rock	Adequate	Adequate	Too small	Adequate
2. Adequate earth backfill to provide an average of 15 feet cover for shielding	Adequate	Adequate	Adequate	Adequate
3. Close proximity to LANL support facilities and services	Remote from existing facilities/ services	Remote from existing facilities/ services	Adjacent to existing facilities/ services	Remote from existing facilities/ services
4. Reasonable access to disposal area for rock and excess earth excavation	Reasonable access	Reasonable access	Reasonable access	Reasonable access
5. Avoid relocating significant overhead/underground utilities	Avoids underground utilities but requires realignment of overhead electrical line	Avoids underground utilities but requires realignment of overhead electrical line	Relocation of multiple utilities	Avoids underground utilities but requires realignment of 2 overhead electrical lines
6. Proximity/access to existing utility systems (40 MW power, potable water, compressed air, natural gas, sanitary sewer, steam and chilled water [desirable but can be provided on-site], construction power within one mile	Remote from existing utility systems	Remote from existing utility systems	Close to existing utility systems	Remote from existing utility systems
7. Proximity to primary and/or secondary paved road access	Adequate	Adequate; possible relocation of road required	Adequate	Adequate
8. Adequate buffer zone	Adequate	Close proximity to Bandelier National Monument	Adjacent to highly populated TA	Close proximity to residential area

Table 1 (cont.). Analysis of Siting Criteria at Four Potential LANL Sites

Siting Criteria	TA-70, Alternative Site #1	TA-33, Alternative Site #2	TA-58, Alternative Site #3	TA-71, Alternative Site #4
ENVIRONMENTAL				
9. Avoid disturbance of floodplains and wetlands	No adverse floodplain or wetland impacts	No adverse floodplain or wetland impacts	No adverse floodplain impacts, possible wetland impact	No adverse floodplain or wetland impacts
10. Avoid locations with threatened or endangered plant or animal species (0.25 mile radius)	Bald eagle roosting habitat	Bald eagle roosting habitat	Northern goshawk foraging habitat; unoccupied Mexican spotted owl habitat	No impact
11. Avoid locations with threatened or endangered plant or animal species (1.0 mile radius)	Bald eagle roosting habitat	Bald eagle roosting habitat; Peregrine falcon nesting habitat	Northern goshawk foraging habitat; Spotted owl roosting habitat	Bald eagle roosting habitat
12. Avoid SWMUs and PRSs	No SWMUs or PRSs	No SWMUs or PRSs	No SWMUs or PRSs	No SWMUs or PRSs
13. Avoid locations with historic, cultural, or archaeological resources present	Not surveyed but known to have cultural resources present	56% surveyed, cultural resources present	49% surveyed, no cultural resources identified yet	24% surveyed, cultural resources present
14. Minimize impact on National Environmental Research Park (NERP)	All LANL is within NERP boundaries	All LANL is within NERP boundaries	All LANL is within NERP boundaries	All LANL is within NERP boundaries
PROGRAMMATIC				
15. Compatible with site development and land use plans	Consistent with 1990 Site Devel-opment Plan and annual updates	Consistent with 1990 Site Devel-opment Plan and annual updates	Consistent with 1990 Site Devel-opment Plan and annual updates	Consistent with 1990 Site Devel-opment Plan and annual updates
16. Avoid existing recreation uses	Existing trails	Visible to hikers in Bandelier	Existing trails	Existing trails

EVALUATION OF CANDIDATE SITES

TA-58 (Alternative Site #3), has appropriate gross acreage, but its narrow shape and topography do not permit a sufficiently level site for construction of the facility on one level. There is also insufficient area for an adequate buffer around the site. TA-3, the most developed and populated of LANL's technical areas, is within 100 meters of the boundary of the potential site. Also, a major, multiple-utility corridor traversing the site would require relocation. Therefore, this candidate site has been eliminated from consideration.

Three remaining sites are of sufficient size to accommodate the NSNS facility: TA-33, TA-70 and TA-71. There is sufficient earth back fill to cover the facility for shielding at any of the sites, and reasonable access to a disposal area for excess earth excavation materials exists. Runoff to, through and from each of the sites could be minimized by standard engineering techniques. All three of these sites have direct access to New Mexico State Route Four. None of the sites have SWMUs or PRSs. However, none of the three sites are completely free from constraints, as discussed in the next paragraphs.

TA-70 (Alternative Site #1) is a completely undeveloped mesa except for a major electric power line that traverses the site. There are several unpaved paths used for recreational hiking. The footprint of the NSNS facility would cover an area with grade changes of 140 feet. There are no significant underground utilities requiring relocation, however, an overhead electrical line will require realignment. Adequate electric power can be made available. Potable water will have to be brought to the site, and compressed air, natural gas, sanitary sewer, steam and chilled water will have to be provided by on-site facilities. This site is within 0.25 mile of bald eagle roosting habitat. The site has never been surveyed officially for cultural resources but four archaeological sites have been recorded in the area.

TA-33 (Alternative Site #2) has been the site of former tritium laboratories and an explosive test site. It is also immediately adjacent to Bandelier National Monument where preservation of archaeological ruins and the natural environment is a major goal. TA-33 can accommodate the facility, but will require relocation of the road leading to an existing radio telescope facility and to a former explosives test site. The footprint of the NSNS facility would cover an area with grade changes of 120 feet. There are no significant underground utilities requiring relocation, however, an overhead electrical line will require realignment. Adequate electric power can be made available. Potable water will have to be brought to the site, and compressed air, natural gas, sanitary sewer, steam and chilled water will have to be provided by on-site facilities. This site is within 0.25 mile of bald eagle roosting habitat and within one mile of peregrine falcon nesting habitat. Twelve cultural resources have been recorded in the surveyed area of this alternative site.

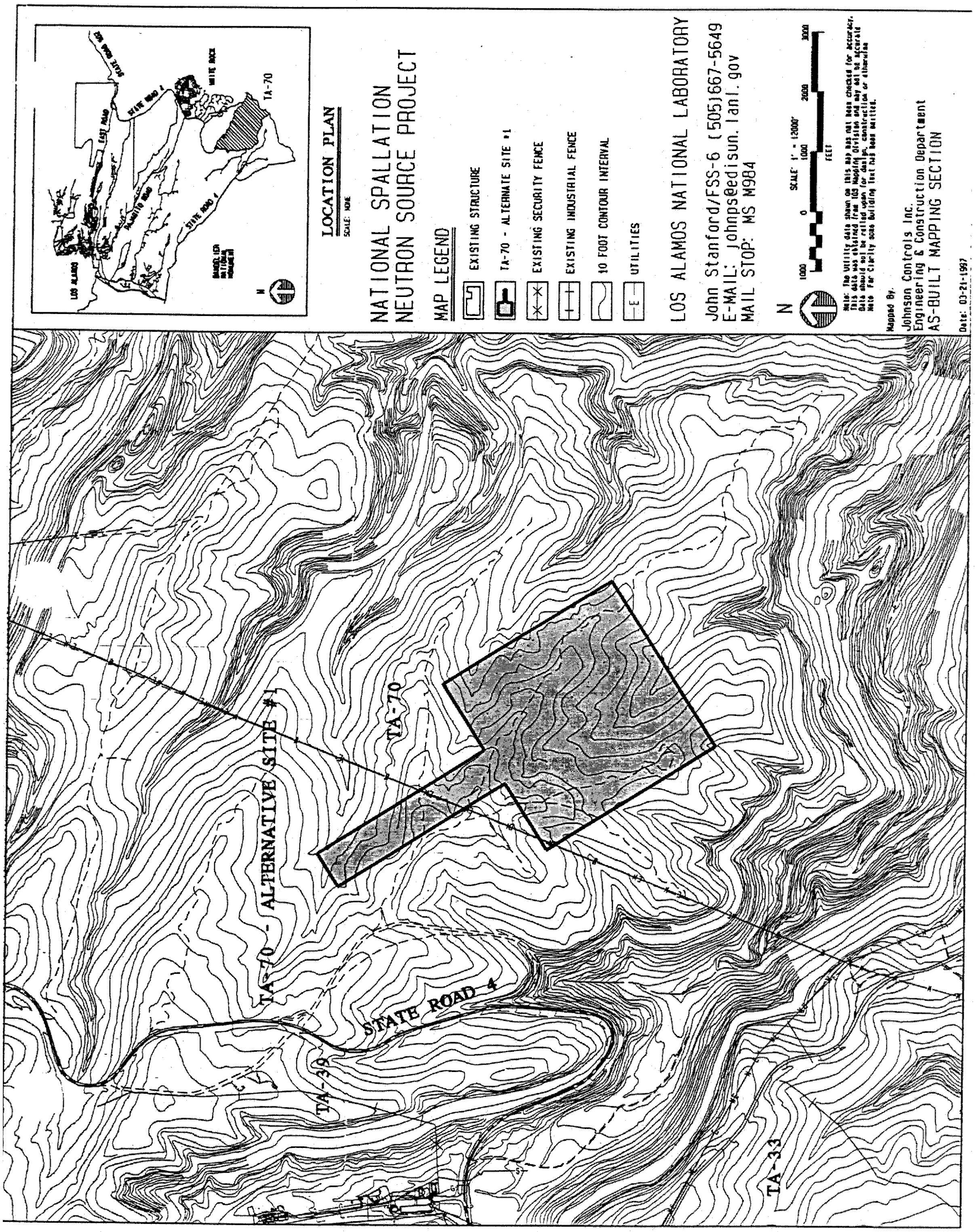
TA-71 (Alternative Site #4) is another undeveloped mesa and similar to TAs-70 and 33. The footprint of the NSNS facility would cover an area with grade changes of 110 feet. Both an existing power line and a second power/utility line will have to be relocated. This site is adjacent to the residential community of White Rock which is less than one mile to the east. This site is not within 0.25 mile of habitat for any threatened or endangered species. However, it is within one mile of bald eagle roosting habitat. Six cultural resources have been recorded in the surveyed area of this site.

RECOMMENDED SITE

Candidate sites at TAs 70, 33 or 71 could physically accommodate the NSNS facility. None of these three sites is located on the major fault lines shown in the 1990 Site Development Plan for LANL. However, there are similar constraints at each site:

- Construction on sites with grade changes ranging between 110 and 140 feet
- Utility corridors requiring realignment
- Cultural resources are either documented or expected at all alternative sites but mitigation of adverse effects on cultural resources could be achieved through data recovery
- Threatened or endangered species concerns
- Buffer encroachments - particularly at TA-33 (Bandelier National Monument) and TA-71 (the White Rock community)

A comparison of the sites was accomplished by assigning a score to each of the cells in Table 1, weighting each criteria and summing the scores. This analysis showed that TA-70 and TA-71 rank nearly the same and either one could be chosen as the recommended site. However, the fact that TA-70 has an adequate buffer zone and its utility corridor could be more easily realigned gives it a slight advantage over TA-71. Therefore, we recommend that TA-70 (Alternative Site #1) be designated as the LANL candidate site to accommodate the NSNS facility.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TA-70
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NEUTRON SOURCE PROJECT
MAP LEGEND
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TA-70 - ALTERNATE SITE #1
EXISTING SECURITY FENCE
EXISTING INDUSTRIAL FENCE
10 FOOT CONTOUR INTERVAL
UTILITIES
LOS ALAMOS NATIONAL LABORATORY
John Stanford/FSS-6 (505)667-5649
E-MAIL: johnps@edisun.lanl.gov
MAIL STOP: MS M984
N
SCALE 1" = 1200'
FEET
Mapped By:
Johnson Controls Inc.
Engineering & Construction Department
AS-BUILT MAPPING SECTION
Date: 03-21-1997
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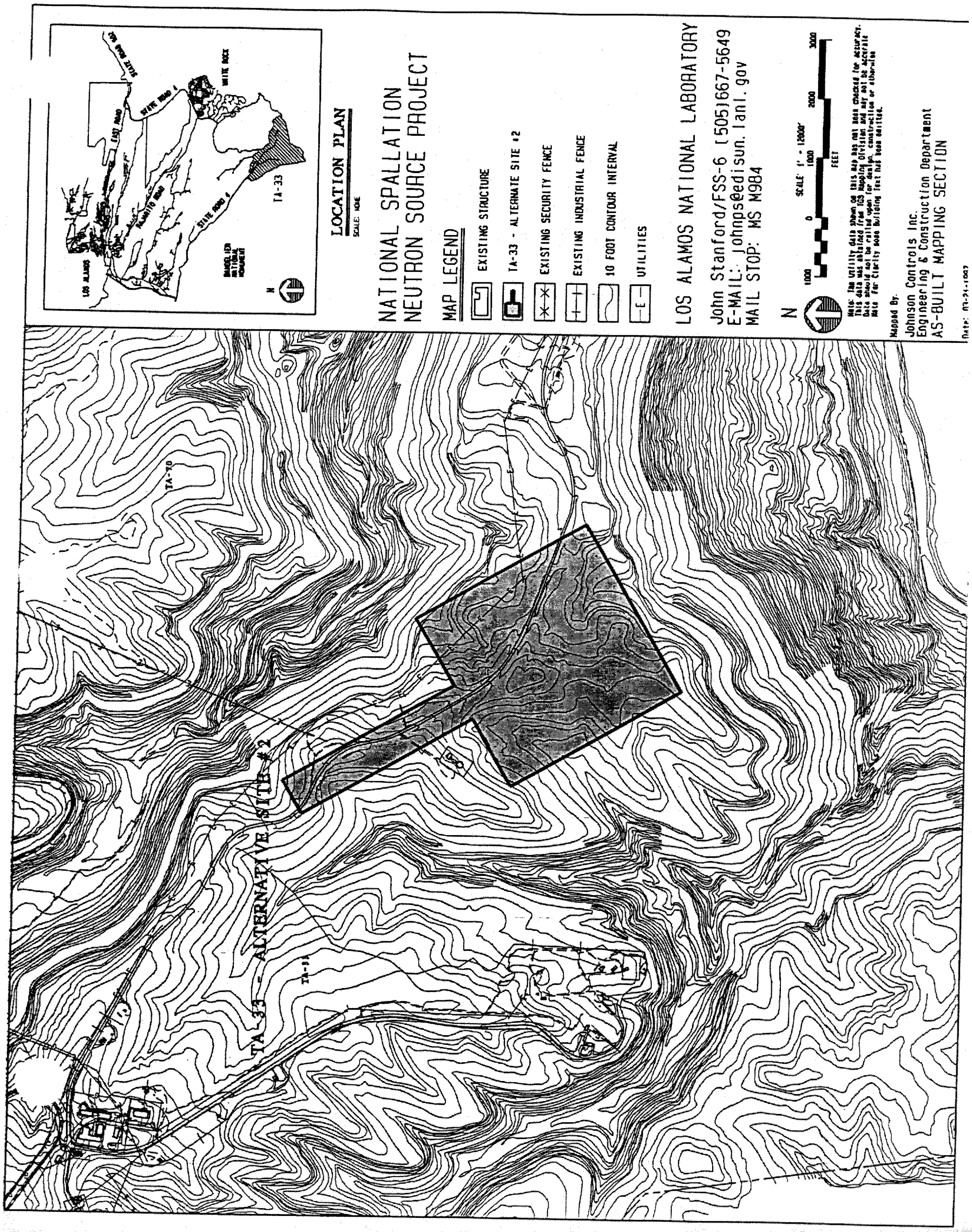
TA-70
STATE ROAD 4
TA-39
TA-33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EXISTING INDUSTRIAL FENCE
10 FOOT CONTOUR INTERVAL
UTILITIES
LOS ALAMOS NATIONAL LABORATORY
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E-MAIL: johnps@edisun.lanl.gov
MAIL STOP: MS M984
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Johnson Controls Inc.
Engineering & Construction Department
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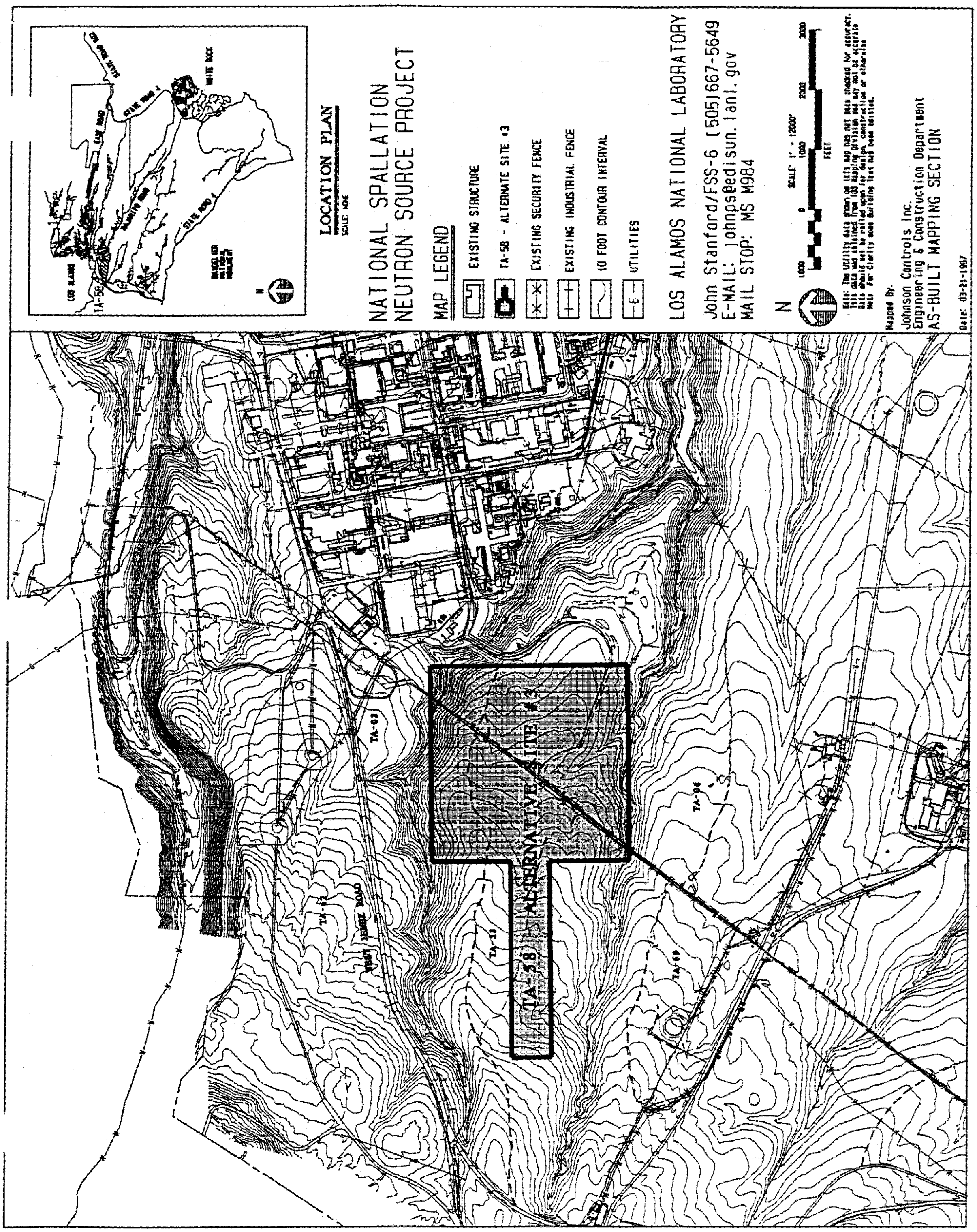
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EXISTING SECURITY FENCE
EXISTING INDUSTRIAL FENCE
10 FOOT CONTOUR INTERVAL
UTILITIES
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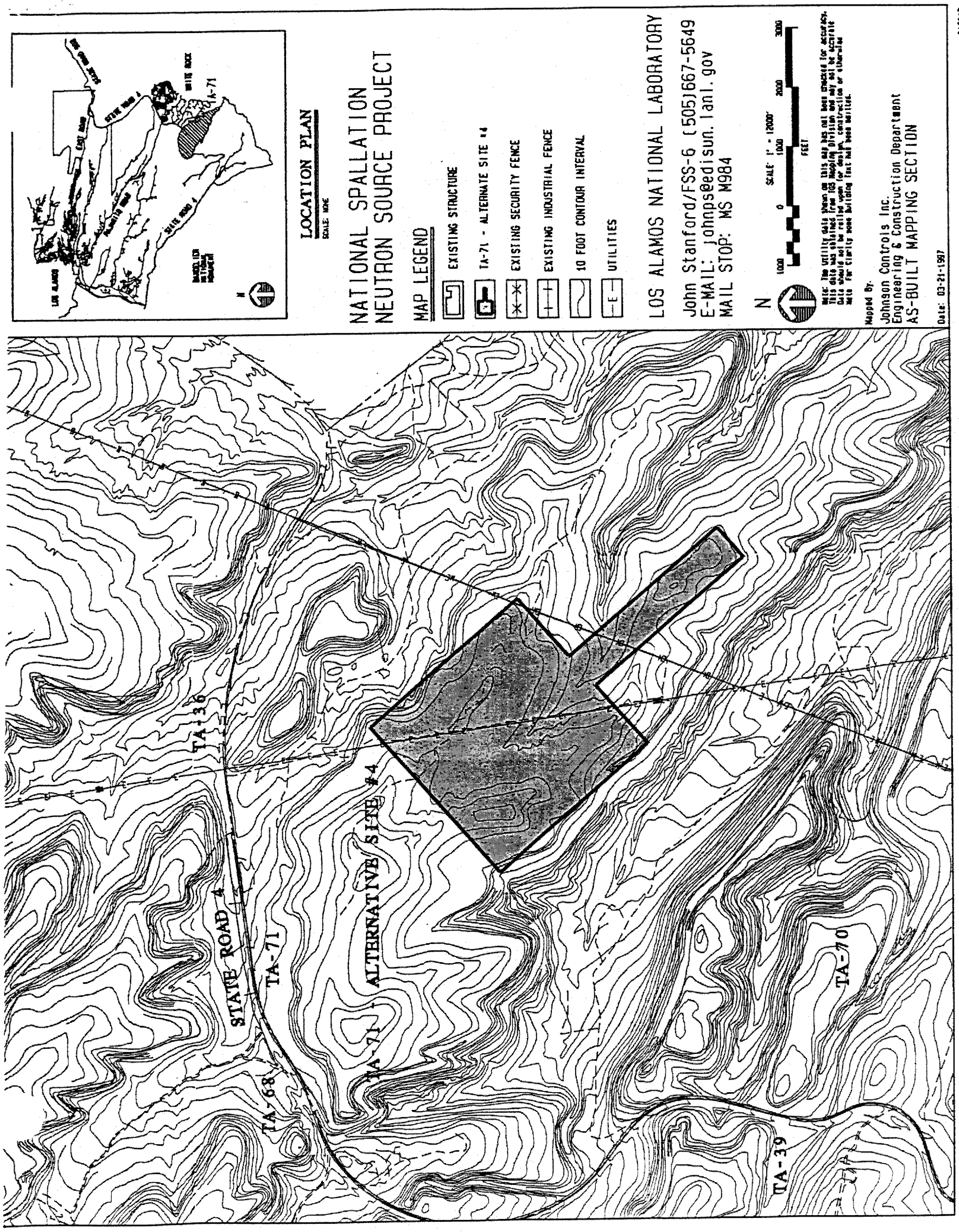
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ARGONNE NATIONAL LABORATORY
SITE SELECTION REPORT

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Final Report

Selection of a Single Alternative Site at Argonne National Laboratory-East for the National Spallation Neutron Source

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Environmental Assessment Division
Argonne National Laboratory

May 1998

Background

This report describes the selection of a single alternative site at Argonne National Laboratory-East (ANL) for the National Spallation Neutron Source (NSNS). The purpose of selecting a site at ANL is to provide an alternative site for analysis in the NSNS EIS, which will be prepared according to the requirements of the National Environmental Policy Act of 1969. DOE has determined that ANL is a reasonable alternative site for this facility. Other alternative sites include the preferred site, Oak Ridge National Laboratory (ORNL) and Los Alamos National Laboratory (LANL).

This siting analysis is based on a draft report, entitled *Draft National Spallation Neutron Source Project Alternative Selection at Argonne National Laboratory-East,* prepared by W. S. White, Chicago Operations Office, on February 27, 1997. That report tentatively identified four potential sites (Figure 1), one each in the 400 Area in the southwestern corner of the site (Alternative 1), the 800 Area in the northwestern corner of the site (Alternative 2), the 600 Area in the central area of the site (Alternative 3), and the East Area (Alternative 4). These sites were selected by overlaying a representative 110-acre quadrant onto an Argonne National Laboratory-East site map. At the time that report was written, area was the only siting criteria available. Current requirements for site area are greater in extent than were used in the February 27, 1997 report, the site configuration is now known, and general siting criteria have been established. This siting report reflects the changes in site area requirements, site configuration, and siting requirements.

This siting analysis is based on certain assumptions about the description of the project. These assumptions were used at the request of the NSNS NEPA Document Manager in order to ensure that the ANL site analysis would be consistent with the alternatives at ORNL and LANL. It should be noted that certain organizations within ANL have proposed that an NSNS at ANL would be of a different configuration than that proposed for ORNL and should be located at a site not selected in this report based on the EIS siting assumptions. The EIS assumptions are:

- That the area of land required for the facility would be the same as used for siting at ORNL and Los Alamos National Laboratory. There would be no adaptation for preconceptual designs earlier proposed by ANL.

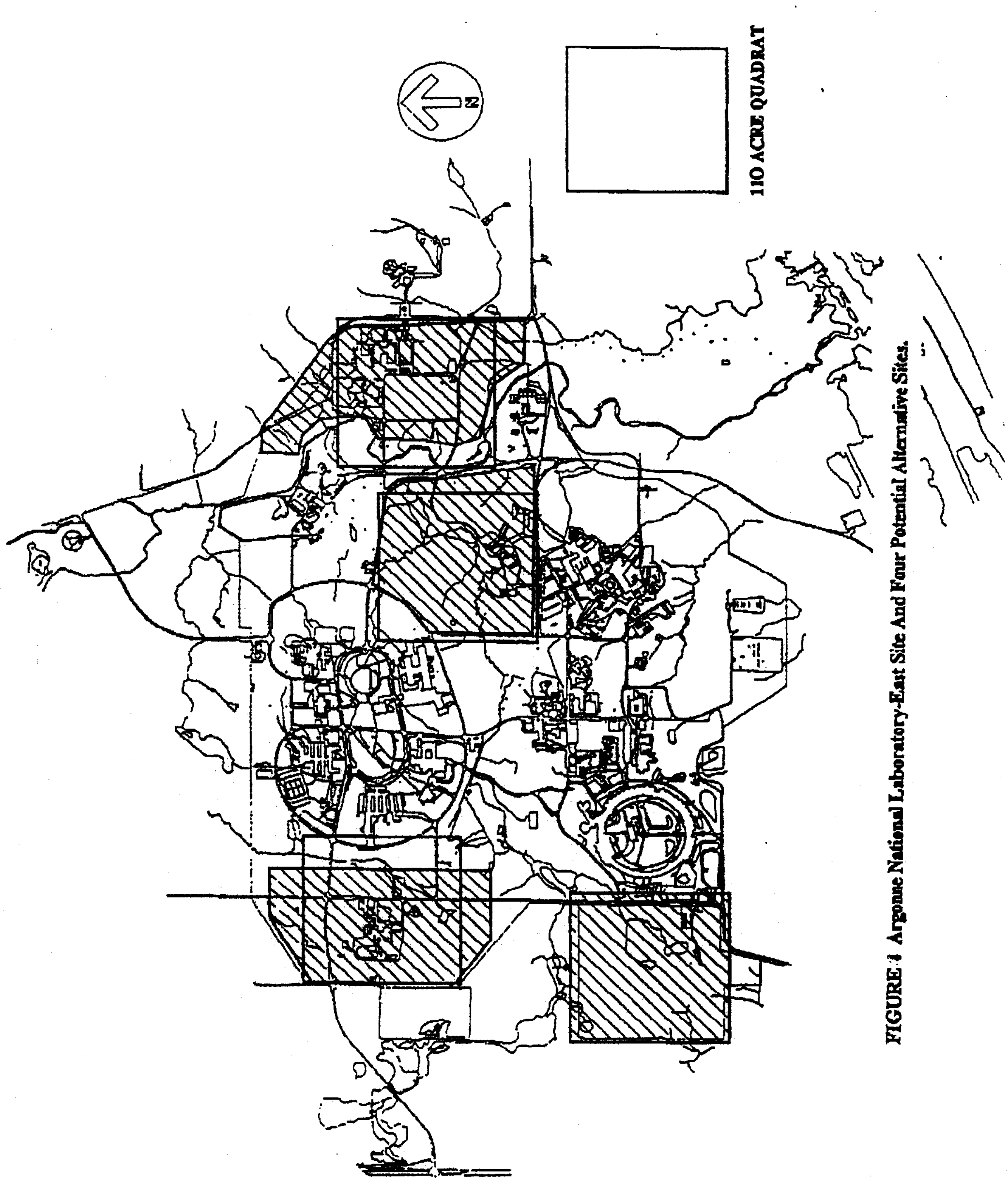

FIGURE 4 Argonne National Laboratory-East Site And Four Potential Alternative Sites.

- That the configuration and shape of the site would be the same at ANL as at ORNL or LANL. There would be no adaptation to ANL conditions or adaptations for preconceptual designs optimized for ANL site conditions.
- That the NSNS accelerator and support facilities would be of the same design assumed for ORNL or LANL; there would be no adaptation or optimization for conditions and existing facilities at ANL.
- That the same siting criteria developed for conditions at ORNL would be used for the ANL siting analysis, although several of these may not have much bearing on the development constraints present in the glacial till area in which ANL is located.

Siting Criteria

Since the initial DOE siting report was prepared for ANL, further siting criteria for the NSNS have been specified, including 1) functional criteria, based on construction and operational requirements of the facility; 2) environmental criteria, 3) criteria related to health and safety, and 4) programmatic criteria. These criteria have been developed for selecting a NSNS site at ORNL; and they have been applied for selection of an alternative site at LANL. The criteria are:

1. Functional Criteria

    - The main building site has a requirement of 500 m x 500 m with an adjoining 100 m x 500 m centered on the main area (T- or hammer-shaped); all on the same elevation after excavation and founded on bedrock. An adjacent area, measuring 100,000 m^2, is needed for support facilities, roads, buffer, etc., which can be on different elevations.
    - The main buildings must be constructed on solid rock foundation; however, karst formations are not to be eliminated as candidate sites.
    - Sufficient earth backfill must be available on site or nearby to provide an average of 15 ft cover for the main building.
    - The site must be in reasonable proximity to a disposal area for rock and excess earth excavation, such as a previously expended borrow area.
    - The site location minimizes excavation of contaminated soils.
    - The site should avoid the cost of relocating significant overhead and underground utilities (e.g. power lines, water line mains, and gas transmission lines).
    - The location should minimize runoff to or through the site.
    - The site should be in close proximity and access to existing utility systems, including 30-40 MW of electrical power. Other utility requirements include potable water, compressed air, natural gas, sanitary sewer, steam and chilled water (can be provided by onsite facilities), and construction power within one mile.
    - The site should be in close proximity to primary and/or secondary roads.

2. Environmental Criteria

- The site should avoid disturbance of wetlands and streams.
- The site should avoid locations with threatened or endangered plant or animal species.
- The site should avoid locations with historic, cultural, or archeological resources.
- The site should minimize impact on natural, reference, and research areas, including NERPs[1].

2. Health and Safety Criteria

- The site must be located above the 500-year floodplain elevation.
- The site must avoid geological faults prone to seismic movement.
- The site must provide a minimum 500 meter separation from existing occupied structures.

3. Programmatic Criteria:

- The site should consider appropriate site development and land use plans.

Method of Analysis

The characteristics of the four sites with respect to the siting criteria were determined by examining existing data sets contained in the ANL Sitewide Geographic Information System. The footprint of the proposed facility was overlaid on each of the four areas identified in the earlier siting report, and the footprints were rotated and moved so at to achieve the best possible fit with the siting criteria in or near each of the four areas (Figure 2). Because the footprint of the facility has a maximum dimension of 1000 meters, which is greater than the dimensions (691 m) of the 110-acre areas originally identified in the first siting report, none of the footprints fit exactly within the boundaries identified in the earlier report.

Each of the four sites were evaluated against each siting criterion, and a subjective opinion developed as to whether 1) the site easily met or exceeded the criterion [+], 2) could meet the criterion with a small degree of mitigation or site conditions were only mildly unfavorable [O], or 3) the site clearly failed the criterion or site conditions were clearly unfavorable [-]

Results

The results of the evaluation of potential sites against the siting criteria are presented in Table 1. On the basis of this evaluation, Alternative 1 (400 Area) met or exceeded five of the criteria and clearly failed ten, Alternative 2 (800 Area) met or exceeded seven of the

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[1] National Environmental Research Parks (NERPs) are areas of DOE sites designated for environmental and ecological research.

criteria and clearly failed five, Alternative 3 (600 Area) met or exceeded six of the criteria and clearly failed eight, and Alternative 4 (East Area) met or exceeded six of the criteria and clearly failed eight.

All sites meet several of the siting criteria.

1. All sites have the necessary area available to accommodate the site footprint.

2. None of the locations are over known faults.

3. All areas are near or are crossed by paved roads.

4. Research and development use is consistent with the Site Development Plan.

All sites also do not meet several of the siting criteria.

1. At all sites the depth to bedrock is greater than 60 ft. It is assumed that an NSNS at ANL would not be founded on bedrock. Even so, construction and operation of accelerator facilities has been highly successful at ANL.

2. ANL does not have an onsite source of backfill; material from excavation would have to be used, unless fill were brought in from offsite.

3. ANL does not have an onsite disposal area for large volumes of excavated material; offsite disposal would be necessary

4. All sites contain wetland areas or streams.

5. All areas have historic, cultural, or archeological resources; one with an site that eligible for listing and the others with areas for which eligibility needs to be determined.

6. All locations are closer than 500 m to the nearest occupied structure.

Alternative 2 in the 800 Area at the northwest corner of ANL comes the closest to meeting the siting criteria (Table 1), and was determined to be the best siting location at ANL. The advantages of this location are: 1) differences in surface elevation are moderate (30 ft), 2) no state or federal threatened or endangered species are known to use the site, and 3) the area has little ecological research potential. Limited utilities are onsite, but are located nearby. Other disadvantages of the location include: 1) four contaminated areas which are currently under consideration for remediation, 2) an unused water pumping station and associated water mains might have to be removed, and 3) presence of a small drainage way on site.

As with all the other sites, fill for the 800 Area site would be obtained off the ANL site and rock and excess earth would be disposed of off the ANL site. One of the archeological sites would need a determination whether it is eligible for listing under the National Historic Preservation Act. The site is very close to other occupied structures; a guard house at 20 meters and an office/laboratory building at 110 meters. This site has one disadvantage which is not related to a site selection criteria; it overlays and blocks the Westgate Rd. entrance to the site. Westgate road and the entrance guard house would have to be relocated around the periphery of the facility.

Alternative 4 in the East Area was determined to be the second best location. The advantages of this location are: 1) differences in elevation are moderate (30 ft), 2) no known state of federal threatened or endangered species are known to use the site, and 3) the area has little ecological research potential. The disadvantages of this location are: 1) the foot print overlays the main gas line to the ANL site, possibly requiring removal and relocation; 2) the linac portion of the footprint would cross Sawmill Creek, a permanent stream, and the associated 100-yr and 500-yr floodplain and bordering wetlands. Other disadvantageous characteristics include: 1) four contaminated areas which are currently under consideration for remediation, and 2) partial utility availability onsite with others located nearby. Alternative 4 would be located in an area which houses storage areas, plant facilities services buildings, and shipping and receiving. Relocation of these facilities might be necessary.

Alternative 3 in the 600 Area is the third best of the alternatives. The advantages of this location include: 1) no known state of federal threatened or endangered species are known to use the site, and 2) the area has little ecological research potential. The disadvantages of this location are: 1) the foot print overlays the main steam and gas lines to the ANL site, possibly requiring removal and relocation; 2) the linac portion of the footprint would cross Freund Brook, a permanent stream, and the associated 100-yr and 500-yr floodplain and bordering wetlands, and 3) a pond on Freund Brook and associated wetlands are within the main portion of the footprint. Other disadvantageous characteristics include: 1) greater differences in elevation than the other sites (60 ft), 2) one known area of contamination which is under consideration for remediation, and 3) partial availability of utilities onsite with others located nearby. Construction of the NSNS at Alternative 3 might require removing the original Freund Lodge (which predates ANL), a motel-like facility, several cottages, the swimming pool, and the tennis courts. The lodging function of these facilities could be taken over by ANL's new hotel-like lodging facility near the Advanced Photon Source.

Alternative 1 in the 400 Area was judged to be the least favorable site. Advantageous characteristics include: 1) differences in surface elevation are moderate (30 ft) and 2) there are no identified areas of site contamination. Disadvantages of this location include: 1) the only possible orientation for the footprint overlays an interstate gas transmission line; 2) utility service to the site is very limited, although utilities are nearby, 3) state-listed birds, reptiles, and plants are present, 4) the site contains a remnant prairie, old oak woodlands, ponds and wetlands with good research potential, 5) and the site contains headwater ephemeral ponds and wetlands and the 500-yr and 100-yr floodplains of Upper Freund Brook.

One difficulty with this site is that the footprint alignment can not be reoriented to avoid the gas transmission line without either a land exchange to modify the boundaries of ANL or moving the facility further into Upper Freund Brook and associated wetlands. If some rounding of the corners of the site were allowed, the gas transmission line might be avoided. The site is very close to another accelerator facility, the Advanced Neutron Source, which constrains site rotation in the clockwise direction. If the site were rotated in the counter-clockwise direction, main area and the linac of the NSNS would further encroach on the floodplain and wetlands associated with Upper Freund Brook. These drainage features include the headwaters of Upper Freund Brook and a series of small ponds and marshes. State endangered species known from this location include the Black-crowned Night Heron (feeding habitat), the Great Egret (feeding habitat), Kirkland's Water Snake (resident), and a state-listed marsh plant. This site also contains eight archeological sites. A site near the tip of the linac is eligible for listing. Several of the other sites would need a determination whether they are eligible for listing. One corner of the site is within an area that is thought to be a prairie remnant, a habitat-type with significant regional cumulative impacts and potential value for research purposes.

Conclusion

The alternative location which most closely matches the siting criteria for the NSNS is Alternative 2 in the 800 Area at the northwest corner of the ANL site. This location has the least involvement with floodplains, wetlands, threatened and endangered species, research areas, important habitats, and unfavorable topography. This site has several disadvantages related to several small areas of contamination and proximity to occupied structures. In addition, the site overlays Westgate Road, the west entrance to ANL. Without further engineering design information for NSNS, it is uncertain whether the alignment of the footprint could be moved south enough to reroute Westgate Road around the perimeter of the facility. Moving the facility to the south would place the linac portion of the footprint near on Upper Freund Brook and impinge on wetlands and floodplains in that area.

Table 1. Evaluation of the Potential Sites for the National Spallation Neutron Source.

(+ = favorable or meets or exceeds criterion; 0 = could meet criterion with minor mitigation or mildly unfavorable;
- = clearly fails the criterion or conditions clearly unfavorable)

Siting Criteria	Alt. 1: 400 Area Suitability	Alt. 2: 800 Area Suitability	Alt. 3: 600 Area Suitability	Alt. 4: East Area Suitability
FUNCTIONAL CRITERIA				
Main building site requirement of 500 m x 500 m with an adjoining 100 m x 500 m centered on the main area (T- or hammer-shaped); all on the same elevation after excavation and founded on bedrock. An adjacent area measuring 100,000 m2 for support facility	Area available. Surface elevation differences of about 30 ft. (see below for geology) **+**	Area available. Surface elevation differences of about 30 ft. (see below for geology) **+**	Area available. Surface elevation differences of about 60 ft. (see below for geology) **0**	Area available. Surface elevation differences of about 30 ft. (see below for geology) **+**
Main buildings must be constructed on solid rock foundation; however karst formations are not to be eliminated as candidate sites.	110-120 ft of material above bedrock. **-**	110-130 ft of material above bedrock. **-**	80-170 ft of material above bedrock. **-**	60-70 ft of material above bedrock. **-**
Sufficient earth backfill available on site or nearby to provide an average of 15 ft cover for the main building.	Material from excavation of site available for backfill, no other onsite source. **0**	Material from excavation of site available for backfill, no other onsite source. **0**	Material from excavation of site available for backfill, no other onsite source. **0**	Material from excavation of site available for backfill, no other onsite source. **0**
Reasonable proximity to disposal area for rock and excess earth excavation, such as previously expended borrow area.	No onsite disposal area. **-**	No onsite disposal area. **-**	No onsite disposal area. **-**	No onsite disposal area. **-**
Site minimizes excavation of contaminated soils.	no identified areas of contamination **+**	4 known areas of contamination **0**	1 known area of contamination **0**	4 known areas of contamination **0**

Siting Criteria	Alt. 1: 400 Area Suitability	Alt. 2: 800 Area Suitability	Alt. 3: 600 Area Suitability	Alt. 4: East Area Suitability
Should avoid cost of relocating significant overhead and underground utilities (e.g. power lines, water line mains, and gas transmission lines).	Footprint overlays an interstate gas transmission line at the southern boundary of the ANL site, footprint placement constrained by wetlands. -	Buildings in area needing utilities have been demolished or are slated for demolition. Water pumping station and associated water mains are not in use. +	Footprint overlays main steam line and gas line to the interior of ANL. -	Footprint overlays main gas line to the ANL site. -
Minimize runoff to or through the site.	Some short-term runoff during storm events. Ponding in headwater wetlands to Upper Freund Brook. -	Some short-term runoff during storm events. O	Major receiving stream for stormwater runoff. -	Major receiving stream and floodway for stormwater runoff. -
Close proximity and access to existing utility systems, including 30-40 MW of electrical power. Other utility requirements include: potable water, compressed air natural gas, sanitary sewer, steam and chilled water, and construction power.	Limited utilities on site, utilities available nearby. O	Limited utilities on site, utilities available nearby. O	Good utility service adjacent to site. +	Partial utility availability onsite. O
Close proximity to primary and/or secondary roads.	Road access to area. +	Road access to area. +	Road access to area. +	Road access to area. +

Siting Criteria	Alt. 1: 400 Area Suitability		Alt. 2: 800 Area Suitability		Alt. 3: 600 Area Suitability		Alt. 4: East Area Suitability	
<u>ENVIRONMENTAL CRITERIA</u>								
Avoid disturbance of wetlands and streams	Small ponds and marshes on site, main area and linac contains the headwaters of Upper Freund Brook and its associated wetlands.	-	Main area contains a small drainage way with wetland vegetation and a remnants an abandoned beaver pond. Tip of linac reaches border of wetlands on Upper Freund Brook.	-	Main area and linac contains Freund Brook and a pond and associated wetlands.	-	Main area and linac contains Sawmill Creek and associated wetlands.	-
Avoid locations with threatened or endangered plant or animal species	State listed birds, reptiles, and plants.	-	No Involvement	+	No Involvement.	+	No Involvement.	+
Avoid locations with historic, cultural, or archeological resources present	Eight known sites, one eligible site at the tip of the linac, several sites need to have eligibility determined.	-	Two sites, one not eligible, one site needs eligibility determined.	-	One large area needs to have eligibility determined.	-	One large area needs to have eligibility determined.	-
Minimize impact on natural, reference, and research areas, including NERPs.	Remnant prairie present, old oak woodlands, ponds and wetlands with best research potential.	-	Small amount of old oak. Little research potential.	+	Some areas of woodland. Research potential low.	+	Research potential low.	+
<u>HEALTH AND SAFETY CRITERIA</u>								
The site must be located above the 500-year floodplain elevation.	Site contains 500 year floodplains, and is in the 100-year floodplain of Upper Freund Brook.	-	Site avoids 500-year floodplains, except for small drainage way at the north east edge of the site.	O	Linac portion of the footprint crosses Freund Brook and its 500-year and 100-year floodplains.	-	Linac portion of the footprint crosses Sawmill Creek and its 500-year and 100-year floodplains.	-

Siting Criteria	Alt. 1: 400 Area Suitability		Alt. 2: 800 Area Suitability		Alt. 3: 600 Area Suitability		Alt. 4: East Area Suitability	
The site must avoid geological faults prone to seismic movement.	No known faults.	+	No known faults.	+	No known faults.	+	No known faults.	+
The site must provide a minimum 500 meter separation from existing occupied structures.	Nearest occupied buildings are 65 m.	-	Nearest occupied buildings are 110 m. Guard post at site entrance is within 20 m, but would be moved.	-	Nearest occupied buildings are 160 m.	-	Nearest occupied buildings are130 m.	-
PROGRAMMATIC CRITERIA								
Site considers appropriate site development and land use plans.	Research and development use consistent with Site Development Plan	+	Research and development use consistent with Site Development Plan	+	Research and development use consistent with Site Development Plan	+	Research and development use consistent with Site Development Plan	+
Total Suitability	5 + 2 O 10 -		7 + 5 O 5 -		6 + 3 O 8 -		6 + 3 O 8 -	

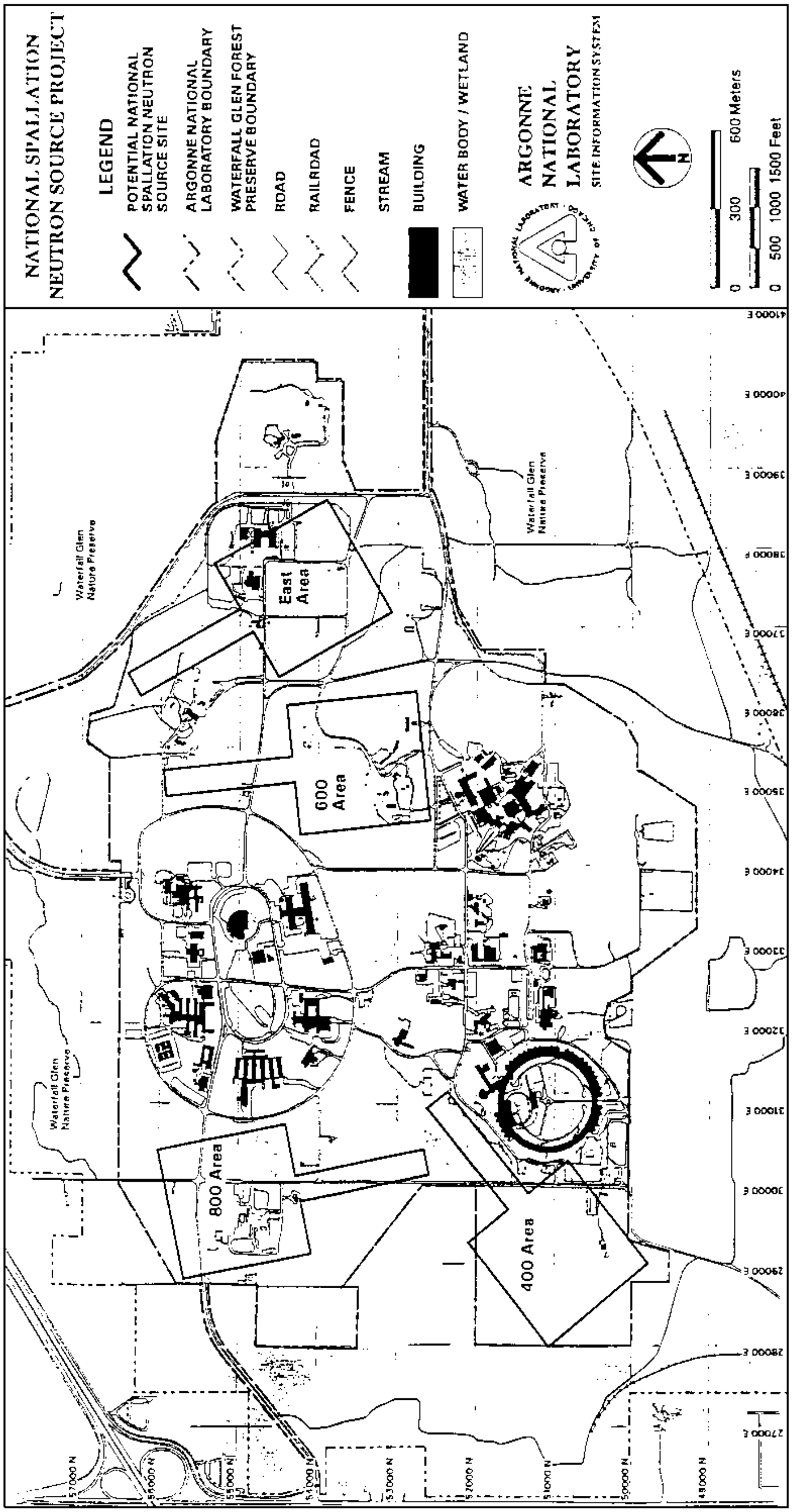

Figure 2. Argonne National Laboratory-East Site and Four Potential Alternative Sites

BROOKHAVEN NATIONAL LABORATORY
SITE SELECTION REPORT

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NATIONAL SPALLATION NEUTRON SOURCE
BNL SITE SELECTION REPORT

Brookhaven National Laboratory
September 16, 1997

INTRODUCTION

This report evaluates four potential sites for construction of the National Spallation Neutron Source (NSNS) at Brookhaven National Laboratory (BNL) in Upton, New York. In 1995 the Department of Energy (DOE) determined that NSNS would require an Environmental Impact Statement (EIS). The DOE then developed a process to identify suitable alternatives to the DOE's "preferred alternative" at Oak Ridge National Laboratory (ORNL). The process evaluated 39 DOE sites, and BNL qualified as one of three alternative locations besides ORNL for the facility. The other two alternative locations were Argonne National Laboratory and Los Alamos National Laboratory. *(Draft National Spallation Neutron Source Project, Alternate Site Selection Report: U.S. Department of Energy, Office of Energy Research; prepared by Roy F. Weston, Inc., August 23, 1996)*

This report provides the NSNS program with a decision-making tool for selecting an alternative candidate site at Brookhaven National Laboratory for the NSNS facility. The site evaluation process uses the following steps for selecting a recommended site:

- List NSNS physical design parameters provided by the NSNS design team
- Inventory of candidate BNL sites
- Evaluation of each candidate site according to NSNS siting criteria
- Determination of the candidate site with the best attributes and least restrictions to accommodate the NSNS

Four candidate sites were identified from which the recommended site was determined to best meet the NSNS criteria. These areas and the project footprint are illustrated on the four maps presented at the end of this report.

NSNS SITE REQUIREMENTS

The NSNS site must accommodate several physical and environmental requirements. These requirements are categorized as functional, environmental, and programmatic and are listed below.

Functional

- A site that accommodates a hammer-head shaped structure measuring 500 x 500 meters with a tail centered on the above square and measuring 100 x 500 meters
- A site that can be cut to provide proper fill for shielding of hammer-head shaped area.
- Additional space for support buildings and access roads requiring an additional 100,000 square meters
- Reasonable proximity to other facilities at BNL
- Avoid significant overhead and underground utility relocation (e.g., power lines, water line mains and gas transmission lines, steam lines)
- Minimize runoff to, through and from the site
- Reasonable access to existing utility systems to include:
    - 40 MW electrical power
    - potable water
    - compressed air, natural gas, sanitary sewer, steam and chilled water (desirable, can be provided by on-site facilities) availability of construction power within one mile
- Reasonable proximity to primary and/or secondary paved roads for users, researchers, materials, supplies; for target transport; for waste and irradiated material removal
- Buffer zone to avoid residential areas and large worker populations

Environmental

- Avoid construction in or disturbance of wetlands
- Avoid locations with threatened or endangered plant or animal species

Programmatic

- Conform with appropriate site development and land use plans
- Avoid existing recreation uses

INVENTORY OF CANDIDATE BNL SITES

Siting and construction of the NSNS facility is a major undertaking requiring a large site. While BNL covers 10 square miles, a significant portion of the undeveloped area is the head water region of the Peconic River. The four sites are presently undeveloped, and located adjacent to developed areas, and sized to accommodate the NSNS facility. In general terms, the four sites are Central, Northern, North Eastern, and Southern.

Siting Criteria	Central Site	Northern Site	North-Eastern Site	Southern Site
Functional				
1. Physical accommodation of building footprint (500m x 500m with attached 100m x 500m addition)	Adequate	Adequate	Adequate	Adequate
2. Adequate earth backfill to provide an average of 15 feet of cover for shielding	Adequate	Fill will be trucked in from on site	Fill will be trucked in from on site	Adequate
3. Close proximity to BNL support facilities and services	Adjacent to existing facilities / services	Remote from existing facilities / services	Remote from existing facilities / services	Remote from existing facilities / services
4. Avoid relocating significant overhead/ underground utilities	No major utilities in area	No utilities in area	No major utilities in area	No major utilities in area
5. Minimize runoff to, through, and from the site	Acceptable	Located near the head waters of the Peconic River	Located near the head waters of the Peconic River	Acceptable
6. Proximity/ access to existing utility systems (40MW power, potable water, compressed air, natural gas, sanitary sewer, steam, chilled water, construction power	All utilities are local except chilled water & natural gas	Only sanitary is local	Only sanitary is local	No utilities are local
7. Proximity to primary and/or secondary roads	Adequate	Roads will have to be installed	Roads will have to be installed	Adequate
8. Adequate buffer zone	Adequate	Close proximity to residential area	Close proximity to residential area	Close proximity to major public highway
ENVIRONMENTAL				
9. Avoid construction in wetlands	No adverse impact to wetlands	Possible impact to wetlands	Possible impact to wetlands	No adverse impact to wetlands
10. Avoid locations with threatened or endangered plant or animal species	No impact	No impact	No impact	Salamander
PROGRAMMATIC				
11. Compatible with site development and land use plans	Consistent with 1994 Site Development Plan	Encroaches into future RHIC experimental area	Encroaches into future RHIC experimental area	Encroaches into future linear accelerator area
12. Avoid existing recreation uses	Impacts shot gun range	None	None	None

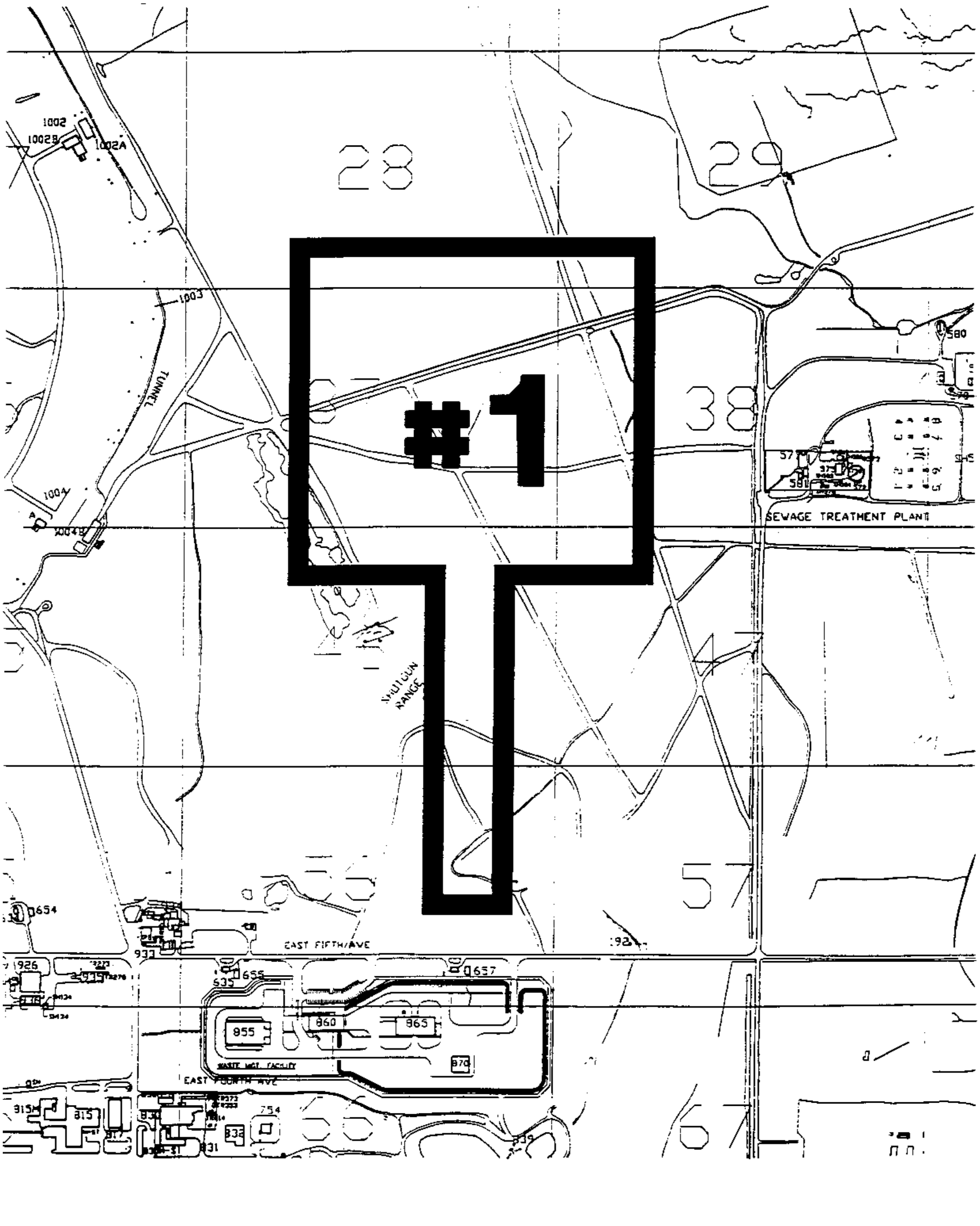
EVALUATION OF CANDIDATE SITES

The Central Site has the appropriate gross acreage, topography, proximity to the research community, utility support with the exception of a supply of chilled water and natural gas, roadways, and buffer zone. The site does not impact environmental concerns and can be accommodated into the site development plan.

The Northern Site has the appropriate gross acreage. However, the topography requires fill to be truck to the site for the necessary shielding. The site requires new roads and utilities to be constructed into the area. The site is near the head waters of the Peconic River and encroaches into future RHIC experimental areas.

The North-Eastern Site has the appropriate gross acreage. However, the topography requires fill to be truck to the site for the necessary shielding. The site requires new roads and utilities to be constructed into the area. The site is near the head waters of the Peconic River and encroaches into future RHIC experimental areas.

The Southern Site has the appropriate gross acreage, topography and access by major roads. The site requires utilities to be constructed into the area. The site encroaches into future Linear Accelerator Project.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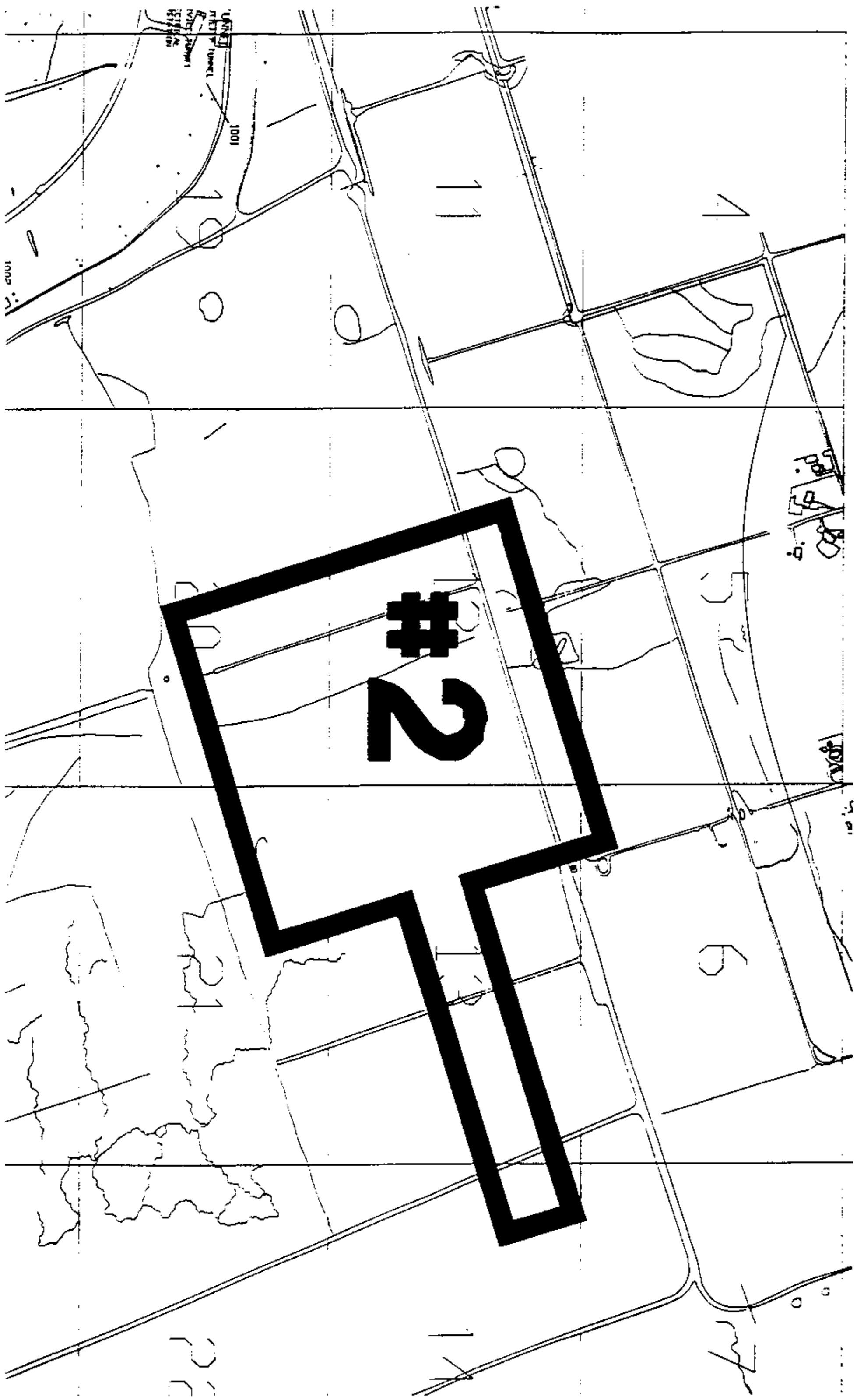
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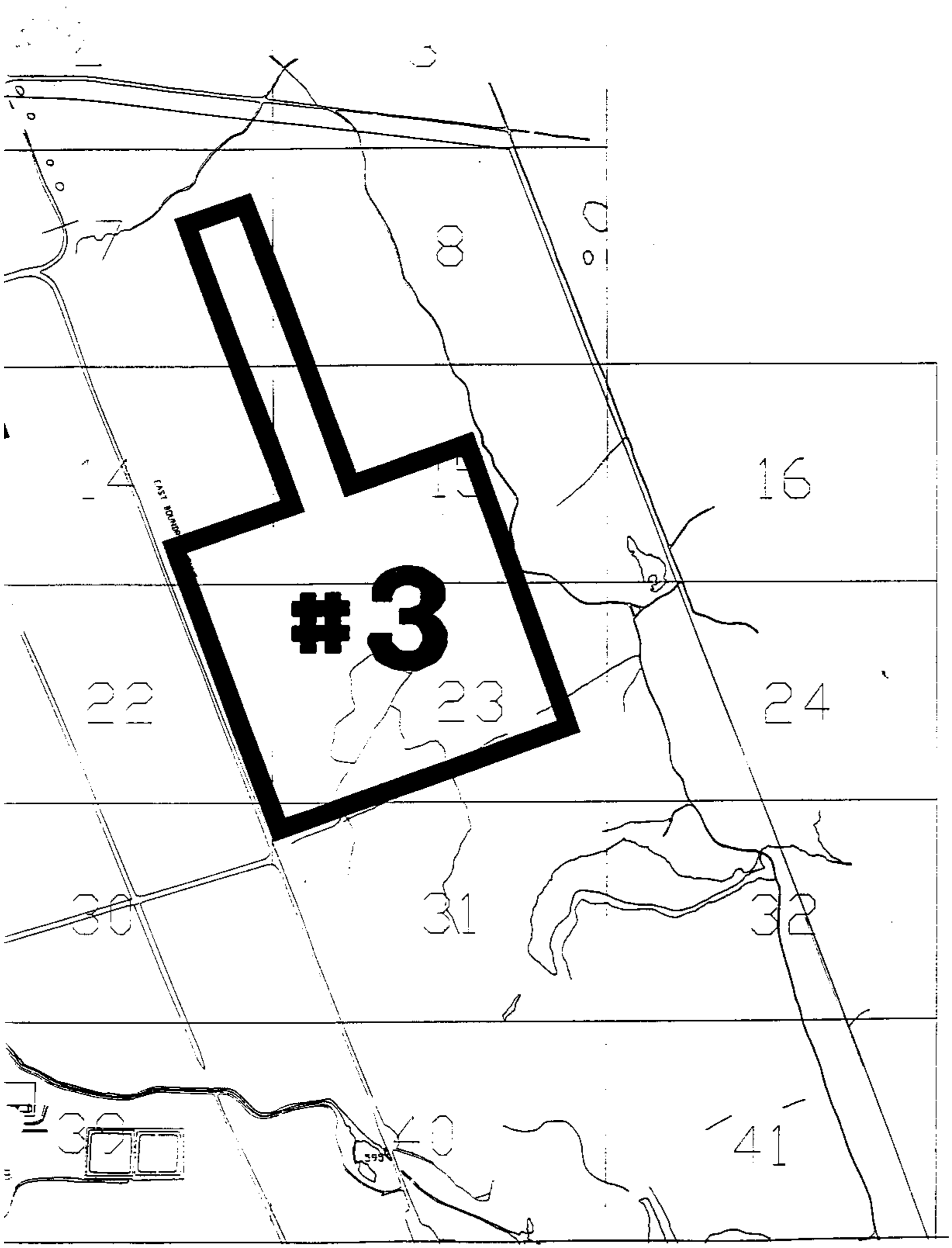
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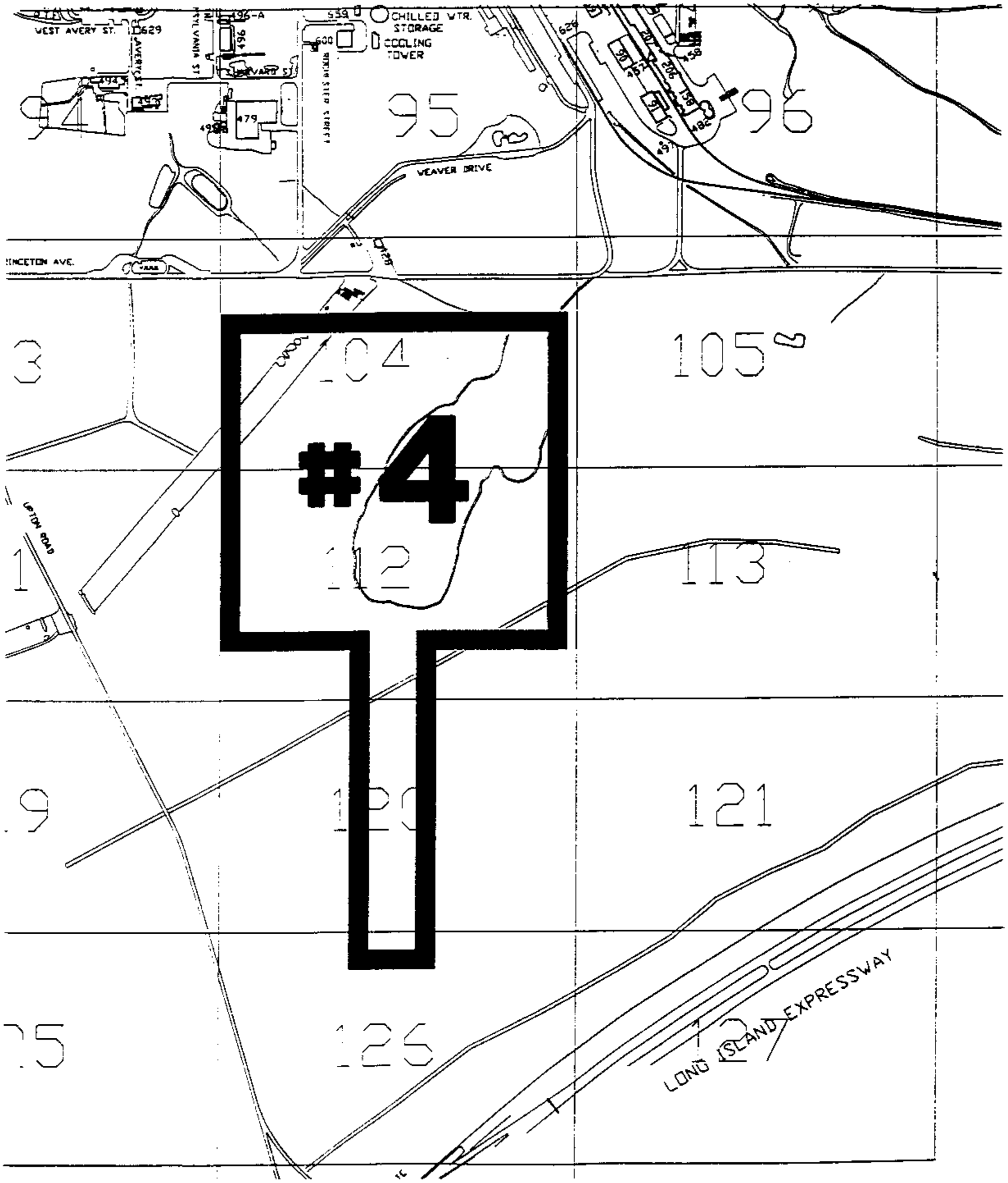
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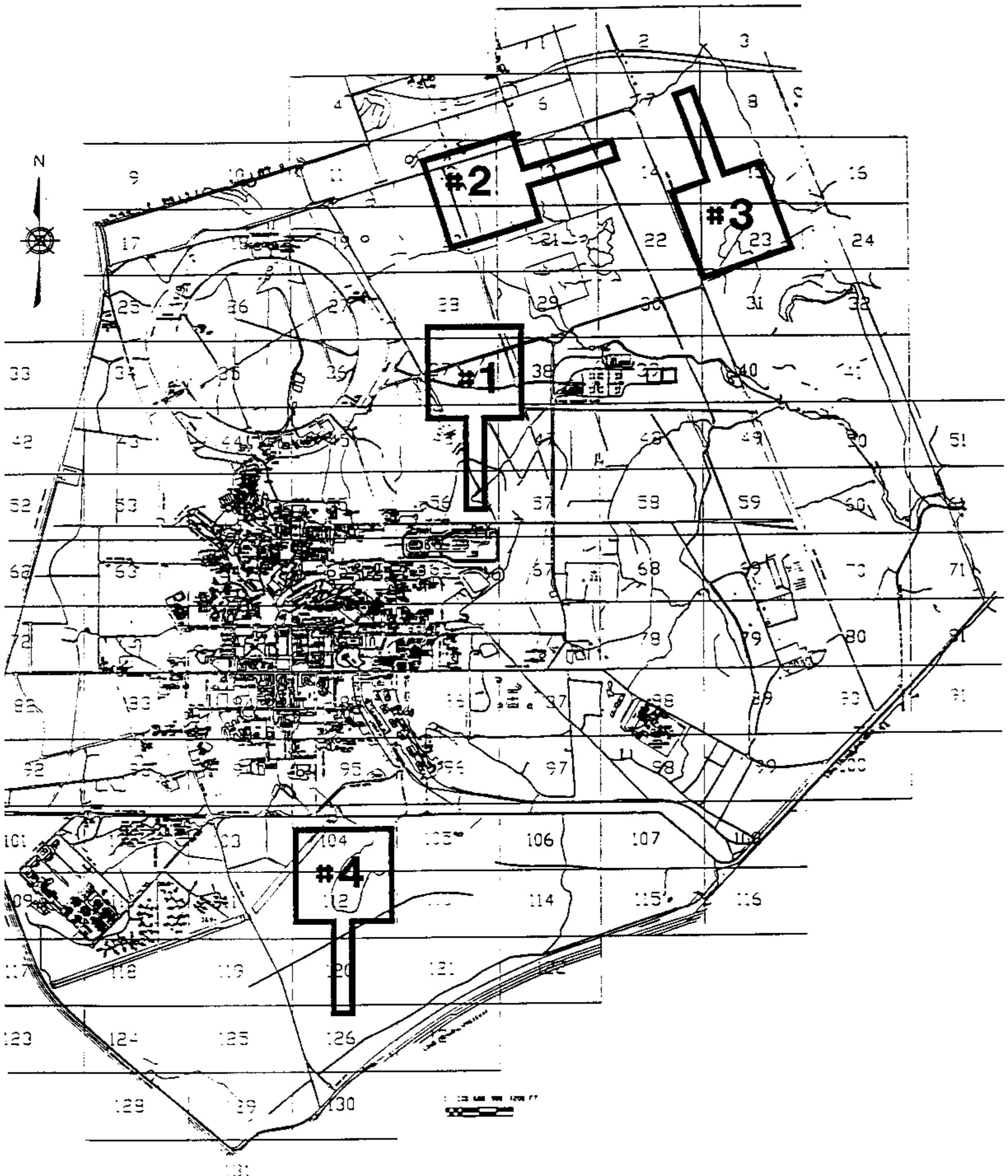
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APPENDIX C

SNS ACCIDENT SOURCE TERMS FOR EIS INPUT

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C. SNS ACCIDENT SOURCE TERMS FOR EIS INPUT

This appendix presents a description of postulated accidents at the proposed Spallation Neutron Source (SNS) facility. Specifically, it describes accidents with the potential to release radioactive materials into the environment surrounding the SNS.

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SNS_1998_00002
(ORNL/M-6575)

SPALLATION NEUTRON SOURCE ACCIDENT SOURCE TERMS FOR ENVIRONMENTAL IMPACT STATEMENT INPUT

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Work sponsored by the
Office of Energy Research
U. S. Department of Energy

Date Published: August 1998

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for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-96OR22464

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CONTENTS

LIST OF TABLES

ACRONYMS

ac	alternating current
A/C	air conditioning
BDB	beyond-design Basis
BP	beam pulse/beam permit
CDR	Conceptual Design Report
DAC	derived air concentrations
DOE	U.S. Department of Energy
EIS	environmental impact statement
EU	extremely unlikely
FP	fast protect
HEPA	high-efficiency particulate air
HOG	hot off-gas
HT	tritiated hydrogen
HTO	tritiated water
HVAC	heating, ventilation, and air-conditioning
LLLW	liquid low-level waste
MCNP	monte carlo neutron photon
NIOSH	National Institute for Occupational Safety and Health
NRC	Nuclear Regulatory Commission
PPS	personnel protection system
R&D	research and development
SNS	Spallation Neutron Source
TBD	to be determined
TPS	target protection system
U	unlikely

SPALLATION NEUTRON SOURCE ACCIDENT SOURCE TERMS FOR ENVIRONMENTAL IMPACT STATEMENT INPUT

1. INTRODUCTION

This report is about accidents with the potential to release radioactive materials into the environment surrounding the Spallation Neutron Source (SNS). As shown in Chap. 2, the inventories of radioactivity at the SNS are dominated by the target facility. Source terms for a wide range of target facility accidents, from anticipated events to worst-case beyond-design-basis events, are provided in Chaps. 3 and 4. The most important criterion applied to these accident source terms is that they should not underestimate potential releases. Therefore, conservative methodology was employed for the release estimates. Although the source terms are very conservative, excessive conservatism has been avoided by basing the releases on physical principles.

Since it is envisioned that the SNS facility may eventually (after about 10 years) be expanded and modified to support a 4-MW proton beam operational capability, the source terms estimated in this report are applicable to a 4-MW operating proton beam power unless otherwise specified. This is bounding with regard to the 1-MW facility that will be built and operated initially. See further discussion below in Sect. 1.2.

1.1 OTHER TYPES OF ACCIDENTS

The accidents addressed in this report do not consider two types of accidents that could occur at the SNS: accidents involving nonradiological hazards and accidents involving external exposure to penetrating radiation. The nonradiological hazards are not included because, as explained in Sect. 9 of the *SNS Conceptual Design Report*[1] (CDR), the nonradiological hazards present at an accelerator site during construction or operation can be characterized as standard industrial hazards. None of the SNS nonradiological accident hazards have any potential for harming people away from the immediate vicinity of the SNS buildings.

1.1.1 Toxic Materials

The presence of a nominal 1-m^3 volume of mercury could be considered to be a nonroutine industrial hazard, but two factors mitigate against such a conclusion: (1) the SNS mercury target is kept inside a closed system maintained at temperatures well below the boiling point of mercury, which is located inside a nonoccupied, ventilated hot cell and (2) the degree of containment and surveillance dictated by its radioactivity is more than sufficient to prevent excessive human contact. As shown in Exhibit A, the air concentration limit necessary to prevent occupational mercury poisoning exceeds by a factor of ~10 (i.e., is 10 times more permissive than) the limit that would be necessary to prevent excessive exposure to radiation after only one year of operation of the accelerator at the initially planned 1 MW of proton beam power. As the facility undergoes the planned upgrading to 2 MW, followed by the eventual upgrade to 4 MW, the specific radioactivity content of the mercury increases in direct proportion. Therefore, controlling the airborne radioactivity of mercury will be more limiting than controlling airborne mercury toxicity throughout the planed life of the facility.

1.1.2 Flammable Gases

The SNS target facility cryogenic neutron moderator employs a small quantity of hydrogen gas (about 1.5 kg), normally in the liquid form. Accidents of this system are considered in Sect. 3.10 of this report and are shown not to form a significant source term for release of radioactive material. The conceptual design, as discussed in Sect. 5.3.2 of the SNS CDR, provides a double-barrier (triple-boundary) hydrogen containment concept (hydrogen surrounded by vacuum surrounded by helium), monitoring instrumentation with alarm annunciation and controls to minimize the risk presented to workers involved in the operation and/or maintenance of this system. The installed hardware, safety and warning devices, automatic alarms and controls, and administrative procedures are expected and intended to make serious work injury by hydrogen combustion an extremely unlikely event.

1.1.3 External Exposure

Accidents involving external exposure to penetrating radiation are not specifically addressed in this report because beam control accidents or other accidents involving external irradiation have no potential for injuring members of the public at the well shielded SNS. The SNS proton beam is at every point, and for every possible beam misdirection, separated from the outside of the facility by many feet of concrete, steel, and/or dirt. The SNS shielding is designed in accordance with a shielding design policy (J. A. Alonso et al, "NSNS Shielding Policy," NSNS/97-9, May 1997) that requires shielding sufficient to render radiation levels very low on the exterior of the shield. For example, the external radiation exposure rate must not exceed 10 mrem/year at the site boundary.

There is a nonnegligible possibility for radiation injury to workers, but the SNS design and operational teams plan to make full use of the successful approaches to personnel protection that have been worked out during the past 50 years of accelerator development in the United States. The SNS is proposed to be built for scientific investigations, but the accelerator design involves concepts that have been proven at other facilities. Each of the candidate laboratories for SNS siting currently has active radiological control programs for accelerators. As explained in Sect. 9 of the SNS CDR, the SNS worker radiological protection program will use shielding, automatic beam cut-off devices, entry control devices, warning devices, and operator radiological training to ensure minimal risk to workers during operation of the SNS.

The Department of Energy (DOE) Regulation 10 CFR 835, "Occupational Radiation Protection," provides standards that must be followed in order to minimize the risk of excessive radiation exposure at DOE facilities. This includes requirements that must be followed for controlling access to and posting of radiation areas, high radiation areas, and very high radiation areas. The 10 CFR 835 definition of very high radiation areas is >500 rads in 1 h at 1 m, which is clearly in the potentially lethal range. During beam operation at high beam power, the SNS high energy tunnels meet the definition of a very high radiation area. In addition to training, use of procedures, posting, and other administrative safety features and programs, the SNS will have a high integrity automatic safety system, the personnel protection system, that will discontinue the proton beam whenever anyone tries to gain access to the interior of the proton beam tunnel.

Considering both administrative and automatic control functions, the risk of fatality or radiation injury because of external radiation (e.g., attempting tunnel access during beam operation) is judged to be in the extremely unlikely category. Moreover, this risk is well understood and accepted by those who operate accelerators in the DOE complex. The risk of tunnel access during beam operation is addressed above because it involves the highest radiation levels and is the most “dramatic” throughout the SNS facility.

There are other lesser risks involving direct radiation, such as the possibility for excess exposure during movement of highly activated components inside the target hot cell, for example, or when loading highly activated components into shipping casks. These risks are controlled within 10 CFR 835 by administrative programs, automatic protective or warning devices, and/or facility design measures, as appropriate to each particular application. Movement of activated components in shipping casks on public roads is subject to the regulation of the U.S. Department of Transportation.

1.2 ACCIDENTS WITH POTENTIAL TO RELEASE RADIOACTIVE MATERIAL

The potential radiological consequence of an accident involving release of radioactive material is determined by the inventory of radioactivity present in the process, the available transport mechanisms, and the installed mitigative features. Section 2 discusses the inventories and dispersabilities of radioactive nuclides to be found in the SNS components and structures. Section 3 presents the spectrum of accidents for the target and target components and provides estimates of the source terms for reasonably foreseeable accidents involving the potential for release of radioactive material. Chapter 4 derives source terms for accidents involving the target facility hot off-gas system and other waste-related systems.

The initial design for the SNS is for a 1-MW accelerator with a 1-MW target facility, upgradable to a 2-MW operation with modest refitting (the goal is that the needed modifications should be able to be completed during a 6-month shutdown of the facility). It is expected that the 2-MW operation will be achieved within approximately 5 years. After that, it is planned that a second ring will be built and a target plug/cooling system will be installed in the target facility that will be capable of 4-MW operation. It will probably take more than 10 years for 4-MW operation to be realized, and additional approvals from DOE will be required before its realization. An objective of this report is to specify bounding source terms that are applicable to the 4-MW operation that may eventually be achieved, provided that the extensive target modifications are made and that the additional ring is constructed. Unless indicated otherwise, the source terms were calculated for the 4-MW operation and, thus, bounding for the 1-MW operation. In some cases, source terms are given for both the 1-MW and the 4-MW configuration for comparison purposes. (Note: the target facility radionuclide inventory is directly proportional to the proton beam power, so the initial radioactivity for 4-MW target operation is four times higher than that for 1-MW operation.)

The evaluation of risk must consider the probability that a given hypothetical accident will occur during a given period of time. Quantitative probabilities have not been developed for the SNS accident sequences, but the various potential events have been placed in the frequency categories introduced in DOE-STD-3009-94: Anticipated, Unlikely, Extremely Unlikely, and Beyond Extremely Unlikely (beyond design basis). Probability per unit time (frequency) ranges are indicated in Chap. 3 based upon whether an accident is likely to occur at least once in the life of the facility (anticipated event—frequency >0.025/year for a 40-year lifetime), not likely to occur even once in the facility lifetime (unlikely event—frequency range 0.025/year to 10^{-4}/year), or very unlikely to occur even during many facility lifetime or longer (extremely unlikely event). All of these three categories are considered to be design-basis events. A fourth category is postulated for risk assessment purposes—the beyond-design-basis (BDB) category. Events in this category are physically plausible but are not considered credible events. The frequency range could, in a very approximate sense, be stated as being from 10^{-8}/year to 10^{-6}/year. The BDB category events are postulated in order to obtain full understanding of potential consequences without being constrained as to whether the event(s) are actually credible.

Events are assigned to a frequency category based on experience and on engineering judgement considerations such as whether the failure in question is something relatively likely, such as a pump stopping or a valve being inadvertently closed by an operator; something somewhat unlikely (e.g., a sudden major pipe break or other boundary failure); or something very unlikely (e.g., the total failure of a redundant, multichannel beam cutoff system.

A bounding approach has been used for accident analysis in this report. The objective of the methods used to estimate source terms is to provide accident release estimates that have enough conservatism to allow for design evolution that will occur as the design proceeds from conceptual to detail design and then to construction.

In one spirit of ensuring bounding source terms, the accident durations are typically much longer than would be the case if any of the hypothetical events actually occurred. This is true because very little or no credit has been taken for accident mitigation procedures that would be available to the facility operators. Therefore, some accident durations longer than 8-hours, for example, are listed. This is done only to maximize the calculated bounding source terms and does not imply that the facility operators would not be able to take action to curtail an actual release much sooner.

This report should be read in conjunction with the SNS CDR and the SNS Design Manual (to be published later this year). The extensive descriptions of facilities and drawings contained in these design documents are not repeated here. In addition, reference can be made to recent papers[2,3] addressing the use of mercury in spallation neutron source systems.

1.3 REFERENCES

1. The NSNS Collaboration, *National Spallation Neutron Source Conceptual Design Report*, NSNS/CDR-2/V1 and V2, Lockheed Martin Energy Research Corp., Oak Ridge Natl. Lab., May 1997.
2. D. Filges, R. D. Neef, and H. Schaal, “Nuclear Studies of Different Target Systems for the European Spallation Source (ESS),” ICANS-XIII, 13th Meeting of the International Collaboration on Advanced Neutron Sources, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland, October 11–14, 1995.
3. G. S. Bauer, “Mercury as a Target Material for Pulsed (Fast) Spallation Neutron Source Systems,” ICANS-XIII, 13th Meeting of the International Collaboration on Advanced Neutron Sources, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland, October 11–14, 1995.

2. RADIONUCLIDE INVENTORIES

The purpose of this section is to acquaint the reader with the inventories of radioactive material that will accumulate in the SNS systems, structures, and components, and to point out which inventories of radionuclides could realistically be released in quantities sufficient to cause significant radiation exposure at a distance from the SNS facilities.

For the SNS, the greatest inventory of radioactive material is found in the target facility, more specifically in the mercury that is bombarded by the beam of 1000-MeV protons to produce neutrons by the spallation reaction. Activated mercury and radioactive spallation products (of atomic weight all the way down to tritium) are the byproducts of the intense neutron flux and the spallation reactions. Components other than the target become radioactive by virtue of spallation and/or activation, but at a much lower level and with a much more restricted list of radionuclides.

The methodology described in Sect. 5.4 of the SNS CDR was employed to calculate the inventories of radionuclides. This involved use of the HETC96 particle generation and hadronic transport code, the Monte Carlo neutron photon (MCNP) code for low energy (<20 MeV) neutron transport, and the ORIHET95 code to track isotope production and decay.[1] Only the radionuclides that are potentially significant are presented in Table 2.1.

The reported inventories are calculated under the assumption that the accelerator operates continuously at 4 MW for 30 years. This is a reasonable or conservative assumption for three reasons. First, the accelerator operation is not continuous. The total yearly operating time will actually be about 70% of the time (~6000 h per year). Typically, the proton beam will be on target for 3 or 4 weeks and then will be down for adjustment or experiment change-out. Once a year, there will be an approximately 6-week to 2-month outage for more time consuming maintenance and refurbishment. Thus, the nominal 40-year facility life will accumulate no more MW × years of proton beam time on-target than would 30 years of continuous service, if that were possible. Second, upgrading the SNS to a 4-MW power level will be a deliberate process, with the final upgrade from 2 MW to 4 MW requiring construction of a second accumulator ring (each ring will be capable of handling 2 MW of proton beam power). Thus, it may be 10 years before the power is upgraded to 4 MW. The reader is referred to the discussion in Sect. 1.3.5 of the CDR. Third, it is expected that a second target facility will be added early in facility life. This second target facility (a separate building) will operate at a lower pulsing rate (about 10/s instead of about 50 to 60/s) and also a lower beam power. This will take MW × years away from the higher-power main target building to which this report is addressed. These factors add a degree of conservatism to the Table 2.1 target system inventories.

DOE Standard 1027-1992 (Change Notice No. 1, September 1997) provides radioactivity thresholds for evaluating, on a quick, screening basis, whether the quantity of radioactivity in a facility is capable of causing only localized consequences (i.e., consistent with low hazard or Category 3 facilities), as opposed to being able to cause consequences that could cover a wider area on site (moderate hazard or Category 2 facilities). The Category 2 thresholds were used as a basis for comparison of inventories of radionuclides in different locations. For instance, where threshold values were not provided by STD-1027-92, the methodology defined in STD-1027-92 was used to calculate the appropriate thresholds.

Specifically, the Category 2 thresholds define how much radioactivity would have to be involved in a generic accident in order to cause a radiation dose of 1 rem at 300 m assuming a ground level release and specified meteorological conditions. The source terms (release fractions) assumed by STD-1027-92 for the generic accident are based on the physical form of the radioactive material involved: 100% is assumed for gaseous and highly volatile materials; 50% is assumed for halogens (e.g., iodine); 1% is assumed for semivolatiles such as mercury; and 0.1% is assumed for all others. For nuclides not specifically addressed in STD-1027-92 or other DOE publications, one user must input dose conversion factor values. For example, updated dose conversion values,[2,3] were used for mercury and mercury daughter radionuclides.[2,3]

In this chapter, radioactivity inventory thresholds based on STD-1027-92 methodology are used to obtain a relative understanding of the potential radiological health impacts of amounts of radioactivity found throughout the SNS facilities.

The results of the radionuclide inventory hazard screening (Table 2.1) show very clearly that the radionuclides in the target mercury dominate the potential release hazards. For example, if all the radionuclides in the SNS target mercury are considered, the SNS target mercury's spallation/activation products are estimated after 30 years of continuous operation at the maximum 4-MW beam power (see last two pages of Table 2.1 and/or Exhibit B) to have an aggregate radioactivity inventory of about 9.5 times the DOE Category 2 threshold, whereas the corresponding aggregate for any accelerator component (e.g., the neutral beam stop, first page of Table 2.1) would be more than two orders of magnitude lower. This identifies the mercury target and its hot cell as a preliminary candidate Hazard Category 2 facility. Whether the preliminary Category 2 designation remains, or is changed to Category 3, will depend upon safety analyses to be done in the next phase of design. As explained in DOE-STD-1027-92, ". . . for facilities initially classified as Hazard Category 2, if credible release fractions can be shown to be significantly different than these values based only on physical and chemical form and available dispersive energy sources . . .," the facility may be placed in Category 3 instead. This designation must be approved by DOE, and the burden of proof is upon the contractor to demonstrate that the ground rule conditions exist. Chapters 3 and 4 of this report provide conservative, event-sequence-specific source terms for more detailed study of the consequences of radioactivity release accidents of the SNS target mercury and related off-gas system.

A conclusion that can be drawn from Table 2.1 is that radioactive material release accidents of the accelerator, including its beam stops(but not including the mercury target system), would not be capable of causing significant radiation exposures beyond the confines of the accelerator because the amounts of radioactivity present range from negligible to modest and because the radioactivity present is primarily distributed throughout activated metal structures and is thus of very low dispersability. Considering the most highly activated part of the accelerator, the ring injection beam stop, we see that the total inventory is about 10% of the Category 2 limit (see first page of Table 2.1). The corresponding radiation exposure that could, per the DOE-STD-1027-92 methodology, be expected at 300 m as a result of a beam stop accident, with ground level release of the prescribed fractions of the radionuclide inventory, would therefore be about 10% of 1 rem, or about 100 millirem, which is comparable to the annual natural background. For this reason, the source terms reported for further analysis in Chap. 3 concentrate on the much more radioactive target and related systems.

Exhibit B presents the inventory of radionuclides in the target mercury after 30 years of continuous irradiation by a 1-MW proton beam, which is equivalent to about 40 years of actual operation (~6000 h/year of high power beam operation). The inventory corresponding to operation for the same period at a 2-MW or a 4-MW proton beam power can be accurately determined by multiplying by 2 or 4, respectively, since the buildup and decay of radioactive nuclides is linear with respect to the proton beam power level.

Table 2.1. SNS radioactivity inventories survey for operation with 4-MW proton beam

Area or component (Ref. Table 5.4-5, Fig. 5.4-6 in SNS CDR, NSNS/CDR-2/V1)	**Radioactivity (Ci)** Decay energy (W)	Nuclides present in quantity >0.1% of DOE Cat. 2 hazard threshold[a]: Nuclide inventories[b] (Ci)	Fraction of DOE Cat. 2 threshold	**Dispersability assessment**
Per 10 m of linac or ring high energy beam tube and surroundings[c]	1.4 W in 680 Ci	None in quantity >0.1% of Cat 2 threshold	None	N/A
Accelerator neutral (i.e., ring injection) beam stop Cu + H_2O. Irradiated by 200 kW proton beam continuously for 30 years; equivalent to nominal 40-year life. This is bounding with respect to the other beam stops, which are operated intermittently	300 W in 2.8E6 Ci	***Volatile/gaseous*** H-3: 4.6E3 N-13: 166 N-16: 120 O-15: 654	 1.6E-2 2.6E-3 1.0E-2 1.1E-2	Most of the indicated H-3 inventory is bound in the copper metal of the beam stop and thus not readily releasable. The amount in beam stop coolant H_2O is estimated at well below 1000 Ci (this H_2O is periodically replenished). The gaseous isotopes of N and O are associated with the cooling water, and therefore subject to release
		Nonvolatile Cu-64: 2.8E6 P-32: 1.6E2 Co-60: 1.8E3 Na-22: 2.2E1 Co-56: 2.4E3	3.0E-2 1.6E-2 9.6E-3 3.0E-3 2.4E-3	Release of these nuclides would require vaporization of the metallic beam stop (highly unlikely) combined with failure of the beam stop ventilation system HEPA[d] filters to eliminate any resulting aerosol from the exhaust air
Accelerator neutral beam stop, stainless steel + H_2O (i.e., inner shielding)	114 W in 2.8E5 Ci	***Nonvolatile*** Fe-55: 1.2E5	 4.8E-3	Significant release would require vaporization of the stainless steel shielding structure combined with failure of the beam stop ventilation system HEPA filters
Target SS-316 after 1 year (expected replacement before 0.5-year)	3.3E2 W in 3.6E5 Ci	***Nonvolatile*** P-32: 2.0E2 Cr-51: 2.8E5 Fe-59: 5.7E3 Fe-55: 5.0E4 Na-22: 1.1E1 K-42: 7.4E1 Mn-54: 4.6E3	 1.9E-2 2.7E-3 2.1E-3 2.1E-3 1.7E-3 1.6E-3 1.1E-3	Nonvolatile elements held inside stainless steel. Not subject to release unless stainless steel is vaporized and HEPA filters fail
Target, H_2O (shroud cooling water)	46 W in 4.7E3 Ci	N-13: 6.2E2 N-16: 3.9E2 O-14: 2.1E2 O-15: 2.9E3	1.0E-2 3.4E-2 1.8E-2 4.6E-2	Volatile/gaseous nuclides subject to release if water spill occurs

Table 2.1 (continued)

Area or component (Ref. Table 5.4-5, Fig. 5.4-6 in SNS CDR, NSNS/CDR-2/V1)	**Radioactivity (Ci)** Decay energy (W)	Nuclides present in quantity >0.1% of DOE Cat. 2 hazard threshold[a] Nuclide inventories[b] (Ci)	Fraction of DOE Cat. 2 threshold	**Dispersability assessment**
Target, moderator Al	540 W in 3.0E4 Ci	Na-22: 42 Na-24: 330 Al-28: 2.9E4	6.6E-3 9.8E-2 1.E-3	Structure made of nonvolatile aluminum that is not released unless vaporized
Target, cryogenic H_2 moderator	~0	None	None	N/A
Target, moderator H_2O	7 W in 488 Ci	***Volatile/gaseous*** N-13: 75 N-16: 110 O-15: 270	 1.2E-3 9.6E-3 4.4E-3	Gaseous nuclides could be released if target moderator water spilled
Target, Reg. IV & V, reflector Be/D_2O (As noted in the SNS CDR, lead is under consideration for use in reflector rods; due to the relatively low activation characteristics of lead, this does not increase the hazard profile of the reflector activation products substantially above what is shown here for Be)	4.3 kW in 2.7E6 Ci	***Volatile/gaseous*** H-3: 3200 N-13: 420 N-16: 520 O-15: 1700	 1.1E-2 6.8E-3 4.6E-2 2.7E-2	Gaseous nuclides could be released if reflector cooling water spilled
		Nonvolatile P-32: 2.0E1 Cr-51: 1.4E6 Mn-54: 1.E4 Fe-55: 1.1E6 Fe-59: 3.3E4 Co-60: 2.8E2 Ni-63: 1.3E5	 1.9E-3 1.4E-2 2.4E-3 4.5E-2 1.2E-2 1.5E-3 8.6E-3	Nonvolatile elements in the reflector metal structure. Release would require mass vaporization combined with failure of HEPA filtration
Target, Reg. VI & VII Ni reflector + D_2O coolant	0.64 kW in 2.5E5 Ci	***Volatile/gaseous*** N-16: 23 O-15: 74	 2.0E-3 1.2E-3	Gaseous nuclides could be released if reflector cooling water spilled.
		Nonvolatile Co-56: 1.1E4 Co-57: 2.7E4 Co-58: 1.4E4 Co-60: 1.2E3 Ni-63: 1.2E5	 1.0E-2 7.2E-3 3.6E-3 6.1E-3 8.1E-3	Nonvolatile elements in the reflector metal structure. Release would require mass vaporization combined with failure of HEPA filtration

Table 2.1 (continued)

Area or component (Ref. Table 5.4-5, Fig. 5.4-6 in SNS CDR, NSNS/CDR-2/V1)	Radioactivity (Ci): Decay energy (W)	Radioactivity (Ci): Nuclides present in quantity >0.1% of DOE Cat. 2 hazard threshold[a]: Nuclide inventories[b] (Ci)	Radioactivity (Ci): Nuclides present in quantity >0.1% of DOE Cat. 2 hazard threshold[a]: Fraction of DOE Cat. 2 threshold	**Dispersability assessment**
Target, Reg. VIII & IX Ni reflector + H_2O coolant	3.1 kW in 6.0E5 Ci	***Volatile/gaseous***		Gaseous nuclides could be released if reflector cooling water spilled
		N-13: 122	2.E-3	
		N-16: 87	7.6E-3	
		O-15: 860	1.4E-2	
		Nonvolatile		Nonvolatile elements in the reflector metal structure. Release would require mass vaporization combined with failure of HEPA filtration
		Na-22: 2.7E1	4.2E-3	
		Mn-52: 1.2E4	2.9E-3	
		Mn-54: 8.5E3	2.0E-3	
		Co-55: 1.4E3	1.3E-3	
		Co-56: 7.4E4	7.1E-2	
		Co-57: 1.5E5	4.1E-2	
		Co-58: 4.2E4	1.1E-2	
		Co-60: 6.3E3	3.3E-2	
		Ni-56: 3.6E3	1.3E-3	
		Ni-57: 4.1E4	3.7E-3	
		Ni-63: 1.4E4	9.1E-3	
Target, Reg. X Ni reflector + H_2O coolant	2.1 kW in 7.0E5 Ci	***Volatile/gaseous***		Gaseous nuclides could be released if reflector cooling water spilled.
		N-13: 68	1.1E-3	
		N-16: 82	7.1E-3	
		O-15: 260	4.1E-3	
		Nonvolatile		Nonvolatile elements in the reflector metal structure. Release would require mass vaporization combined with failure of HEPA filtration
		Co-56: 3.13E4	3.0E-2	
		Co-57: 8.3E4	2.2E-2	
		Co-58: 5.3E4	1.4E-2	
		Co-60: 3.9E3	2.0E-2	
		Ni-57: 1.9E4	1.7E-3	
		Ni-63: 4.1E5	2.7E-2	
		Ni-65: 6.7E4	1.0E-3	
Target, Reg. XI and XII, Fe shielding + H_2O coolant	200 W in 2.0E5 Ci	***Volatile/gaseous***		Gaseous nuclides could be released if shield cooling water spilled
		N-16: 14 Ci	1.3E-3	
		Nonvolatile		Nonvolatile elements in the reflector metal structure. Release would require mass vaporization (not credible) and failure of HEPA filtration (unlikely)
		Na-22: 1.4E1	2.2E-3	
		P-32: 4.0E1	3.9E-3	
		Mn-54: 6.7E3	1.8E-3	
		Fe-55: 1.8E5	7.5E-3	

Table 2.1 (continued)

Area or component (Ref. Table 5.4-5, Fig. 5.4-6 in SNS CDR, NSNS/CDR-2/V1)	Decay energy (W)	**Radioactivity (Ci)** Nuclides present in quantity >1.0% of DOE Cat. 2 hazard threshold[a]: Nuclide inventories[b] (Ci)	Fraction of DOE Cat. 2 threshold	**Dispersability assessment**
Target, Hg, after 30-year continuous irradiation by 4 MW proton beam (The mercury H_2O coolant does not become activated because it is outside the target plug. Double-walled heat exchanger tubes are used to prevent Hg from entering the cooling H_2O) The target mercury is not changed during the facility life. The buildup of radioactivity is not dependent upon the total Hg volume (~1 m^3), or upon the rate of circulation of the mercury.	9.6 kW in 3.6E6 Ci	**Volatile/gaseous**		The parentheses indicate that this inventory will not actually be present—a helium purge flow purges gaseous H-3 from the target Hg and transports it to a hydride bed in the hot off-gas system, where it is unlikely to be released (see Sect. 4). Some tritium will form stable, nonvolatile hydrides with spallation products in the Hg, but tritium in this state will not be readily releasable
		H-3: 2.4E5	(0.78)	
		Semivolatile		Iodine combines chemically with Hg to form Hg2I2, but the accident source terms assume 100% release to ensure conservatism (see Chap. 3)
		I-124: 6.8E1	0.052	
		I-125: 3.0E2	0.27	
		I-126: 1.4E1	0.023	
		Hg-189: 6.8E3	0.16	
		Hg-193:4.1E4	0.067	Hg is subject to evaporation in Hg spill accidents, which is considered in formulation of the source terms (see Chap. 3).
		Hg-194: 4.5E3	0.24	
		Hg-195: 6.9E4	0.13	
		Hg-197: 4.7E5	2.6	
		Hg-203: 3.3E5	3.0	

Table 2.1 (continued)

Area or component (Ref. Table 5.4-5, Fig. 5.4-6 in SNS CDR, NSNS/CDR-2/V1)	Decay energy (W)	**Radioactivity (Ci)** **Nuclides present in quantity** >1.0% of DOE Cat. 2 hazard threshold[a] Nuclide inventories[b] (Ci)	Fraction of DOE Cat. 2 threshold	**Dispersability assessment**
		Nonvolatile		Not subject to release: these elements have essentially zero vapor pressure at normal and accident temperatures. They are either dissolved in the Hg or have plated out on an interior Hg system surface or been filtered out of the Hg
		Gd-148: 7.6E2	2.2	
		Hf-172: 1.6E4	0.14	
		Au-195: 9.0E4	3.8E-2	
		Au-188: 1.3E4	3.1E-2	
		W-175: 1.3E4	3.0E-2	
		W-174: 1.2E4	2.8E-2	
		Hf-171: 9.4E3	2.2E-2	
		Os-183M: 8.76E3	2.0E-2	
		Lu-168: 7.2E3	1.7E-2	
		Ta-171: 7.2E3	1.7E-2	
		Lu-167: 7.0E3	1.6E-2	
		Os-179: 7.0E3	1.6E-2	
		Tb-152: 6.4E3	1.5E-2	
		Hf-168: 6.1E3	1.4E-2	
		Ho-158: 5.8E3	1.4E-2	
		Ta-170: 5.6E3	1.3E-2	
		Dy-153: 5.0E3	1.2E-2	
		Er-158: 5.0E3	1.2E-2	
		Tm-164: 4.9E3	1.1E-2	
		Dy-152: 4.8E3	1.1E-2	
		Yb-164: 4.8E3	1.1E-2	
		W-172: 4.8E3	1.1E-2	
		Ho-160: 4.5E3	1.1E-2	
		Tm-165: 4.4E3	1.0E-2	
		Er-160: 4.4E3	1.0E-2	

Table notes:

[a]DOE Standard 1027-1992 defines facility hazard categories and inventory thresholds for screening purposes. The Category 2 threshold for a nuclide is the quantity of that nuclide that, if involved in an accident, could impart a radiation dose of 1 rem at a distance of 300 m under average meteorological conditions. Published threshold values were available from STD-1027 or from DOE-STD-6003-96 for most of the nuclides in this table. Where neither published threshold values nor dose conversion factors were available, the thresholds were typically taken as the 4.3E5 generic threshold value suggested by STD-1027-1992 for beta-gamma emitters. (See also Exhibit B)

[b]Note “E” nomenclature used to indicate 10 raised to a power (e.g., E-3 means 10^{-3}). Reported inventories are for 4-MW operation for 40 years (40 years of on and off operational cycles is simulated as 30 years of continuous operation in the calculations). The beam stops are assumed to operate continuously at 0.2 MW for 30 years. Beam stops may be operated for short periods at higher beam power, but the 0.2 MW for 30 years is conservative with respect to inventory buildup over the life of the facility. Only the neutral beam stop (ring injection stop) operates continuously during normal operation.

[c]The high energy end of the linac and the ring operate with particle energy of ~1000 MeV. The activation levels become progressively lower from the high energy end to the low energy end. The activity calculations represented the beam tube and its immediate surroundings (e.g., magnets) as one lump of copper. The activation levels present in the linac and ring beam tube and surrounding structures depends on beam losses that are not a direct function of proton beam power. When the SNS is upgraded from 1 to 2 and/or to 4 MW, every attempt will be made to maintain the same beam losses in order to avoid increased structural activation that would complicate radiation protection for maintenance activities. No activation occurs in the ion-source facility because particle energies are below the coulomb barrier there.

[d]High-efficiency particulate air.

2.1 REFERENCES

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2. "Dose Coefficients for Intakes at Radionuclides by Workers," ICRP-68, Annals of the ICRP, 24(4), 1994.
3. K. Eckerman, ORNL, E-mail letters dated June 18, 1998 and August 24, 1998, transmitting "Hg and Hg Daughter and Hg Spallation Product Dose Conversion Factors."

3. SOURCE TERM DEVELOPMENT: TARGET AND TARGET COMPONENTS

3.1 INTRODUCTION

This chapter provides detailed consideration of target and target component accidents that could release significant amounts of radioactive material to the environment (see Chap. 4 for target facility hot off-gas system accidents and liquid waste system–related accidents). Recommended source terms for target facility accidents are summarized in Table 3.1, and the major facts of the accident sequences are presented in Table 3.2. Individual sequences and source term development are discussed in Sects. 3.1 through 3.17. In some cases, the same source term applies—in a bounding sense—to several accidents. Table 3.1 indicates which events are bounded by each of the given recommended source terms.

The initial design for the SNS is a 1-MW target facility upgradable to a 2-MW operation with minimal refitting (e.g., up to a 6-month shutdown for any needed modifications). It is expected that the 2-MW operation will be achieved within approximately 5 years. After that, it is planned that a second ring will be built, and a target plug/cooling system will be installed in the target facility that will be capable of 4-MW operation. It will probably take more than 10 years for 4-MW operation to be realized. An objective of this chapter has been to specify source terms that are applicable to 4-MW operation. Unless indicated otherwise, the stated source terms are for 4-MW operation, and, therefore, bounding with respect to 1-MW operation.

3.1.1 Selection of Target Accident Sequences

As shown in Chap. 2, the target mercury has the most significant inventory of radioactive materials of all the SNS components and systems. Preventing release of those radioactive materials depends primarily upon three things: (1) maintaining control of the energy input to the mercury (i.e., the proton beam), (2) maintaining continuous cooling of the mercury during proton beam operation, and (3) maintaining the integrity of the mercury system itself. The first four accident sequences in this chapter evaluate potential source terms associated with these three important parameters. Section 3.2 examines beam control faults; Sect. 3.3, system integrity faults; Sect. 3.4, loss of mercury forced flow; and Sect. 3.5, loss of mercury cooling water. Depending on sequence-specific details and additional failures that are assumed, any of the first four sequences could involve release of mercury and/or its contained spallation and activation products. Section 3.14, loss of off-site power; Sect. 3.15, fire; and Sect. 3.16, natural phenomena, evaluate external events or common mode internal events that could affect mercury system integrity and/or cooling. The decay heat generation in the mercury after cutoff of the proton beam is sufficiently low that events such as loss of off-site power (Sect. 3.14) do not have the potential for compromise of mercury confinement integrity.

When the proton beam is operating, about 66% of the beam's energy ends up as thermal energy dissipation in the mercury held in the mercury vessel. The balance of the proton beam's energy supplies binding energy for the spallation process, escapes into the surrounding components, or is subtracted from the beam as it passes through the barriers between the accelerator-produced beam and actual target mercury: these barriers are the proton beam window, the water-cooled shroud, and the front face ("window") of the mercury vessel (see Fig. 5.3-6 in Chap. 5 of the CDR). Clearly, the beam has the potential to cause failure of mercury

Table 3.1. Source term summary—mercury target systems
(frequency ranges: $2.5(10)^{-2}$/year<**A**<10^{0}/year; 10^{-4}/year<**U**<$2.5(10)^{-2}$/year;
10^{-6}/year<**EU**<10^{-4}/year)

Frequency category	**Event(s)** (sequence number(s) as used throughout Chap. 3, Table 3.2)	Recommended source term		
		Material released	Time span[a]	Nuclides released to environment
A	1, 3, 4, 5, 6, 7, 13	None	NA	None
A	2.SL—Loss of Hg vessel or pipe integrity: slow leak to air inside target cell	Hg vapor	Indeterminant	Radiation exposure calculation not required since operation would be curtailed before exceeding EPA off-site airborne exposure limit
A	8.SL—Loss of H_2O or D_2O component cooling system integrity, slow leak	Tritiated H_2O or D_2O vapor, as applicable	Indeterminant	Radiation exposure calculation not required since operation would be curtailed before exceeding EPA off-site airborne exposure limit
A	8.SL—Slow leak into core vessel (this is an example of the sort of event that 8.SL can represent)	Tritiated H_2O or D_2O vapor, as applicable	30 d	18 L of H_2O or D_2O released over 30-d period. Source term is 90 Ci of tritium for D_2O cooling system and 9 Ci of tritium for H_2O cooling system
A	8.MF—Loss of H_2O component cooling system integrity, major failure	Tritiated H_2O plus N and O gaseous nuclides	First 5 min: mist release and N, O release. First 1/2 h: H_2O vapor release	150 L of H_2O evaporated over a ≥1/2-h period releasing 75 Ci of tritium. See Table 3.6 for N and I isotopes release. Mist entrainment release: 7.5 Ci tritium plus List 8 (Exhibit E) * [beam power/ (1 MW)] * 0.005
A	8.MF, 7/ABC/—Loss of D_2O component cooling system integrity, major failure	Tritiated D_2O plus N and O gaseous nuclides	First 5 min: mist release and N, O release. First 1/2 h: D_2O vapor release	150 L of D_2O evaporated over a ≥1/2-h period releasing 750 Ci of tritium. The N and O isotopes (see Table 3.4) released over a ≥5-min period. Mist entrainment releases: 75 Ci tritium plus List 8 (Exhibit E) * (beam power/ 1 MW) * 0.005
U	10—Loss of integrity of target core vessel (~3.5-m diam target containment vessel)	Gaseous products from spallation, activation of air	NA	Radiation exposure calculation not required since operation would be curtailed before exceeding EPA off-site airborne exposure limit
U	12—HEPA filter failure	Unfiltered target cell exhaust released	NA	Radiation exposure calculation not required since operation would be curtailed before exceeding EPA off-site airborne exposure limit
U	2.MF—Loss of Hg vessel or pipe integrity: major fault	Hg vapor, radio-iodine	Initial release specified for first 10 min; additional release over 8 d	1 L of nondrained Hg assumed to evaporate over 8-d (0.14% of total inventory). See Table 3.4. Iodine contained in 1 L of Hg assumed to be released

Table 3.1 (continued)

Frequency category	**Event(s)** (sequence number(s) as used throughout Chap. 3, Table 3.2)	**Recommended source term**		
		Material released	Time span[a]	Nuclides released to environment
U	Design basis natural phenomena—tornado, earthquake	Either no release or minor releases since natural phenomena in the unlikely range are within the target facility design basis		
EU	2.MF/mercury enclosure/—Major loss of Hg vessel or pipe integrity with assumed failure of mercury enclosure and/or its drainage system. Also bounds other EU events (e.g., EU filter fire, EU natural phenomena)	Hg vapor, radio-iodine	Initial release specified for first 10 min; additional release over 30 d	See Table 3.4. Total of 0.24% of Hg and 100% of iodine released
BDB	2/ABC/, 3/ABC/—Loss of Hg forced circulation with failure of the BP and TPS automatic beam cutoffs, plus Hg drainage path blocked, water-cooled shroud failure	Hg vapor, radio-iodine	Releases broken down for first 10 min, days 1–7, and days 8–30	Total of 1.1% (1-MW case) or 1.3% of Hg released (4-MW case). 100% of radioiodines released in either case. See Table 3.8

[a]The time spans listed are bounding and do not credit the full range of recovery actions that operations personnel would take to curtail or stop releases much sooner.

containment barriers and/or to cause elevated mercury temperatures in a short period of time. After cut off of the proton beam, the rate of decay heat dissipation within the mercury (~2.5 kW at 1 MW or 10 kW at 4 MW) does not require active cooling.

Other target systems (e.g., moderators and reflectors) have radioactive material inventories, and this chapter also considers accident sequences that could threaten release of radioactive material from those systems. Chapter 4 considers potential target facility off-gas and waste system accident sequences and source terms.

3.1.2 Proton Beam Cutoff

The single most important parameter in any target facility accident sequence is timely cut off of the proton beam when unusual conditions occur. In order to prevent damage, the cutoff must occur on a time scale consistent with the abnormal condition that is occurring. For example, following a loss of forced mercury flow, the beam must be cut off while the flow is coasting down if damage is to be avoided (i.e., within a few seconds). At the slower end of the spectrum, following a loss of cooling to the mercury heat exchanger, the beam must be cut off within a few minutes. Failure to cut the beam off can result in inadequate cooling of the mercury vessel walls with uncontrolled heat-up and over-temperature failure. Furthermore, continued proton beam operation following barrier failure would provide a driving energy for escape of radioactive material from the target system.

Table 3.2. Target accidents
(frequency ranges: $2.5*10^{-2}$/year<**A**<10^{0}/year; 10^{-4}/year<**U**<$2.5*10^{-2}$/year;
10^{-6}/year<**EU**<10^{-4}/year)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
Events that initially (by definition) or potentially involve mercury system integrity					
1.A—Loss of control of proton beam: too narrow beam focus (A)	•Focusing magnet diagnostic signals •Beam current density detector upstream of target	•Automatic beam cutoff (ABC) via beam permit (BP) system	No damage. High proton flux density for one or two pulses not sufficient to cause damage	NA	Proton beam cutoff, target facility in standby
1.A/ABC/—Too narrow beam focus, with failure of focusing magnet and beam focus alarms (EU)	•Same as above, plus possibility of Hg spill-related alarms •Change in neutron production	•Failure of BP beam trip(s) on focus fault •BP or TPS cutoff on Hg spill-related signals	Proton beam might overheat the Hg vessel and/or water-cooled shroud leading to H_2O and/or Hg spill(s)	•Mercury spill confinement and drainage system •Hot cell ventilation and air treatment systems •If water-cooled shroud fails, neutron beam windows prevent radioactive material from entering the neutron beam tubes/guides	Proton beam cutoff, and: •Passive dissipation of Hg decay heat (no pumping required) •Spilled mercury in collection tank or other closed location within hot cell or core vessel
1.B—Loss of control of proton beam: diffuse focus (A)	•Change in neutron production	NA—none needed	No damage expected—diffuse focus distributes proton beam over wider area, reducing heat flux	NA—none needed	May continue operating at near normal, or proton beam may be cut off
1.C—Misdirected proton beam (A)	•Magnet status alarm •Tunnel radiation level	•ABC—via BP	None. Beam cutoff occurs before any damage can occur	•The collimator prevents impingement of proton beam upon nontarget components (e.g., moderators or reflectors)	Beam off for troubleshooting
1.C/ABC/—Misdirected proton beam with failure of magnet status and tunnel radiation alarms (EU)	Same as above plus alarms on: •Loss of beam tube vacuum, and •Isolation valve closure	•ABC on magnet status, tunnel radiation fail •ABC on isolation valve closure after loss of vacuum	Proton beam may burn through the beam tube: •Resulting loss of beam tube vacuum initiates signal for auto closure of "upstream" isolation valve	•The collimator prevents impingement of proton beam upon nontarget components	Beam tube burned through and isolated from ring beam tube by closed isolation valve; some ablation of scraper

Table 3.2 (continued)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
2.MF—Loss of Hg vessel or pipe integrity: major fault (U) (MF = major failure)	•Hg presence (e.g., conductivity alarm) •Low level in reservoir tank	•ABC by BP and/or TPS	Hg pump maintains Hg circulation until level too low. ABC occurs before circulation ceases or additional damage	•Mercury spill confinement and drainage system •Hot cell ventilation and air treatment systems	Spilled mercury drains to collection tank. Passive dissipation of decay heat
2.MF/ABC/—Loss of Hg vessel or pipe integrity with failure of mercury level and leakage alarms (EU)	Same as above, plus •Target cell radiation levels	•ABC by BP and TPS fail •ABC by the personnel protection system (PPS) based on high radiation levels in target hot cell	The initiating boundary failure plus possibly some additional ablation of otherwise uninvolved target structures	Same as above	Same as above
2.SL—Loss of Hg vessel or pipe integrity: slow leak to air (A) (SL = slow leak)	Radiation levels in cell exhaust, stack emission monitors	NA	No damage except spread of contamination	Operators take the target out of service to avoid exceeding annual emission limits	Proton beam is cut off with active or passive cooling to remove residual heat from the Hg
2.HXL—leak in Hg*H2O heat exchanger (A)	Interspace between double-walled heat exchanger tubes is monitored	NA	NA	Operators shut down the operation when/if tube leakage excessive	•Shutdown in preparation for heat exchanger repair and cell cleanup
3—Loss of mercury pumping (A)	•Hg Pump status •Hg flow, or pump ΔP •Hg temperature	•ABC by BP and/or TPS	No damage. Proton beam cut off before Hg temperature becomes excessive	NA	•Proton beam is cut off •Passive removal of nuclide decay heat from target Hg
3/ABC/—Loss of mercury pumping with failures of pump status/flow alarms (EU to BDB)	Same as above, plus spill-related signals: •Hg level inside Hg system •Hg presence outside Hg system	•ABC failure but back-up ABC on spill-related signal(s) occurs if Hg vessel fails	•Hg temp increases •Hg vessel may fail if Hg boiling occurs •Sequence after Hg vessel failure (if any) similar to other Hg spill events	If severe enough to cause Hg boundary failure, then Hg drainage and confinement features provide mitigation	•Proton beam is cutoff •Passive removal of nuclide decay heat from target Hg
4—Loss of H_2O cooling of Hg*H_2O heat exchanger (A)	•H_2O cooling flow •H_2O pump status, or •Hg temperature	•ABC by BP and/or TPS	No damage. Hg temp begins increasing, but proton beam is quickly cut off	None needed	•Proton beam is cut off •Passive removal of nuclide decay heat from target Hg

Table 3.2 (continued)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
4/ABC/—Loss of cooling H_2O flow in Hg*H_2O heat exchanger with failure of cooling water pumping status alarm(s) (EU)	Same as above, plus spill-related signals: •Hg level inside Hg system •Hg presence outside Hg system	•ABC failure •Back-up ABC on spill-related signals	•Hg temp increases •Burn through or rupture of Hg vessel could occur if localized Hg boiling occurs •Sequence after Hg vessel failure (if any) similar to other Hg spill events	•Heat-up rate (25°C/min for 1-MW operation) allows adequate time for operator cut off of proton beam before damage (e.g., failure of Hg boundary)	•Proton beam is cut off before significant damage •Hg circulation continues with passive dissipation of decay heat-to-heat sinks surrounding the Hg system
Events involving target component cooling					
5—Loss of H_2O flow: water-cooled shroud (A)	Pump status and/or low flow alarm(s)	•ABC by BP and/or TPS	No damage due to prompt beam cut off	NA	Proton beam cut off, target facility in standby
5/ABC/—Same as above, with failure of pump status and/or low flow alarm(s) (EU)	•Increase in neutron production •Increase in core vessel pressure	•ABC failure	•Shroud may fail if H_2O boils	Spilled H_2O, if any, drains to the collection tank or remains inside core vessel. Aluminum windows prevent radioactivity from entering the neutron beam tubes/guides	Proton beam cut off, target facility shut down for recovery and repair
6—Loss of H_2O flow to proton beam window (A)	•Cooling system status alarms •Cooling H_2O low flow alarm	•ABC	No damage due to prompt beam cut off	NA	Proton beam cut off, target facility in standby
6/ABC/—Loss of H_2O flow to proton beam window with failure of proton beam cut off (EU or BDB)	The above, plus alarms related to loss of proton beam tube vacuum and isolation valve closure	•ABC by TPS and BP fail •ABC on isolation valve closure signal or inherent beam loss due to loss of vacuum	•Proton beam window may fail if H_2O boils, causing loss of vacuum inside the proton beam tube, resulting in automatic closure of "upstream" isolation valve (to preserve vacuum in ring tube, etc.) •H_2O spill if proton beam window fails	•Neutron beam windows prevent transport of radioactive material released inside core vessel (e.g., due to spilled H_2O, if any) from entering the neutron beam tubes/guides	•Proton beam cut off, target facility shut down for damage assessment. Cooling water may be spilled inside core vessel. •He from core vessel has filled the failed proton beam tube up to the upstream isolation valve

Table 3.2 (continued)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
7—Loss of H_2O or D_2O flow to target component (reflector, moderator, etc.) (A)	•Cooling system status alarms •Cooling H_2O and/or D_2O flow alarms	•ABC by TPS and/or BP	•Proton beam cut off occurs before significant heat-up can occur •Active cooling not required for removal of radionuclide decay heat after proton beam cut off	NA	Proton beam cut off; target facility in standby
7/ABC/—Same, with failure of proton beam cut off (EU)	Same as above, plus: •Core vessel pressure alarm	•ABC failure	•If boiling occurs, component cooling pipe or vessel may burst, spilling H_2O or D_2O inside core vessel •Component may overheat, but heat losses to surrounding structures will prevent extensive melting	•If no automatic beam cut off occurs, the operators would initiate manual beam cut off in response to various alarms. There would be adequate time (>1 min for most components) for operator action •H_2O spillage drains to drain tanks or remains inside core vessel	Target facility shut down for damage assessment
8.MF—Loss of H_2O or D_2O system integrity [U for any given system, A for multiple systems]	•Cooling system status alarms •Cooling H_2O and/or D_2O flow alarms •Core vessel pressure alarm (possible)	•ABC	•Proton beam cut off before significant component heat-up. •Cooling H_2O or D_2O, as applicable released inside core vessel, target cell, or pump vault (depends on location of failure)	•Spillage drains to core vessel or to drain tank, depending on location of failure	Target facility shut down for damage assessment

Table 3.2 (continued)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
8.MF/ABC/—Same with failure of proton beam cut off (EU)	Same as above	•ABC failure	•Cooling H_2O or D_2O, as applicable, released inside core vessel, target cell or pump vault •Component may overheat. Extensive melting unlikely	•If no automatic beam cut off occurs, the operators would initiate manual beam cutoff in response to various alarms •H_2O spillage, if any, drains to drain tanks	Target facility shut down for damage assessment
8.SL—Loss of H_2O or D_2O system integrity (A)	Depending on location, one or more of following: •Core vessel pressure alarm •Exhaust radiation alarm(s) •Affected cooling system low-water-inventory-related signal(s)/alarm(s)	Probably none, until or unless coolant system flow affected	Slow leak does not affect coolant flow initially (or until significant inventory loss has occurred)	•Drainage paths and drain tanks or sumps are provided for coolant leaking from any system •Based on stack monitoring, operation of the target facility would be curtailed before annual release limits exceeded	Target facility shut down for repair
9.A—Loss of cryogenic moderator integrity: both the helium and the vacuum barriers fail inside core vessel (EU—multiple failures required for any release)	•Cryogenic moderator pressure and temperature indications, alarms. Vacuum indications and alarms; helium barrier space indications and alarms	TBD	•No damage expected: release of H_2 to core vessel does not result in a flammable mixture because the core vessel is He purged •Total release of the H_2 inventory to the core vessel actuates the core vessel pressure relief path to safe venting of the He/H_2 gas mixture	•Core vessel He atmosphere prevents flammable mixtures inside •If only the primary hydrogen (H_2) barrier fails, the vacuum system is designed to vent the H leakage safely. Sub-sequent failure of outer vacuum boundary contained by helium barrier	Target facility shut down for assessment of damage to cryogenic system, and reestablishment of the core vessel helium atmosphere prior to further operation

Table 3.2 (continued)

Sequence (frequency range)	How detected	Automatic protective actions	System response or damage	Mitigating actions or features	End state
9.B—Same but between core vessel and safe room (EU)	Same as above	TBD	Leak	The cryogenic lines are enclosed in a protected trench that communicates with the safe room. An H_2 leak in the line would flow to the safe room	Same as above
Other miscellaneous target facility events					
9.C—Same but inside safe room (U to EU—maintenance activities occur in safe room, so this may increase frequency of a hydrogen leak to the U range)	Same as above, plus •Safe room atmosphere H_2 alarm (if all boundaries fail)	Initiation of enhanced ventilation mode	•Ventilation flow rate increases before H_2 increases to the flammable point •Operators take action to transfer the H_2 inventory to the storage tank before it is all lost out the leak	•The H_2 storage tank (located outdoors) can hold the entire H_2 inventory •The safe room has blow-out panel(s) to minimize the formation of projectiles should deflagration or detonation occur inside	Same as above
10—Loss of core vessel integrity (U)	Core vessel pressure alarm; atmosphere gas analyzer alarm	NA	He or air drawn into core vessel •Spallation; activation of air	Operators would shut down the target operation due to inability to maintain desired pressure and/or indication of air in the core vessel helium purge exhaust	Proton beam cut off and target shut down for repair
11—Loss of core vessel He atmosphere control (A)	•Core vessel pressure; helium purge flow indication and alarm		Little or no immediate effect. Long-term loss of He purge would eventually allow air ingress, which would be undesirable	It would take an extended loss of He purge flow to permit inleakage of air into core vessel	Proton beam cut off and target shut down for needed repair of He purge system; reestablish core vessel atmosphere control

Table 3.2 (continued)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
12.A—Target cell ventilation system failures: loss of blower power or ventilation flow (A)	Control room instruments and alarms—cell negative pressure, ventilation system flow	None	Cell exhaust flow stops, hot cell air pressure increases toward atmospheric pressure	Operators would work to reestablish the flow by starting standby blower(s), utilizing standby power, etc. Airborne contamination from inside the target cell could eventually diffuse into adjacent operating spaces	Facility restored to normal operation with the ventilation system returned to service
12.B—Target cell ventilation system failures: HEPA filter failure (U)	Exhaust duct radiation level or concentration	None	Decrease in removal of particulate matter. Gross filter failure could result in some increase in air flow	Operators would take the failed HEPA filter out of service after diagnosis of the condition	Facility restored to normal operation with the faulty filter out of service
Facility-wide, external events, natural phenomena					
13—Loss of off-site power (A)	Loss of normal (A/C) lighting, other services	None	Loss of off-site power cuts off the proton beam. No damage	The proton beam cannot be maintained without magnet and other power. Forced circulation not required for mercury or other decay heat removal. Diesel generators started to maintain hot cell negative pressure until off-site power regained	Facility restored to normal operation after recovery of off-site power
14—Fire (U)	Visual/auditory alarms on fire detector panel	Automatic fire sprinklers provided where needed	Fire could possibly initiate one of the failures that initiate events 1 through 12	See CDR Sect. 9.2.1	Facility shut down for damage assessment

Table 3.2 (continued)

Sequence (frequency range)	**How detected**	**Automatic protective actions**	**System response or damage**	**Mitigating actions or features**	**End state**
15—Natural phenomena-tornado and seismic (U)	Primary senses. Information updates from laboratory shift supervisor	None	No "significant" damage since safety significant component required to function after design basis earthquake or high wind event	Target facility is classed PC-2 for natural phenomena resistance (CDR Table 8.4-2, Sect. 9.2.1)	Facility shut down for damage assessment
Events involving target hot off-gas system and waste systems—see Chap. 4.					
Beyond-design-basis accidents—see Sect. 3.17.					

In recognition of the economic and safety significance of proton beam cutoff to the target, a highly reliable system has been provided: the target protection system (TPS). This system was discussed in the SNS CDR as part of the personnel protection system (PPS). The new name was chosen to designate formally that the target protection function should be separated from the PPS function in order to ensure the appropriate design and operation of each. The TPS will be documented in the SNS Design Manual (to be published later in FY 1998).

The TPS consists of the instrumentation necessary to measure target cooling and integrity parameters, and the wiring and logic necessary to prevent the initiation of proton beam pulses when parameters are not within specified ranges. The basic design objective is to cut off the beam for any event that could result in loss of mercury system integrity or upon any indication that loss of mercury system integrity has occurred. The actual mechanism for beam cut off is to prevent formation of pulses at the ion source in the very low energy end of the accelerator instead of trying to interrupt the high-energy proton beam itself. The parameters being considered for inclusion in the TPS include target mercury temperature, flow, pump outlet pressure, pump power status, and mercury presence outside the mercury system. In general, a design objective is that more than one operational parameter should be available to trigger the TPS beam cutoff for any given event. For example, mercury flow as well as pump status could signal a loss-of-flow event.

The TPS is envisioned to be a two-channel system, with 1-out-of-2 logic and fail-safe design. Separation and independence between the two channels is provided in the design as needed to ensure very high reliability for the beam cut-off function.

The primary purpose of the PPS is to protect personnel, by cutting off the proton beam in the event of unusual radiation levels or if accelerator tunnel access is attempted during beam operation, but the PPS also provides a beam cutoff of last resort for accident sequences involving the total failure of both the TPS and the run permit/beam pulse (BP) enable systems. The PPS is able to do this because any accident sequence that leads to voiding in the target plug or loss of mercury from the target plug will, in effect, put the beam about 3 m closer to the outside of the shielding, resulting in higher than normal radiation levels in and near the target hot cell wall. With respect to the target integrity, the PPS is a considered to be a cutoff of "last resort" because it is not predictive—it does not occur until some leakage of mercury has occurred (or boiling causes voiding in the mercury). Under full beam power, the voiding in the target vessel is consistent with loss or impairment of mercury vessel integrity. By contrast, the TPS and BP systems are predictive because they sense conditions that could cause loss of integrity and could actuate beam cutoff before the barrier damage happens.

The BP automatic beam cut-off function is credited in the analysis of some target accidents because it is implemented in a manner that is separate and independent from the TPS and PPS. If BP and TPS do share instrument outputs, it is through circuits that provide electrical/electronic isolation. The fast protect (FP) system is provided for equipment protection and to provide a means of very rapid detection of abnormal beam conditions in the accelerator, storage ring, or transfer tunnels. The purpose of the FP system is to prevent the initiation of more than 1 pulse under conditions of poor beam focus or directional control. Besides providing rapid equipment protection, the FP system minimizes activation of components surrounding the proton beam tube by very rapid cutoff when beam losses exceed a preset value. The FP system is directed at the proton beam upstream from the target facility. The FP system is not credited in the analysis of target facility accidents.

One additional proton beam cut-off mechanism is available and is credited or considered in some accident sequences. This is a manual beam cutoff by the control room operator. Although the control room operator would promptly cut off the proton beam within seconds of major process upset alarms, a delay of one minute is assumed between accident initiation and operator action to manually cut off the proton beam. This has been evaluated to be a conservative assumption because it will be required that the SNS control room be occupied by a qualified operator during beam operation at power and because the operators will be trained to initiate the manual cutoff immediately upon the occurrence of multiple target system alarm annunciations.

3.1.3 Radionuclide Transport for Source Term Determinations

The unique nature of using a low-temperature liquid metal as a target and the physical properties of the spallation products have been recognized in the derivation of source terms. The target mercury is expected to last the entire life of the facility (40 year) because, even considering the eventual upgrade to a 4-MW proton beam power, only about 0.2% of the mercury is transformed by spallation into nonmercury spallation and/or activation products over the facility's life. Most of the spallation products are well below their solubility limits in mercury at the end of the 40-year facility design life. The need or desirability for cleanup of the mercury during facility life has not been determined, although allowance has been made in the conceptual design for cleanup. As a minimum, it is expected that filtration will be provided for the removal of insoluble spallation products.

The SNS accidents are relatively low temperature and are low-pressure events for several reasons. The boiling point of mercury is 357°C at 1 atm of pressure. The SNS mercury system operates at low pressure (a maximum of about 3 atm in the mercury vessel, for example) because the target vessel is not designed to withstand a high internal pressure. The normal hot leg temperature of the circulating mercury is only 110°C, and automatic, highly reliable systems interrupt the proton beam when conditions deviate significantly from normal. If the automatic beam trips fail and boiling of the mercury occurs, failure of the vessel could result, allowing the mercury to leak from the mercury vessel, and bringing other automatic beam trips into play.

In contrast to the low temperatures achievable in accidents of the SNS, the boiling points of all of the spallation products, excepting I and Xe, are well above the boiling point of mercury. At the boiling point of mercury, all but Xe and I have very low to negligible vapor pressures. Therefore, in an accident in which mercury is heated above the normal range, or in which mercury is spilled and can evaporate, the mercury vaporizes selectively, separating from and leaving the spallation products behind. Distillation is a recognized method of purifying mercury. The five most risk-significant nongaseous spallation or activation products that are generated in the target mercury are shown in Table 3.3 (see Table 2.1 for radioactivity quantities involved).

As can be seen from Table 3.3, the dissolved solids have negligible vapor pressure in the temperature range for mercury accidents. Exhibit C discusses the vapor pressures of spallation products and their potential for release.

Table 3.3. The five most risk significant nongaseous radioactive elements found in target mercury

Element[a]	Melting point (°C)	Boiling point (°C)	Fraction released in SNS accidents
Hg	–39	357	<1%, as limited by evaporation or Hg carrying capacity of air
I	114	184	Assumed release of 100% of I in Hg heated to boiling point or exposed to air for >24 h[b]
Gd	1314	3264	Negligible
Hf	2233	4603	Negligible
Au	1064	2856	Negligible

[a]Essentially all of the gaseous spallation products (e.g., H and Xe) are removed from the target Hg by the normal He purge flow, and are, therefore, not present in significant quantities for release in an accident of the target mercury. Their possible release in off-gas system accidents is covered in Chap. 4 of this report.

[b]The elemental melting and boiling points are given above for discussion purposes. In the target Hg, the I is held in the form Hg2I2, which decomposes upon heating or oxidation, releasing HgI2 that can be released and transported in vapor form.

Although it is evident that the solid spallation products are not susceptible to vaporization-based transport at the relatively low temperature range for SNS accidents, other methods of transport need to be examined. This would include the postulated entrainment of small mercury droplets in the air from the interior of the hot cell during the leakage phase of a loss-of-integrity accident. By this essentially mechanical transport method, each droplet carried along with the flowing air would take all of its spallation products with it. There are several reasons why such transport is not a practical reality in accidents examined for the SNS:

- Mercury has a high surface tension, which makes it difficult for small droplets to form; and, if droplets of mercury are formed, mercury’s high density requires relatively high air velocity to remain suspended.
- For accidents involving boiling of mercury, the possible two-phase mixture (i.e., liquid plus gaseous mercury) is first discharged to an interior space where velocity is very low, allowing droplets to settle out.
- The ventilation flow in the interior of the hot cell has a residence time on the order of 10 min and, therefore, cannot stir up any kind of a breeze of air that could sweep up particulate or help mist particles remain aloft.
- Mist eliminator stages are provided as necessary to prevent the downstream HEPA filters from becoming clogged or wetted by any feasible mist component.

- The HEPA filters would be effective in stopping airborne particulate matter of any kind. Small mercury droplets stopped on a HEPA filter would continue to evaporate, eventually leaving behind a concentrated mercury–spallation product amalgam mixture.

These factors combine to justify the conclusion that the release fractions of mercury solid/ nonvolatile fission products are negligibly small.

3.1.4 Core Vessel Atmosphere Control and Venting

The core vessel is the ~3.5-m diam. vessel (continuing design work has resulted in an increase in diameter from ~2 m to ~3.5 m) in the target station that holds the target's moderators, reflectors, and the shielding that requires active water cooling. The normal atmosphere inside the core vessel is helium gas. The helium purge flow is supplied at such a rate that the vessel's atmosphere is exchanged about once per 100 h (see CDR Table 5.3-6). The purge exhaust is routed to the contaminated off-gas system.

The normal pressure inside the core vessel is slightly less than 1 atm, but should the pressure inside the vessel exceed 2 atm, a relief line opens to prevent overpressurization. The vessel could withstand more than 2 atm, but the neutron beam windows are made thin to minimize neutron losses, so they can be expected to fail first. The reason that this venting capability is provided is that a 2-atm internal pressure could be exceeded (without venting) if a worst-case, multiple-barrier failure of the cryogenic moderator system released the cryogenic hydrogen into the core vessel. Special design requirements on the venting path design will be required in order to control flammability of the helium/hydrogen effluent should venting occur after a cryogenic moderator failure. The design of the venting path is ongoing, but, because of the possible flammability of its effluent, it is expected that the vent line will not vent into the normal ventilation system, or through a blower (unless it is hydrogen-qualified), and that parts or all of the vent path may be normally inerted. Potential hydrogen flammability accidents are examined in Sect. 3.10.

Since significant amounts of contamination may exist inside the core vessel during normal operation and more could be released in the event of an accident, it is required that the normal and relief venting paths discharge to the environment through HEPA filters. The relief venting path will have the appropriate features to protect the HEPA filters and ensure their operation including, for example, a diffuser section to allow velocity to decrease and a demister stage to remove any entrained mist.

3.1.5 Target Building and Beam Stop Ventilation

Target building ventilation is discussed in Sect. 8.6.3.7 of the CDR, and illustrated schematically on CDR drawing NSNS-18-012. Target building areas with potential for airborne radioactive material are included in the target confinement systems (primary and/or secondary confinement systems). The conceptual design follows accepted practices, such as ensuring that air flows from areas with lower potential for airborne contamination to areas of higher potential for contamination. Exhaust air is routed through HEPA filter banks. Each HEPA filter bank is designed to include prefilters and/or mist eliminators, as appropriate, and the exhaust point is the target building stack. The HEPA filters are credited with being able to remove non-volatile particulate matter, but not with being able to remove iodine or mercury (i.e., since these two elements can become airborne in vapor form). Filtration units specifically for mercury vapor removal from air inside the target hot cell are under consideration, but any such additional mercury vapor removal capability is not credited in any of the accident source terms.

Ventilation for beam stop buildings is exhausted to the environment through HEPA filters (as discussed in CDR Sect. 8.6.3.10). Each beam stop is designed for 200-kW continuous duty, although it is expected that only the ring injection beam stop will be operated continuously during normal operation. Activation levels of the coolant in the ring injection beam stops are expected to be significantly greater than in the other beam stops. Therefore, it has been decided that the HEPA exhaust for the ring injection beam stop should be routed such that it joins the target confinement exhaust and is discharged to the environment through the target building exhaust stack (see CDR Sect. 8.6.3.7).

3.2 LOSS OF CONTROL OF PROTON BEAM FOCUS OR DIRECTIONAL CONTROL (ACCIDENT SEQUENCE 1)

3.2.1 Sequence of Events

The proton beam could, hypothetically, be misdirected in such a manner as to cause overheating and release of radioactive material. To prevent such a possibility, the accelerator is equipped with the highly reliable, automatic systems discussed above that cut off the beam when abnormal conditions apply. In addition, the close-fitting collimator in the transfer tunnel immediately upstream from the proton beam window (in the ~3.5-m diam core vessel) is a passive device that prevents the beam from being misdirected onto target components other than the mercury vessel (i.e., the mercury-filled vessel that is the actual target of the proton beam). For any anticipated failures of beam control, inherent design features and automatic cut-off circuits preclude system damage.

The only beam control event that has any potential for causing release of mercury would be a focusing fault in which the beam is concentrated into a smaller than normal area as it impinges upon the mercury vessel. Preliminary conceptual design information shows that it may be possible for the beam under these abnormal circumstances to be focused onto a smaller, but not yet quantified, fraction of its normal area. Analysis has not been done to determine how much beam concentration the mercury vessel can withstand. Therefore, in addition to focusing magnet status signals, the conceptual design includes a provision for a beam focus sensor (comb-like device that detects the spatial energy distribution of the beam) that will be keyed in to one of the automatic beam cut-off systems. Thus, the excess beam focus base case anticipated event has no damage or release of radioactive material because the beam is cut off before damage can occur.

3.2.2 Estimated Frequency Range

It is anticipated that beam control faults will occur during the 40-year nominal life of the facility (i.e., frequency $>2.5 \cdot 10^{-2}$/year), but it is highly certain that the beam will be automatically cut off after a small number of pulses when the abnormal conditions occur. The conditional probability for failure of the automatic beam cut-off system is estimated at less than 10^{-4} per demand because there are typically two independent signals for achieving automatic beam cutoff, e.g., focus magnet status signal and beam focus sensor signal. It is concluded that a potentially damaging beam control fault compounded by failure of prompt automatic proton beam cutoff would be an unlikely [10^{-4}/year < frequency < $2.5(10)^{-2}$/year] or extremely unlikely event (frequency 10^{-4}/year to 10^{-6}/year). If the focus fault were severe enough to cause boundary failure after failure at prompt automatic beam cutoff, the subsequent mercury leakage would result in proton beam trip by the TPS.

3.2.3 Source Term

There is no source term for any of the beam control events in the anticipated range. The source term for extremely unlikely beam control events is bounded by the worst-case source term developed in Sect. 3.3 for extremely unlikely loss of mercury system integrity events.

3.3 LOSS OF MERCURY VESSEL OR PIPE INTEGRITY: MAJOR FAULT (ACCIDENT SEQUENCE 2)

3.3.1 Sequence of Events for the Mercury Spill

This event would be initiated by a major failure in the primary mercury boundary. The failure could be in the mercury vessel itself (the actual target of the proton beam), piping between components, the mercury reservoir, the mercury pump, or the mercury/H_2O heat exchanger. The fault is assumed to occur suddenly and to have a flow area consistent with rapid spillage of mercury (e.g., over a 10-min or shorter period).

The most likely places for boundary failures are thought to be the mercury vessel itself, which is directly in the proton beam, and the two bellows sections provided to allow for thermal expansion of the long pipe that runs through the target plug. The nominal conceptual design value for total mercury inventory is 1000 L, including the target vessel, the target plug, piping, heat exchanger, and pump. The rate of pumping is on the order of about 1000-L per min, giving a very approximate loop time of about 1 min for the circulating mercury. (None of the analyses of this report are sensitive to this loop time, including the mercury radionuclide inventories given in Chap. 2). The maximum static pressure inside the mercury vessel during operation is about 0.3 Mpa (static pressure does not include the pressure pulsations that are always present during normal operation because the proton beam is actually a train of discrete pulses).

The mercury system has features designed to work together to confine any mercury that might be inadvertently spilled or spilled because of an accident (see CDR Figs. 5.3-1 and 5.3-2). These features include a collection tank to which spilled mercury drains, engineered drainage paths to ensure that any spilled mercury is directed to the collection tank, and an enclosure that surrounds much of the “rear end” part of the mercury system that protrudes into the target cell (e.g., the mercury reservoir, heat exchanger, and related piping). In addition, the water-cooled shroud separates the mercury vessel from the interior of the core vessel that houses the reflectors, moderators, and associated shielding. The water-cooled shroud would prevent mercury from flowing into the core vessel in the event of a failure of the mercury vessel.

The floor of the mercury enclosure is sloped appropriately and otherwise engineered to ensure complete drainage of the mercury to the collection tank. This enclosure is entirely inside the target hot cell. If the mercury leak were spraying outward, it would strike a surface on the inside of the enclosure, drop to the floor, and drain to the collection tank. It is not intended to be a sealed containment vessel; the target cell ventilation system will be designed to pull a slight negative pressure on the mercury enclosure to maintain inward flow of air from the target cell into the enclosure. The vent connection for this will be engineered so that mercury from a boundary failure in any component cannot stream directly into the exhaust duct. Special air treatment for the air exhausted from the mercury enclosure is currently under consideration by the project. Specifically, the need for mercury removal stage(s) is being determined, but has not been credited in any of the present accident source term estimates. As a minimum, the enclosure exhaust will include a mist elimination stage or robust prefilter that will accomplish the same purpose (i.e., the removal of entrained mercury and/or mercury-contaminated gross particulate). Downstream equipment, including HEPA filters, will accomplish the final air treatment for hot cell exhaust.

For completeness, it can be noted that the mercury enclosure serves another purpose unrelated to this discussion: it shields instrument components mounted near the mercury system from gamma irradiation. The degree of shielding provided is only that needed to ensure a reasonable lifetime for these electronic components.

Immediately upon initiation of the mercury leak, the system would continue to circulate mercury as normal, etc., but sensors (e.g., conductivity sensors) at the bottom of the stainless steel catch pan that forms the floor of the mercury enclosure and/or at other points in the system would detect rapidly the existence of the leaked mercury. The signals from these sensors, indicating spilled mercury, would initiate an automatic proton beam cut off. After some delay, other signals would confirm the spill sensors (e.g., low reservoir tank level or eventually perhaps low mercury pressure and/or flow). These other sensors can also actuate automatic alarms and/or proton beam cutoffs.

Upon detection of the leak and following verification of proton beam cutoff, the prescribed operator action would be to turn off the mercury circulation pump, and open valves that allow any mercury not spilled from the mercury system to drain to the mercury collection tank. The reason for this action is to minimize the amount of mercury leaked from the mercury system and thus minimize the subsequent cleanup efforts.

The only source of heat to the mercury after beam cutoff is the approximately 9.6 kW of decay heat distributed throughout the mercury inventory (at end of a 4 MW operating cycle). Active cooling is not required to remove decay heat from the mercury. The mercury circulation pump would, however, continue to run without operator intervention. Since the pump is at the low point in the mercury circuit, its continued running would tend to maintain circulation and force more mercury through the leak. Eventually most of the mercury inventory would have leaked from the mercury system. However, essentially all of the leaked mercury will be collected and confined by gravity drainage to the mercury collection tank.

The multiplicity of ways in which the proton beam would be cut off in this event make it incredible that the beam would not be cut off in this event. Major mercury spill with failure of multiple automatic beam cutoffs is considered in Sect. 3.17, Beyond-Design-Basis Accidents.

3.3.2 Estimated Frequency Range for the Mercury Spill

The basic initiating event, a major failure in the mercury system pressure boundary, is an unlikely event (10^{-4}/year < frequency <2.5×10^{-2}/year). Generic data on bellows,[1] the most vulnerable part of the system with the possible exception of the mercury vessel itself, indicate a failure frequency of somewhat less than 2.5×10^{-2}/year. Failure likelihood for bellows is minimized by designing the bellows for an adequate number of cycles (the bellows are provided to allow the target plug to expand without stress buildup when it is heated from ambient temperature to operating temperature, and vice versa for the cooldown that occurs after the beam is cut off). Piping flexibility analysis and other design work will be done with the objective of eliminating as many of the bellows as possible.

Potential proton and neutron irradiation effects, normal pressure pulsations, and other cyclic stresses are of concern for the mercury vessel. However, the research and development (R&D) program for the mercury vessel and evaluation of experience during initial facility operation will allow the staff to develop design and maintenance parameters, including replacement frequency, that minimize the probability of its failure.

The worst case (extremely unlikely) mercury spill source term calculated below assumes, in addition to a major mercury spill, the failure of the mercury enclosure and/or its engineered drainage paths and/or pipes that would allow any spilled mercury to drain to a collection tank in a vault below the target hot cell floor. These failures combine to put this postulated event in the extremely unlikely category.

3.3.3 Source Term for the Mercury Spill

3.3.3.1 Base case unlikely event (no additional failures)

The source term for this event consists of the mercury and I isotopes. The other spallation products dissolved in the mercury are not released because they have very low vapor pressures in the temperature range of interest (i.e., below the boiling point of mercury). There may be some creation of spray droplets if mercury is sprayed from the boundary failure, but the high surface tension and density of mercury work against that tendency, and a mist elimination step will be included in the design of the cell exhaust to remove droplets carried out of the mercury enclosure by the ventilation flow. The mercury enclosure is ventilated at a low rate such that there is not a significant amount of turbulence in the air flowing through the enclosure. If the ventilation system failed during this event, the source term with no ventilation would be lower than derived here under the assumption of continuing flow.

The mercury spill drainage features are required to ensure that all the spilled mercury drains to the collection tank or other closed location. To provide a conservative source term for analysis purposes, it is assumed that 1 L of mercury fails to drain and is in a configuration with a large surface area exposed to air, such that it can evaporate and be released. The source term for this event is calculated as follows:

1. The release of mercury vapor during the first 10 min is bounded by assuming that the leakage flow and surface area presented by the leaking mercury (e.g., as it strikes a wall and flows across the catch pan floor to the drain) are sufficient to elevate the air temperature flowing inside the mercury enclosure to 95°C (the average of 80°C the 110°C inlet and outlet temperatures of the circulating mercury). Furthermore, it is assumed that the air becomes and remains saturated with mercury vapor for the entire period. This is very conservative because it is equivalent to assuming that the evaporation rate is, in effect, instantaneous during this stage of the accident.

The equilibrium concentration of air saturated in mercury vapor is obtained as shown at bottom of page 2 and top of page 3 of Exhibit D, but utilizing the desired 90°C temperature. This concentration is then multiplied by the air bulk flow rate to give the bounding release rate. At the mercury enclosure air flow rate of 400 cfm, the bounding initial release is therefore 200 g of mercury over the 10 min (see discussion below for the accompanying iodine release).

2. After the first 10 min, all the mercury inventory has leaked from the system, or the operator takes action to stop the leak. The mercury enclosure air temperature thus returns to its normal value of less than 60°C. The release after this point is bounded by assuming that the spilled mercury occupies the whole enclosure floor and that its temperature would be 60°C (floor should actually be cooler than this). Exhibit D calculates an evaporation rate at 110°C of 87.1 g mercury/m^2/day under assumed turbulent air flow conditions. The equivalent rate at 60°C is calculated by multiplying the 110°C rate by the ratio of vapor pressures: VP(60°)/VP(110°C). Exhibit D (second page) gives a correlation for mercury vapor pressure as a function of temperature. Thus, the evaporation rate at 60°C is calculated to be 5 g/m^2/day. A somewhat lower rate would be obtained if the reduction in diffusion coefficient as a function of temperature (see last page of Exhibit D) were credited. To bound the possible geometry and mass transfer correlation uncertainties, a factor of 10 is applied to the 5 g/m^2/d estimate. To further bound the surface area for evaporation, we assume that the entire floor area of the enclosure is covered by a thin layer of mercury. The resulting bounding total mercury release rate is 1.6 kg of mercury per day. At this rate it would take more than 8 d to evaporate the entire liter. Even though the enclosure would cool significantly over this period, reducing the evaporation rate significantly, it is conservatively assumed that the release takes place over an 8-d period. With the great bulk (i.e., ~99.9%) of the mercury having drained via gravity to the collection tank, and all the undrained mercury having been evaporated, there would be essentially no releases after the 8-d period. A small fraction of the postulated 1 L of undrained mercury would, in reality, not be released because the evaporation process would tend to concentrate the normally very dilute dissolved spallation products in the mercury, leaving behind small amounts of concentrated mercury-spallation product amalgam, which would not be easily volatilized or entrained by the low air flow in the mercury enclosure.

   If such a mercury leak occurred, only a small fraction of the 1 L could be vaporized because facility operators would take actions to curtail the release rate. For example, they would ensure or enhance cell cooling, would cleanup the spilled mercury (using remote manipulators to activate and control cleanup equipment inside the hot cell) and/or would utilize a chemical agent (e.g., amalgamating compounds) to bind the mercury chemically.

The SNS target system designers are considering an mercury removal step for the cell ventilation system, but mercury removal is not credited in the present analysis. The entire 1 L of mercury and its contained iodine (as discussed below) are assumed to be released to the environment.

Since a helium purge regularly transports the gaseous spallation products from the mercury to the hot off-gas system during operation, they are not available for release in a mercury spill event. For example, the helium purge sweeps any tritium gas into a hydride bed in the hot off-gas (HOG) system instead of allowing it to accumulate in the target mercury (see Chap. 4 for hot off-gas system events). Or, for another example, xenon spallation products are also swept to a hold-up stage in the hot off-gas system to allow for decay before release.

Iodine readily combines chemically with mercury and is therefore not immediately available for release from the 1 L of spilled mercury. With sufficient time of exposure to air, the Hg_2I_2 can oxidize slowly and release iodine (see Exhibit C). To bound the release, it is assumed that this conversion can occur over the same time scale as the mercury evaporation, and that 100% reaction occurs, releasing all the radioiodine in the 1 L of non-draining mercury. The balance of the mercury drains to, or remains within, a tank where it is not effectively exposed to oxygen, so its contained Hg_2I_2 remains unoxidized and therefore releases negligible iodine.

In conclusion, the base case loss of target mercury system integrity (unlikely event) source term consists of 1 L of mercury and its initially contained radioiodine (i.e., the entire volatile and semi-volatile content of the mercury that fails to drain to the collection tank). Since the designers are trying to improve the target system design to minimize mercury inventory, it will be assumed that the mercury inventory will be reduced from the nominal 1000 L (13,600 kg of mercury) to a value of 10,000 kg (~735 L) of mercury. Thus, the fractional release of both mercury and I nuclides is adjusted upward from 0.l% to 0.14% of the total inventory, with all but the initial (first 10 min) release occurring over the abovementioned 8-d period. The radionuclide release source term (see Table 3.4) is estimated on the basis of 40-year end-of-life radionuclide inventory. See Table 3.4 for a summary of the release fractions and the initial mercury and iodine radionuclide-specific activities present immediately before the accident.

3.3.3.2 Bounding source term for the extremely unlikely (EU) event mercury spill

If a mercury spill occurs with failures in the mercury confinement and drainage system, the bounding source term would be worse than determined above for the base case (unlikely event). The bounding EU mercury spill is a failure(s) of the mercury enclosure that allows the mercury leak to escape from the mercury enclosure into the target hot cell. A compounding failure of the cooling water system that maintains normal mercury temperature is assumed with coincident failure of the first automatic proton beam cutoff (e.g., the beam cutoff based on cooling water pump status), such that the bulk temperature of the mercury has increased by 20°C over normal values at the time of the spill (i.e., to a value consistent with the beam cutoff based on mercury temperature). The discussions in the subsection above, pertaining generally to radionuclide release and transport, etc., are all applicable to the EU spill. The assumptions regarding mercury transport are analogous but must be scaled up to the entire mercury hot cell, and to mercury temperatures consistent with this EU event. Releases tend to be larger because the entire cell air flow specified in the conceptual design is 4800 cfm (136 m^3/min). The mercury releases are calculated as follows:

1. The release of mercury vapor during the first 10 min is bounded by assuming that the leakage flow and the surface area presented by the leaking mercury (e.g., as it strikes a wall and flows down the wall and across the floor) are adequate to ensure complete thermodynamic mixing between the cell air (40°C) and the leaking mercury (with the mercury at 215°C due to the assumed heat-up before the spill). Thus, the air temperature during the initial 10-min period is elevated from 40°C to 86°C. The further bounding assumption is made that the air is saturated with mercury vapor during this entire phase of the spill. This is a very conservative assumption (probably unrealistically conservative) because it neglects the limitations on heat transfer rate

due to low temperature differences and the tendency for mercury to drain to or gather at any low point or drain opening, thus reducing exposed surface area. At the hot cell air flow rate of 4800 cfm, the bounding release during this initial 10-min period is, per the stated conservative assumptions, 1.5 kg of mercury.

Table 3.4. Source terms for the unlikely event and extremely unlikely event mercury spills

a. Radionuclide specific activities

Note 1: After 40 years of operation at 1 MW, with specific activity values given for the instant before the spill.

Note 2: Except as noted, multiply by 4 to get corresponding 4-MW values.

Radionuclide	**Specific activity**	
	(Ci/g Hg)[a]	(Ci/g I)[b]
I-119	6.76E–7	5.59
I-120	1.01E–6	8.34
I-121	2.03E–6	16.8
I-122	2.87E–6	23.7
I-123	3.72E–6	30.7
I-124	1.69E–6	14
I-125	7.43E–6	61.4
I-126	3.38E–7	2.79
I-128	3.38E–7	2.79
I-129	8.85E–13	7.31E–6
I-130	1.69E–7	1.4

Radionuclide	**Specific activity** (Ci per gram of Hg)
Hg-180	8.45E–7
Hg-181	2.37E–6
Hg-182	3.55E–6
Hg-183	6.42E–6
Hg-184	1.2E–5
Hg-185	1.96E–5
Hg-186	5.12E–5
Hg-187	1.05E–4
Hg-188	2.4E–4
Hg-189	3.7E–4
Hg-190	5.36E–4
Hg-191	6.75E–4
Hg-192	9.01E–4
Hg-193	1.05E–3
Hg-194	1.14E–4
Hg-195	1.75E–3
Hg-197	1.17E–2
Hg-203	8.32E–3
Hg-205	3.6E–4

[a]Specific activity in Ci/g Hg = nuclide inventory (Ci) divided by mercury mass (10^7 g Hg, constant throughout facility life)

[b]Specific activity in Ci/g I = nuclide inventory (Ci) divided by iodine mass (1.21 g I at end of facility 40-year design life). The Ci/g I specific activity after 40-year of 4-MW operations would be the same as above because not only the mass of iodine but also the radionuclide inventories would be four times as large. The total mass of iodine, dominated by stable I-127 and long-lived I-129, decreases by ~0.1% during a 30-d accident period due primarily to decay of I-125 (the shorter lived ones also decay, but their contribution to mass is negligible).

b. Accident release fractions (applicable to either 1-MW or 4-MW cases)-bulk mass fractions released[c]

Accident	Time period	Hg release fraction	Iodine release fraction
Hg Spill (U = unlikely)	0–10 min	2.0E–5	2.0E–5
Hg Spill (U)	10 min–8 d	1.4E–3	1.4E–3
Hg Spill (U)	>8 d	0	0
Hg Spill (EU) = extremely unlikely)	0–10 min	1.5E–4	1.5E–4
Hg Spill (EU)	10 min – 10 d	1.9E–3	3.3E–1
Hg Spill (EU)	10 days – 30 d	3.8E–4	6.7E–1
Hg Spill (EU)	>30 d	0	0

[c]Note: Release fractions for shorter-lived radionuclides would be smaller than the bulk mass release fractions provided that the release period is long in comparison to the half-life of the radionuclide.

2. After the first 10 min, all the mercury inventory has leaked from the system, or the operator takes action to stop the leak. The hot cell air temperature thus returns to its normal value of less than 40°C. The release after this point is bounded by assuming that the spilled mercury occupies the whole hot cell floor, and that its temperature would be 40°C (floor should actually be considerably colder). Based on the derivation in Exhibit D, the maximum evaporation rate of this spilled mercury is estimated to be 1.2 g Hg/m^2/d at a 40°C temperature. To bound the possible geometry and mass transfer correlation uncertainties, a factor of 10 is applied to this estimate. To further bound the surface area for evaporation, we assume that the entire floor area of the hot cell is covered by a thin layer of mercury. The resulting estimated total mercury release rate is 1.9 kg of mercury per day. The release is assumed to continue at 1.9 kg of mercury/d for a 10-d prerecovery period. After this 10-d period, it is assumed that the several available accident recovery strategies would reduce the rate to 10% of the rate of the first 10 d (i.e., to 0.19 kg mercury/d). After 30 d, the release rate would be essentially terminated because of continuing cleanup efforts. As discussed in the previous section it is expected that the facility operators should be able to greatly curtail or stop the releases much sooner than either 10- or 30-days because of the several actions they would be able to take.

The bounding assumptions (discussion above, plus Table 3.5) are thought to be sufficiently conservative that the resulting source term bounds the entire spectrum of events in the EU category (10^{-6}/year < frequency < 10^{-4}/year). The only way to have greater release would be to postulate events that are beyond credible (see Sect. 3.17).

The nuclides released in this event include only the mercury and iodine radionuclides. As previously mentioned, other potentially significant volatiles (e.g., tritium gas) are swept from the reservoir tank during normal operations by the helium purge flow. Release of tritium is considered under target off-gas accidents (Chap. 4). As with the unlikely event mercury spill , the assumption is made that all the iodine contained in nondrained mercury is volatilized. Thus, since the assumed failures include nondrainage of the whole mercury inventory (i.e., the engineered drainage paths and the mercury enclosure are failed somehow), the release fraction for the iodine is 100% for the 30-d accident period.

In summary, 0.015% of the mercury and I inventories are released over the first 10 min, and 0.228% of the mercury and 99.985% of the I is released to the environment over the balance of the 30-d accident period. Source terms and initial mercury and iodine radionuclide specific activities are summarized in Table 3.4.

Table 3.5. Worst case input parameter assumptions used to derive bounding source term for extremely unlikely events (10^{-6}/year < frequency < 10^{-4}/year); based on mercury spill event with multiple additional failures

Parameter	**Nominal value** (or nominal accident value)	Bounding value	Basis
Hg surface area exposed to air, early part of spill event	Estimated at <1 m^2 surface area of Hg as it drains across the catch pan to the collection tank	Sufficient Hg exposed to air to saturate air in mercury enclosure with Hg vapor during early part of spill	Conservative assumption that the leak is sprayed vigorously enough to result in a large surface of area for Hg/air contact
Target cell mercury enclosure air flow; hot cell air flow	Hg enclosure: 11.3 m^3/min Hot cell: 136 m^3/min	11.3 m^3/min Hot cell: 136 m^3/min	Assuming the ventilation flow continues at the nominal value, will maximize Hg vapor transport during the accident (there would be little-to-no air flow and, hence, little-to-no Hg vapor transport if the ventilation system fails or is turned off)
Hg decay heat	Depends on operating time in the proton beam; after 1 year in a 4-MW proton beam, decay heat is <10 kW immediately after beam cut-off	Hold at 10 kW throughout the accident	Decay heat decreases continuously after proton beam cut-off (e.g., is at ~70% of the initial value 1-h after cut off)
Hg decay heat dissipation paths	Decay heat would be dissipated to structures and to air	Assume 100% of decay heat is transferred to air	Higher air temperature increases Hg carrying capacity of the air.
Cell air inlet temperature	14°C is the annual average outdoor air temperature for Oak Ridge, Tennessee. Building air is typically heated or cooled to ~22°C by the building HVAC system	30°C	Assuming 30°C is equivalent to assuming an A/C failure during summer months. Note: 24.8°C is the daily average temperature for hottest month of the year (July)
Duration of significant accident release	~0 days (if various systems work as designed, there is essentially no environmental release)	Bounding releases specified for short, intermediate, and long term releases, as applicable	Various factors would minimize or end the release after several days, including lower decay heat, oxide films on any exposed Hg, and possible operator actions

HVAC–heating, ventilating, and air conditioning.
A/C–air conditioning.

3.4 LOSS OF MERCURY PUMPING DURING PROTON BEAM OPERATION (ACCIDENT SEQUENCE 3)

3.4.1 Sequence of Events for Loss of Mercury Pumping

Forced circulation of the mercury is required to transport the heat deposited by the beam as it impinges upon the mercury target. If power is lost to the circulation pump or the pump fails for any other reason, the mercury flow decreases while temperature of the mercury increases. The circulation pump status and the mercury flow and/or pressure signals are utilized to initiate automatic cutoff of the proton beam whenever an abnormality is detected. If either the run permit/pulse enable [or beam permit (BP), for short] systems or the TPS discontinues the proton beam during the first few seconds, then no damage occurs in any part of the mercury system. The BP and the TPS are independent. The likelihood that both the BP and the TPS might fail is thought to be beyond extremely unlikely, but is considered in Sect. 3.17, Beyond-Design-Basis Accidents.

If ac power were lost to the facility as a whole, then the beam would inherently and rapidly be discontinued as the mercury pump coasted down.

3.4.2 Estimated Frequency of the Loss of Mercury Pumping

It is anticipated that failure of the mercury pump or its power supply will occur during the life of the facility. Failure of the BP (but not TPS) automatic beam cutoff after mercury pump failure would be an unlikely event, but simultaneous, total failure of both of these independent systems (BP and TPS) would be extremely unlikely or beyond design basis.

3.4.3 Source Term

The source term for loss of mercury circulation flow events is zero because of the multitude and independence of ways in which the proton beam can be cut off before damage can occur to the mercury boundary. The source term for loss of mercury flow with failure of both BP and TPS automatic proton beam cutoffs is developed in Sect. 3.17.

3.5 LOSS OF H_2O FLOW IN MERCURY*H_2O HEAT EXCHANGER DURING PROTON BEAM OPERATION (ACCIDENT SEQUENCE 4)

3.5.1 Sequence of Events for Loss of H_2O Flow to Mercury Heat Exchanger

A loss of cooling water flow to the mercury heat exchanger would result in increasing mercury temperature as the heat deposited by the proton beam is distributed throughout the mercury loop instead of being removed by the cooling water. Automatic beam cutoffs would detect the condition and discontinue the proton beam. If the automatic proton beam cutoff is assumed to fail, it is probable there would be sufficient time for the operators to react to alarms and cut off the beam before any damage occurred. The heat-up rate with no water in the mercury heat exchanger would be about 25°C/min for the 1-MW configuration or about 100°C/min for the 4-MW target configuration. In the worst case, without intervention, local boiling would eventually occur in the mercury vessel and the insufficiently cooled mercury vessel walls would fail (i.e., probably after >1 min even for the 4-MW configuration), causing a mercury spill event that would be similar to the sequences considered in Sect. 3.3.

3.5.2 Estimated Frequency Range for Loss of H_2O Flow to Mercury Heat Exchanger

The base case loss of cooling water flow is an anticipated event. Failure of both the BP and TPS automatic beam cutoffs and operator initiated manual cutoffs is estimated to have an annual probability of occurrence below 10^{-6}/year because the TPS and BP automatic cutoffs are independent, and because there is sufficient time to make operator-initiated cutoff very likely. An appropriate EU loss of mercury H_2O cooling water would be to have a delayed automatic proton beam cutoff following loss of the cooling water. For example, the trips based on H_2O flow and/or pump status will cut the beam off before the mercury has a chance to heat up, whereas the trip based on mercury temperature occurs only after some heat-up has occurred. To avoid spurious beam cutoffs, the high temperature–based trip will be adjusted to allow perhaps about 15°C of heat-up before preventing further beam pulsing (20°C was assumed for analysis of the EU mercury spill that bounds this event). Consistent with the EU probability level, this amount of heat-up might be the last straw for some incipient mercury boundary failure, in effect allowing this event sequence to develop into a mercury spill accident.

3.5.3 Source Term for Loss of H_2O Flow to Mercury Heat Exchanger

There is no damage and therefore no release or source term for the base case anticipated event. The source term for the EU event with failure of the more promptly occurring automatic beam cutoff(s) is bounded by the worst case EU mercury spill event source term developed in Sect. 3.3.

3.6 LOSS OF H_2O FLOW: WATER-COOLED SHROUD (ACCIDENT SEQUENCE 5)

3.6.1 Sequence of Events for Loss of H_2O Flow to the Water-Cooled Shroud

The water-cooled shroud is provided to minimize the probability for mercury contamination to enter the core vessel. It is cooled because the proton beam passes through it before striking the mercury vessel. The base case loss of cooling water flow to the water-cooled shroud is an anticipated event. Automatic beam cutoffs based on status of the cooling water system would cut off the beam before any damage. There is a possibility that the operators could react to an alarm and discontinue the proton beam manually.

In the EU event of full beam power and no water flow, the shroud would not be adequately cooled, boiling of water would occur inside the shroud, and the shroud would fail soon thereafter. Some water might be spilled inside the core vessel, but the <60°C temperature of components inside the core vessel would not be sufficient to boil enough water to actuate the core vessel relief valve (that actuates for core vessel internal pressures exceeding 2 atm). The part of the uncooled shroud remaining in the beam might overheat, possibly melting and dropping down out of the path of the beam. This would cause an increase in the energy deposition rate into the mercury vessel but not enough to be likely to fail the mercury vessel. There should also be an increase in the neutron production rate. Melting of the water-cooled shroud could cause mercury vessel failure if the molten stainless steel drips onto the core vessel.

3.6.2 Estimated Frequency Range for Loss of H_2O Flow to the Water-Cooled Shroud

Loss of cooling water flow to the water-cooled shroud is an anticipated event. The shroud fills a contamination barrier function, and its replacement would require lengthy facility shutdown; therefore, sufficiently redundant and diverse shutdown mechanisms will ensure highly reliable prompt proton beam cutoff in the event of loss of its cooling water flow. Compounding the loss of cooling water with failure of automatic beam cutoff mechanisms would make this an extremely unlikely event.

3.6.3 Source Term for Loss of H_2O Flow to the Water-Cooled Shroud

There is no source term associated with the base case anticipated event. The extremely unlikely case with failure of automatic beam cutoff and possible spillage of cooling water is bounded by the unlikely event source term developed in Sect. 3.9, Loss of D_2O or H_2O Integrity in Target Cooling Loop.

3.7 LOSS OF H_2O FLOW: PROTON BEAM WINDOW (ACCIDENT SEQUENCE 6)

3.7.1 Sequence of Events for Loss of Water Cooling Flow to Proton Beam Window

The proton beam window forms the boundary between the proton beam tube and the core vessel. Its main purpose is to protect the high vacuum that is maintained in the beam tube against the helium atmosphere maintained inside the core vessel. The sequence of events upon loss of cooling water flow would be very similar to the sequence outlined in Sect. 3.6 for loss of water flow to the water-cooled shroud. There would, however, be an additional beam cut-off mechanism that would actuate should the undercooled window fail. Loss of beam tube vacuum automatically triggers closure of an isolation valve (to protect vacuum in the beam tube farther upstream), which simultaneously and automatically initiates beam cut off.

3.7.2 Estimated Frequency Range for Loss of Water Cooling Flow to Proton Beam Window

The base case loss of coolant flow is an anticipated event. Loss of coolant flow without beam cutoff would be an extremely unlikely event. Large amounts of radioactivity are not present in the proton beam window's cooling water, and failure of the proton beam window would not threaten a mercury spill event, but the window fills a contamination barrier and also a facility segmentation function. Therefore, sufficiently redundant and diverse shutdown mechanisms will ensure highly reliable prompt proton beam cutoff in the event of loss of its cooling water flow.

3.7.3 Source Term for Loss of Water Cooling Flow to Proton Beam Window

There is no source term associated with the base case anticipated event. The extremely unlikely case with failure of automatic beam cutoff and possible spillage of cooling water is bounded by the unlikely event source term developed in Sect. 3.9, Loss of D_2O or H_2O Integrity in Target Cooling Loop.

3.8 LOSS OF WATER FLOW TO TARGET COMPONENT COOLING LOOP (ACCIDENT SEQUENCE 7)

3.8.1 Sequence of Events for Loss of Water Flow to Target Component Cooling Loop

This event can refer to any one of the following components:

- The moderator/proton beam window H_2O cooling loop
  - proton beam window
  - ambient moderator
  - cryogenic moderator
- The D_2O cooling loop
  - Ni and Be reflectors
- The shroud H_2O cooling system
  - target water-cooled shroud
- The shield cooling H_2O cooling water loop
  - stainless steel shielding units

These components are held inside the core vessel. The conceptual design provides a separate cooling loop for each component. The loss of water flow could be caused by failure of a pump, a valve, or the electrical power supply to the pump. Sensors provide status monitor signals for each component cooling loop to ensure that proton beam cutoff would be initiated in the event of loss of cooling water flow. The amount of heat-up that can occur after the loss of flow and proton beam cutoff is small because of the relatively low power densities involved and because of the rapidity with which proton beam cutoff can be accomplished.

If automatic beam cutoff fails, the amount of time for operators to respond to abnormal indications depends on which component is under consideration. Components that are closer to the mercury vessel have higher power density and corresponding higher adiabatic heat-up rates. For example, the ambient (H_2O) moderator has the highest power density at about 12 kW/L for a beam power of 4 MW. Total loss of coolant flow to the ambient moderator at full beam power could, therefore, cause the temperature of the water inside to increase from the normal value (about 20°C) to 100°C in about 15 s. Longer times would apply for the other components because they, being further from the target mercury, have lower power densities. See Fig. 5.3-30 and Table 5.3-4 of the SNS CDR.

If the temperature in any component increased enough to cause boiling of the cooling water inside, the resulting pressure surge could cause failure of the component pressure boundary. This would release the component cooling water inside the core vessel. Loss of coolant system integrity is addressed in Sect. 3.9. If the proton beam were still not cut off after this point, the temperature of the component would continue to increase until a thermal equilibrium was reached. Extensive melting would not occur because the component would begin exchanging heat with the surrounding adjacent components and achieve thermal equilibrium before the melting point was reached. After the proton beam is cut off, active cooling is not needed by any component.

The failure modes discussed above are loss of cooling water flow in the primary cooling loop for each component. An event such as loss of deionized water system flow could affect several of the target components in the core vessel at the same time. Thus, the BP system will provide automatic cutoff of the proton beam. Nevertheless, tens of minutes would be available for the operator to respond to alarm annunciations associated with this problem because of the large thermal inertia provided by the volume of primary coolant in each loop. In its extremely unlikely conclusion, a loss of deionized water without proton beam cutoff would lead to loss of one or more component cooling loops, with source term as described in this section or in Sect. 3.9.

3.8.2 Estimated Frequency Range for Loss of Water Flow to Target Component Cooling Loop

The base event, loss of component cooling flow, is an anticipated event (2.5×10^{-2}/year < frequency < 10°/year), expected to occur during facility life. Compounding the base event with a failure of the automatic beam cut-off system(s) reduces the net sequence frequency to the unlikely range (frequency <2.5×10^{-2}/year), or lower. Automatic beam cutoff in the event of loss of component cooling water is highly desirable from an operational point of view, but, in some cases, it is not clear that the loss of cooling water flow would cause component failure in a short period of time. Consequently, reliable beam cutoff will be provided (>99% probability of beam cutoff given occurrence of the loss of cooling water), but the degree of diversity and/or redundancy may be lower than is provided for other, more damaging events [e.g., ones that could escalate into a mercury spill event without prompt beam cutoff (see Sect. 3.4 and/or 3.5)]. In conclusion, loss of component cooling flow compounded by a failure of automatic beam cutoff is assigned to the unlikely event category. This is a very conservative assumption because components with a defined segmentation function (e.g., the proton beam window or the water-cooled shroud) will receive both TPS and BP coverage for automatic proton beam cutoff.

3.8.3 Source Term for Loss of Water Flow to Target Component Cooling Loop

There is no source term for the base event with automatic beam cutoff because there is no damage or release of material of any kind. If the automatic beam cutoff does not function, the operators may have time to initiate beam cutoff before damage. The possible source term for the extremely unlikely event with failure of automatic and manual proton beam cutoff is bounded by the source terms developed in Sect. 3.9 for loss of cooling water integrity in target component cooling loop.

3.9 LOSS OF H_2O OR D_2O INTEGRITY IN TARGET COMPONENT COOLING LOOP (ACCIDENT SEQUENCE 8)

There are four target cooling loops that will become activated during proton beam operation:

1. The proton beam window and moderator H2O cooling loop:
   - proton beam window
   - ambient moderator
   - cryogenic moderator

2. The D_2O cooling loop
   - Ni and Be reflectors
3. The shroud H_2O cooling system
   - target water-cooled shroud
4. The shield cooling H_2O cooling water loop
   - stainless steel shielding units

The pumps and heat exchangers for these systems are located in the utility vault, and the actual cooled components (listed above) are inside the core vessel.

3.9.1 Sequence of Events for Loss of Integrity of Component Cooling Loop

If there is a major loss of integrity in any component cooling water system, this would soon result in loss of cooling of the affected component. For possible thermal response, see the discussion in Sect. 3.8. If there is a minor loss of integrity, cooling of the component would continue to be effective as long as there is adequate inventory for circulation.

3.9.2 Estimated Frequency Range for Loss of Integrity of Component Cooling Loop

The base event, loss of component cooling integrity, is an anticipated event (2.5×10^{-2}/year <frequency < 10°/year) for the slow leak loss of integrity and would be an unlikely event (10^{-4}/year < frequency <2.5×10^{-2}/year) for the major failure loss of integrity. The low likelihood of major failure stems from the fact that these are low-pressure systems, with connections and leaktightness verified during installation before operation. However, since there are four of these systems, the major loss of component cooling loop integrity is assigned to the anticipated category.

3.9.3 Source Term for Loss of Integrity of Component Cooling Loop

The source term for a loss of coolant system integrity depends on the mode of failure and the location of the breach. For example, water spilled by a major failure outside the core vessel would, in general, tend to drain to sump tanks (in the utility vault except for the shroud-cooling system sump tank, which is inside the target hot cell) or floor sumps and thus not be available for evaporation and release. Nevertheless, the source terms developed for the major failure include a significant evaporation component. If the failure occurred inside the core vessel, the source term due to evaporation of water inside the warm core vessel would be as discussed below.

3.9.3.1 For slow leaks

The source term might not be sensitive to location (inside vs outside the core vessel) because such a leak outside the core vessel would evaporate before the leaked water reached the sump. The bounding source term for a slow leak would be one that causes a stack discharge rate that is high enough to exceed the allowable yearly total release (based on tritium) in a small fraction of a year (e.g., a week or a month). Since discharges are monitored, it is very unlikely that facility management would allow continued operation such that the yearly release limit would be exceeded. A source term is not specified because facility operations would be curtailed before the yearly release limit is exceeded.

3.9.3.2 For leak into core vessel

In the event of a cooling water leak or spill inside the core vessel, some fraction of the spilled water would evaporate and be carried off with the core vessel helium purge that is discharged to the target hot off-gas system (discharge point upstream from the demisters that are upstream from the HEPA filter banks). The evaporation rate would be limited by the rate of flow of the He purge that is supplied to the core vessel, (i.e., the ~10 m^3 free volume is replaced every ~100 h) (see Table 5.3-6 in the CDR. *Note*: post- CDR design work has resulted in an increase in core vessel diameter—from 2-m to 3.5-m, with a higher estimate of core vessel free volume—10 m^3 instead of 3 m^3). For the purposes of this analysis the nominal 10 m^3/100-h purge rate will be doubled to account for possible operational variation of the purge flow.

If the bounding assumption is made that the helium purge is saturated with water vapor at the temperature of the core vessel (which should average less than 55°C based on CDR information concerning cooling water temperatures, see Sect. 5.3.6), the release can be estimated conservatively, as follows:

- Helium discharge temperature: 60°C (based on the 55°C estimated maximum value)
- Helium discharge rate: 20 m^3/100-h (twice the current nominal design figure)
- Water vapor density: 0.143 kg of D_2O or 0.13 kg H_2O/m^3 @ 60°C (i.e., 100% humidity)
- Discharge rate (D_2O or H_2O, as applicable, based on the above three assumptions): 0.6 L/d

As a conservative assumption for environmental impact statement (EIS) studies, it is assumed that the discharge continues for a period of one month. This is very conservative because conditions inside the core vessel are monitored and water vapor is not an operationally desirable atmosphere for the core vessel, since radiolytic effects may lead to corrosion of components inside. The nuclides of interest for this source term are tritium (H-3) and gaseous nuclides such as N-13, N-16, and O-15. As a practical matter, the release of the N and O nuclides would be nil because they are dissolved in the cooling water and would decay before being released. Any radioactive ions in the coolant would not be transported with the evaporated water, and insufficient other agitation or energy sources are present to create a vapor fog/aerosol that would be transported to the environment.

As developed above, the bounding release is 0.6 L/d for 30 days, for a total of 18 L of water evaporated and released to the environment. The nuclide of primary interest is tritium, and it will be in the form of HTO and T_2O. The coolant loop with highest tritium content determines the maximum tritium release. That most tritiated loop is the D_2O coolant loop that circulates through the reflectors. The tritium content is estimated at less than 5 Ci/L after equilibrium 4-MW operation is achieved. The maximum tritium source term is, therefore, 90 Ci of tritiated water vapor released over a 30-d period.

The light water component cooling loops will also have tritium contamination, but at much lower concentrations than the end-of-life concentrations in the heavy water coolant loop—because they are light water and thus have much less deuterium (which becomes tritium upon absorption of a neutron), and because the light water systems are replenished with new coolant several times per year. The tritium concentration for activated light water cooling systems is estimated not to exceed 0.5 Ci/L, based on the lower production rate of tritium and periodic replenishment of the H_2O, resulting in a 9 Ci source term for evaporation of the same (18-L) volume of water.

3.9.3.3 For rapid, worst case leak into target hot cell or utility vault

The other type of leak would unfold rapidly because the leak rate would be too large for operation to continue for more than a few minutes, at most, forcing a shutdown for repair of the leak. For a bounding analysis it is assumed that the leak occurs near the pump outlet where the pressure is highest, so that the water is propelled out over a wide area of the enclosure in which it occurs [e.g., the target hot cell, the pipe chase, the target shielding enclosure, or the utility vault (inside the core vessel covered above)]. This is a very conservative assumption because the piping is typically located inside a pipe chase or trench or is behind shielding (provided to allow limited entry to the utility vault during operation). The source term for the bounding analysis would include two contributors: the water vapor that evaporates from the puddle over the floor and the small random droplets of water (e.g., formed if the leak hits an obstruction) that could be entrained in the ventilation system flow. The balance of the spilled water would gravity drain to a sump tank.

For bounding analysis, the puddle area is taken as the maximum floor area that could be wetted by any one pipe breaking in either the target hot cell or the utility vault, estimated at 50 m^2, and the puddle depth is assumed to be 3 mm, a value consistent with water lying on a flat floor. The puddle depth is limited by the surface tension of water; large floor areas cannot be flooded to greater depths because of gravity drainage to trenches and/or sump tanks. The mist contribution is assumed to be 1% of the spilled water—about 15 L (note: the total spill volume is taken to be 1500 L, but the puddle volume is limited to 150 L because of the limited floor area). The 1% mist fraction assumed here is greater than assumed for pressurized water/solution spills in the *Final EIS for the Safe Interim Storage of Hanford Tank Wastes* (DOE/EIS-0212, October 1995), and is thought to be conservative because the water pressure in these loops is relatively low (only a few atmospheres) and because the air velocities are not high in either the target hot cell or the utility vault. The amount of water becoming airborne is thus

Puddle evaporation: 150 L of H_2O or D_2O
Mist entrainment: 15-L of H_2O or D_2O

The tritium source term associated with these losses is calculated based on a concentration of 5.0 Ci/L for the D_2O cooling system and 0.5 Ci/L for the H_2O cooling systems. The source term associated with the mist entrainment depends (except for the tritium releases) primarily on how much credit is taken for the HEPA filters. If no credit is taken for the HEPA filters, then any radioactive solids or ions present in the entrained mist would be released. For conservatism, it is assumed here that the HEPAs do not function, so that the whole 15 L of H_2O or D_2O is released to the environment. The nontritium radionuclide content is estimated by modeling this as low-level liquid waste (LLLW, which is composed of used coolant); thus, the release is found by multiplying the nuclide inventories specified in List 8 of Exhibit E for 1-MW operation and a total volume of 800 gal of LLLW by the factor 15/(3.78*800) = 4.96E–3. The tritium content is determined from the same concentrations used to estimate the puddle evaporation source term. The mist release occurs over the time scale consistent with the residence time of ventilation air in the room and ducts, greater than 5 min. The puddle evaporation can occur no faster than air can carry away the water from the puddle. Air at 90°F (summertime exhaust temperature) that is saturated at 100% humidity could hold about 38 g D_2O/m^3, so the 125 m^3/min (4400 cfm) of utility exhaust flow could, theoretically, transport 4.25 kg/min of D_2O. Thus, it would take at least 35 min for the 150 L of D_2O to evaporate.

In addition to the tritium released by this event, some fraction of the gaseous radionuclides dissolved in the coolant could be released, with the bounding assumption being the immediate release of 100% of these gases to the interior space or cell in which the coolant pipe break or leak occurs. Since the residence time of air in the cells is greater than 5 min, it would take at least that long to sweep the released gaseous nuclides to the environment through the target facility ventilation exhaust stack. It is appropriate to take credit for this delay because the assumption of 100% immediate release into the indoor space is very conservative for release of dissolved gases from a low-pressure coolant system from which the immediate release would be less than 50%, with the balance requiring considerable time for the dissolved gases to diffuse out of the water. The shroud-cooling water system generates the greatest quantity of radioactive gases, and this source term (Table 3.6) can be applied conservatively to all the target cooling water release accidents.

Table 3.6. Target shroud cooling water system gaseous radionuclides inventory
[Given numbers are for 1-MW operation—multiply by 4 to get 4-MW numbers.]

Radionuclide	Half life	Inventory for 1-MW continuous proton beam operation for 1 year (Ci)	Stack release after 5 min delay (Ci)
N-13	598 s	155	109
N-16	7 s	124	0
O-14	70 s	56	6.4
O-15	122 s	786	143

s-seconds.

Source terms for the loss of cooling system integrity events can be summarized as below. The results are expressed in a manner to allow convenient bracketing of the estimated releases between that consistent with the initial 1-MW proton beam operation and the eventually planned 4-MW beam operation. The reason for listing the worst case water spill event as an anticipated event for the H_2O cooling systems is that there are three such systems (or more, considering the beam stop cooling systems—see discussion, below), which means that even though the estimated frequency of occurrence might be in the unlikely category for any one system, the aggregate frequency for three systems will probably exceed the 0.025 per year threshold for the anticipated category, considering that there are three such systems (specific design data nor currently available will be required for quantitative estimates of the failure frequencies).

Anticipated event: D_2O cooling water system (line break in utility vault)
Tritium: 750 Ci as DTO or T_2O (0.5 h-release period; bounds 4-MW operation)
Gases: See Table 3.6 (5-min release period; multiply by 4 for 4-MW operation)
Mist: 75 Ci of tritium plus 0.005 times List 8, Exhibit E (5-min release period) (multiply List 8 by 4 for 4-MW operation)

Anticipated event : D_2O cooling water system (leak in core vessel)

Tritium: 90 Ci as DTO or T_2O (30 d-release period; bounds 4-MW operation)
Gases: negligible (decay before release)
Mist: none

Anticipated event: any of three H_2O cooling water systems (line break in utility vault)
Tritium: 75 Ci as HTO or T_2O (0.5 h-release period; bounds 4-MW operation)
Gases: See Table 3.6 (5-min release period; multiply by 4 for 4-MW operation)
Mist: 7.5 Ci of tritium plus 0.005 times List 8, Exhibit E (5-min release period) (multiply List 8 by 4 for 4-MW operation)

3.9.4 Beam Stop Cooling Water Line Breaks

Three beam stops are to be installed for the original construction and two more (beam injection and beam extraction) will be installed when the second ring is built for the upgrade to 4-MW operation. The ring injection beam stop for each ring will operate continuously at maximum power of 200 kW (during normal beam operation the estimated continuous dumped power is only 40 kW, so the 200 kW is a bounding number). The other beam stops operate at lower power and/or are used intermittently. The injection stops thus have the largest radioactivity inventories. The line break events for the beam stop H_2O coolant systems are very similar to those considered above for the target cooling systems. Since their HEPA-filtered ventilation exhaust is routed to the target station ventilation exhaust path for discharge to the environment by the target stack, and since the maximum beam dump source terms are bounded by the target facility cooling water spill accident source terms, there is no need to do a separate consequence analysis for beam stop coolant accidents.

3.10 LOSS OF INTEGRITY OF CRYOGENIC MODERATOR (ACCIDENT SEQUENCE 9)

The cryogenic moderator system circulates an ~1.5 kg inventory of ~20 K hydrogen through cryogenic moderator vessels located in the core vessel above the water-cooled shroud and back to helium-cooled heat exchangers and pumps located in the safe room, which is located on the floor level of the high bay above, and to the west of, the target hot cell. Under abnormal conditions, or for system shutdown, the cryogenic hydrogen is allowed to heat up and expand into a 4500-L expansion tank (which is located outdoors). As described in Sect. 5 of the CDR, the safe room houses the active components of the system—pump, valves, heat exchanger. The safe room is so called because of special safety features, including explosive-rated (nonsparking) electrical equipment, hydrogen detection, and special ventilation. The safe room is not normally occupied. When personnel are present, hydrogen safety protocols will be followed.

3.10.1 Sequence of Events for Loss of Cryogenic Moderator System Integrity

The cryogenic moderator is maintained under multiple barriers both for safety and for cryogenic insulation reasons. The innermost tubing is surrounded by vacuum for insulation, and the vacuum is surrounded by a helium barrier for safety. The vacuum and He barriers are continuously monitored for any loss of integrity. The sequence of events for a leak would depend on where the loss of integrity occurred and how many of the barriers were compromised (see also events 9.A, 9.B, 9.C in Table 3.2). If only the primary boundary fails, the hydrogen escapes into the vacuum system, which is vented safely. If all boundaries fail, the hydrogen is released to the immediate surroundings of the failure.

Combustion is not likely in any potential release location. Release of hydrogen into the core vessel would not involve combustion because a helium atmosphere is maintained inside the vessel. Release of hydrogen in the safe room could possibly involve combustion in this relatively small space; however, the hydrogen concentration is continuously monitored, and the safe room ventilation rate increased upon detection of airborne hydrogen. This automatic detection and accompanying actuation of a ventilation flow increase is designed to prevent combustion upon any credible hydrogen leak inside the safe room. An accompanying alarm would cause personnel present in the safe room to evacuate immediately. Credible leakage from the 4500-L expansion tank would be unlikely to lead to combustion because of the tank's outdoor location.

3.10.2 Estimated Frequency Range for Loss of Cryogenic Moderator System Integrity

Since cryogenic line and system connections are tested before use with hydrogen, failure is not an anticipated event. Monitoring of the vacuum and helium barriers during normal operation should catch any developing leaks in the early stage, making sudden, gross failures that occur during operation of the cryogenic system extremely unlikely events.

The hydrogen moderator vessel is positioned close outside the mercury vessel, but the close-fitting collimator (in the transfer tunnel upstream of the proton beam window) and the proton beam passages in the reflector plugs prevent beam directional and/or focus control failures from allowing the beam to strike the hydrogen moderator vessel.

3.10.3 Source Term for Loss of Cryogenic Moderator System Integrity

There is no source term of interest because calculations show that there is essentially no activation of the hydrogen. Combustion is a potential consequence, as discussed above, but this combustion would not initiate the release of radioactive material because the air-atmosphere locations that could receive such a leak (e.g., the safe room, the outdoor expansion tank) are not close to any other radioactive material. The accident sequence discussion provided above is for the purpose of pointing out how the accident potential for combustion of hydrogen has been considered in system and facility design. The design features and administrative controls that will be followed should make the risk of personnel injury due to combustion very small.

3.11 LOSS OF INTEGRITY: CORE VESSEL, 3.5-M DIAM TARGET CONTAINMENT VESSEL (ACCIDENT SEQUENCE 10)

3.11.1 Sequence of Events for Loss of Core Vessel Integrity

The core vessel helium atmosphere is maintained at or below atmospheric pressure. There is essentially no pressure stress, making failure probability low. The low pressure tends also to make the loss of vessel integrity a benign event. The helium atmosphere is monitored because it is desired to exclude air for two reasons: to maintain an inert atmosphere as a safety precaution against hydrogen leakage inside the vessel and to maintain an atmosphere that will have much lower activation/spallation because of the passage of the proton beam through it than would other atmospheres (e.g., air).

3.11.2 Estimated Frequency Range for Loss of Core Vessel Integrity

Loss of integrity of a vessel that is not highly stressed would be an unlikely event.

3.11.3 Source Term for Loss of Core Vessel Integrity

Considering that this is an unlikely event, leakage of the vessel's slightly radioactive atmosphere would be of minimal interest for consequence analysis.

3.12 LOSS OF HE FLOW TO CORE VESSEL (ACCIDENT SEQUENCE 11)

3.12.1 Sequence of Events for Loss of He Flow

Loss of the helium purge flow would be unlikely to result in a significant source term because the He inlet flow and core vessel atmosphere are both monitored, allowing detection of the loss of He flow before air has time to diffuse into the vessel.

3.12.2 Estimated Frequency Range for Loss of He Flow

Anticipated.

3.12.3 Source Term for Loss of He Flow

Considering the unlikelihood of such an event developing into a significant release and the resistance of helium to activation, no source term is specified for this event.

3.13 TARGET CELL VENTILATION SYSTEM FAILURES (ACCIDENT SEQUENCE 12)

3.13.1 Sequence of Events for Target Cell Ventilation System Failures

Various target cell ventilation system failures could be postulated. For example, the power supply to the cell ventilation system blowers could fail or the blowers could fail. Without blower operation, the target cell pressure, normally maintained lower than atmospheric pressure, would equilibrate with the ambient pressure outside the cell. Contamination could then begin to diffuse out of the cell through any imperfections in the cell boundary. Reestablishment of power to the blowers or repair of the blowers would restore the cell's normally negative pressure.

It could be postulated that a target cell ventilation system HEPA filter might fail, initiating a period of higher than normal radioactivity in the target system ventilation exhaust. The higher than normal stack discharges would be detected, and actions would be initiated as needed to correct the situation.

3.13.1.1 Frequency of occurrence for target cell ventilation system failures

Mishaps such as a loss of blower power are anticipated to occur during the facility lifetime. A HEPA filter could be improperly seated during installation, but post-installation testing conducted to confirm proper seating would make this unlikely. Spontaneous failure of a HEPA filter would be unlikely. The installed instrumentation and preventive and periodic maintenance make prolonged or undetected ventilation system failures unlikely.

3.13.1.2 Source terms for target cell ventilation system failures

There are no source terms of particular interest beyond the immediate confines of the facility. This is because high levels of airborne radioactivity inside the target hot cell are not necessary nor are they expected during normal operation of the hot cell. The radiological health protection and contamination control measures employed at the facility are adequate to protect the workers within the confines of the facility. These measures include ventilation system monitoring, air sampling, routine surveys, as well as administrative controls.

3.14 LOSS OF OFF-SITE POWER (ACCIDENT SEQUENCE 13)

Loss of off-site power would immediately cut off the beam because the linac and ring magnets must be powered in order to maintain a beam on the target. Since the mercury decay heat level (~9.6 kW after continuous 4-MW operation) is only about 0.25% of the full beam power, the decay heat removal requirements of the target facility are not demanding. For example, the mass of the target mercury combined with the relatively low decay heat means that forced circulation is not required for decay heat removal. Therefore, the loss of off-site power puts the target into a safe state in which any decay heat present is removed by passive means.

Loss of off-site power would cause a loss of target hot cell ventilation, which is discussed above in Sect. 3.13. Diesel-backed power is provided. In the event of a prolonged power outage, the diesel generator would be started to power loads like the ventilation system blowers.

There is no accident-related source term of particular interest for loss of off-site power.

3.15 FIRE (ACCIDENT SEQUENCE 14)

Fire safety is discussed in Sect. 9.2.4.1 of the SNS CDR. As stated there, the SNS facility does not involve large accumulations of particularly hazardous flammable materials. Furthermore, smoke detector systems, sprinklers, and ventilation system features that can be controlled by fire fighters for smoke control purposes are provided. It is planned to do a fire-hazards analysis under the guidance of DOE Order 420.1 during Title 1 Design. For this reason, detailed analyses of fire hazard scenarios have not been conducted at this stage of the project.

3.16 NATURAL PHENOMENA—TORNADO AND SEISMIC (ACCIDENT SEQUENCE 15)

As outlined by Table 8.4-2 of the SNS CDR, the SNS facilities have been categorized in accordance with the DOE natural phenomena performance categories for the application of the appropriate levels of seismic and wind conditions. The target building is considered to be PC-2, which is consistent with a once per 1000 years seismic event. Safety-related systems would be expected to survive or at least perform their designated safety function(s) before failing during and after a PC-2 level seismic or wind event. Thus, a significant release of radioactive material would not be expected for an unlikely natural phenomena event.

A seismic event more severe than the design level could act as an initiator for any of the events considered in Sects. 3.2 through 3.14. The resulting source term would not be different because it was initiated by a natural phenomenon; thus, the source term would also be bounded by those evaluated in Sects. 3.2 through 3.14. The frequency of such failure initiation would be low because the system is basically designed for a 10^{-3}/year level of event without significant source term. It is concluded that natural phenomena will not significantly increase either the frequency or magnitude of SNS source terms. Therefore, special natural phenomena source terms are not recommended for detailed calculation and study in the EIS.

3.17 BEYOND DESIGN-BASIS ACCIDENTS (ACCIDENT SEQUENCE 16)

The purpose of postulating these events is to determine if any risk significant source terms are present in the probability range somewhat below the 10^{-6} /year cut-off frequency used for design-basis events. The criterion selected for a BDB event selection is that the estimated frequency should be greater than 10^{-8}/year but less than 10^{-6}/year.

Table 3.7 lists the target facility accidents considered in this chapter and considers additional failures that could result in increased source terms. The results show that the mercury spill event (Sect. 3.3) and the loss of mercury circulation pump events (Sect. 3.4) provide the most significant additional source terms for residual risk evaluation. One source term that bounds both the 3.3 and the 3.4 BDB accident sequences (and also the other BDB events screened) is derived in Exhibit F. The source term is summarized below in Table 3.8.

Table 3.7. Screening for selection of limiting beyond-design-basis accident

Initiating event and section of report where considered as design basis event	Additional failures	Approx. annual probability level	Consequence assessment
Note: no sequences are postulated involving the failure of all automatic proton beam cutoffs. There are three separate automatic cut-off systems: the target protection system (TPS), the beam permit/pulse enable (BP) system(s), and the personnel protection system (PPS) that can initiate cutoff of the beam. Accident sequences with the assumption that all these fail simultaneously have annual probability below the 10^{-8}/year cutoff.			
3.2 Proton beam excessive focus density	In the worst case , this event leads to a Hg spill event. Thus, considerations under 3.3 (below, in this table) cover this event		
3.3 Hg spill	BP + TPS + mercury enclosure Hg drainage path + water-cooled shroud	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Short period of boiling of Hg may occur before PPS beam cutoff, depending on Hg spill rate. Short and long term Hg, I releases (see Exhibit E)
3.4 Loss of Hg pumping	BP + TPS + mercury enclosure Hg drainage path + water-cooled shroud	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Short period of bulk boiling of Hg may occur before PPS beam cutoff. Short and long term Hg, I releases (see Exhibit E)
3.5 Loss of Hg cooling water flow	BP + TPS + operator (>2 min available for manual beam cutoff)	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Bounded by the source term derived for 3.3 and 3.4. Additional failures (e.g., of the mercury enclosure Hg drainage path and/or water-cooled shroud would bring this event below the 10^{-8}/year screening criterion)
3.6–3.9 Loss of component cooling water, various combinations	BP + TPS + operator	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Overheating of the uncooled component. Worst case could lead to failure of water-cooled shroud and Hg spill. Bounded by 3.3/3.4 BDB event
3.10 Loss of integrity of cryogenic moderator	Core vessel relief valve and/or burst disc	$<10^{-6}$/year	Overpressurization of core vessel, release of He/H_2 mixture to shielding cavity. Negligible He/H_2 transport to hot cell. Combustion possible in shielding cavity or inside core vessel after long times (to allow air to diffuse in). No enhanced Hg source term. Consequences bounded by 3.3/3.4
3.11 Loss of core vessel integrity [seal(s) bad] + 3.12 loss of core vessel He purge flow (extended)	Loss of cryogenic moderator integrity postulated to occur at same time when core vessel atmosphere is mostly air, and the proton beam is on	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Combustion of H_2 inside the core vessel, failure of core vessel at weak points (e.g., the neutron beam windows). Conceivably could cause failure of the water-cooled shroud and the Hg vessel, with Hg spill, but not excessive Hg temperature. Source term bounded by BDB event for 3.3/3.4

Table 3.7 (continued)

Initiating event and section of report where considered as design basis event	Additional failures	Approx. Annual Probability Level	Consequence assessment
3.13 Target cell ventilation system failures	As noted in Exhibit F and other sections of this chapter, for an Hg spill accident that occurs in conjunction with ventilation system failure, the release source term would be lower because there would be much weaker mechanism(s) for transporting mercury vapor to an atmospheric release point		
3.14 Loss of off-site power	There are no significant source terms in this category because a loss of off-site power results in essentially immediate, inherent termination of the proton beam, and because the post-operation decay heat level does not require active cooling to prevent damage		
3.15 Fire	Fire could result in destruction of wiring, resulting in the long-term outage of cooling pumps and/or other active equipment. However, the TPS is designed to be fail-safe, so that loss of TPS wiring insulation integrity resulting from a fire would be expected to cause automatic shutdown of the proton beam. The SNS decay heat level (10 kW immediately after beam cutoff from 4-MW operation) is such that active cooling is not required for decay heat removal		
3.16 Natural phenomena—beyond-design-basis wind event	Roof level ventilation equipment + facility stack(s) + cooling towers	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Damage to Hg system equipment inside the heavily shielded hot cell or the core vessel would be very unlikely. The damage to outside systems could lead to higher than normal releases due to loss of a filtration stage, etc., but not a source term of interest in the BDB context
3.16 Natural phenomena—beyond-design-basis earthquake	Any active system could be failed	$>10^{-8}$/year (but $\leq 10^{-6}$/year)	Could cause loss of cryogenic H_2 moderator integrity, and subsequent combustion could cause Hg spill, but the combustion would not be in the hot cell. The Hg releases from the Hg spill would not be greater than presented for U or EU events because automatic beam cutoff would be highly likely for two reasons: (1) the TPS has fail-safe design so that loss of signal causes beam trip and (2) extreme earthquakes tend to cause loss of off-site power that would terminate the proton beam

**Table 3.8. Beyond-design-basis accident source term summary-
bulk mass fractions released**

Radionuclide category	Fractional release of total inventory		
	Short term (~10 min)	First 7 d	7 d to 30 d
	1-MW target configuration—fractional releases		
Mercury	6.6E–5	0.8E–2	3.0E–3
Iodine	1.40E–1	2.0E–1	6.6E–1
Nonvolatile solids	Negligible	Negligible	Negligible
	4-MW target configuration—fractional releases		
Mercury	1.83E–3	0.8E–2	3.0E–3
Iodine	1.4E–1	2.0E–1	6.6E–1
Nonvolatile solids	Negligible	Negligible	Negligible

Note: For initial Hg and I radionuclide specific activities, see Table 3.4.a. Release fractions for shorter-lived radionuclides would be smaller than the bulk mass fractions indicated above provided that the release period is long in comparison to the half-life of the radionuclide.

3.18 REFERENCES

1. Computationally-Compatible Component Database Release 0.0, New Production Reactors Program, Reliability, Availability, Maintainability and Inspectability, Engineering Technology Division, Department of Nuclear Energy, Brookhaven National Laboratory, Upton, New York, April 1990.

4. SNS WASTE SYSTEMS ACCIDENT SCENARIOS AND SOURCE TERMS

SNS Waste Systems Description

SNS wastes consist of gaseous, liquid and solid components. Wastes are collected in the appropriate system within the facility and transferred to ORNL for processing or are packaged for off-site disposal. Accidents were analyzed only for the gaseous and liquid waste systems because these systems offer the greatest potential for radionuclide release to the environment.

Gaseous Wastes

The HVAC system will collect off-gases from systems that generate radioactive or potentially radioactive gases and discharge them to two central stacks after final filtration and radiation monitoring. The Gaseous Waste System is located between the mercury target off-gas (i.e., primarily the helium purge flow that maintains the helium atmosphere in the mercury reservoir) and the HVAC system and serves to remove mercury, noble gases, iodine, and tritium from this off-gas stream. The system consists of a chilled condenser to return mercury back to the target system, a liquid nitrogen cooled charcoal bed to remove xenon and iodine, and a circulating hydride bed system for the removal of tritium. The charcoal adsorbs the xenon and iodine spallation products and holds them for decay. It also removes any mercury that is not removed by the mercury condenser. The Tritium Removal System consists of a uranium metal bed and a circulation pump. The helium exiting the charcoal absorber system is passed through this system, and is discharged to the HVAC system.

Another system to process gaseous wastes is a set of decay tanks and a compressor for off-gas from the target, moderator, reflector, and beam stop cooling systems. During shutdown for maintenance, these cooling systems are vented. The compressors compress the vented gases into the decay tanks, where they are held for the decay of the short-lived isotopes.

Liquid Wastes

Liquid wastes from the SNS are characterized in four broad categories: low level liquid, process liquid, hazardous and conventional. Accidents concerning the hazardous and conventional wastes were not analyzed because they were thought to present significantly lower hazards that the other two categories.

The low level liquid wastes are collected from the linac, transfer line, ring, target and beam stop cooling water systems, from the target and other cells, and from the radioactive target ventilation systems. The LLLW system in the tunnels consists of a series of piping headers and a central collection tank. The waste in this tank is pumped to another set of storage tanks located in the Target building, where it is combined with target building LLLW. The waste will be pre-treated as necessary before it is transferred to a load-out station and to a 1000-gallon DOT-certified tank truck, which will transport it to the ORNL LLLW evaporator for further processing.

Process wastes are collected from clean and buffer area building floor drains, cooling water system leakage, building HVAC condensate, central services building ion exchange regeneration solutions, and groundwater in-leakage from tunnel French drains. The process waste system consists of a series of sumps, sump pumps and collection headers leading to a diversion tank system where the waste is monitored for radioactivity. Waste that exceeds a pre-set limit will be diverted to the LLLW collection system, otherwise the waste drains by gravity drainage to a set of storage tanks, from where it is transported to the ORNL treatment facilities in a 3000-gal truck tanker.

Listed below are accident scenarios for the SNS waste systems. This suite of accidents is based in nuclide inventories calculated with a beam power of 1 MW. These inventories are given by the ORIHET-calculated activity inventory at 30 years continuous irradiation, which is equivalent to 40 years of facility operation. To obtain source terms for higher power levels, these activities should be multiplied by the appropriate factor (e.g., 2 or 4) depending on the power level desired. The calculations of the source terms for these accident sequences are contained in the Excel 97 spreadsheet "SNS Waste Accident Source Terms 5 Rev 4." The resulting source terms are presented in Exhibit E.

4.1 FAILURE TO REMOVE MERCURY FROM OFF-GAS

4.1.1 Mercury Condenser Failure (Event Sequence 17)

4.1.1.1 Sequence of events for mercury condenser failure

The mercury condenser serves to remove mercury from the helium purge applied to the mercury loop through the pump seal. The condenser is served by a refrigerated cooling system, which is operated at a temperature of –20°C. Operating at this temperature reduces the vapor pressure of mercury in the stream outlet to the maximum extent possible, without freezing. The charcoal absorber downstream of the condenser functions as a polishing filter for the removal of all traces of mercury before entering the rest of the off-gas treatment system and also serves as a backup to the condenser. This event is initiated by a failure of the cooling system to the mercury condenser.

4.1.1.2 Frequency range for mercury condenser failure

The frequency range for mercury condenser failure is an anticipated event, since no additional reliability enhancement requirements will be placed on the refrigeration system.

4.1.1.3 Source term for mercury condenser failure

The source term is calculated as the quantity of mercury that would exit the condenser under a 1 L/min flow, at the maximum temperature of the mercury loop (110°C). See Exhibit E, list 6 for the accident source term. Since the helium is added to the pump seal, it is a good assumption that the He is saturated with mercury. Therefore, the vapor pressure of mercury at this temperature is 0.56 torr (relationship between temperature and vapor pressure from the CRC handbook, p. D-212), and the resulting mercury flow is 0.0047 g/min (calculated with the ideal gas law). The mercury specific activity is given by the ORIHET-calculated activity inventory of the mercury at 30 years continuous irradiation at 1-MW beam power (equivalent to 40 years of operation), assumed to be uniformly distributed in the 1-m^3 mercury volume. This, when multiplied times the calculated flow, gives the activity release past the condenser. No plate-out or removal of mercury in the off-gas or ventilation system is conservatively assumed, since the charcoal absorber is also assumed to be ineffective, in order to bound the source term. The duration is estimated to be 48 h, or the time required for repair of the refrigeration system.

4.1.2 Mercury Charcoal Absorber Failure (Event Sequence 18)

4.1.2.1 Sequence of events for mercury charcoal adsorber failure

A design study is presently underway to determine if charcoal filtration is required for the cell ventilation system. These sulfur-impregnated charcoal adsorbers would be for final removal of mercury from the target cell ventilation air. This accident sequence assumes that the adsorbers are improperly installed or are not changed on a timely basis, and the mercury detector in the ventilation stream fails, causing mercury to exit the ventilation system.

4.1.2.2 Frequency range for mercury charcoal adsorber failure

The frequency range for mercury charcoal adsorber failure is that of an unlikely event. The principal failure mode for this component is saturation, and downstream mercury detectors would detect breakthrough of the adsorbers and permit shutdown of the system for replacement of the adsorbers before any significant loss of mercury could occur. This detector is assumed to fail. Detection is assumed to occur with the SNS stack detectors, and 10 d is estimated to be required to change the mercury adsorbers.

4.1.2.3 Source term for mercury charcoal adsorber failure (Event Sequence 2)

The source term is calculated based on a mercury release to the target cell, which is anticipated to occur every time the target end is changed. The total quantity of mercury estimated to be spilled is 10 cc, and it is assumed to be transformed into droplets of 1-mm diam. This is assumed to evaporate at a rate of 2.5 g/m^2 surface area per day. If the adsorbers were not functioning, the entire spill quantity could be ventilated out of the cell in 900 d. This means that there is a net accumulation of mercury in the target cell, equal to 900/365 $\times$ 4 target changes/year $\times$ 10 cc/change = 98.6 cc of mercury present in the cell at any one time. Cleanup of the released mercury is ignored. See Exhibit E, list 7 for the accident source term.

Note: This source term is the same as the routine release would be if the charcoal adsorbers were not present in an untreated cell air scenario.

4.2 FAILURE TO REMOVE TRITIUM FROM OFF-GAS

4.2.1 Helium Circulator Failure (Event Sequence 19)

4.2.1.1 Sequence of events for helium circulator failure

The tritium removal system consists of a getter bed with a helium circulator. Because the tritium concentration in the helium is expected to be low, the circulation rate must be large relative to the helium flow of 1 L/min. In order to provide positive off-gas relief, the system has fail-open and fail-closed valves, which bypass the tritium removal system upon detection of loss of helium flow from the circulator. This event is initiated by circulator failure, causing the loss of flow and the bypassing of the tritium removal system. This would result in the loss of tritium removal capability until the circulator could be repaired.

4.2.1.2 Frequency range for helium circulator failure

The frequency range for helium circulator failure is an anticipated event, since the helium circulator is not intended to be redundant.

4.2.1.3 Source term for helium circulator failure

The only isotope affected is tritium, and the loss of tritium removal results in the discharge of 0.46 Ci/h of tritium as triated hydrogen (HT) (the annual mercury target production of 4012 Ci/year expressed on a per hour basis). This release rate is conservative since hydrogen removal by hydriding with impurities within the mercury loop is ignored. Spallation product impurity hydriding could remove a significant fraction of the hydrogen isotopes produced. The duration of the outage is one day because the helium circulator would be designed for a direct change-out and should be relatively easy to replace.

4.2.2 Oxidation of Getter Bed (Event Sequence 20)

4.2.2.1 Sequence of events for oxidation of getter bed

The getter bed consists of a container filled with uranium metal. Hydrogen isotopes flowing over the uranium react with it to produce uranium hydride, effectively removing them from the gas stream. Oxidation of the uranium could occur over a period of time, such that the uranium surface was coated with uranium oxides, and tritium absorption rates would be greatly reduced. This effect is assumed to affect the getter bed such that it ceases to absorb tritium.

4.2.2.2 Frequency range for oxidation of getter bed

The frequency range for getter bed oxidation is considered unlikely, because of the general lack of oxygen in the helium atmosphere of the mercury off-gas system.

4.2.2.3 Source term for oxidation of getter bed

The source term is the same as in Sect. 4.2.1 above, and results in the discharge of 0.46 Ci/h or 4012 Ci/year of tritium as HT. The duration of the event is assumed to be 24 h, because the bed is designed to be easily replaceable.

4.3 RELEASE OF STORED RADIOACTIVITY

4.3.1 Failure of Getter Bed (Event Sequence 21)

4.3.1.1 Sequence of events for failure of getter bed

The getter bed is heated to remove the tritium from it for storage on an annual basis. Overheating of the getter bed is assumed to cause it to rupture, resulting in combustion of the pyrophoric metal in the bed and a release of the tritium contained in it as tritiated water (HTO). The bed would be designed for a pressure greater than its operating pressure and would have a redundant temperature control system.

Frequency range for failure of getter bed. The frequency range of failure for getter bed failure is extremely unlikely, since a catastrophic boundary failure would be required to allow free contact of oxygen to the getter bed.

Source term for failure of getter bed. Since the bed can contain up to one year's production of tritium before the tritium is removed, a source term of 4,000 Ci is expected. The duration of the event is considered to be one hour because of the required diffusion of tritium from the ruptured bed to the cell atmosphere. In addition to tritium, the oxidized uranium is a source of particulates. It is assumed that 10% of the 2 kg of uranium contained in the bed is fine particulate and is exhausted to the cell ventilation.

4.4 FAILURE TO TREAT OFF-GAS

4.4.1 Cryogenic Charcoal Absorber (Event Sequence 22)

4.4.1.1 Sequence of events for cryogenic charcoal absorber failure

Because the mass of xenon and iodine isotopes is small, an alternative method of hold-up for decay other than storage in compressed gas form is being considered. These short-lived isotopes can be absorbed on charcoal at liquid nitrogen temperatures. Since the mass is so small, replacement of the charcoal should be infrequent, and retention of the isotopes should be essentially 100% allowing for 100% decay. Such a method could have significantly reduced emissions while at the same time is more reliable and less expensive. This system consists of a charcoal absorber column cooled with liquid nitrogen. This option is currently under study.

Loss of liquid nitrogen cooling would reduce significantly the effect of charcoal for the absorption of short-lived xenon and iodine. This would result in the release of a significant portion of the off-gas undecayed. An option exists for holding the off-gas in the compressed gas storage for later release, but is assumed to be unavailable.

Frequency range for cryogenic charcoal absorber failure. The frequency range for failure for cryogenic charcoal absorber failure is in the unlikely range, since reliability enhancements to the cryogenic cooling system are anticipated. In addition, charcoal has an affinity for both xenon and iodine at room temperature, although at a reduced capacity.

Source term for cryogenic charcoal absorber failure. The source term is calculated based on ORIHET calculations of the production of volatile isotopes from the mercury target. Very short time steps (10 s) were used in the ORIHET calculations for the mercury and activated air to estimate the production rate instead. In calculating the off-gas from the mercury, consideration was also given to decay of the xenon isotopes to iodine using the Bateman equation to calculate the equilibrium daughter distributions. The xenon produced is assumed to be removed as soon as it is produced, and the off-gas produced was assumed to be vented with short period decay. See Exhibit E, list 1 for the source term. The duration is 24 h because of the ease of repairing the liquid nitrogen cooling.

4.5 OPERATOR ERROR

4.5.1 Tritium Release from Removal System (Event Sequence 23)

4.5.1.1 Sequence of events for tritium release from removal system

An operator is assumed to commit a valve sequence error when transferring one year's accumulation of tritium for recovery. It is assumed that the material is discharged through a vacuum system to ventilation and then to the stack on a short-term basis.

Frequency range for tritium release from removal system. The frequency range for a general operator error is anticipated, but the frequency range for this particular accident sequence is unlikely. This is because the control system will contain interlocks to prevent this accident, which would have to fail before this accident could happen.

Source term for tritium release from removal system. The source term is the same as in 4.3.1 above, or 4,000 Ci tritium as HT. No absorption in the vacuum pump is anticipated. The duration of the event is 20 min because the evacuation of this volume is estimated to be approximately this long.

4.5.2 Release of Off-Gas from Decay Tank (Event Sequence 24)

4.5.2.1 Sequence of events for release of off-gas from decay tank

An operator is assumed to commit a valve sequence error, resulting in sudden loss of the contents of one off-gas tank to cell ventilation system. Although this is a routine discharge, the operator is assumed to release the wrong tank. The tank released is assumed to have recently been filled.

Frequency range for release of off-gas from decay tank. The frequency range for a general operator error is anticipated, but the frequency range for this particular accident sequence is unlikely. This is because the control system will contain interlocks to prevent this accident, which would have to fail before this accident could happen.

Source term for release of off-gas from decay tank. The source term is the contents of one off-gas decay tank at initial fill-up. To bound the release, the total quantity of gas in the tank calculated to be an equilibrium mixture of the xenon and daughter isotopes that would exist after the 7-d fill time. The duration of the event is 1 h, because of the anticipated pumping rate. See Exhibit E, list 2 for the source term.

4.5.3 Spill of LLLW from Storage Tanks (Event Sequence 25)

4.5.3.1 Sequence of events for spill of LLLW from storage tanks

An operator is filling the LR-56 transport tank and fails to connect the hose properly, releasing the contents of 1 tank to the floor drain in the loading area. This floor drain is routed to the LLLW tank cell instead of process waste.

Frequency range for spill of LLLW from storage tanks. The frequency range for this operator error is anticipated, because no special equipment is provided to prevent this other than operator training and procedures.

Source term for spill of LLLW from storage tanks. The source term is a zero liquid release because tank vault provides secondary containment of the leak. Sumps are provided for pumping the liquid back into the LLLW system. A gaseous release source term is provided in list 11 in Exhibit E.

4.5.4 Airborne Release of LLLW from Storage Tanks (Event Sequence 26)

4.5.4.1 Sequence of events for airborne release of LLLW from storage tanks

The LLLW tanks are located inside a shielded cell, capable of containing the contents. This accident sequence is assumed to be an operator pumping a tanker load of LLLW into the LR-56 tanker during a loading operation, but having a crack in the fill line caused either by a defective line or poor connection. The operator is assumed to notice the spray after 20 min pumping and to shut off the pump.

Frequency range for airborne release of process waste from storage tanks. The frequency range for this operator error is anticipated, because no special equipment is provided to prevent this other than operator training and procedures.

Source term for airborne release of process waste from storage tanks. The tanker is assumed to be filled in 1.6 h at a pumping rate of 50 gpm. Curbing is assumed to contain the spray (assumed to be 5% of 50 gpm $\times$ 20 m = 50 gal), but 10% (5 gal) is assumed to become airborne as a mist. The natural processes of settling-out and impingement would be expected to receive most of the mist and the HEPA filtration system would remove 99.95% of any remaining mist (or solid particulate from dried mist). To yield a conservative source term, only the HEPA filtration system is assumed to affect the source term, and the natural removal processes are ignored.. See Exhibit E, list 10 for the source term. Nuclides and nuclide concentrations of representative LLLW, which are assumed to consist of a mixture of target water coolants, were obtained from the Excel-97 spreadsheets “Cooling Water Waste Volume & Activation 5 rev-2” and “SNS Waste Accident Source Terms 5 rev-4.” This is based on the total volume of the target coolants, which are assumed to represent the maximum of LLLW radionuclide concentrations.

4.5.5 Spill of Process Waste from Storage Tanks (Event Sequence 27)

4.5.5.1 Sequence of events for spill of process waste from storage tanks

The process waste tanks are located inside a diked area capable of containing the contents. This accident sequence is assumed to be an operator error spilling a tanker load of process waste into the tanker curbing during a tanker loading operation. This area is not designed to retain the entire tanker load of liquid.

Frequency range for spill of process waste from storage tanks. The frequency range for this operator error is anticipated, because no special equipment is provided to prevent this other than operator training and procedures.

Source term for spill of process waste from storage tanks. The tanker curbing is assumed to contain 10% of the spill, but 90% (13,500 gal) is assumed to overflow to the retention basin and then to the White Oak Creek headwaters. The duration of this accident is 3-1/3 h, because of the anticipated pumping rate of the process waste pumps (75 gpm). See Exhibit E, list 4 for the liquid source term. The gaseous release source term is in list 12. Nuclides and nuclide concentrations of representative process wastewater, which are assumed to consist of magnet coolant, were obtained from the Excel-97 spreadsheets “Cooling Water Waste Volume & Activation 5 rev-2” and “SNS Waste Accident Source Terms 5 rev-4.” This is based on the total volume of the linac and ring magnet coolant, which is assumed to represent the maximum of process waste radionuclide concentration.

4.5.6 Airborne Release of Process Waste from Storage Tanks (Event Sequence 28)

4.5.6.1 Sequence of events for airborne release of process waste from storage tanks

The process waste tanks are located inside a diked area capable of containing the contents. This accident sequence is assumed to be an operator pumping a tanker load of process waste into the tanker during a loading operation, but having a crack in the fill line caused either by a defective line or poor connection. The operator is assumed to notice the spray after 20 min pumping and to shut off the pump.

Frequency range for airborne release of process waste from storage tanks. The frequency range for this operator error is anticipated, because no special equipment is provided to prevent this other than operator training and procedures.

Source term for airborne release of process waste from storage tanks. The tanker is assumed to be filled in 3-1/3 h at a pumping rate of 75 gpm. Curbing is assumed to contain the spray (assumed to be 5% of 75 gpm × 20 m = 75 gal), but 10% (7.5 gal) is assumed to become airborne as a mist. See Exhibit E, list 9 for the source term. Nuclides and nuclide concentrations of representative process wastewater, which are assumed to consist of magnet coolant, were obtained from the Excel-97 spreadsheets “Cooling Water Waste Volume & Activation 5 rev-2” and “SNS Waste Accident Source Terms 5 rev-4.” This is based on the total volume of the linac and ring magnet coolant, which is assumed to represent the maximum of process waste radionuclide concentration.

4.6 EQUIPMENT FAILURE

4.6.1 Off-Gas Treatment Pipe Leak/Break (Event Sequence 29)

4.6.1.1 Sequence of events for off-gas treatment pipe leak/break

This event is a pipe leak or break resulting in the release of off-gas to cell ventilation.

Frequency range for off-gas treatment pipe leak/break. The frequency range for this is unlikely, since a boundary failure (weld crack or valve leak) would be required. The location of the off-gas piping should reduce the chance of mechanical damage during material moving operations in the target cell.

Source term for off-gas treatment pipe leak/break. Since there is no hold-up for decay, all of the isotopes released to cell ventilation would be released from the stack. See Exhibit E, list 1 for the source term. The duration is 24 h because the continuous purging of the mercury would continue past the beam-off condition, until the inventory could be expected to be exhausted. The off-gas stream is conservatively estimated to be at the production concentrations. The duration of this sequence is 24 h, because the mercury would be purged of gases during this time after beam cutoff.

4.6.2 Off-Gas Compressor Failure (Event Sequence 30)

4.6.2.1 Sequence of events for off-gas compressor failure

This sequence is the general failure of the off-gas compressor. This compressor may not be required except during cooling water system venting (cooling water systems are assumed to be operated pressurized and unvented during normal operation). This is because of the presence of the cryogenic charcoal absorber. In the event this is not the design, then the compressor would be needed for all operations.

Frequency range for off-gas compressor failure. The frequency range for this is unlikely, since reliability enhancements to the off-gas compressor, adding additional compressors, accelerator power reduction, or operations curtailment is anticipated.

Source term for off-gas compressor failure. In order to bound it, the source term is conservatively assumed to be the mercury off-gas, assuming there is no cryogenic charcoal absorber. Since there is no hold-up for decay, all of the isotopes released to cell ventilation would be released from the stack. See Exhibit E, list 1 for the source term. The duration is 1 h before operator response to the release would begin. Continuous purging of the mercury would continue, until the compressor was repaired.

4.6.3 Off-Gas Decay Tank Failure (Event Sequence 31)

4.6.3.1 Sequence of events for off-gas decay tank failure

The off-gas decay tank is assumed to fail, resulting in sudden loss of contents of one off-gas tank to the cell ventilation system.

Frequency range for off-gas decay tank failure. The frequency range for this is extremely unlikely, since a catastrophic boundary failure would be required.

Source term for off-gas decay tank failure. See Exhibit E, list 2 for the source term. The duration is 1 min because of the anticipated sudden release.

4.6.4 Iodine Filter Failure (Event Sequence 32)

4.6.4.1 Sequence of events for iodine filter failure

The iodine filter is a charcoal filter located in the off-gas filter train to provide iodine containment for decay of the longer-lived iodine isotopes. This filter could become saturated or could be improperly installed, resulting in iodine discharge to the cell ventilation. The iodine filter may not be required if there is a cryogenic charcoal absorber. This is presently under study.

Frequency range for iodine filter failure. The frequency range for this is unlikely, because similar installations have a great degree of experience with this filter type.

Source term for iodine filter failure. See Exhibit E, list 1 for the source term, but assume only the iodine is present. The duration is 24 h before the filter could be replaced.

4.6.5 LLLW Piping System Failure (Event Sequence 33)

4.6.5.1 Sequence of events for LLLW piping system failure

LLLW piping is routed through the linac tunnels to avoid the requirement for double-contained piping. In this accident sequence, the LLLW piping is assumed to break during heavy component handling, releasing LLLW to the floor of the linac or ring tunnel.

Frequency range for LLLW piping system failure. The frequency range for this is unlikely, since a boundary failure (weld crack or valve leak) would be required. The location of the piping relative to the components moved (magnets and beamline components) should preclude damage from potential falling objects that would be the principal hazard.

Source term for LLLW piping system failure. The source term is zero release because the linac tunnel provides secondary containment of the leak. Sumps are provided with pumping through a diversion tank system to the LLLW system. A gaseous release source term is provided in list 11 in Exhibit E.

4.6.6 LLLW Storage Tank Failure (Event Sequence 34)

4.6.6.1 Sequence of events for LLLW storage tank failure

An LLLW tank is assumed to leak or rupture releasing contents of one tank to the cell floor.

Frequency range for LLLW storage tank failure. The frequency range is in the extremely unlikely range, since a catastrophic boundary failure would be required.

Source term for LLLW storage tank failure. The source term is zero release to environment because tank vault provides secondary containment of the leak. Sumps are provided with pumping back to the LLLW system. A gaseous release source term is provided in list 11 in Exhibit E.

4.6.7 LLLW Pumping System Failure (Event Sequence 35)

4.6.7.1 Sequence of events for LLLW pumping system failure

This sequence is the loss of the ability to pump LLLW because of pump failure.

Frequency range for LLLW pumping system failure. The frequency range is anticipated.

Source term for LLLW pumping system failure. The source term is zero release to environment because of backup pumps and pump containment.

4.6.8 Process Waste System Piping Failure (Event Sequence 36)

4.6.8.1 Sequence of events for process waste system piping failure

This accident sequence is an underground piping leak/break resulting from damage to piping during excavation, improper installation, or corrosion over a period of time.

Frequency range for process waste system piping failure. The frequency range is anticipated, because process waste piping of this design is known to develop leaks over the design life of the piping.

Source term for process waste system piping failure. The source term is release of process waste underground to soil, assumed to be 10% of annual system flow (1.04E6 gal/year). See Exhibit E, list 3 for the source term. The duration is 1 year, assumed to be the time for detection and repair of the leak.

4.6.9 Process Waste Storage Tank Failure (Event Sequence 37)

4.6.9.1 Sequence of events for process waste storage tank failure

In this accident sequence, a process waste tank is assumed to leak or rupture, releasing the contents of one tank to the diked containment area.

Frequency range for process waste storage tank failure. The frequency range is unlikely, since a boundary failure (weld crack or valve leak) would be required.

Source term for process waste storage tank failure. The source term is zero release to the environment because the tank dike provides secondary containment of the leak. Sumps are provided with pumping back to the process waste system. A gaseous release source term is provided in list 12 in Exhibit E.

4.6.10 Process Waste Pumping System Failure (Event Sequence 38)

4.6.10.1 Sequence of events for process waste pumping system failure

This accident sequence is the loss of the ability to pump process waste because of pump failure.

Frequency range for process waste pumping system failure. The frequency range is anticipated.

Source term for process waste pumping system failure. The source term is zero release to the environment because of backup pumps and pump containment.

4.7 TRANSPORTATION

4.7.1 LLLW Transportation Accident (Event Sequence 39)

4.7.1.1 Sequence of events for LLLW transportation accident

This sequence of events is a transportation accident involving the LR-56 LLLW tanker, which releases the contents of the tanker to the environment.

Frequency range for LLLW transportation accident. The frequency range of release of radionuclides during type B shipping casks like the LR-56 is estimated to be 5×10^{-9}/mi $\times$ 3.5 mi = 1.75×10^{-8} (estimated from data given in ref.1). The frequency for this accident is therefore BDB.

Source term for LLLW transportation accident. The source term is 800 gal of LLLW released to environment. See Exhibit E, list 8 for the source term. The duration of the accident is 24 h. Nuclides and nuclide concentrations of representative LLLW wastewater, which are assumed to consist of a mixture of coolant, were obtained from the Excel-97 spreadsheets "Cooling Water Waste Volume & Activation 5 rev-2" and "SNS Waste Accident Source Terms 5 rev-4." This is based on the total volumes from the various target, linac, and beam-stop coolant systems, which are assumed to be changed with each target end change (ion exchange effectiveness is ignored). The postulated accidents are expected to be predominately those that breach the LR-56 cargo tank, resulting in a liquid spill. Since the LLLW contents of the LR-56 are non-pressurized, it is unlikely that a significant airborne source term would be created. Drying and subsequent airborne release of spilled liquid is mitigated by the low volatility of the liquids transported and by the quick response of emergency clean-up personnel following this on-reservation accident.

4.7.2 Process Waste Transportation Accident (Event Sequence 40)

4.7.2.1 Sequence of events for process waste transportation accident

This sequence of events is a transportation accident involving the process waste tanker.

Frequency range for process waste transportation accident. The frequency range of truck accidents is estimated to be 5×10^{-7}/mi $\times$ 3.5 mi = 1.75×10^{-6} (estimated from data given in ref.1). The frequency for this accident is therefore extremely unlikely, since a catastrophic boundary failure would be required, and the tanker is designed to withstand the transportation environment in which it will be used.

Source term for process waste transportation accident. The source term is 15,000 gal of process waste released to environment. See Exhibit E, list 5 for the source term. The duration of the accident is 1 h.

Information source terms are summarized in Table 4.1. Other information about the individual accidents, including method of detection, system response, and mitigating actions or features, are summarized in Table 4.2.

4.8 REFERENCES

1. *Final Environmental Impact Statement*, Safe Interim Storage of Hanford Tank Wastes, Hanford Site, Richland, Washington, DOE/EIS-0212, Vol. 1, F47–48.

Table 4.1. Source term summary—waste systems
(Frequency ranges: 2.5 * 10^{-2}/year < A <10^{0}/year; 10^{-4}/year < U < 2.5 * 10^{-2}/year; 10^{-6}/year < EU < 10^{-4}/year)

Frequency category	Event(s) [sequence number(s) from Table 4-2]	Recommended source term		
		Material released	Time span	Nuclides released to environment[a]
A	35, 38	None	NA	None
A	25	LLLW	1 h	List 11
A	19	Tritium	24 h	0.46 Ci/h
A	17	Mercury	48 h	4.7 mg/min (list 6)
A	27, 36, 28	Process waste	3-1/3 h (27), 1 year (36), 20 min (28)	Lists 4 and 12 (27), list 3 (36), list 9 (28)
A	26	LLLW	20 min	List 10
U	24	Off-gas	1 h	List 2
U	22, 30	Off-gas	24 h (22), 72 h (30)	List 1 (22, 30)
U	33	LLLW	1 h	List 11
U	20, 23	Tritium	24 h (20), 20 min (23)	0.46 Ci/h (4), 4000 Ci (7)
U	18	Mercury	10 d	List 7
U	29, 32	Off-gas	24 h	List 1 (29), list 1 (32, iodine only)
EU	34	LLLW	1 h	List 11
EU	37	Process waste	1 h	List 12
EU	40	Process waste	1 h	15,000 gal (list 5)
EU	21	Tritium, uranium	1 h	4000 Ci tritium, 0.2 kg depleted U as oxide
EU	31	Off-gas	1 min	List 2
BDB	39	LLLW	24 h	800 gal (list 8)

[a]See Exhibit E for source term lists.

Table 4.2. Waste system accidents

Sequence	How detected	System response or damage	Mitigating actions or features
17. Failure to remove Hg from off-gas–Hg condenser failure	Increase in temperature in condenser	Condenser ceases to condense Hg	Charcoal absorber downstream
18. Failure to remove Hg from ventilation; Hg charcoal absorber failure	Increase in Hg in air concentration measured by Hg detector	Hg is released from cell ventilation until absorber is replaced	Detection of absorber breakthrough by Hg detector prior to last absorber saturation
19. Failure to remove tritium from off-gas–He circulator failure	Operator observation of process instrumentation	Tritium is released from off-gas until circulator is repaired or replaced	NA
20. Failure to remove tritium from off-gas–getter bed oxidation	Operator observation of tritium in off-gas	Tritium is released from off-gas until circulator is repaired or replaced	NA
21. Release of stored activity–failure of getter bed	Operator observation of conditions in cell after failure	Combustion of pyrophoric uranium and release of tritium	NA
22. Failure to treat off-gas–cryogenic charcoal absorber failure	Detection of activity in off-gas	Radioactive off-gas is released from cell ventilation until off-gas can be shut off	Off-gas contains short-lived isotopes only
23. Operator error–tritium release from removal system	Operator observation of tritium in off-gas	Tritium is released from cell ventilation	NA
24. Operator error–off-gas release from decay tank	Operator observation of activity in off-gas	Undecayed off-gas is released from cell ventilation	NA
25. Operator error–spill from LLLW storage tanks	Operator observation of liquid in sumps	LLLW drains to sump, is pumped back to LLLW system	NA
27. Operator error–spill from process waste storage tanks	Operator observation of liquid in dikes	Process waste drains to curb; 10% is pumped back to process waste system; 90% is released to environment	Process waste contains low levels of short-lived isotopes only
29. Off-gas pipe leak/break	Detection of activity in cell ventilation	Off-gas leaks to cell ventilation and is released	Off-gas contains short-lived isotopes only
30. Off-gas compressor failure	Operator observation of failure to compress off-gas	Undecayed off-gas is released from cell ventilation	Off-gas contains short-lived isotopes only

Table 4.2 (continued)

Sequence	How detected	System response or damage	Mitigating actions or features
31. Off-gas decay tank failure	Detection of activity in cell ventilation	Radioactive off-gas is released from cell ventilation	Off-gas contains short-lived isotopes only
32. Iodine filter failure	Detection of activity in off-gas	Radioactive iodine is released from cell ventilation	Iodine has been decayed partially
33. LLLW piping system failure	Detection of activity in process waste	LLLW leaking into linac tunnel is returned to LLLW system	NA
34. LLLW storage tank failure	Detection of liquid In LLLW cell sump	LLLW leaking into sump is returned to LLLW system	NA
35. LLLW pumping system failure	Operator observation of pump not operating	LLLW leaking into sump is returned to LLLW system	NA
36. Process waste piping system failure	Detection of activity In groundwater monitoring well	Process waste leaks into soil	Process waste contains low levels of short-lived isotopes only
37. Process waste storage tank failure	Operator observation of water in dike	Process waste leaking into dike is returned to process waste system	NA
38. Process waste pumping system failure	Operator observation of pump not operating	Process waste leaking into dike is returned to process waste system	NA
39. LLLW transportation accident	Driver observation of accident	LLLW leaking from LR-56 tanker spills to environment	NA
40. Process waste transportation accident	Driver observation of accident	Process waste leaking from tanker spills to environment	NA
28. Process waste airborne release	Operator observation of water spray	Airborne release of process waste	Process waste contains low levels of short-lived isotopes only
26. LLLW airborne release	Operator observation of water spray	Airborne release of LLLW	HEPA Filters on ventilation air

EXHIBIT A

A COMPARISON OF THE AIRBORNE CONCENTRATIONS OF METALLIC MERCURY ALLOWED FROM CHECMIAL TOXICITY vs RADIOLOGICAL HEALTH POINTS OF VIEW

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EXHIBITA. A COMPARISON OF THE AIRBORNE CONCENTRATIONS OF METALLIC MERCURY ALLOWED FROM CHEMICAL TOXICITY VS RADIOLOGICAL HEALTH POINTS OF VIEW

The current OSHA Standard for occupational exposure to nonradioactive metallic mercury is a ceiling limit of 0.1 mg/m^3 (29 CFR 1910.20, OSHA Regulations). The National Institute of Occupational Safety and Health (NIOSH) has recommended an alternative limit of 0.05 mg/m^3 averaged over an 8-h period. The American Congress of Government Industrial Hygienists (ACGIH) recommends a threshold limit value (TLV) of 0.025 mg/m^3 [time-weighted average (TWA)]. Adherence to these limits prevents mercury sickness in workers exposed to airborne, nonradioactive mercury.

This exhibit considers the following question: If an airspace in contact with Spallation Neutron Source irradiated mercury were at the AICGH-recommended threshold limit value-time-weighted average (TLV-TWA) of 0.025 mg Hg/m^3, would the concentration of radioactive mercury isotopes exceed the occupational limit for radiation exposure?

It will be assumed that the SNS mercury has been irradiated by a 1-MW proton beam for a period of 1 year, allowing all the mercury radionuclides, except Hg-194, to come to equilibrium. The irradiation time of only 1 year is chosen intentionally to show that the radioactivity content becomes controlling early in life of the facility. Similarly, the proton beam (pre-upgrade) power of 1 MW is chosen because the intent is to demonstrate that the radioactivity content of this mercury is, in effect, more controlling than the toxic material content under the least radioactive scenario. As the radioactivity content of this mercury increases with each year of operation and is further increased by the planned upgrades to 2 MW and eventually to 4 MW, the conclusion will only be strengthened. The total amount of each mercury radionuclide present in the target mercury is provided by SNS HECT96/MCNP/ORIHET95 calculations (See CDR, Sect. 5.4):

Hg-193 = 1.05(10)^4	Ci	(half life = 3.8 h)
Hg-194 = 39	Ci	(half life = 529 year)
Hg-195 = 1.75(10)^4	Ci	(half life = 9.9 h)
Hg-197 = 1.17(10)^5	Ci	(half life = 2.67 d)
Hg-203 = 8.28(10)^4	Ci	(half life = 46.6 d)

The total volume of mercury in the SNS target is ~1 m^3. The concentration of each radionuclide in air with 0.025 mg/m^3 of irradiated SNS mercury is determined by simple ratios. The resulting concentrations are then multiplied by the breathing rate, and by the effective dose conversion factor given for each nuclide by ICRP-68. The hourly and yearly effective dose accumulation rates due to inhalation of each nuclide then summed in Table A.1 to give an integral comparison to the 5 rem yearly radiation dose limit specified by 10CFR835.202.

From Table A.1, we see that, if the mercury were present in air at the 0.025 mg/m^3 ACGIH recommended TLV-TWA concentration, the radioactivity of the airborne mercury would be too high to allow normal occupancy since the 19.4 rem yearly effective dose commitment would exceed the 10CFR835.202 limit by a factor of four. Considering the lower administrative limits that are routinely applied to radiation exposures would make the radioactivity content more limiting than the ACGIH TLV by a factor of approximately ten. Increasing integrated target proton beam exposure time above the 1 year assumed in the calculations above would increase the factor even further by increasing the amount of Hg-194 present. Considering volatile spallation or activation products other than the mercury isotopes included in the calculation would only further reinforce the conclusion. Since the facility features to control airborne mercury concentrations inside the facility, to separate the workers from the mercury, and to prevent airborne emissions of mercury will have to be built into the facility from the very first day of operation, it can be concluded that strong protection against the chemical toxicity of the mercury will be provided by those installed systems and radiological control procedures.

The above analysis is not intended to imply that the chemical toxicity of mercury can be ignored during operation of the SNS. The laboratory industrial hygiene department will maintain cognizance of planned SNS target facility operations and will prescribe additional controls for special situations in which chemical toxicity may be more important. Such special situations might arise infrequently, either before initial facility operation when the mercury is not irradiated at all, or after a long shutdown when the dominant nuclides have decayed (Hg-203, for example, has a 47-d half life). If the installed facility ventilation, compartmentation, and surveillance features are not totally adequate for those special situations that may arise, the hygienist will be able to prescribe additional surveillance, training, and/or ventilation as needed to control exposure to the hazard.

Table A.1. Radiation dose commitment rate due to inhalation of SNS-activated mercury, assuming that the total mercury concentration of the air is 0.025 mg/m^3 of irradiated (1 MW for 1 year) SNS mercury
(0.025 mg/m^3 is the ACGIH recommended occupational limit (TLV)[a] for nonradioactive Hg)

Hg radionuclide	Concentration Ci/m^3	DCF[b] (Rem/Ci)	Radiation Dose Rate (Rem/h)	Radiation Dose Rate (Rem/y)
Hg-193	1.93E-08	4.07E+03	9.90E-05	1.98E-01
Hg-194	7.17E-11	1.48E+05	1.34E-05	2.67E-02
Hg-195	3.22E-08	5.18E+03	2.10E-04	4.20E-01
Hg-197	2.15E-07	1.63E+04	4.41E-03	8.82E+00
Hg-203	1.52E-07	2.59E+04	4.97E-03	9.93E+00
		TOTAL	9.70E-03	1.94E+01

[a]The 0.025 mg/m^3 TLV-TWA is the limit set by the ACGIH for the maximum allowable TWA mercury vapor concentration for a normal 8-hour work day or 40-hour work week.
[b]DCF mean Dose Conversion Factor, with values taken from ICRP-68 publication (July 1994) titled "Dose Coefficients for Intakes of Radionuclides by Workers." (Annals of the ICRP, 24(4), 1994).

EXHIBIT B

TARGET MERCURY SPALLATION/ACTIVATION PRODUCT RADIONUCLUDE INVENTORY

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EXHIBIT B. TARGET MERCURY SPALLATION/ACTIVATION PRODUCT RADIONUCLUDE INVENTORY

(1-MW beam power—multiply by 4 to get 4-MW beam end-of-life inventory)

SNS target mercury decay activity after 30 years continuous irradiation (equivalent to 40 years of actual operation); 1 GeV proton energy; 1 MW beam power (decay); nuclide radioactivity during decay (curies); time units = seconds, except as otherwise noted.

Note: the column labeled “TS” gives the source of the hazard category threshold:

- A = threshold taken from DOE-STD-6003-96, “Safety of Magnetic Fusion Facilities: Guidance”
- B = threshold calculated from published dose conversion factors (DOE/EH-0071, July 1988) using the DOE-STD-1027-92 threshold definition formula
- C = threshold calculated using recently calculated dose conversion factors (K. Eckerman, ORNL, letters dated 6/18/98 and 8/24/98) and the threshold definition formula in DOE-STD-1027-92
- C* = threshold bounded by comparison to available bounding similar isotope of same element
- D = threshold taken as the generic 4.3E5 Ci value for beta-gamma emitters specified by DOE-STD-1027-92 (9/97 Change Notice No. 1)

Fraction of Cat. 2 calculated by dividing 10-min inventory by the Cat. 2 threshold (10 min is transport time between target hot cell and receptor at 300 m).

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
H3	4.50E+03	5.90E+04	5.90E+04	5.90E+04	5.90E+04	5.90E+04	3.03E+05	A	1.95E-01	5.90E+04	5.90E+04	5.90E+04	5.90E+04	5.90E+04
RH101	1.20E+03	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	4.30E+05	A	3.92E-06	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00
AG109M	4.58E-04	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.41E+10	A	1.20E-10	1.69E+00	1.69E+00	1.67E+00	1.61E+00	1.28E+00
CD109	4.64E+02	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	6.81E+05	A	2.48E-06	1.69E+00	1.69E+00	1.67E+00	1.61E+00	1.28E+00
CD115	2.23E+00	1.69E+00	1.69E+00	1.69E+00	1.68E+00	1.67E+00	7.35E+06	A	2.30E-07	1.45E+00	1.24E+00	1.92E-01	1.31E-04	3.41E-25
IN110	2.04E-01	1.69E+00	1.69E+00	1.65E+00	1.57E+00	1.47E+00	9.50E+07	B	1.74E-08	3.09E-01	5.67E-02	8.01E-11	0.00E+00	0.00E+00
IN111	2.83E+00	3.38E+00	3.38E+00	3.37E+00	3.36E+00	3.35E+00	3.05E+07	A	1.10E-07	2.99E+00	2.65E+00	6.08E-01	1.95E-03	1.19E-19
IN112	1.43E-02	1.69E+00	1.61E+00	1.04E+00	3.99E-01	9.41E-02	3.60E+09	B	2.89E-10	1.50E-15	1.34E-30	0.00E+00	0.00E+00	0.00E+00
IN114	8.33E-04	3.38E+00	1.90E+00	1.04E-02	9.83E-08	2.86E-15	1.57E+09	A	6.62E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IN115M	1.87E-01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.66E+08	A	1.02E-08	1.55E+00	1.35E+00	2.09E-01	1.43E-04	3.72E-25
IN116M	3.92E-03	3.38E+00	1.81E-01	6.44E-13	0.00E+00	0.00E+00	4.30E+05	A	1.50E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IN117	3.04E-02	1.69E+00	1.66E+00	1.44E+00	1.05E+00	6.57E-01	8.20E+07	A	1.76E-08	2.00E-05	2.38E-10	0.00E+00	0.00E+00	0.00E+00
SN113	1.15E+02	3.38E+00	3.38E+00	3.38E+00	3.38E+00	3.38E+00	3.20E+06	A	1.06E-06	3.37E+00	3.36E+00	3.24E+00	2.81E+00	1.12E+00
SB113	4.63E-03	3.38E+00	3.05E+00	1.21E+00	1.55E-01	7.07E-03	4.30E+05	D	2.81E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SB115	2.23E-02	8.45E+00	8.27E+00	6.79E+00	4.39E+00	2.28E+00	5.30E+07	B	1.28E-07	1.29E-06	1.98E-13	0.00E+00	0.00E+00	0.00E+00
SB116	1.10E-02	5.07E+00	4.85E+00	3.24E+00	1.33E+00	3.46E-01	2.20E+07	B	1.47E-07	5.27E-14	5.49E-28	0.00E+00	0.00E+00	0.00E+00
SB117	1.17E-01	2.37E+01	2.36E+01	2.32E+01	2.21E+01	2.03E+01	2.97E+08	A	7.81E-08	1.56E+00	7.99E-02	2.60E-17	0.00E+00	0.00E+00
SB118	2.50E-03	2.20E+01	2.04E+01	1.47E+01	1.35E+01	1.35E+01	4.30E+05	D	3.42E-05	1.28E+01	1.20E+01	6.02E+00	4.02E-01	9.04E-09
SB119	1.59E+00	2.20E+01	2.20E+01	2.20E+01	2.19E+01	2.19E+01	2.10E+08	C	1.05E-07	2.02E+01	1.78E+01	1.60E+00	5.62E-05	0.00E+00
SB120	1.10E-02	1.52E+01	1.46E+01	9.83E+00	4.11E+00	1.11E+00	7.60E+06	B	1.29E-06	3.49E-13	8.00E-27	0.00E+00	0.00E+00	0.00E+00
SB122	2.70E+00	3.38E+00	3.38E+00	3.37E+00	3.36E+00	3.34E+00	5.84E+06	A	5.77E-07	2.98E+00	2.62E+00	5.67E-01	1.44E-03	1.95E-20
SB124	6.02E+01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.31E+06	A	1.29E-06	1.68E+00	1.67E+00	1.56E+00	1.19E+00	2.06E-01
SB125	9.96E+02	5.02E+00	5.02E+00	5.02E+00	5.02E+00	5.02E+00	2.86E+06	A	1.76E-06	5.02E+00	5.02E+00	5.02E+00	5.02E+00	5.02E+00
TE117	4.29E-02	1.18E+01	1.17E+01	1.06E+01	8.41E+00	5.98E+00	4.30E+05	D	2.47E-05	3.31E-03	9.27E-07	0.00E+00	0.00E+00	0.00E+00
TE118	6.00E+00	1.35E+01	1.35E+01	1.35E+01	1.35E+01	1.35E+01	4.30E+05	D	3.14E-05	1.28E+01	1.20E+01	6.02E+00	4.01E-01	9.03E-09
TE119	6.69E-01	1.69E+01	1.69E+01	1.68E+01	1.66E+01	1.63E+01	4.20E+06	C	4.00E-06	1.02E+01	6.05E+00	1.20E-02	3.39E-13	0.00E+00
TE121	1.68E+01	2.70E+01	2.70E+01	2.70E+01	2.70E+01	2.70E+01	1.54E+06	A	1.75E-05	2.66E+01	2.60E+01	2.03E+01	7.72E+00	1.42E-02

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
TE125M	5.80E+01	7.76E-01	7.76E-01	7.76E-01	7.76E-01	7.76E-01	4.27E+05	A	1.82E-06	7.76E-01	7.76E-01	7.75E-01	7.72E-01	7.17E-01
TE127	3.90E-01	1.69E+00	1.69E+00	1.67E+00	1.63E+00	1.57E+00	9.78E+06	A	1.71E-07	6.94E-01	2.85E-01	6.56E-06	5.09E-24	0.00E+00
I119	1.33E-02	6.76E+00	6.63E+00	5.30E+00	2.77E+00	9.59E-01	8.50E+04	C	6.24E-05	4.88E-11	2.88E-22	0.00E+00	0.00E+00	0.00E+00
I120	5.63E-02	1.01E+01	1.01E+01	9.56E+00	8.44E+00	6.88E+00	2.00E+04	C	4.78E-04	2.84E-02	6.00E-05	0.00E+00	0.00E+00	0.00E+00
I121	8.83E-02	2.03E+01	2.02E+01	1.93E+01	1.74E+01	1.49E+01	1.00E+05	C	1.93E-04	4.16E-01	8.22E-03	2.88E-23	0.00E+00	0.00E+00
I122	2.52E-03	2.87E+01	2.58E+01	1.43E+01	1.17E+01	1.15E+01	1.10E+05	C	1.30E-04	7.84E+00	5.19E+00	3.61E-02	1.36E-10	0.00E+00
I123	5.50E-01	3.72E+01	3.72E+01	3.70E+01	3.67E+01	3.62E+01	6.60E+04	C	5.61E-04	2.16E+01	1.15E+01	5.35E-03	5.29E-16	0.00E+00
I124	4.18E+00	1.69E+01	1.69E+01	1.69E+01	1.68E+01	1.68E+01	1.30E+03	C	1.30E-02	1.55E+01	1.43E+01	5.25E+00	1.05E-01	9.18E-13
I125	6.01E+01	7.43E+01	7.43E+01	7.43E+01	7.43E+01	7.43E+01	1.10E+03	C	6.75E-02	7.42E+01	7.39E+01	6.92E+01	5.29E+01	9.16E+00
I126	1.30E+01	3.38E+00	3.38E+00	3.38E+00	3.38E+00	3.37E+00	5.80E+02	C	5.83E-03	3.29E+00	3.20E+00	2.33E+00	6.68E-01	2.00E-04
I128	1.74E-02	3.38E+00	3.29E+00	2.56E+00	1.47E+00	6.40E-01	2.10E+05	C	1.22E-05	7.23E-09	1.55E-17	0.00E+00	0.00E+00	0.00E+00
I129	5.73E+09	8.85E-06	8.85E-06	8.85E-06	8.85E-06	8.85E-06	1.60E+02	C	5.53E-08	8.85E-06	8.85E-06	8.85E-06	8.85E-06	8.85E-06
I130	5.15E-01	1.69E+00	1.69E+00	1.67E+00	1.64E+00	1.60E+00	7.20E+03	C	2.32E-04	8.64E-01	4.42E-01	1.41E-04	3.11E-18	0.00E+00
XE119	4.03E-03	3.38E+00	3.01E+00	1.06E+00	1.06E-01	3.30E-03	4.30E+05	D	2.47E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
XE120	2.78E-02	3.38E+00	3.34E+00	2.88E+00	2.04E+00	1.21E+00	4.30E+05	D	6.70E-06	1.31E-05	4.99E-11	0.00E+00	0.00E+00	0.00E+00
XE121	2.78E-02	1.69E+00	1.66E+00	1.41E+00	9.89E-01	5.79E-01	4.30E+05	D	3.28E-06	4.38E-06	1.14E-11	0.00E+00	0.00E+00	0.00E+00
XE122	8.38E-01	1.18E+01	1.18E+01	1.18E+01	1.16E+01	1.14E+01	1.05E+06	A	1.12E-05	7.82E+00	5.17E+00	3.60E-02	1.35E-10	0.00E+00
XE123	8.67E-02	2.03E+01	2.02E+01	1.95E+01	1.76E+01	1.49E+01	9.92E+04	A	1.97E-04	3.81E-01	6.98E-03	9.89E-24	0.00E+00	0.00E+00
XE125	7.08E-01	5.74E+01	5.74E+01	5.72E+01	5.66E+01	5.57E+01	2.52E+05	A	2.27E-04	3.61E+01	2.23E+01	6.95E-02	1.13E-11	0.00E+00
XE127	3.64E+01	1.45E+02	1.45E+02	1.45E+02	1.45E+02	1.45E+02	2.39E+05	A	6.07E-04	1.45E+02	1.43E+02	1.28E+02	8.19E+01	4.50E+00
CS120	7.01E-04	1.69E+00	8.57E-01	1.91E-03	2.45E-09	3.54E-18	4.30E+05	D	4.44E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS123	4.08E-03	8.45E+00	7.67E+00	2.93E+00	2.86E-01	8.28E-03	4.30E+05	D	6.81E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS124	3.56E-04	1.86E+01	8.42E+00	2.75E+00	7.36E-01	1.02E-01	4.30E+05	D	6.40E-06	1.22E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CS125	3.13E-02	2.03E+01	2.00E+01	1.75E+01	1.29E+01	8.10E+00	6.20E+06	B	2.82E-06	3.12E-04	4.76E-09	0.00E+00	0.00E+00	0.00E+00
CS126	1.14E-03	5.41E+01	4.70E+01	3.24E+01	2.79E+01	2.27E+01	5.59E+06	A	5.80E-06	2.34E-01	1.59E-03	0.00E+00	0.00E+00	0.00E+00
CS127	2.60E-01	1.20E+02	1.20E+02	1.19E+02	1.15E+02	1.09E+02	1.00E+07	B	1.19E-05	3.23E+01	8.54E+00	9.85E-07	0.00E+00	0.00E+00
CS128	2.51E-03	1.88E+02	1.76E+02	1.31E+02	1.21E+02	1.20E+02	4.30E+05	D	3.05E-04	1.06E+02	9.16E+01	1.65E+01	2.07E-02	2.71E-21
CS129	1.34E+00	2.04E+02	2.04E+02	2.04E+02	2.04E+02	2.03E+02	1.07E+07	A	1.91E-05	1.67E+02	1.30E+02	5.91E+00	3.45E-05	0.00E+00
CS130	2.08E-02	3.89E+01	3.80E+01	3.08E+01	1.94E+01	9.67E+00	8.80E+06	B	3.50E-06	2.19E-06	1.24E-13	0.00E+00	0.00E+00	0.00E+00
CS131	9.69E+00	2.59E+02	2.59E+02	2.59E+02	2.58E+02	2.58E+02	1.75E+07	A	1.48E-05	2.58E+02	2.57E+02	2.33E+02	1.03E+02	3.02E-02
CS132	6.47E+00	6.76E+00	6.76E+00	6.75E+00	6.74E+00	6.73E+00	1.87E+06	A	3.61E-06	6.41E+00	6.07E+00	3.19E+00	2.60E-01	2.12E-08
CS136	1.32E+01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	3.35E+05	A	5.04E-06	1.65E+00	1.60E+00	1.16E+00	3.33E-01	9.83E-05
BA123	1.88E-03	1.69E+00	1.31E+00	1.30E-01	7.64E-04	3.46E-07	4.30E+05	D	3.02E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA124	8.22E-03	5.07E+00	4.75E+00	2.62E+00	7.00E-01	9.66E-02	4.30E+05	D	6.09E-06	1.16E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA125	2.43E-03	1.69E+00	1.39E+00	2.33E-01	4.44E-03	1.17E-05	4.30E+05	D	5.42E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BA126	6.96E-02	3.38E+01	3.36E+01	3.15E+01	2.75E+01	2.23E+01	4.50E+07	B	7.00E-07	2.30E-01	1.56E-03	0.00E+00	0.00E+00	0.00E+00
BA127	8.82E-03	6.25E+01	6.00E+01	3.92E+01	1.35E+01	2.64E+00	4.30E+05	D	9.12E-05	6.00E-16	5.15E-33	0.00E+00	0.00E+00	0.00E+00
BA128	2.43E+00	1.22E+02	1.22E+02	1.21E+02	1.21E+02	1.20E+02	9.70E+06	B	1.25E-05	1.06E+02	9.15E+01	1.65E+01	2.07E-02	2.71E-21
BA129	9.25E-02	1.61E+02	1.60E+02	1.55E+02	1.42E+02	1.22E+02	4.30E+05	D	3.60E-04	3.82E+00	8.70E-02	1.69E-21	0.00E+00	0.00E+00
BA131	1.18E+01	2.40E+02	2.40E+02	2.40E+02	2.40E+02	2.40E+02	3.27E+07	A	7.34E-06	2.34E+02	2.27E+02	1.61E+02	4.15E+01	6.22E-03
BA133	3.84E+03	8.11E+01	8.11E+01	8.11E+01	8.11E+01	8.11E+01	4.05E+06	A	2.00E-05	8.11E+01	8.11E+01	8.10E+01	8.07E+01	7.85E+01
BA136M	3.59E-06	2.70E-01	2.70E-01	2.70E-01	2.70E-01	2.70E-01	4.30E+05	D	6.28E-07	2.63E-01	2.56E-01	1.86E-01	5.33E-02	1.57E-05
LA126	6.94E-04	1.69E+00	8.45E-01	1.65E-03	1.57E-09	1.47E-18	4.30E+05	D	3.84E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA127	2.66E-03	1.69E+01	1.41E+01	2.73E+00	7.10E-02	2.99E-04	4.30E+05	D	6.35E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA128	3.47E-03	4.90E+01	4.26E+01	1.20E+01	7.28E-01	1.08E-02	4.30E+05	D	2.79E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA129	8.06E-03	8.28E+01	7.72E+01	4.14E+01	1.04E+01	1.29E+00	4.30E+05	D	9.63E-05	1.76E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA130	6.04E-03	1.22E+02	1.16E+02	7.55E+01	3.43E+01	1.32E+01	4.30E+05	D	1.76E-04	1.44E-07	3.09E-16	0.00E+00	0.00E+00	0.00E+00
LA131	4.10E-02	1.67E+02	1.66E+02	1.53E+02	1.23E+02	8.76E+01	6.60E+07	B	2.32E-06	4.85E-02	1.36E-05	0.00E+00	0.00E+00	0.00E+00
LA132	2.00E-01	1.61E+02	1.60E+02	1.59E+02	1.55E+02	1.50E+02	1.70E+07	B	9.35E-06	4.87E+01	1.05E+01	1.17E-08	0.00E+00	0.00E+00
LA133	1.63E-01	9.12E+01	9.12E+01	9.03E+01	8.82E+01	8.46E+01	4.30E+05	D	2.10E-04	1.59E+01	1.92E+00	1.58E-11	0.00E+00	0.00E+00
LA134	4.48E-03	1.17E+02	1.14E+02	1.01E+02	9.38E+01	9.24E+01	4.30E+05	D	2.35E-04	8.35E+01	7.49E+01	2.01E+01	1.18E-01	3.65E-16
LA135	8.13E-01	2.03E+02	2.03E+02	2.03E+02	2.03E+02	2.02E+02	3.90E+08	B	5.21E-07	1.85E+02	1.54E+02	2.71E+00	9.79E-09	0.00E+00
LA136	6.85E-03	2.20E+01	2.05E+01	1.09E+01	2.67E+00	3.25E-01	4.30E+05	D	2.53E-05	2.42E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LA137	2.19E+07	1.44E-01	1.44E-01	1.44E-01	1.44E-01	1.44E-01	1.50E+06	A	9.57E-08	1.44E-01	1.44E-01	1.44E-01	1.44E-01	1.44E-01
LA140	1.68E+00	1.69E+00	1.69E+00	1.68E+00	1.68E+00	1.66E+00	5.19E+06	A	3.24E-07	1.37E+00	1.12E+00	9.33E-02	5.76E-06	0.00E+00
CE130	9.99E-01	4.39E+01	4.27E+01	3.33E+01	1.91E+01	8.32E+00	4.30E+05	D	7.74E-05	9.41E-08	2.01E-16	0.00E+00	0.00E+00	0.00E+00
CE131	6.94E-03	6.76E+01	5.88E+01	1.69E+01	1.06E+00	1.65E-02	4.30E+05	D	3.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CE132	9.99E-01	8.96E+01	8.93E+01	8.68E+01	8.13E+01	7.36E+01	4.30E+05	D	2.02E-04	8.39E+00	7.84E-01	3.47E-13	0.00E+00	0.00E+00
CE133	2.04E-01	6.08E+01	6.05E+01	5.76E+01	5.03E+01	4.06E+01	4.30E+05	D	1.34E-04	3.64E-01	2.12E-03	0.00E+00	0.00E+00	0.00E+00
CE134	3.16E+00	9.29E+01	9.29E+01	9.28E+01	9.26E+01	9.22E+01	3.90E+06	B	2.38E-05	8.34E+01	7.47E+01	2.01E+01	1.18E-01	3.65E-16
CE135	7.37E-01	1.91E+02	1.91E+02	1.90E+02	1.89E+02	1.86E+02	1.50E+07	B	1.27E-05	1.22E+02	7.63E+01	2.76E-01	8.07E-11	0.00E+00
CE137	3.75E-01	4.14E+02	4.14E+02	4.14E+02	4.12E+02	4.09E+02	4.60E+08	B	9.00E-07	2.02E+02	8.02E+01	1.22E-03	1.87E-22	0.00E+00
CE139	1.38E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02	3.78E+06	A	1.43E-04	5.38E+02	5.37E+02	5.21E+02	4.63E+02	2.14E+02
CE141	3.25E+01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	3.35E+06	A	5.04E-07	1.67E+00	1.65E+00	1.46E+00	8.83E-01	3.43E-02

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
CE142	1.83E+19	3.35E-10	3.35E-10	3.35E-10	3.35E-10	3.35E-10	4.30E+05	D	7.78E-16	3.35E-10	3.35E-10	3.35E-10	3.35E-10	3.35E-10
PR132	9.99E-01	2.20E+01	1.42E+01	2.89E-01	4.98E-05	1.13E-10	4.30E+05	D	6.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PR133	4.51E-03	2.20E+01	1.97E+01	7.56E+00	8.96E-01	3.66E-02	4.30E+05	D	1.76E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PR134	1.18E-02	3.55E+01	3.41E+01	2.36E+01	1.04E+01	3.07E+00	1.20E+07	B	1.97E-06	6.32E-12	1.13E-24	0.00E+00	0.00E+00	0.00E+00
PR135	1.67E-02	1.37E+02	1.34E+02	1.11E+02	6.98E+01	3.25E+01	4.30E+05	D	2.58E-04	5.10E-07	1.50E-15	0.00E+00	0.00E+00	0.00E+00
PR136	9.10E-03	3.06E+02	2.97E+02	2.34E+02	1.50E+02	8.88E+01	2.30E+07	B	1.02E-05	1.00E-02	5.28E-07	0.00E+00	0.00E+00	0.00E+00
PR137	5.33E-02	3.85E+02	3.84E+02	3.73E+02	3.43E+02	2.90E+02	1.10E+08	B	3.39E-06	9.88E-01	1.49E-03	0.00E+00	0.00E+00	0.00E+00
PR138	1.01E-03	4.43E+02	4.01E+02	3.31E+02	3.16E+02	2.95E+02	4.30E+05	D	7.70E-04	6.50E+01	1.25E+01	3.10E-08	0.00E+00	0.00E+00
PR139	1.84E-01	5.34E+02	5.34E+02	5.32E+02	5.23E+02	4.99E+02	2.30E+08	B	2.31E-06	9.17E+01	1.39E+01	2.04E-09	0.00E+00	0.00E+00
PR140	2.35E-03	6.47E+02	6.42E+02	6.23E+02	6.18E+02	6.16E+02	4.30E+05	D	1.45E-03	5.61E+02	5.06E+02	1.47E+02	1.19E+00	2.87E-14
PR142	7.97E-01	3.38E+00	3.38E+00	3.36E+00	3.32E+00	3.26E+00	1.05E+07	A	3.20E-07	2.19E+00	1.42E+00	7.74E-03	1.13E-11	0.00E+00
PR143	1.36E+01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	3.92E+06	A	4.31E-07	1.65E+00	1.61E+00	1.18E+00	3.57E-01	1.49E-04
ND135	8.56E-03	3.89E+01	3.67E+01	2.22E+01	7.27E+00	1.36E+00	4.30E+05	D	5.16E-05	1.29E-16	4.25E-34	0.00E+00	0.00E+00	0.00E+00
ND136	3.52E-02	1.40E+02	1.39E+02	1.23E+02	9.39E+01	6.23E+01	1.10E+08	B	1.12E-06	7.45E-03	3.92E-07	0.00E+00	0.00E+00	0.00E+00
ND137	2.67E-02	2.62E+02	2.59E+02	2.24E+02	1.57E+02	9.13E+01	4.30E+05	D	5.21E-04	6.31E-04	1.48E-09	0.00E+00	0.00E+00	0.00E+00
ND138	2.10E-01	3.35E+02	3.34E+02	3.29E+02	3.14E+02	2.94E+02	2.60E+07	B	1.27E-05	6.47E+01	1.24E+01	3.09E-08	0.00E+00	0.00E+00
ND139	2.06E-02	4.90E+02	4.86E+02	4.27E+02	2.82E+02	1.40E+02	1.00E+08	B	4.27E-06	2.87E-05	1.45E-12	0.00E+00	0.00E+00	0.00E+00
ND140	3.37E+00	6.20E+02	6.20E+02	6.19E+02	6.18E+02	6.15E+02	4.30E+05	D	1.44E-03	5.60E+02	5.05E+02	1.47E+02	1.19E+00	2.87E-14
ND141	1.04E-01	7.72E+02	7.72E+02	7.66E+02	7.39E+02	6.73E+02	3.49E+09	A	2.19E-07	3.30E+01	1.18E+00	5.34E-18	0.00E+00	0.00E+00
ND147	1.10E+01	3.38E+00	3.38E+00	3.38E+00	3.37E+00	3.37E+00	4.57E+06	A	7.40E-07	3.27E+00	3.17E+00	2.17E+00	4.95E-01	3.31E-05
PM136	1.24E-03	3.72E+01	2.52E+01	7.62E-01	3.21E-04	2.77E-09	4.30E+05	D	1.77E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM137	1.67E-03	1.05E+02	7.85E+01	5.83E+00	1.81E-02	3.12E-06	4.30E+05	D	1.36E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM138	1.16E-04	1.88E+02	1.55E+02	2.71E+01	5.44E-01	1.48E-03	4.30E+05	D	6.30E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM139	2.88E-03	3.41E+02	3.04E+02	8.58E+01	3.38E+00	2.28E-02	4.30E+05	D	2.00E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PM140	1.06E-04	5.10E+02	2.26E+02	1.46E+02	5.71E+01	1.40E+01	4.30E+05	D	3.40E-04	4.73E-13	9.58E-28	0.00E+00	0.00E+00	0.00E+00
PM141	1.45E-02	6.91E+02	6.82E+02	5.80E+02	3.51E+02	1.42E+02	6.20E+07	B	9.35E-06	4.64E-08	1.98E-18	0.00E+00	0.00E+00	0.00E+00
PM142	4.69E-04	8.43E+02	7.35E+02	6.22E+02	5.13E+02	3.85E+02	4.30E+05	D	1.45E-03	7.00E-01	7.19E-04	0.00E+00	0.00E+00	0.00E+00
PM143	2.65E+02	9.26E+02	9.26E+02	9.26E+02	9.26E+02	9.26E+02	3.95E+06	A	2.34E-04	9.25E+02	9.24E+02	9.09E+02	8.55E+02	5.74E+02
PM144	3.63E+02	7.27E+01	7.27E+01	7.27E+01	7.27E+01	7.27E+01	6.84E+05	A	1.06E-04	7.26E+01	7.26E+01	7.17E+01	6.84E+01	5.06E+01
PM145	6.46E+03	6.22E+02	6.22E+02	6.22E+02	6.22E+02	6.22E+02	1.06E+06	A	5.87E-04	6.22E+02	6.22E+02	6.22E+02	6.23E+02	6.27E+02
PM146	2.02E+03	7.76E+00	7.76E+00	7.76E+00	7.76E+00	7.76E+00	2.59E+05	A	3.00E-05	7.76E+00	7.76E+00	7.74E+00	7.68E+00	7.29E+00
PM147	9.56E+02	8.41E+00	8.41E+00	8.41E+00	8.41E+00	8.41E+00	8.41E+05	A	1.00E-05	8.41E+00	8.41E+00	8.38E+00	8.26E+00	7.40E+00
PM148	5.37E+00	6.76E+00	6.76E+00	6.75E+00	6.74E+00	6.72E+00	2.78E+06	A	2.43E-06	6.34E+00	5.94E+00	2.74E+00	1.33E-01	3.80E-10
PM150	1.12E-01	3.38E+00	3.36E+00	3.24E+00	2.97E+00	2.61E+00	9.86E+07	A	3.29E-08	1.52E-01	6.81E-03	4.49E-19	0.00E+00	0.00E+00
PM153	3.75E-03	1.69E+00	1.49E+00	4.68E-01	3.59E-02	7.64E-04	1.66E+07	A	2.82E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM138	2.08E-03	5.07E+00	4.02E+00	5.03E-01	4.94E-03	4.83E-06	4.30E+05	D	1.17E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM139	1.78E-03	1.13E+02	8.58E+01	7.08E+00	2.76E-02	6.75E-06	4.30E+05	D	1.65E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM140	1.03E-02	2.31E+02	2.21E+02	1.45E+02	5.65E+01	1.38E+01	4.30E+05	D	3.37E-04	4.69E-13	9.48E-28	0.00E+00	0.00E+00	0.00E+00
SM141	7.08E-03	4.11E+02	3.87E+02	2.11E+02	5.43E+01	7.07E+00	6.20E+07	B	3.40E-06	2.36E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM142	5.04E-02	6.78E+02	6.71E+02	6.16E+02	5.09E+02	3.82E+02	3.80E+07	B	1.62E-05	6.92E-01	7.12E-04	0.00E+00	0.00E+00	0.00E+00
SM143	6.13E-03	7.87E+02	7.56E+02	4.37E+02	9.44E+01	8.97E+00	4.30E+05	D	1.02E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
SM145	3.40E+02	1.08E+03	1.08E+03	1.08E+03	1.08E+03	1.08E+03	2.80E+06	B	3.86E-04	1.08E+03	1.08E+03	1.07E+03	1.03E+03	7.53E+02
SM147	3.87E+13	1.85E-07	1.85E-07	1.85E-07	1.85E-07	1.85E-07	4.03E+02	A	4.58E-10	1.85E-07	1.85E-07	1.85E-07	1.85E-07	1.85E-07
SM151	3.24E+04	1.01E+00	1.01E+00	1.01E+00	1.01E+00	1.01E+00	9.86E+05	A	1.03E-06	1.01E+00	1.01E+00	1.01E+00	1.01E+00	1.01E+00
SM153	1.95E+00	1.69E+00	1.69E+00	1.69E+00	1.68E+00	1.67E+00	1.66E+07	A	1.02E-07	1.42E+00	1.19E+00	1.40E-01	3.30E-05	0.00E+00
EU141	4.63E-04	9.46E+01	3.35E+01	2.89E-03	2.69E-12	7.64E-26	4.30E+05	D	6.72E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EU142	2.78E-05	2.74E+02	8.16E-06	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EU143	1.83E-03	4.12E+02	3.35E+02	3.96E+01	2.16E-01	7.57E-05	4.30E+05	D	9.21E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EU144	1.18E-04	6.61E+02	2.02E+02	4.85E+01	2.23E+00	2.20E-02	4.30E+05	D	1.13E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
EU145	5.93E+00	9.64E+02	9.64E+02	9.64E+02	9.63E+02	9.61E+02	8.50E+06	B	1.13E-04	9.13E+02	8.62E+02	4.27E+02	2.76E+01	5.05E-07
EU146	4.59E+00	1.05E+03	1.05E+03	1.05E+03	1.05E+03	1.05E+03	5.60E+06	B	1.88E-04	1.03E+03	1.01E+03	8.39E+02	5.54E+02	6.18E+01
EU147	2.40E+01	8.91E+02	8.91E+02	8.91E+02	8.90E+02	8.90E+02	8.70E+06	B	1.02E-04	8.87E+02	8.81E+02	7.54E+02	3.55E+02	2.61E+00
EU148	5.45E+01	1.01E+02	1.01E+02	1.01E+02	1.01E+02	1.01E+02	1.90E+06	B	5.32E-05	1.01E+02	1.00E+02	9.27E+01	6.86E+01	9.69E+00
EU149	9.31E+01	9.32E+02	9.32E+02	9.32E+02	9.32E+02	9.32E+02	1.70E+07	B	5.48E-05	9.32E+02	9.31E+02	9.18E+02	8.08E+02	2.63E+02
EU150	1.25E+04	1.93E+01	1.93E+01	1.93E+01	1.93E+01	1.93E+01	1.06E+05	A	1.82E-04	1.93E+01	1.93E+01	1.93E+01	1.93E+01	1.93E+01
EU152	4.86E+03	1.49E+01	1.49E+01	1.49E+01	1.49E+01	1.49E+01	1.29E+05	A	1.16E-04	1.49E+01	1.49E+01	1.49E+01	1.49E+01	1.49E+01
EU154	3.14E+03	3.08E+00	3.08E+00	3.08E+00	3.08E+00	3.08E+00	1.10E+05	A	2.80E-05	3.08E+00	3.08E+00	3.07E+00	3.06E+00	2.96E+00
EU155	1.81E+03	1.68E+00	1.68E+00	1.68E+00	1.68E+00	1.68E+00	7.32E+05	A	2.30E-06	1.68E+00	1.68E+00	1.67E+00	1.64E+00	1.56E+00
EU156	1.52E+01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	2.45E+06	A	6.90E-07	1.65E+00	1.61E+00	1.23E+00	4.22E-01	4.03E-04
GD143	4.51E-04	9.80E+01	6.67E+01	2.08E+00	9.42E-04	9.05E-09	4.30E+05	A	4.84E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GD144	3.13E-03	2.18E+02	1.87E+02	4.67E+01	2.15E+00	2.11E-02	4.30E+05	A	1.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
GD145	1.60E-02	4.31E+02	4.17E+02	3.14E+02	1.66E+02	6.40E+01	2.00E+07	B	1.57E-05	4.93E-08	5.63E-18	0.00E+00	0.00E+00	0.00E+00
GD146	4.83E+01	7.73E+02	7.73E+02	7.73E+02	7.73E+02	7.73E+02	7.50E+05	B	1.03E-03	7.68E+02	7.62E+02	6.99E+02	4.99E+02	5.59E+01
GD147	1.59E+00	7.06E+02	7.06E+02	7.05E+02	7.03E+02	6.98E+02	1.30E+07	B	5.42E-05	5.78E+02	4.65E+02	3.37E+01	1.20E-03	0.00E+00

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
GD148	2.72E+04	1.89E+02	1.89E+02	1.89E+02	1.89E+02	1.89E+02	3.41E+02	A	5.55E-01	1.89E+02	1.89E+02	1.89E+02	1.89E+02	1.88E+02
GD149	9.38E+00	8.36E+02	8.36E+02	8.36E+02	8.35E+02	8.35E+02	1.10E+07	B	7.60E-05	8.14E+02	7.86E+02	5.01E+02	8.65E+01	9.47E-04
GD150	6.53E+08	1.16E-02	1.16E-02	1.16E-02	1.16E-02	1.16E-02	4.30E+05	D	2.70E-08	1.16E-02	1.16E-02	1.16E-02	1.16E-02	1.16E-02
GD151	1.24E+02	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	3.60E+06	B	3.64E-04	1.31E+03	1.31E+03	1.27E+03	1.11E+03	4.60E+02
GD152	3.94E+16	2.14E-10	2.14E-10	2.14E-10	2.14E-10	2.14E-10	4.68E+02	A	4.57E-13	2.14E-10	2.14E-10	2.14E-10	2.14E-10	2.14E-10
GD153	2.42E+02	1.61E+03	1.61E+03	1.61E+03	1.61E+03	1.61E+03	3.38E+06	A	4.76E-04	1.61E+03	1.61E+03	1.59E+03	1.49E+03	9.59E+02
TB146	9.26E-05	1.13E+02	1.86E+01	1.59E-06	0.00E+00	0.00E+00	4.30E+05	D	3.70E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TB147	6.83E-02	2.85E+02	2.83E+02	2.66E+02	2.30E+02	1.86E+02	2.60E+07	B	1.02E-05	1.63E+00	9.29E-03	0.00E+00	0.00E+00	0.00E+00
TB148	4.17E-02	6.68E+02	5.79E+02	1.08E+02	1.55E+00	1.93E-03	4.30E+05	D	2.51E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TB149	1.72E-01	6.90E+02	6.89E+02	6.76E+02	6.40E+02	5.89E+02	3.80E+06	B	1.78E-04	9.38E+01	1.26E+01	4.49E-10	0.00E+00	0.00E+00
TB150	1.45E-01	7.87E+02	7.85E+02	7.69E+02	7.24E+02	6.56E+02	2.00E+07	B	3.85E-05	7.33E+01	6.72E+00	2.32E-12	0.00E+00	0.00E+00
TB151	7.34E-01	1.19E+03	1.19E+03	1.19E+03	1.18E+03	1.16E+03	2.60E+07	B	4.58E-05	7.53E+02	4.70E+02	1.61E+00	3.86E-10	0.00E+00
TB152	7.29E-01	1.59E+03	1.59E+03	1.59E+03	1.58E+03	1.57E+03	4.30E+05	D	3.70E-03	1.10E+03	6.90E+02	2.30E+00	4.84E-10	0.00E+00
TB153	2.34E+00	1.54E+03	1.54E+03	1.54E+03	1.54E+03	1.54E+03	3.30E+07	B	4.67E-05	1.42E+03	1.25E+03	2.06E+02	1.77E-01	1.98E-21
TB154	8.96E-01	2.35E+02	2.35E+02	2.34E+02	2.31E+02	2.27E+02	1.20E+07	B	1.95E-05	1.59E+02	1.08E+02	1.02E+00	1.24E-08	0.00E+00
TB155	5.32E+00	1.70E+03	1.70E+03	1.70E+03	1.70E+03	1.70E+03	3.70E+07	B	4.59E-05	1.67E+03	1.59E+03	7.40E+02	3.49E+01	8.28E-08
TB156	5.35E+00	6.08E+01	6.08E+01	6.08E+01	6.07E+01	6.05E+01	6.10E+06	B	9.97E-06	5.70E+01	5.34E+01	2.46E+01	1.18E+00	3.12E-09
TB157	3.59E+04	2.18E+02	2.18E+02	2.18E+02	2.18E+02	2.18E+02	3.16E+06	A	6.88E-05	2.18E+02	2.18E+02	2.18E+02	2.18E+02	2.18E+02
TB158	6.59E+04	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.14E+05	A	1.57E-05	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
DY148	2.15E-03	3.36E+02	2.79E+02	3.76E+01	4.30E-01	5.29E-04	4.30E+05	D	8.74E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DY149	2.94E-03	3.32E+02	2.93E+02	6.75E+01	2.33E+00	1.50E-02	4.30E+05	D	1.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DY150	4.98E-03	5.48E+02	5.06E+02	2.13E+02	3.05E+01	1.64E+00	6.16E+06	C	4.95E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
DY151	1.24E-02	8.74E+02	8.51E+02	5.96E+02	2.63E+02	7.67E+01	2.10E+07	C	1.39E-03	1.35E-10	2.02E-23	0.00E+00	0.00E+00	0.00E+00
DY152	9.88E-02	1.24E+03	1.24E+03	1.19E+03	1.08E+03	9.32E+02	4.30E+05	D	2.77E-03	3.73E+01	1.12E+00	5.63E-19	0.00E+00	0.00E+00
DY153	2.66E-01	1.26E+03	1.26E+03	1.24E+03	1.20E+03	1.13E+03	4.30E+05	D	2.88E-03	3.37E+02	8.99E+01	1.15E-05	0.00E+00	0.00E+00
DY154	1.04E+09	3.35E-03	3.35E-03	3.35E-03	3.35E-03	3.35E-03	4.30E+05	D	7.78E-09	3.35E-03	3.35E-03	3.35E-03	3.35E-03	3.35E-03
DY155	4.17E-01	1.57E+03	1.57E+03	1.56E+03	1.55E+03	1.52E+03	5.00E+07	B	3.12E-05	7.30E+02	3.18E+02	1.46E-02	1.71E-19	0.00E+00
DY157	3.39E-01	1.62E+03	1.62E+03	1.61E+03	1.59E+03	1.55E+03	1.25E+08	A	1.29E-05	6.08E+02	2.16E+02	9.02E-04	8.84E-25	0.00E+00
DY159	1.44E+02	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.36E+07	A	9.63E-05	1.31E+03	1.31E+03	1.27E+03	1.13E+03	5.45E+02
H0150	1.02E-03	1.40E+02	5.26E+01	4.54E-03	4.23E-12	1.20E-25	4.30E+05	D	1.06E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H0151	4.07E-04	4.16E+02	2.30E+02	1.41E-01	3.19E-09	9.46E-21	4.30E+05	D	3.28E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H0152	1.88E-03	6.20E+02	3.68E+02	3.58E+00	1.00E-04	1.69E-11	4.30E+05	D	8.33E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H0153	1.39E-03	7.01E+02	5.35E+02	2.62E+01	2.56E-02	7.82E-07	4.30E+05	D	6.09E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
H0154	8.22E-03	1.02E+03	9.83E+02	6.41E+02	2.06E+02	3.56E+01	4.30E+05	D	1.49E-03	5.18E-16	2.23E-34	0.00E+00	0.00E+00	0.00E+00
H0155	3.33E-02	1.19E+03	1.18E+03	1.07E+03	8.20E+02	5.38E+02	7.90E+07	B	1.35E-05	4.74E-02	1.79E-06	0.00E+00	0.00E+00	0.00E+00
H0156	3.89E-02	1.34E+03	1.14E+03	5.40E+02	2.56E+02	8.82E+01	4.30E+05	D	1.26E-03	5.71E-09	4.39E-20	0.00E+00	0.00E+00	0.00E+00
H0157	8.75E-03	1.45E+03	1.42E+03	1.18E+03	7.35E+02	3.35E+02	1.00E+08	B	1.18E-05	1.88E-06	1.75E-15	0.00E+00	0.00E+00	0.00E+00
H0158	7.64E-03	1.62E+03	1.60E+03	1.46E+03	1.26E+03	1.07E+03	4.30E+05	D	3.40E-03	4.45E+01	1.39E+00	1.19E-18	0.00E+00	0.00E+00
H0159	2.30E-02	1.28E+03	1.27E+03	1.24E+03	1.12E+03	8.63E+02	1.10E+08	B	1.13E-05	1.19E-02	1.42E-08	0.00E+00	0.00E+00	0.00E+00
H0160	9.99E-01	1.15E+03	1.15E+03	1.13E+03	1.11E+03	1.09E+03	4.30E+05	D	2.63E-03	8.30E+02	6.20E+02	1.88E+01	2.24E-05	0.00E+00
H0161	1.03E-01	9.80E+02	9.80E+02	9.78E+02	9.74E+02	9.63E+02	1.40E+09	B	6.99E-07	2.31E+02	2.33E+01	1.15E-12	0.00E+00	0.00E+00
H0162	1.04E-02	5.07E+00	4.84E+00	3.19E+00	1.27E+00	3.17E-01	3.10E+08	B	1.03E-08	1.80E-14	6.41E-29	0.00E+00	0.00E+00	0.00E+00
H0163	1.67E+06	4.14E+02	4.14E+02	4.14E+02	4.14E+02	4.14E+02	4.30E+05	D	9.63E-04	4.14E+02	4.14E+02	4.14E+02	4.14E+02	4.11E+02
ER151	2.72E-04	7.27E+01	1.24E+01	1.06E-06	0.00E+00	0.00E+00	4.30E+05	D	2.47E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ER152	1.17E-04	1.88E+02	1.51E+01	2.38E-06	0.00E+00	0.00E+00	4.30E+05	D	5.53E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ER153	4.29E-04	3.13E+02	1.50E+02	1.73E-02	2.64E-12	2.62E-27	4.30E+05	D	4.02E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ER154	2.56E-03	4.02E+02	3.34E+02	6.33E+01	1.57E+00	6.14E-03	4.30E+05	D	1.47E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ER155	3.68E-03	5.20E+02	4.57E+02	1.41E+02	1.03E+01	2.04E-01	4.30E+05	D	3.28E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ER156	1.35E-02	6.67E+02	6.44E+02	4.68E+02	2.30E+02	7.91E+01	4.30E+05	D	1.09E-03	5.13E-09	3.94E-20	0.00E+00	0.00E+00	0.00E+00
ER157	1.30E-02	9.07E+02	8.89E+02	7.11E+02	4.03E+02	1.69E+02	4.30E+05	D	1.65E-03	8.93E-07	8.33E-16	0.00E+00	0.00E+00	0.00E+00
ER158	9.38E-02	1.29E+03	1.29E+03	1.24E+03	1.13E+03	9.81E+02	4.30E+05	D	2.88E-03	4.09E+01	1.28E+00	1.09E-18	0.00E+00	0.00E+00
ER159	2.50E-02	1.13E+03	1.12E+03	1.03E+03	7.60E+02	4.40E+02	4.30E+05	D	2.40E-03	1.34E-03	1.28E-09	0.00E+00	0.00E+00	0.00E+00
ER160	1.19E+00	1.09E+03	1.09E+03	1.09E+03	1.08E+03	1.07E+03	4.30E+05	D	2.53E-03	8.17E+02	6.11E+02	1.86E+01	2.21E-05	0.00E+00
ER161	1.34E-01	9.50E+02	9.49E+02	9.43E+02	9.16E+02	8.56E+02	4.80E+07	B	1.96E-05	8.52E+01	6.54E+00	2.70E-13	0.00E+00	0.00E+00
ER163	5.21E-02	8.01E+02	8.01E+02	7.97E+02	7.83E+02	7.44E+02	4.30E+05	D	1.85E-03	2.52E+01	2.83E-01	0.00E+00	0.00E+00	0.00E+00
ER165	4.32E-01	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	5.80E+08	B	1.91E-06	1.02E+03	8.55E+02	3.51E+01	8.17E-05	0.00E+00
TM154	9.38E-05	5.91E+01	1.44E-02	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM155	3.94E-04	1.22E+02	4.19E+01	2.84E-03	1.55E-12	1.98E-26	4.30E+05	D	6.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM156	9.72E-04	2.06E+02	1.23E+02	1.14E+00	3.48E-05	5.86E-12	4.30E+05	D	2.65E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM157	2.43E-03	2.89E+02	2.38E+02	4.21E+01	8.96E-01	2.78E-03	4.30E+05	D	9.79E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM158	2.79E-03	6.13E+02	5.34E+02	1.19E+02	3.80E+00	2.16E-02	4.30E+05	D	2.77E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM159	6.35E-03	7.15E+02	6.75E+02	3.78E+02	8.81E+01	8.93E+00	4.30E+05	D	8.79E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM160	6.53E-03	7.67E+02	7.34E+02	4.49E+02	1.14E+02	1.23E+01	4.30E+05	D	1.04E-03	3.15E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TM161	2.64E-02	8.14E+02	8.05E+02	6.90E+02	4.43E+02	2.22E+02	4.30E+05	D	1.60E-03	5.29E-05	3.16E-12	0.00E+00	0.00E+00	0.00E+00

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
TM162	1.51E-02	1.34E+03	1.33E+03	1.21E+03	8.74E+02	4.55E+02	2.90E+07	B	4.17E-05	8.79E-07	9.98E-17	0.00E+00	0.00E+00	0.00E+00
TM163	7.54E-02	7.70E+02	7.69E+02	7.49E+02	6.80E+02	5.68E+02	4.30E+05	D	1.74E-03	8.63E+00	8.94E-02	0.00E+00	0.00E+00	0.00E+00
TM164	1.39E-03	1.38E+03	1.35E+03	1.22E+03	1.02E+03	7.74E+02	4.30E+05	D	2.84E-03	1.85E+00	2.56E-03	0.00E+00	0.00E+00	0.00E+00
TM165	1.25E+00	1.10E+03	1.10E+03	1.10E+03	1.09E+03	1.08E+03	4.30E+05	D	2.56E-03	8.41E+02	6.38E+02	2.30E+01	5.36E-05	0.00E+00
TM166	3.24E-01	2.18E+03	2.18E+03	2.18E+03	2.18E+03	2.17E+03	1.90E+07	B	1.15E-04	2.04E+03	1.82E+03	3.19E+02	3.29E-01	1.24E-20
TM167	9.24E+00	1.98E+03	1.98E+03	1.98E+03	1.98E+03	1.98E+03	1.10E+07	B	1.80E-04	1.92E+03	1.85E+03	1.18E+03	2.04E+02	2.23E-03
TM168	9.31E+01	3.38E+00	3.38E+00	3.38E+00	3.38E+00	3.38E+00	4.30E+05	D	7.86E-06	3.37E+00	3.35E+00	3.21E+00	2.69E+00	8.66E-01
YB155	1.98E-05	2.03E+01	2.85E-03	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB156	3.02E-04	4.06E+01	8.15E+00	1.41E-06	0.00E+00	0.00E+00	4.30E+05	D	3.28E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB157	4.47E-04	1.20E+02	4.85E+01	8.95E-04	2.12E-14	2.46E-30	4.30E+05	D	2.08E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB158	1.15E-03	1.52E+02	8.10E+01	2.79E-01	9.39E-07	5.79E-15	4.30E+05	D	6.49E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB159	9.72E-04	1.86E+02	1.60E+02	4.12E+01	2.02E+00	2.20E-02	4.30E+05	D	9.58E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB160	3.33E-03	3.41E+02	2.95E+02	8.05E+01	4.49E+00	5.89E-02	4.30E+05	D	1.87E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB161	2.92E-03	4.46E+02	3.78E+02	8.56E+01	3.16E+00	2.23E-02	4.30E+05	D	1.99E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB162	1.31E-02	1.01E+03	9.86E+02	7.23E+02	3.47E+02	1.15E+02	1.90E+08	B	3.81E-06	3.41E-09	1.12E-20	0.00E+00	0.00E+00	0.00E+00
YB163	7.67E-03	5.66E+02	5.31E+02	3.01E+02	8.49E+01	1.27E+01	4.30E+05	D	7.00E-04	9.50E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00
YB164	5.25E-02	1.27E+03	1.26E+03	1.19E+03	9.91E+02	7.54E+02	4.30E+05	D	2.77E-03	1.80E+00	2.49E-03	0.00E+00	0.00E+00	0.00E+00
YB165	6.88E-03	1.04E+03	1.02E+03	7.94E+02	3.57E+02	8.29E+01	4.30E+05	D	1.85E-03	1.93E-15	8.34E-34	0.00E+00	0.00E+00	0.00E+00
YB166	2.36E+00	2.15E+03	2.15E+03	2.14E+03	2.14E+03	2.12E+03	1.00E+07	B	2.14E-04	1.86E+03	1.60E+03	2.76E+02	2.84E-01	1.07E-20
YB167	1.22E-02	1.97E+03	1.97E+03	1.92E+03	1.70E+03	1.26E+03	1.70E+08	B	1.13E-05	1.89E-01	1.17E-05	0.00E+00	0.00E+00	0.00E+00
YB169	3.20E+01	1.87E+03	1.87E+03	1.87E+03	1.87E+03	1.87E+03	4.00E+06	A	4.68E-04	1.86E+03	1.86E+03	1.67E+03	1.01E+03	3.72E+01
LU162	9.51E-04	4.26E+02	2.60E+02	3.01E+00	1.51E-04	5.35E-11	4.30E+05	D	7.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LU164	2.18E-03	8.09E+02	6.50E+02	9.09E+01	1.15E+00	1.62E-03	4.30E+05	D	2.11E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LU165	7.45E-03	7.62E+02	7.19E+02	4.24E+02	1.31E+02	2.25E+01	4.30E+05	D	9.86E-04	3.27E-16	1.34E-34	0.00E+00	0.00E+00	0.00E+00
LU166	5.31E-03	2.02E+03	1.85E+03	7.98E+02	1.06E+02	4.93E+00	4.30E+05	D	1.86E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LU167	3.58E-02	1.90E+03	1.89E+03	1.74E+03	1.34E+03	8.95E+02	4.30E+05	D	4.05E-03	1.24E-01	7.69E-06	0.00E+00	0.00E+00	0.00E+00
LU168	3.82E-03	2.14E+03	2.11E+03	1.80E+03	1.12E+03	5.08E+02	4.30E+05	D	4.19E-03	1.12E-05	4.99E-14	0.00E+00	0.00E+00	0.00E+00
LU169	1.42E+00	1.84E+03	1.84E+03	1.84E+03	1.83E+03	1.81E+03	1.50E+07	B	1.23E-04	1.45E+03	1.13E+03	6.05E+01	6.46E-04	0.00E+00
LU170	2.00E+00	3.24E+03	3.24E+03	3.24E+03	3.24E+03	3.24E+03	7.20E+06	B	4.50E-04	3.11E+03	2.85E+03	4.32E+02	1.39E-01	0.00E+00
LU171	8.24E+00	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	9.60E+06	B	2.50E-04	2.37E+03	2.31E+03	1.42E+03	1.96E+02	5.13E-04
LU172	6.70E+00	3.95E+03	3.95E+03	3.95E+03	3.95E+03	3.95E+03	5.10E+06	B	7.75E-04	3.95E+03	3.95E+03	3.93E+03	3.85E+03	3.30E+03
LU173	5.00E+02	1.68E+03	1.68E+03	1.68E+03	1.68E+03	1.68E+03	1.50E+06	B	1.12E-03	1.68E+03	1.68E+03	1.67E+03	1.62E+03	1.31E+03
LU174	1.21E+03	8.30E+00	8.30E+00	8.30E+00	8.30E+00	8.30E+00	8.92E+05	A	9.30E-06	8.30E+00	8.30E+00	8.27E+00	8.16E+00	7.48E+00
LU176	1.32E+13	1.95E-09	1.95E-09	1.95E-09	1.95E-09	1.95E-09	4.50E+04	A	4.33E-14	1.95E-09	1.95E-09	1.95E-09	1.95E-09	1.95E-09
HF159	6.48E-05	3.38E+00	2.01E-03	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HF160	1.39E-04	6.76E+00	2.11E-01	6.00E-15	0.00E+00	0.00E+00	4.30E+05	D	1.40E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HF161	1.97E-04	4.73E+01	5.52E+00	1.52E-09	0.00E+00	0.00E+00	4.30E+05	D	3.53E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HF166	4.70E-03	1.34E+03	1.24E+03	4.98E+02	6.42E+01	2.98E+00	4.30E+05	D	1.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HF167	1.42E-03	1.51E+03	1.27E+03	2.02E+02	1.97E+00	1.55E-03	4.30E+05	D	4.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HF168	9.99E-01	1.87E+03	1.84E+03	1.52E+03	8.93E+02	4.01E+02	4.30E+05	D	3.53E-03	8.85E-06	3.93E-14	0.00E+00	0.00E+00	0.00E+00
HF169	2.25E-03	1.69E+03	1.57E+03	6.34E+02	4.90E+01	8.04E-01	4.30E+05	D	1.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HF170	6.67E-01	3.14E+03	3.14E+03	3.13E+03	3.10E+03	3.03E+03	2.10E+07	B	1.49E-04	1.88E+03	1.11E+03	2.11E+00	4.87E-11	0.00E+00
HF171	5.05E-01	2.36E+03	2.36E+03	2.35E+03	2.33E+03	2.29E+03	4.30E+05	D	5.47E-03	1.23E+03	6.17E+02	1.60E-01	1.58E-15	0.00E+00
HF172	6.83E+02	3.93E+03	3.93E+03	3.93E+03	3.93E+03	3.93E+03	1.10E+05	B	3.57E-02	3.93E+03	3.93E+03	3.90E+03	3.81E+03	3.27E+03
HF173	1.00E+00	1.66E+03	1.66E+03	1.66E+03	1.66E+03	1.66E+03	4.50E+07	B	3.69E-05	1.36E+03	9.77E+02	1.53E+01	1.35E-06	0.00E+00
HF175	7.00E+01	3.81E+03	3.81E+03	3.81E+03	3.81E+03	3.81E+03	6.35E+06	A	6.00E-04	3.80E+03	3.79E+03	3.57E+03	2.83E+03	6.26E+02
TA166	3.98E-04	5.73E+02	1.56E+02	1.30E-03	6.68E-15	7.81E-32	4.30E+05	D	3.02E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TA167	9.99E-01	7.67E+02	6.04E+02	7.03E+01	5.90E-01	4.54E-04	4.30E+05	D	1.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TA168	9.99E-01	1.19E+03	8.98E+02	6.97E+01	2.37E-01	4.73E-05	4.30E+05	D	1.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TA169	3.40E-03	1.15E+03	1.00E+03	2.88E+02	1.80E+01	2.81E-01	4.30E+05	D	6.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TA170	4.70E-03	2.74E+03	2.61E+03	1.39E+03	2.18E+02	1.06E+01	4.30E+05	D	3.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TA171	1.62E-02	2.14E+03	2.11E+03	1.79E+03	1.10E+03	4.72E+02	4.30E+05	D	4.16E-03	1.43E-06	7.11E-16	0.00E+00	0.00E+00	0.00E+00
TA172	2.56E-02	3.79E+03	3.78E+03	3.48E+03	2.54E+03	1.46E+03	2.50E+07	B	1.39E-04	6.26E-03	8.69E-09	0.00E+00	0.00E+00	0.00E+00
TA173	1.31E-01	1.57E+03	1.57E+03	1.55E+03	1.49E+03	1.37E+03	4.80E+07	B	3.23E-05	1.70E+02	1.74E+01	2.30E-11	0.00E+00	0.00E+00
TA174	4.92E-02	3.97E+03	3.96E+03	3.90E+03	3.61E+03	2.97E+03	4.90E+07	B	7.96E-05	2.47E+00	8.30E-04	0.00E+00	0.00E+00	0.00E+00
TA175	4.38E-01	3.79E+03	3.79E+03	3.78E+03	3.76E+03	3.69E+03	3.40E+07	B	1.11E-04	1.82E+03	8.24E+02	6.11E-02	4.56E-18	0.00E+00
TA176	3.37E-01	3.78E+03	3.78E+03	3.78E+03	3.77E+03	3.73E+03	1.50E+07	B	2.52E-04	1.85E+03	6.74E+02	2.90E-03	3.20E-24	0.00E+00
TA177	2.36E+00	3.62E+03	3.62E+03	3.62E+03	3.62E+03	3.62E+03	9.00E+07	B	4.02E-05	3.26E+03	2.82E+03	4.82E+02	4.92E-01	1.66E-20
TA178	6.47E-03	4.87E+03	4.86E+03	4.83E+03	4.80E+03	4.79E+03	2.00E+08	B	2.42E-05	4.72E+03	4.65E+03	3.83E+03	1.80E+03	1.32E+01
TA179	6.46E+02	4.79E+03	4.79E+03	4.79E+03	4.79E+03	4.79E+03	4.90E+06	A	9.78E-04	4.79E+03	4.78E+03	4.75E+03	4.64E+03	3.96E+03
TA182	1.15E+02	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	7.59E+05	A	2.23E-06	1.68E+00	1.68E+00	1.62E+00	1.41E+00	5.61E-01
TA183	5.10E+00	1.69E+00	1.69E+00	1.69E+00	1.68E+00	1.68E+00	5.95E+06	A	2.84E-07	1.58E+00	1.47E+00	6.40E-01	2.48E-02	1.65E-11
W165	5.90E-05	3.21E+01	1.30E-02	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
W166	1.85E-04	1.25E+02	1.12E+01	7.82E-10	0.00E+00	0.00E+00	4.30E+05	D	1.82E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
W170	9.99E-01	1.54E+03	1.32E+03	2.77E+02	8.66E+00	4.78E-02	4.30E+05	D	6.44E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
W171	9.99E-01	1.15E+03	1.06E+03	5.30E+02	1.14E+02	1.13E+01	4.30E+05	D	1.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
W172	4.63E-03	3.07E+03	2.89E+03	1.16E+03	1.46E+02	6.57E+00	4.30E+05	D	2.70E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
W173	9.99E-01	1.09E+03	1.04E+03	7.16E+02	3.09E+02	8.76E+01	4.30E+05	D	1.67E-03	7.98E-11	5.84E-24	0.00E+00	0.00E+00	0.00E+00
W174	2.04E-02	3.62E+03	3.59E+03	3.05E+03	1.90E+03	9.27E+02	4.30E+05	D	7.09E-03	1.31E-04	4.39E-12	0.00E+00	0.00E+00	0.00E+00
W175	2.36E-02	3.57E+03	3.56E+03	3.21E+03	2.22E+03	1.21E+03	4.30E+05	D	7.47E-03	1.73E-03	7.31E-10	0.00E+00	0.00E+00	0.00E+00
W176	9.63E-02	3.63E+03	3.63E+03	3.56E+03	3.26E+03	2.81E+03	8.60E+07	C	4.14E-05	1.02E+02	2.74E+00	3.84E-19	0.00E+00	0.00E+00
W177	9.38E-02	3.54E+03	3.54E+03	3.50E+03	3.30E+03	2.89E+03	4.90E+07	B	7.14E-05	9.82E+01	2.44E+00	1.30E-19	0.00E+00	0.00E+00
W178	2.16E+01	4.80E+03	4.80E+03	4.80E+03	4.80E+03	4.79E+03	1.10E+08	B	4.36E-05	4.72E+03	4.65E+03	3.83E+03	1.80E+03	1.32E+01
W179	2.60E-02	4.77E+03	4.77E+03	4.72E+03	4.36E+03	3.28E+03	8.40E+08	B	5.62E-06	2.29E-02	3.81E-08	0.00E+00	0.00E+00	0.00E+00
W179M	4.44E-03	3.33E+03	3.33E+03	3.18E+03	2.21E+03	8.91E+02	2.20E+08	C*	1.45E-05	7.57E-08	7.54E-19	0.00E+00	0.00E+00	0.00E+00
W181	1.21E+02	5.39E+03	5.39E+03	5.39E+03	5.39E+03	5.39E+03	1.74E+08	A	3.10E-05	5.39E+03	5.38E+03	5.22E+03	4.56E+03	1.90E+03
W183M	6.02E-05	8.96E-01	8.96E-01	8.95E-01	8.93E-01	8.90E-01	4.30E+05	D	2.08E-06	8.36E-01	7.80E-01	3.39E-01	1.32E-02	8.75E-12
W185	7.51E+01	6.76E+00	6.76E+00	6.76E+00	6.76E+00	6.76E+00	3.81E+07	A	1.77E-07	6.73E+00	6.70E+00	6.34E+00	5.10E+00	1.25E+00
W188	6.94E+01	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.69E+00	6.97E+06	A	2.42E-07	1.68E+00	1.67E+00	1.58E+00	1.25E+00	2.72E-01
RE170	9.26E-05	6.10E+02	4.15E+00	1.99E-20	0.00E+00	0.00E+00	4.30E+05	D	4.63E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE172	1.74E-04	1.96E+03	6.16E+02	2.61E-03	2.37E-15	2.11E-33	4.30E+05	D	6.07E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE174	1.60E-03	2.74E+03	2.20E+03	1.75E+02	5.43E-01	9.38E-05	4.30E+05	D	4.07E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE175	9.99E-01	2.88E+03	2.61E+03	7.54E+02	3.72E+01	4.05E-01	4.30E+05	D	1.75E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE176	3.94E-03	3.18E+03	2.96E+03	1.25E+03	1.11E+02	2.20E+00	1.30E+08	C	9.62E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE177	9.72E-03	3.16E+03	3.08E+03	2.19E+03	8.42E+02	1.91E+02	4.90E+07	B	4.47E-05	1.23E-12	4.07E-28	0.00E+00	0.00E+00	0.00E+00
RE178	9.17E-03	4.53E+03	4.46E+03	3.37E+03	1.32E+03	2.80E+02	2.90E+07	B	1.16E-04	2.50E-13	9.51E-30	0.00E+00	0.00E+00	0.00E+00
RE179	1.35E-02	4.61E+03	4.57E+03	4.01E+03	2.34E+03	8.53E+02	4.20E+06	C*	9.55E-04	7.06E-08	7.04E-19	0.00E+00	0.00E+00	0.00E+00
RE180	1.69E-03	5.00E+03	4.81E+03	3.66E+03	1.94E+03	7.44E+02	4.20E+07	C	8.71E-05	5.20E-07	5.35E-17	0.00E+00	0.00E+00	0.00E+00
RE181	8.33E-01	5.33E+03	5.33E+03	5.33E+03	5.32E+03	5.29E+03	2.10E+07	C	2.54E-04	3.82E+03	2.52E+03	1.67E+01	5.17E-08	0.00E+00
RE182	2.67E+00	5.47E+03	5.47E+03	5.47E+03	5.46E+03	5.45E+03	9.19E+06	B	5.95E-04	4.88E+03	3.93E+03	6.42E+01	1.37E-06	0.00E+00
RE183	7.00E+01	5.60E+03	5.60E+03	5.60E+03	5.60E+03	5.60E+03	1.50E+07	B	3.73E-04	5.60E+03	5.58E+03	5.27E+03	4.19E+03	9.47E+02
RE184	3.80E+01	1.30E+02	1.30E+02	1.30E+02	1.30E+02	1.30E+02	7.11E+06	A	1.83E-05	1.29E+02	1.28E+02	1.15E+02	7.47E+01	4.63E+00
RE186	3.78E+00	6.59E+01	6.58E+01	6.58E+01	6.56E+01	6.54E+01	9.49E+06	A	6.93E-06	6.01E+01	5.48E+01	1.82E+01	2.47E-01	1.75E-13
RE188	7.08E-01	5.07E+00	5.07E+00	5.05E+00	5.00E+00	4.93E+00	1.56E+07	A	3.24E-07	3.76E+00	2.95E+00	1.60E+00	1.26E+00	2.75E-01
RE190	2.15E-03	1.69E+00	1.35E+00	1.81E-01	2.06E-03	2.51E-06	4.30E+05	D	4.21E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
RE192	1.85E-04	1.69E+00	1.26E-01	8.69E-12	0.00E+00	0.00E+00	4.30E+05	D	2.02E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS169	4.05E-05	8.45E+00	8.86E-06	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS170	8.22E-05	3.38E+01	9.67E-02	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS171	9.26E-05	1.33E+02	8.87E-01	1.33E-20	0.00E+00	0.00E+00	4.30E+05	D	3.09E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS172	2.20E-04	3.19E+02	3.93E+01	1.09E-07	0.00E+00	0.00E+00	4.30E+05	D	2.53E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS173	1.85E-04	5.44E+02	4.11E+01	2.85E-09	0.00E+00	0.00E+00	4.30E+05	D	6.63E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS174	5.09E-04	8.82E+02	3.54E+02	8.68E-02	8.15E-10	7.41E-22	4.30E+05	D	2.02E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS175	9.99E-01	1.24E+03	7.57E+02	8.79E+00	4.40E-04	1.56E-10	4.30E+05	D	2.04E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS176	2.08E-03	1.54E+03	1.27E+03	2.24E+02	4.77E+00	1.48E-02	4.30E+05	D	5.21E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS177	2.43E-03	1.70E+03	1.40E+03	2.35E+02	4.48E+00	1.18E-02	4.30E+05	D	5.47E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS178	3.53E-03	3.24E+03	2.88E+03	8.29E+02	5.18E+01	8.09E-01	4.30E+05	D	1.93E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS179	4.51E-03	3.66E+03	3.45E+03	1.74E+03	2.51E+02	1.08E+01	4.30E+05	D	4.05E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
OS180	1.49E-02	4.28E+03	4.21E+03	3.27E+03	1.72E+03	6.61E+02	5.90E+08	C	5.54E-06	4.62E-07	4.75E-17	0.00E+00	0.00E+00	0.00E+00
OS181	1.88E-03	4.83E+03	4.82E+03	4.64E+03	4.10E+03	3.37E+03	1.30E+08	C	3.57E-05	4.31E+01	3.72E-01	0.00E+00	0.00E+00	0.00E+00
OS182	9.21E-01	5.14E+03	5.14E+03	5.13E+03	5.10E+03	5.03E+03	1.80E+07	B	2.85E-04	3.56E+03	2.45E+03	2.67E+01	5.81E-07	0.00E+00
OS183	5.42E-01	3.43E+03	3.43E+03	3.42E+03	3.40E+03	3.35E+03	2.10E+07	C	1.63E-04	1.98E+03	1.08E+03	5.66E-01	5.40E-14	0.00E+00
OS183M	4.12E-01	2.19E+03	2.19E+03	2.19E+03	2.18E+03	2.15E+03	4.30E+05	D	5.09E-03	1.05E+03	4.53E+02	1.89E-02	1.48E-19	0.00E+00
OS185	9.36E+01	5.31E+03	5.31E+03	5.31E+03	5.31E+03	5.31E+03	4.38E+06	A	1.21E-03	5.30E+03	5.29E+03	5.07E+03	4.26E+03	1.38E+03
OS189M	2.00E-01	8.03E+02	8.03E+02	8.03E+02	8.03E+02	8.03E+02	9.86E+08	A	8.14E-07	8.00E+02	7.90E+02	5.84E+02	1.69E+02	5.31E-02
OS191	1.54E+01	1.69E+01	1.69E+01	1.69E+01	1.69E+01	1.69E+01	7.65E+06	A	2.21E-06	1.65E+01	1.62E+01	1.23E+01	4.29E+00	4.49E-03
OS193	1.27E+00	3.38E+00	3.38E+00	3.37E+00	3.34E+00	3.30E+00	1.48E+07	A	2.28E-07	2.58E+00	1.96E+00	7.51E-02	2.20E-07	0.00E+00
OS196	2.42E-02	1.69E+00	1.66E+00	1.39E+00	9.33E-01	5.15E-01	4.30E+05	D	3.23E-06	1.08E-06	6.97E-13	0.00E+00	0.00E+00	0.00E+00
IR172	9.99E-01	8.45E+00	2.01E-10	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR173	3.47E-05	1.35E+01	1.29E-05	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR174	4.63E-05	1.30E+02	4.64E-03	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR175	5.21E-05	3.12E+02	3.87E-01	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR176	9.99E-01	5.14E+02	2.84E+00	1.36E-20	0.00E+00	0.00E+00	4.30E+05	D	3.16E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR177	2.43E-04	8.70E+02	1.29E+02	2.34E-06	0.00E+00	0.00E+00	4.30E+05	D	5.44E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR178	1.39E-04	1.33E+03	9.28E+01	1.42E-06	0.00E+00	0.00E+00	4.30E+05	D	3.30E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR179	9.99E-01	1.74E+03	1.49E+03	3.18E+02	9.93E+00	5.49E-02	4.30E+05	D	7.40E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR180	1.04E-03	2.47E+03	1.72E+03	3.22E+01	3.14E-03	3.00E-09	3.00E+07	C	1.07E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR181	3.40E-03	3.18E+03	2.87E+03	8.58E+02	5.36E+01	8.38E-01	3.40E+07	C	2.52E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR182	1.04E-02	3.90E+03	3.79E+03	2.67E+03	1.07E+03	2.68E+02	5.60E+07	B	4.77E-05	1.52E-11	5.42E-26	0.00E+00	0.00E+00	0.00E+00

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
IR183	3.82E-02	4.38E+03	4.35E+03	4.03E+03	3.21E+03	2.21E+03	1.60E+07	C	2.52E-04	5.39E-01	6.18E-05	0.00E+00	0.00E+00	0.00E+00
IR184	1.26E-01	4.97E+03	4.96E+03	4.88E+03	4.62E+03	4.17E+03	2.40E+07	B	2.03E-04	3.37E+02	2.14E+01	9.37E-14	0.00E+00	0.00E+00
IR185	5.79E-01	4.87E+03	4.87E+03	4.85E+03	4.82E+03	4.76E+03	2.50E+07	C	1.94E-04	2.86E+03	1.58E+03	1.26E+00	1.01E-12	0.00E+00
IR186	6.93E-01	5.79E+03	5.79E+03	5.78E+03	5.76E+03	5.72E+03	1.30E+07	C	4.45E-04	3.92E+03	2.40E+03	6.29E+00	5.24E-10	0.00E+00
IR187	4.38E-01	7.12E+03	7.12E+03	7.11E+03	7.08E+03	7.03E+03	5.30E+07	C	1.34E-04	4.03E+03	1.85E+03	1.37E-01	1.03E-17	0.00E+00
IR188	1.73E+00	9.56E+03	9.56E+03	9.56E+03	9.56E+03	9.55E+03	9.90E+06	C	9.66E-04	9.42E+03	9.25E+03	6.61E+03	1.36E+03	4.31E-02
IR189	1.32E+01	1.07E+04	1.07E+04	1.07E+04	1.07E+04	1.07E+04	1.60E+07	C	6.69E-04	1.06E+04	1.04E+04	7.65E+03	2.21E+03	6.95E-01
IR190	1.18E+01	3.28E+02	3.28E+02	3.28E+02	3.27E+02	3.27E+02	4.30E+06	A	7.63E-05	3.18E+02	3.09E+02	2.17E+02	5.47E+01	6.96E-03
IR192	7.38E+01	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.22E+06	A	1.39E-04	1.68E+02	1.67E+02	1.58E+02	1.27E+02	3.06E+01
IR194	7.98E-01	7.43E+01	7.43E+01	7.39E+01	7.30E+01	7.17E+01	1.04E+07	A	7.11E-06	4.82E+01	3.12E+01	1.70E-01	2.44E-10	0.00E+00
IR195	1.04E-01	7.26E+01	7.23E+01	6.91E+01	6.25E+01	5.37E+01	1.90E+08	B	3.64E-07	1.95E+00	5.25E-02	7.34E-21	0.00E+00	0.00E+00
IR196	6.02E-04	4.22E+01	1.99E+01	1.44E+00	9.56E-01	5.28E-01	4.30E+05	D	3.35E-06	1.11E-06	7.14E-13	0.00E+00	0.00E+00	0.00E+00
IR197	4.03E-03	2.03E+01	1.89E+01	1.00E+01	2.45E+00	2.97E-01	4.30E+05	D	2.33E-05	2.01E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IR198	9.26E-05	1.01E+01	5.58E-02	2.67E-22	0.00E+00	0.00E+00	4.30E+05	D	6.21E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT175	2.92E-05	1.95E+01	1.37E-06	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT176	9.99E-01	5.58E+01	8.85E-02	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT177	1.27E-04	1.28E+02	3.53E-01	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT178	2.43E-04	2.16E+02	3.08E+01	6.64E-07	0.00E+00	0.00E+00	4.30E+05	D	1.54E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT179	4.98E-04	3.66E+02	1.05E+02	1.24E-03	1.40E-14	5.33E-31	4.30E+05	D	2.88E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT180	6.02E-04	6.61E+02	2.88E+02	1.62E-01	9.65E-09	1.40E-19	4.60E+09	C	3.52E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT181	5.90E-04	1.17E+03	5.45E+02	3.70E-01	3.19E-08	7.72E-19	1.10E+09	C	3.36E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT182	1.81E-03	1.77E+03	1.40E+03	1.28E+02	6.20E-01	2.08E-04	4.30E+05	D	2.98E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT183	4.51E-03	2.30E+03	2.10E+03	8.16E+02	9.67E+01	3.94E+00	4.30E+05	D	1.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
PT184	1.20E-02	2.93E+03	2.85E+03	2.00E+03	8.98E+02	2.70E+02	2.60E+07	C	7.69E-05	8.86E-10	2.63E-22	0.00E+00	0.00E+00	0.00E+00
PT185	4.92E-02	3.20E+03	3.18E+03	2.96E+03	2.44E+03	1.82E+03	1.60E+07	C	1.85E-04	2.87E+00	2.52E-03	0.00E+00	0.00E+00	0.00E+00
PT185M	9.99E-01	1.87E+02	1.87E+02	1.76E+02	1.26E+02	6.83E+01	4.30E+05	D	4.09E-04	6.52E-05	1.77E-11	0.00E+00	0.00E+00	0.00E+00
PT186	8.33E-02	4.65E+03	4.64E+03	4.49E+03	4.08E+03	3.46E+03	5.00E+07	C	8.98E-05	7.65E+01	1.20E+00	2.48E-22	0.00E+00	0.00E+00
PT187	9.79E-02	6.36E+03	6.35E+03	6.20E+03	5.71E+03	4.95E+03	3.60E+07	C	1.72E-04	1.93E+02	5.60E+00	1.97E-18	0.00E+00	0.00E+00
PT188	1.02E+01	8.93E+03	8.93E+03	8.93E+03	8.92E+03	8.91E+03	4.30E+06	C	2.08E-03	8.64E+03	8.35E+03	5.55E+03	1.13E+03	3.58E-02
PT189	4.54E-01	1.02E+04	1.02E+04	1.02E+04	1.00E+04	9.78E+03	3.80E+07	C	2.68E-04	4.87E+03	2.27E+03	2.32E-01	6.14E-17	0.00E+00
PT191	2.91E+00	1.31E+04	1.31E+04	1.31E+04	1.31E+04	1.31E+04	3.92E+07	A	3.34E-04	1.22E+04	1.09E+04	2.72E+03	1.21E+01	6.13E-15
PT193	1.85E+04	5.68E+03	5.68E+03	5.68E+03	5.68E+03	5.68E+03	1.36E+08	A	4.18E-05	5.68E+03	5.68E+03	5.68E+03	5.68E+03	5.64E+03
PT197	7.63E-01	5.52E+02	5.51E+02	5.48E+02	5.42E+02	5.32E+02	5.38E+07	A	1.02E-05	3.51E+02	2.23E+02	9.51E-01	5.31E-10	0.00E+00
PT197M	6.54E-02	1.01E+01	1.01E+01	9.92E+00	8.93E+00	7.26E+00	1.85E+08	A	5.36E-08	5.72E-02	2.89E-04	0.00E+00	0.00E+00	0.00E+00
PT199	2.14E-02	2.72E+02	2.66E+02	2.18E+02	1.39E+02	7.06E+01	1.90E+08	B	1.15E-06	2.50E-05	2.30E-12	0.00E+00	0.00E+00	0.00E+00
PT200	5.21E-01	1.95E+02	1.95E+02	1.93E+02	1.90E+02	1.85E+02	1.90E+07	B	1.02E-05	1.01E+02	5.21E+01	1.88E-02	6.86E-16	0.00E+00
PT201	1.74E-03	6.36E+01	4.82E+01	3.98E+00	1.55E-02	3.79E-06	4.30E+05	D	9.26E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU178	3.01E-05	1.18E+01	1.34E-06	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU179	8.68E-05	4.30E+01	1.34E-01	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU181	1.32E-04	1.98E+02	5.21E+00	2.14E-14	0.00E+00	0.00E+00	4.30E+05	D	4.98E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU182	2.43E-04	3.96E+02	6.45E+01	2.88E-06	0.00E+00	0.00E+00	4.30E+05	D	6.70E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU183	4.86E-04	5.74E+02	2.18E+02	2.95E-02	7.39E-11	9.27E-24	4.30E+05	D	6.86E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU184	6.13E-04	9.34E+02	4.59E+02	4.29E-01	6.56E-08	3.92E-18	5.80E+07	C	7.40E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU185	3.01E-03	1.14E+03	9.66E+02	2.27E+02	9.02E+00	7.16E-02	5.10E+07	C	4.45E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU185M	9.99E-01	1.87E+02	1.81E+02	7.63E+01	9.94E+00	4.67E-01	4.30E+05	D	1.77E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU186	7.41E-03	2.42E+03	2.30E+03	1.31E+03	3.58E+02	5.13E+01	5.00E+07	C	2.62E-05	1.39E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU187	5.83E-03	3.98E+03	3.74E+03	1.93E+03	3.83E+02	3.32E+01	5.30E+07	C	3.64E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU188	6.13E-03	6.24E+03	5.93E+03	3.33E+03	7.28E+02	6.95E+01	4.30E+05	D	7.74E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU189	1.99E-02	4.24E+03	4.14E+03	3.33E+03	2.06E+03	9.96E+02	2.20E+07	C	1.51E-04	1.19E-04	3.34E-12	0.00E+00	0.00E+00	0.00E+00
AU189M	3.19E-03	3.70E+03	3.68E+03	2.64E+03	6.80E+02	6.58E+01	5.00E+07	C*	5.28E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU190	2.97E-02	1.00E+04	9.97E+03	9.23E+03	7.43E+03	5.02E+03	2.30E+07	C	4.01E-04	1.28E-01	1.11E-06	0.00E+00	0.00E+00	0.00E+00
AU191	1.32E-01	1.17E+04	1.17E+04	1.15E+04	1.11E+04	1.03E+04	5.90E+07	C	1.95E-04	1.03E+03	7.52E+01	1.74E-12	0.00E+00	0.00E+00
AU191M	1.06E-05	6.75E+03	6.67E+03	5.92E+03	4.48E+03	2.93E+03	5.90E+07	C*	1.00E-04	2.59E-01	9.77E-06	0.00E+00	0.00E+00	0.00E+00
AU192	2.06E-01	1.38E+04	1.38E+04	1.37E+04	1.35E+04	1.31E+04	2.00E+07	C	6.85E-04	5.43E+03	1.54E+03	1.35E-05	0.00E+00	0.00E+00
AU193	7.35E-01	1.55E+04	1.55E+04	1.55E+04	1.54E+04	1.53E+04	6.50E+07	B	2.38E-04	1.11E+04	7.01E+03	2.34E+01	4.94E-09	0.00E+00
AU194	1.58E+00	5.64E+03	5.64E+03	5.63E+03	5.60E+03	5.56E+03	1.77E+07	A	3.18E-04	4.72E+03	3.97E+03	1.02E+03	7.61E+02	7.60E+02
AU195	1.86E+02	2.25E+04	2.25E+04	2.25E+04	2.25E+04	2.25E+04	2.37E+06	A	9.49E-03	2.25E+04	2.25E+04	2.20E+04	2.01E+04	1.13E+04
AU195M	3.53E-04	4.54E+02	4.54E+02	4.49E+02	4.40E+02	4.25E+02	3.22E+08	A	1.39E-06	1.92E+02	8.01E+01	2.18E-03	3.27E-21	0.00E+00
AU196	6.18E+00	5.11E+03	5.11E+03	5.11E+03	5.10E+03	5.09E+03	1.30E+08	B	3.93E-05	4.83E+03	4.57E+03	2.33E+03	1.68E+02	6.38E-06
AU197M	9.03E-05	3.34E-01	3.34E-01	3.28E-01	2.95E-01	2.40E-01	4.30E+05	D	7.63E-07	1.89E-03	9.56E-06	0.00E+00	0.00E+00	0.00E+00
AU198	2.70E+00	6.74E+03	6.74E+03	6.73E+03	6.70E+03	6.67E+03	1.44E+07	A	4.67E-04	5.93E+03	5.21E+03	1.11E+03	2.70E+00	2.62E-17
AU199	3.14E+00	7.43E+03	7.43E+03	7.42E+03	7.40E+03	7.36E+03	1.85E+07	A	4.01E-04	6.66E+03	5.96E+03	1.59E+03	9.12E+00	2.42E-14
AU200	3.36E-02	5.00E+03	4.93E+03	4.36E+03	3.32E+03	2.23E+03	9.90E+07	B	4.40E-05	1.08E+02	5.57E+01	2.01E-02	7.33E-16	0.00E+00
AU201	1.81E-02	5.18E+03	5.05E+03	3.97E+03	2.33E+03	1.05E+03	5.10E+08	B	7.78E-06	2.39E-05	1.10E-13	0.00E+00	0.00E+00	0.00E+00

Nuclide ID	Half Life (days)	Time (s) INITIAL	6.00E+01 1 min.	6.00E+02 10 min.	1.80E+03 30 min.	3.60E+03 1 hour	Threshold (Cat 2)	TS	Fraction of Cat. 2	4.32E+04 12 hours	8.64E+04 1 day	6.05E+05 1 week	2.63E+06 1 month	1.58E+07 6 months
AU202	3.33E-04	1.21E+03	2.89E+02	7.16E-04	2.50E-16	0.00E+00	4.30E+05	D	1.67E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU203	6.13E-04	1.06E+03	4.82E+02	4.13E-01	6.31E-08	3.77E-18	4.30E+05	D	9.60E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AU204	4.61E-04	1.50E+02	5.29E+01	4.56E-03	4.25E-12	1.21E-25	4.30E+05	D	1.06E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG180	3.47E-05	8.45E+00	5.00E-06	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG181	4.17E-05	2.37E+01	2.27E-04	0.00E+00	0.00E+00	0.00E+00	4.30E+05	D	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG182	1.31E-04	3.55E+01	8.95E-01	3.68E-15	0.00E+00	0.00E+00	4.30E+05	D	8.56E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG183	1.02E-04	6.42E+01	5.69E-01	1.92E-19	0.00E+00	0.00E+00	4.30E+05	D	4.47E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG184	3.54E-04	1.20E+02	3.13E+01	1.53E-04	2.39E-16	5.17E-34	7.30E+07	C	2.10E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG185	5.67E-04	1.96E+02	8.24E+01	3.38E-02	1.01E-09	5.25E-21	2.20E+07	C	1.54E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG186	9.58E-04	5.12E+02	3.16E+02	3.93E+00	2.26E-04	9.89E-11	1.00E+08	C	3.93E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG187	1.67E-03	1.05E+03	7.96E+02	6.57E+01	2.57E-01	6.27E-05	7.30E+06	C	9.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG188	2.26E-03	2.40E+03	1.96E+03	2.95E+02	4.15E+00	6.89E-03	7.00E+07	C	4.21E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG189	5.28E-03	3.70E+03	3.44E+03	1.70E+03	3.45E+02	3.16E+01	4.30E+05	D	3.95E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
HG190	1.39E-02	5.36E+03	5.20E+03	3.86E+03	1.93E+03	6.84E+02	1.10E+08	C	3.51E-05	7.97E-08	1.16E-18	0.00E+00	0.00E+00	0.00E+00
HG191	3.36E-02	6.75E+03	6.66E+03	5.92E+03	4.48E+03	2.93E+03	2.90E+07	C	2.04E-04	2.59E-01	9.77E-06	0.00E+00	0.00E+00	0.00E+00
HG192	2.03E-01	9.01E+03	9.00E+03	8.82E+03	8.43E+03	7.85E+03	7.40E+06	C	1.19E-03	1.63E+03	2.93E+02	3.36E-07	0.00E+00	0.00E+00
HG193	1.59E-01	1.05E+04	1.05E+04	1.02E+04	9.59E+03	8.72E+03	6.10E+05	C	1.67E-02	9.90E+02	9.19E+01	3.75E-11	0.00E+00	0.00E+00
HG194	1.90E+05	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.90E+04	C	5.97E-02	1.13E+03	1.13E+03	1.13E+03	1.13E+03	1.13E+03
HG195	4.12E-01	1.75E+04	1.74E+04	1.73E+04	1.69E+04	1.63E+04	5.30E+05	C	3.26E-02	7.39E+03	3.08E+03	8.39E-02	1.26E-19	0.00E+00
HG197	2.67E+00	1.17E+05	1.17E+05	1.17E+05	1.16E+05	1.16E+05	1.80E+05	C	6.50E-01	1.03E+05	9.04E+04	1.91E+04	4.36E+01	2.95E-16
HG203	4.66E+01	8.32E+04	8.32E+04	8.32E+04	8.32E+04	8.31E+04	1.10E+05	C	7.56E-01	8.26E+04	8.20E+04	7.50E+04	5.30E+04	5.53E+03
HG205	3.61E-03	3.60E+03	3.15E+03	9.49E+02	6.60E+01	1.21E+00	4.30E+05	D	2.21E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL184	1.27E-04	3.38E+00	7.71E-02	1.29E-16	0.00E+00	0.00E+00	4.30E+05	D	3.00E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL186	3.18E-04	1.18E+01	2.68E+00	4.19E-06	5.26E-19	0.00E+00	4.30E+05	D	9.74E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL188	8.19E-04	1.52E+02	8.49E+01	4.37E-01	3.57E-06	8.33E-14	4.30E+05	D	1.02E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL189	1.60E-03	3.53E+02	2.16E+02	2.52E+00	1.26E-04	4.47E-11	4.30E+05	D	5.86E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL190	1.81E-03	7.03E+02	5.40E+02	4.94E+01	2.39E-01	8.03E-05	4.30E+05	D	1.15E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL191	9.99E-01	8.97E+02	7.87E+02	2.39E+02	1.68E+01	3.12E-01	4.30E+05	D	5.56E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL192	7.50E-03	1.17E+03	1.09E+03	6.16E+02	1.71E+02	2.49E+01	4.30E+05	D	1.43E-03	1.00E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00
TL193	1.50E-02	1.49E+03	1.44E+03	1.07E+03	5.56E+02	2.07E+02	4.30E+05	D	2.49E-03	7.15E-08	3.42E-18	0.00E+00	0.00E+00	0.00E+00
TL194	2.29E-02	1.79E+03	1.75E+03	1.45E+03	9.54E+02	5.08E+02	6.80E+07	B	2.13E-05	4.85E-04	1.31E-10	0.00E+00	0.00E+00	0.00E+00
TL195	4.83E-02	2.02E+03	2.00E+03	1.83E+03	1.50E+03	1.11E+03	3.90E+07	B	4.69E-05	1.55E+00	1.19E-03	0.00E+00	0.00E+00	0.00E+00
TL195M	4.17E-05	2.03E+01	1.95E+01	1.33E+01	5.73E+00	1.61E+00	4.30E+05	D	3.09E-05	1.24E-12	7.55E-26	0.00E+00	0.00E+00	0.00E+00
TL196	7.67E-02	2.28E+03	2.27E+03	2.14E+03	1.89E+03	1.56E+03	2.60E+07	B	8.23E-05	2.48E+01	2.70E-01	0.00E+00	0.00E+00	0.00E+00
TL197	1.18E-01	2.62E+03	2.61E+03	2.51E+03	2.32E+03	2.05E+03	1.00E+08	B	2.51E-05	1.40E+02	7.50E+00	4.03E-15	0.00E+00	0.00E+00
TL198	2.21E-01	2.65E+03	2.65E+03	2.60E+03	2.48E+03	2.33E+03	2.20E+07	B	1.18E-04	5.52E+02	1.15E+02	7.56E-07	0.00E+00	0.00E+00
TL199	3.09E-01	2.43E+03	2.43E+03	2.40E+03	2.32E+03	2.22E+03	1.40E+08	B	1.71E-05	7.94E+02	2.59E+02	3.70E-04	0.00E+00	0.00E+00
TL200	1.09E+00	1.86E+03	1.86E+03	1.86E+03	1.84E+03	1.81E+03	2.67E+07	A	6.97E-05	1.35E+03	9.85E+02	2.15E+01	6.99E-06	0.00E+00
TL201	3.04E+00	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.31E+03	1.06E+08	A	1.25E-05	1.18E+03	1.05E+03	2.71E+02	1.35E+00	1.40E-15
TL202	1.22E+01	7.20E+02	7.20E+02	7.19E+02	7.19E+02	7.18E+02	2.40E+07	A	3.00E-05	7.00E+02	6.80E+02	4.84E+02	1.28E+02	2.27E-02

EXHIBIT C

INITIAL LOOK AT SNS SPALLATION PRODUCT TRANSPORT

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EXHIBIT C. INITIAL LOOK AT SNS SPALLATION PRODUCT TRANSPORT

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I. General Comments About Chemical Reactions in Mercury

Liquid mercury can act like a solvent to promote the reaction of materials that are dissolved in it. The products of reaction may or may not contain mercury. For example, metals in mercury may react to form intermetallic compounds. These compounds may be the same as those that would form without mercury or they may contain mercury. Mercury could be used as a low temperature medium for making some metal alloys.

In a mercury spallation neutron source, the spallation products can react with each other and with mercury. The rare earth-mercury phase diagrams will be very similar (with the possible exception of europium). Thus, rare earth-mercury intermetallic compounds in the mercury source would most likely contain a variety of different rare earth elements: La, Nd, Gd, Sm, etc.

Material in mercury could be in different physical forms. It may be a true solution where the elements are "dissolved" in the liquid mercury and are in the liquid state (compare to salt dissolved in water). It could also be a suspension of solid particles in mercury. This form would occur when the solubility in mercury was exceeded or when a compound formed.

II. Iodine in a Mercury Spallation Neutron Source

It is not likely that iodine in a mercury spallation neutron source would be in the form of unreacted elemental iodine. In pure mercury it would react to form mercurous iodide Hg_2I_2. However, iodine forms compounds with spallation products such as cesium, barium, and the rare earths that are much more stable than Hg_2I_2.

The question: What does iodine do in a mercury spallation neutron source that is sparged with He at 110ºC can best be answered by looking at the iodides.

The vapor pressure of I_2 over Hg_2I_2 is very low. The value calculated at 110ºC for the reaction $Hg_2I_2 = 2\ Hg + I_2$ (gas) was only ~10^{-16} atmospheres. However, mercurous iodide Hg_2I_2 can dissociate into mercury and mercuric iodide, HgI_2:

$$Hg_2I_2 = Hg + HgI_2 \text{ (gas)} \quad .$$

At 110°C the partial pressure of the HgI_2 (gas) was calculated as ~7×10^{-6} atmospheres. This is still not very high, but some iodine could be lost. However, as noted, the spallation product iodides can be much more stable than the mercury iodides. The vapor pressure of iodine species over LaI_3 was calculated as ~4×10^{-27} atmospheres at 110°C, and the vapor pressure over CsI was only ~2×10^{-19} atmospheres at this temperature.

It should be noted that air would react with the iodides and convert them to oxides while releasing iodine as elemental iodine. This may be a concern in an accident situation. In summary, purging with He at 110°C could remove a small amount of iodine in the form of gaseous HgI_2. If equilibrium conditions prevail with the spallation products, iodine release should be very low. Mercuric iodide gas would be trapped in the off-gas system condenser. Its vapor pressure at –20°C is only ~4×10^{-11} atmospheres.

III. Gadolinium and Hafnium Spallation Products

Hafnium and gadolinium are very reactive with oxygen. This is true of the other rare earths as well. This means that any oxygen in the He purge gas would be scavenged to form an oxide. Thus, depending on the purity of the He, hafnium and gadolinium could be in the mercury as metals or as the oxides HfO_2 or Gd_2O_3. The solubility of Gd in He at 100°C has been reported as 5×10^{-2} atom%.[1] Several rare earth-mercury compounds are known. As noted, these compounds would most likely contain a variety of rare earth elements.

There are no data available for the solubility of hafnium in mercury, but by comparison with zirconium, it is very low. A hafnium-mercury compound Hf_2Hg could form.

In summary, gadolinium could be in the form of an oxide; it could be dissolved in liquid mercury; or it could form an intermetallic compound that may or may not contain mercury. I can't conceive of any mechanism where it could be airborne at 110°C. The vapor pressure of Gd would be less than the vapor pressure of elemental Gd at this temperature, which is negligibly small. Hafnium could be in the form of an oxide or an intermetallic compound. Both gadolinium and hafnium will scavenge oxygen either during normal operation if the He gas (or surrounding gas) is not purified or during an accident.

IV. Iron

Iron does not form intermetallic compounds with mercury. It may form compounds with other spallation products. Iron is not soluble in mercury so it would be in the form of small crystallites of Fe or a non-mercury containing intermetallic compound. Most likely these crystallites (as well as those containing gadolinium or hafnium) would be dispersed in the mercury or at the upper surface. The density of the crystallites would be much less than that of mercury. If the mercury evaporated, iron should remain in the residue rather than enter the gas phase.

References

1. F. Messing and O. C. Dean, *Solubilities of Selected Metals in Mercury: Hermex Process*, ORNL- 2871, Oak Ridge Natl. Lab., Union Carbide Corp., June 1960.

EXHIBIT D

MERCURY EVAPORATION IN AN SNS ACCIDENT

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EXHIBIT D. MERCURY EVAPORATION IN AN SNS ACCIDENT

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The following is an attempt to quantify the evaporation behavior of liquid mercury that is spilled in a hypothetical SNS accident in the splash/shielding enclosure, which is located inside the target hot cell. Because the design is still in the conceptual stage, it is impossible to even specify the problem exactly, let alone solve it. Hence, the present analysis is only preliminary, and very approximate.

One possibility is to use the Langmuir equation to analyze this problem. This approach involves a theoretical maximum rate of evaporation into a vacuum, and is always a gross over-exaggeration of the evaporation rate.[1] Benjamin[2] performed vacuum chamber experiments and found an actual rate of between 1×10^{-5} and 4×10^{-5} $g \cdot s^{-1}$ compared to the theoretical rate of 5.8×10^{-5} $g \cdot s^{-1}$ at 20ºC. He also found that exposure to air or O_2 in the presence of water vapor produced an oxide surface film that reduced evaporation by several orders of magnitude. However, the mercury pool needs to be completely quiescent, as even the slightest motion or vibration can severely disrupt the oxide skin.

The Langmuir equation is, of course, bounding; however, its conservatism is unrealistic. To obtain an estimate more reflective of a well-ventilated room near atmospheric pressure, we turn to an approach involving molecular diffusion and interface mass transport. Assumptions regarding room and puddle geometry are somewhat arbitrary, so two different cases are examined.

1. Nominal Case

We assume a 2 × 2 m puddle of mercury on the floor of a rectangular room 3 m high and with floor area 4 × 8 m. Ventilation flow refreshes the room 5 times per hour, so the flow rate is 480 m^3/h. Assuming air flow is uniform and occurs exactly parallel to the longest room dimension (i.e., the 8-m edge), the gas superficial velocity is

$$v = \frac{480}{3 \times 4} = 40 \, \frac{m}{h} = 0.0111 \, \frac{m}{s} \quad .$$

This flow rate is painfully slow, and most mass transport is probably by molecular diffusion. However, it is possible that other factors could eventually alter this scenario, so we will develop a mass transfer coefficient approach.

The flux of mercury evaporating across the gas-liquid interface can be approximated as follows:

$$\text{Flux} = K \, (C_l - PC_g) \quad , \qquad (1)$$

where

K = overall mass transfer coefficient, $\frac{1}{K} = \frac{P}{k_g} + \frac{1}{k_l}$,

k_g, k_l = gas and liquid film coefficients (m/s),

P= partition coefficient (inverse Henry's Law Constant) ,
C_g, C_l = concentrations of mercury in gas and liquid (mol/m^3) .

First, assume for now that $k_l = 0$, which implies no resistance to evaporation in the liquid. (If an oxide film needs to be considered, then k_l can be chosen to represent this.) We hope to establish a maximum reasonable evaporation rate. Hence, Eq. (1) becomes

$$\text{Flux} = \frac{k_g}{P}(C_l - PC_g) = k_g(\frac{C_l}{P} - C_g) = k_g(C_g^* - C_g) \qquad (2)$$

where C_g^* = equilibrium concentration in gas phase .

The gas film coefficient is determined from a correlation for forced convection parallel to an infinite flat plate:

$$\frac{k_g L}{D} = .664\ Re^{\frac{1}{2}}\ Sc^{\frac{1}{3}}, \quad (\text{valid for } Re < 2 \times 10^4) \qquad (3)$$

where L = characteristic length of flow ,
D = binary diffusion coefficient ,
Re = $L\nu/\nu$ = Reynolds number ,
Sc = ν/D = Schmidt number ,
ν = kinematic viscosity .

Diffusion coefficients for many gas pairs have been correlated and can be estimated.[1] For mercury and air at 90ºC, we get (see Sect. 3 for details):

$$D = 0.192\ \frac{cm^2}{s} = 1.92 \times 10^{-5}\ \frac{m^2}{s}.$$

Assuming the flow length is the length of the mercury puddle, we have L = 2 m. From ref. 3 (p. 388), for pure air at 90ºC, $\nu = 2.195 \times 10^{-5}\ m^2/s$. Hence, we have

$$Re = 1011,\ Sc = 1.14,\ \text{and}\ K_g = 2.12 \times 10^{-6}\ \frac{m}{s}.$$

The equilibrium concentration C_g^* can be determined from vapor pressure data. From ref. 4, the vapor pressure of mercury in kPa is estimated to within 1% by:

$$\log_{10} P_{Hg} = 7.150 - \frac{3212.5}{T},\ T < 423\ K\ .$$

Hence, at 90ºC, $P_{Hg} = 0.200$ kPa = 2×10^{-4} bar. Then assuming an ideal gas, the equilibrium concentration is

$$C_g^* = \frac{n}{v} = \frac{P_{Hg}}{RT} = .0066 \text{ mol/m}^3 .$$

Now, assume $C_g << C_g^*$, so that Eq. (2) can be written

$$\text{Flux} = k_g \ C_g^* = 1.4 \times 10^{-8} \text{ mol/m}^2 \cdot \text{s (at 90ºC)} \quad . \qquad (4)$$

This is quite low, probably because the mass transfer coefficient is not reliably predicted using a forced convection correlation with such a low velocity flow. Using purely molecular diffusion, we have from Fick's law,

$$\text{Flux} = -D \ \frac{dC_g}{dy} \quad .$$

Assuming the concentration profile is $C_g = C_g^*$ at the puddle surface, and $C_g = 0$ at a height of 1 m, we then have

$$-\frac{dC_g}{dy} \cong \frac{C_g^*}{1 \text{ m}} = C_g^* .$$

Hence, the flux is

$$\text{Flux} = D\,C_g^* = 1.3 \times 10^{-7} \text{ mol/m}^2 \cdot \text{s} \qquad (5)$$

Even though it is an order of magnitude larger than Eq. (4), this value is still quite small. For example, using a volume correlation in ref. 4 and standard density from ref. 5, we calculate that a cubic meter of mercury contains:

$$n_{TOT} = 68{,}600 \text{ mol} \quad .$$

With a puddle of surface area A = 4 m^2, the time for 1 m^3 of mercury to evaporate [assuming only molecular diffusion, i.e., Eq. (5)] is

$$t = \frac{68{,}600}{4(1.3 \times 10^{-7})} = 1.32 \text{ x } 10^{11} \text{ s} = 4180 \text{ years} \quad .$$

2. Parametric Sensitivity Analysis

The previous section involved a best-guess estimate of how a mercury puddle might evaporate in a hypothetical SNS accident. This section involves some parameter adjustments so as to construct an overly conservative scenario—a worse-than-worst-case estimate. The general formulation is the same as in the previous study, but we make the following parameter adjustments:

(1) Temperature = 110°C (instead of 90°). This is the maximum possible. Generally, higher temperatures increase mass transfer processes. In this case, the effect is slight.
(2) Area. Assume the puddle surface is the entire splash-shielding enclosure: 4×8 m. The floor geometry would probably not allow this, so it is unusually conservative.
(3) Gas flow rate. Assume a slow turbulent flow parallel to the puddle surface. The forced convection correlation assumes turbulent flow for $Re \geq 2 \times 10^4$, so we assume $Re = 2 \times 10^4$, which is probably unrealistically high. Considering the entire 8-m edge parallel to flow, this is consistent with an air velocity of 6 cm/s.

From Eq. (4), the evaporative flux of mercury is:

$$\text{Flux} = k_g \, C_g^* .$$

The equilibrium gas concentration is again calculated from the ideal gas equation and the empirical vapor pressure equation:

$$C_g^* = \frac{P_{Hg}}{RT} = 0.0183 \frac{\text{mol}}{\text{m}^3} .$$

The mass transfer coefficient in Eq. (3) refers to laminar flow. Here it determined from a correlation for turbulent plane flow:

$$\frac{k_g L}{D} = .036 \; Re^{0.8} \, Sc^{.33} .$$

The characteristic length is now L = 8 m, and the kinematic viscosity of air at 110ºC is $\nu = 2.4 \times 10^{-5}$ m^2/s. The diffusion coefficient is calculated as before (see the next section for details) to give $D = 2.12 \times 10^{-5}$ m^2/s. Hence, we have

$$Sc = \frac{\nu}{D} = 1.134 \quad ,$$

$$k_g = \frac{D}{L} (.036 \; Re^{.8} \; Sc^{.33}) = 2.745 \times 10^{-4} \;\; \text{m s}^{-1} \quad .$$

With this flux operating over the area of 4 × 8 m, a puddle of 1 cubic meter (68,600 mol) is evaporated as follows:

$$t = \frac{68{,}600}{32(5.024 \times 10^{-6})} = 4.267 \times 10^{8}\,\mathrm{s} = 13.52 \text{ years.}$$

Thus, in spite of the overly conservative assumptions, this estimate is still a fairly long time.

3. Calculation of Diffusion Coefficient

Over the past 50 years, the kinetic theory of gases has been developed using classical statistical mechanics, and validated on numerous binary gas pairs. The usual approach involves the following assumptions:

(1) only binary (i.e., two-particle) collisions occur,
(2) particle motion is described by classical mechanics (no quantum effects),
(3) all collisions are elastic,
(4) molecular forces operate through fixed centers of mass, and
(5) the Lennard-Jones 6–12 potential represents the intermolecular potential energy.

The theory results in the following equation[1]:

$$D_{AB} = \frac{.001858\ T^{\frac{3}{2}} \left[\frac{1}{M_A} + \frac{1}{M_B}\right]^{\frac{1}{2}}}{P\ \sigma_{AB}^{2}\ \Omega} \quad , \qquad (6)$$

where D_{AB} = diffusion coefficient of A in B or B in A (cm^2/s),
T = temperature (K),
M_A, M_B = molecular weights (200.59 for mercury, 28.8 for air),
P = pressure (atm),
σ_{AB} = interparticle "distance" of closest approach (Å),
Ω = collision integral.

The last parameter accounts for all potential energy terms, and is a function of kT/ε, where *k* = Boltzmann's constant and ε is the energy parameter from the Lennard-Jones potential. For each component, ε and σ are determined by fitting thermodynamic data, and are known for a great many real gas species. For air and mercury, we have

	σ	$\frac{\varepsilon}{k}$
Air	3.711	78.6
Hg	2.969	750.0

The mixture quantities are then determined as follows:

$$\sigma_{\text{Air - Hg}} = \frac{1}{2}(\sigma_{\text{Air}} + \sigma_{\text{Hg}}) = 3.34 \quad ,$$

$$\left(\frac{\varepsilon}{k}\right)_{\text{Air} - \text{Hg}} = \frac{(\varepsilon_{\text{Air}}\ \varepsilon_{\text{Hg}})^{\frac{1}{2}}}{k} = 243 \quad .$$

For the case in Sect. 2, where T = 383 K, then $kT/\varepsilon = 1.576$, and $\Omega = 1.175$ can be obtained from tables.[1] Substituting each of these quantities into Eq. (6) yields

$$D_{\text{Air - Hg}} = 0.2117\ \frac{cm^2}{s} = 2.117 \times 10^{-5}\ \frac{m^2}{s} .$$

References

1. T. K. Sherwood, R. L. Pigford, and C. R. Wilke, *Mass Transfer*, McGraw-Hill (1975).
2. D. J. Benjamin, *Mat. Res. Bull.* **19**, 443–450 (1984).
3. W. M. Kays and M. E. Crawford, *Convective Heat and Mass Transfer*, McGraw-Hill (1980).
4. *Kirk-Othmer Encyclopedia of Chemical Technology*, 4th Ed., Vol. 16, John Wiley & Sons (1991).
5. *CRC Handbook of Chemistry and Physics*, 59th Ed., CRC Press (1978).

EXHIBIT E

SOURCE TERMS FOR THE ACCIDENT SEQUENCES IN CHAPTER 4

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EXHIBIT E. SOURCE TERMS FOR THE ACCIDENT SEQUENCES IN CHAPER 4

Source term for accident sequences 22, 29, 30 & 32		Source term for accident sequences 24 & 31		Source term for accident sequence 36		Source term for accident sequence 27		Source term for accident sequence 40	
List 1		List 2		List 3		List 4		List 5	
Nuclide	Ci/hr	Nuclide	Ci	Nuclide	Ci/y	Nuclide	Ci	Nuclide	Ci
H-3	4.58E-03	H-3	7.69E-01	H3	5.07E-01	H3	6.58E-02	H3	7.31E-02
Xe-119	1.87E+01	Xe-119	3.23E+00	BE7	3.84E-01	BE7	4.98E-02	BE7	5.53E-02
I-119	1.22E+00	I-119	3.23E+00	C14	3.47E-04	C14	4.51E-05	C14	5.01E-05
Te-119	1.09E-04	Te-119	3.23E+00	V48	4.80E-05	V48	6.23E-06	V48	6.92E-06
Sb-119	1.87E-08	Sb-119	3.23E+00	V49	3.13E-04	V49	4.07E-05	V49	4.52E-05
Xe-120	1.77E+00	Xe-120	1.78E+00	CR51	1.06E-04	CR51	1.38E-05	CR51	1.53E-05
I-120	2.55E-02	I-120	1.78E+00	MN52	1.02E-04	MN52	1.32E-05	MN52	1.47E-05
Xe-121	1.73E+00	Xe-121	1.69E+00	MN54	1.51E-08	MN54	1.95E-09	MN54	2.17E-09
I-121	1.59E-02	I-121	1.69E+00	FE55	4.12E-04	FE55	5.34E-05	FE55	5.94E-05
Te-121	4.00E-08	Te-121	1.69E+00	FE59	3.53E-02	FE59	4.58E-03	FE59	5.09E-03
Xe-122	4.01E-01	Xe-122	1.18E+01	CO56	1.09E-03	CO56	1.42E-04	CO56	1.57E-04
I-122	1.10E-01	I-122	1.18E+01	CO57	6.25E-03	CO57	8.11E-04	CO57	9.01E-04
Xe-123	3.87E+00	Xe-123	1.14E+01	CO58	1.32E-02	CO58	1.72E-03	CO58	1.91E-03
I-123	5.71E-03	I-123	1.14E+01	CO60	5.33E-03	CO60	6.92E-04	CO60	7.69E-04
Te-123	1.91E-08	Te-123	1.14E+01	NI59	3.55E-03	NI59	4.61E-04	NI59	5.12E-04
Xe-125	1.47E+00	Xe-125	3.67E+01	NI63	2.48E-04	NI63	3.22E-05	NI63	3.58E-05
I-125	1.97E-05	I-125	2.47E+01						
Xe-127	1.99E-02	Xe-127	3.17E+00						
C10	1.83E-04	C10	3.07E-02						
C11	1.35E-02	C11	2.26E+00						
C14	6.77E-06	C14	1.14E-03						
N13	5.66E-02	N13	9.51E+00						
N16	5.14E-04	N16	8.63E-02						
O14	1.37E-02	O14	2.30E+00						
O15	2.56E-01	O15	4.30E+01						
AR37	7.51E-03	AR37	1.26E+00						
AR39	7.42E-06	AR39	1.25E-03						
AR41	1.93E-04	AR41	3.24E-02						
AR42	4.00E-06	AR42	6.71E-04						

EXHIBIT E (continued)

Source term for accident sequence 17		Source term for accident sequence 18		Source term for accident sequence 39		Source term for accident sequence 28		Source term for accident sequence 26	
List 6		List 7		List 8		List 9		List 10	
Nuclide	Ci/hr	Nuclide	Ci	Nuclide	Ci	Nuclide	Ci	Nuclide	Ci
HG184	2.50E-06	HG184	1.30E-05	H3	3.97E+00	H3	3.66E-05	H3	2.84E-02
HG185	3.97E-06	HG185	2.06E-05	BE7	3.24E-01	BE7	2.77E-05	BE7	1.1E-06
HG186	1.09E-05	HG186	5.68E-05	C14	2.79E-03	C14	2.51E-08	C14	8.71E-09
HG187	2.31E-05	HG187	1.20E-04	V49	2.77E-03	V48	3.46E-09	V49	8.65E-09
HG188	5.15E-05	HG188	2.67E-04	MN54	8.78E-03	V49	2.26E-08	MN54	2.74E-08
HG189	8.93E-05	HG189	4.63E-04	FE55	2.78E-01	CR51	7.65E-09	FE55	8.68E-07
HG190	1.13E-04	HG190	5.87E-04	FE59	4.88E-04	MN52	7.33E-09	FE59	1.52E-09
HG191	1.43E-04	HG191	7.40E-04	CO56	1.05E-02	MN54	1.09E-12	CO56	3.27E-08
HG192	1.88E-04	HG192	9.74E-04	CO57	7.18E-02	FE55	2.97E-08	CO57	2.24E-07
HG193	2.04E-04	HG193	1.06E-03	CO58	7.36E-03	FE59	2.54E-06	CO58	2.30E-08
HG194	1.19E-05	HG194	6.17E-05	CO60	4.66E-03	CO56	7.87E-08	CO60	1.46E-08
HG195	3.68E-04	HG195	1.91E-03	NI63	2.47E-01	CO57	4.5E-07	NI63	7.73E-07
HG197	2.47E-03	HG197	1.28E-02			CO58	9.53E-07		
HG203	1.76E-03	HG203	9.15E-03			CO60	3.84E-07		
HG205	7.59E-05	HG205	3.94E-04			NI59	2.56E-07		
						NI63	1.79E-08		

EXHIBIT E (continued)

Source term for accident sequence 34		Source term for accident sequence 37	
List 11		List 12	
Nuclide	Ci	Nuclide	Ci
H3	4.96E-03	H3	7.31E-05
BE7	2.03E-05	BE7	5.53E-05
C14	1.74E-07	C14	5.01E-08
V49	1.73E-07	V48	6.92E-09
MN54	5.48E-07	V49	4.52E-08
FE55	1.74E-05	CR51	1.53E-08
FE59	3.04E-08	MN52	1.4E-07
CO56	6.55E-07	MN54	2.17E-12
CO57	4.49E-06	FE55	5.94E-08
CO58	4.60E-07	FE59	5.09E-06
CO60	2.91E-07	CO56	1.57E-07
NI63	1.55E-05	CO57	9.01E-07
		CO58	1.91E-06
		CO60	7.69E-07
		NI63	3.58E-08

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EXHIBIT F

SOURCE TERM FOR WORST-CASE BEYOND-DESIGN-BASIS LOSS OF FORCED MERCURY FLOW ACCIDENT

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EXHIBIT F. SOURCE TERM FOR WORST-CASE BEYOND-DESIGN-BASIS LOSS OF FORCED MERCURY FLOW ACCIDENT

This exhibit develops the source term for the limiting beyond-design-basis (BDB) accident for the Spallation Neutron Source. This BDB source term is developed for both the 1-MW configuration and the 4-MW configuration. The target plug and associated systems are currently being developed for the 1-MW configuration, and may, after proving successful, be operated at proton beam power levels as high as 2-MW. The source term for a 2-MW configuration will be bracketed between the "1-MW" and "4-MW" cases derived in this appendix. The 4-MW configuration has not actually been detailed yet because it will require redesign and reanalysis of the target plug and mercury coolant system, and that work is not planned to begin for several years. The calculations below assume that the 4-MW configuration has geometry identical to that of the 1-MW configuration, with power level 4 times as high. The geometry may change somewhat when the actual 4-MW target plug is designed, although it is expected that such changes are likely to be in the direction that would moderate the accident response (i.e., by more diffuse beam focusing or larger mercury inventory, etc.) The radionuclide inventory of the 4-MW configuration is assumed to be 4 times as high as the 1-MW configuration since the buildup of spallation products is linear with respect to beam power level.

Table F.1. Event sequence table

Time (s, unless otherwise noted)	Event or process	Assumptions	Calculation(s)
0	Pump coastdown begins		
0+	TPS trip on pump status fails	Common mode failure of all Target Protection System (TPS) trips	
0++	TPS trip on pump outlet pressure fails	Run permit/beam pulse enable systems (BPS) trip(s) on same or similar process variables also assumed to fail	
0+++	TPS trip on loop flow fails		
Tcd (time elapsed during mercury pump coastdown)	Loop flow coast down is over.	All damage would be prevented if TPS or BPS function per design	Tcd is TBD—assume = 5 s
t > Tcd	Local Hg boiling begins, Hg vessel steel window (front face) heat-up begins	Max. Hg heat-up rate at peak local point in Hg is ~6 %C/pulse, and is ~1.25 %C/pulse in window (@1 MW, per CDR Table 5.3-2 peak energy densities)	**1 MW**: Hg local boiling begins ~1 s after coastdown. Window steel begins melting >17 s later. **4 MW:** Hg local boiling begins < 1 s after coastdown. Window steel begins melting >4 s later.

Table F.1 (continued)

Time (s, unless otherwise noted)	Event or process	Assumptions	Calculation(s)
t > Tcd	Beam heating of Hg without forced circulation causes intermittent boiling and condensation of Hg in inner ~½ of target plug; no net Hg vapor production	1. 66% of beam energy deposited in Hg (CDR Table 5.3-4). 2. Inner ½ of target plug only intermittently and partially voided during this period. 3. Inner ½ of plug holds ~ 0.1 m^3 of Hg	**<u>1 MW</u>**: Avg. Hg temp. of inner ½ of plug reaches bulk saturation (~360ºC) 69 s after coastdown, i.e., 69 s = (0.1 m^3) (13.3E3 kg/m^3) * (137 J/kg°C)(250°C)/ (0.66*1E6 J/s) **<u>4 MW:</u>** Avg. Hg temp. of inner ½ of plug reaches bulk saturation (~360ºC) ~17 s after coastdown
t < Tpps	Water-cooled shroud may fail	Water-cooled shroud can fail because of its close proximity to the Hg vessel front face, which fails on account of high temperature	N/A: effect of water-cooled shroud failure not clear. Would probably make beam cutoff by PPS occur sooner by allowing Hg to drain more rapidly out of the target plug
<u>1 MW:</u> Tpps = Tcd + 69 s **<u>4 MW:</u>** Tpps = Tcd + 17 s [Note: Tpps = time when <u>the Personnel Protection System (</u>PPS<u>)</u> initiates beam cutoff]	Bulk boiling of Hg in target plug. PPS detects elevated neutron flux due to beam hitting shielding steel in outer part of plug	PPS cuts off the proton beam after 2 s of bulk boiling (1 s for boiling to void the target plug inboard of the shielding steel and 1 s for instrument response time)	**<u>1 MW:</u>** Bulk boiling does not occur because the operator would cut off the beam before 60 s **<u>4 MW:</u>** 2 s of bulk boiling creates: 18.1 kg of Hg vapor (~4.6 m^3 of vapor at 1 atm pressure): 18.1E3= 0.66*4 E6*2/292
t > Tpps	Hg continues to leak from failed Hg Vessel front window unless it had already leaked to below the level of the bottom of the beam envelope	1. Hg will drain until level is below the bottom edge of the proton beam: this is <1/3 of total Hg inventory (by design) 2. Some of leaked Hg drains to collection tank in hot cell floor and some may drain to core vessel	

2.0 MERCURY RELEASE CALCULATIONS

The worst case BDB loss of mercury flow accident will have two distinct phases—the initial phase in which a short period of vigorous boiling of mercury may take place and the long-term phase in which residual amounts of mercury would slowly evaporate. For this bounding analysis, the mercury vapor produced in the vigorous boiling phase is assumed to remain in vapor form and be exhausted by the mercury enclosure ventilation without being condensed. Any cooling that takes place would condense the mercury vapor and, thus, prevent its rapid release. It is possible that some of the mercury vapor could be vented to the hot off-gas (HOG) system, but the resulting releases would be lower, so the HOG is not credited here.

The transport of mercury is addressed specifically in the next two subsections. The possibility of transport of other radionuclides is discussed in a separate subsection at the end. The possible use of a low temperature condenser and/or a sulphur-impregnated activated charcoal for mercury removal from the target cell air exhaust will be examined during Title I design; none of the calculations in this section credit the ventilation system with mercury removal capability.

2.1 SHORT TERM RELEASE

A rapid release of mercury vapor occurs due to the assumed period of vigorous mercury boiling that occurs immediately before the PPS actuates cutoff of the proton beam. As noted in the table, for the 1-MW case, it takes more than 60 s for the beam to heat the mercury in the inner part of the mercury target plug to the saturation temperature. Thus, it is very likely that the operator would interrupt this event before the bulk boiling occurred for the 1-MW target configuration. For the 4-MW case, however, the bulk boiling occurs well before 1 min has elapsed, so the PPS would be more likely to interrupt the beam than would the operator. Therefore, the short term releases would be:

4-MW configuration: 18.1 kg mercury (i.e., ~4.6 m^3 of mercury vapor) released to the mercury enclosure inside the target hot cell and thence to the environment through the target hot cell ventilation exhaust. The ~4.6 m^3 of mercury vapor that is released to the mercury enclosure in a short period of time is assumed to mix with the air and be swept out of the enclosure by the ventilation system flow. It is possible that the mixing would be poor and that much of the mercury vapor would settle to the floor and condense. The assumption that mixing is good and that condensation does not occur is conservative. Since the residence time for air flowing through the mercury enclosure is longer than 5 min, it would take the enclosure ventilation system about 10 min to sweep the bulk of this mercury vapor/air mixture from the enclosure.

1-MW configuration: no bulk boiling occurs because the operator initiates manual beam cutoff in response to multiple alarms. However, the failed mercury vessel window may result in drainage of mercury across the mercury enclosure floor. The source term for the first 10 min is conservatively estimated by assuming that the mercury enclosure exhaust air is saturated with mercury vapor during the entire period.

2.2 LONG TERM RELEASE

2.2.1 Assumptions

1. Air exhausted from the mercury enclosure is saturated with mercury vapor for 7 d after the accident when the spilled mercury is cooling from its initial temperature, which for part of the spilled mercury could be as high as the saturation temperature (357ºC), back toward the normal ambient range in the enclosure.

2. After 7 d, the concentration of mercury vapor in the mercury enclosure air would be limited by evaporation from ambient temperature mercury in the catch pan sump depression. This assumption is tantamount to assuming that the drain from the catch pan sump depression to the collection tank (located below the sump depression for gravity drainage) has been inadvertently plugged. If this drain were assumed to be open, the mercury would drain to the collection tank, from which there would be negligible mercury evaporation since it has only a small opening for the drain(s) flowing into it.
3. Mercury enclosure air exhaust flow continues at the nominal 11.3 m^3/min (400 cfm) for all times after the accident. This is conservative since releases would be much lower after the accident if there were no air exhausted from the mercury enclosure.
4. Mercury enclosure air inlet temperature is 30ºC (summer temperature).
5. The bounding mercury enclosure air exhaust temperature is determined as the maximum of the following: (1) the value consistent with the assumption that 100% of the decay heat energy is transferred to the air and not to structures that would serve as heat sinks (Note: immediately after beam cutoff the decay heat values are 10 kW @ 4 MW and 2.5 kW @ 1 MW. Corresponding air exhaust temperatures are 76ºC for 4-MW proton beam configuration and 42ºC for the 1-MW proton beam configuration) or (2) the value consistent with the normal heat load plus the additional heat load due to heat transfer from a 1 m^2 surface area of mercury at 350ºC. The larger of these two choices will bound the air exit temperature for the first 7 d. By this procedure the bounding air exhaust temperature is 76ºC for the 4-MW case and 73ºC for the 1-MW case; thus, the 76ºC value will be used for both. This procedure is conservative because it does not allow the heat input to the air to decrease after the beam cutoff.

<u>Release for either the 4-MW or 1-MW configuration</u>

Release over first 7 d =(7 d * (11.3 m^3/min) * (0.61 g/m^3) * (1440 min/d)
= (7 d) * 9.9 kg mercury/d = 69.5 kg mercury

<u>Release between 7 d and 30 d for either 4-MW or 1-MW configurations</u>

After the first 24-h, the temperature of spilled mercury has cooled to <100ºC, so that mercury transport is limited by the evaporation of mercury from the catch pan sump depression (1 m^2 surface area if the catch pan drain is plugged, and the spilled mercury does not drain). As discussed in Exhibit D, this evaporation rate is estimated to be 130 g mercury/d/m^2 for evaporation from a 1 m^2 surface area at a temperature of 110ºC. Assuming no further cooling of the mercury during this period is a bounding conservatism. A factor of 10 is applied to the estimate to ensure conservatism against possible correlation or geometry uncertainties.

Release (7 d to 30 d) = 1.3 kg mercury/d

2.3 EFFECT OF WATER-COOLED SHROUD FAILURE ON SHORT AND LONG TERM RELEASES (i.e., CORE VESSEL RELEASE PATHS)

The analysis above considers mercury release paths from the mercury system to the mercury enclosure inside the target hot cell, and from there to the environment via the hot cell ventilation system. No releases from the core vessel are listed because the water-cooled shroud continues to provide separation between the mercury system/target hot cell and the core vessel. Failure of the water-cooled shroud was not postulated as part of the definition of this event, but it could fail if, for example, the mercury vessel window actually melts and molten stainless steel contacts the water-cooled shroud and softens it enough to cause its failure.

If only the inside wall of the water-cooled shroud failed, that would allow shroud cooling water to contact the mercury inside the target vessel. The water would boil, and this would displace mercury from the mercury vessel back into the mercury cooling system in the mercury enclosure. The voiding would allow the proton beam (still on because of the assumed failure of multiple TPS and BP beam cutoffs) to strike shielding steel in the outer part of the target plug. This would elevate the neutron flux levels in the target hot cell sooner and therefore bring about the PPS cutoff of the proton beam sooner. Shut-off of the beam before bulk boiling of the mercury in the target plug would result in a lower source term, or at least one without the prompt mercury vapor release resulting from a brief period of vigorous boiling.

If both walls of the double-walled, water-cooled shroud failed, this would provide an additional path for drainage of mercury from the mercury vessel, the likely effect of which would be the same as discussed in the previous paragraph for the single-wall failure; the PPS sees elevated neutron levels and cuts off the proton beam sooner than it would have otherwise and before bulk boiling of mercury occurs in the target plug.

Failure of the water-cooled shroud therefore seems to have the major beneficial effect of interrupting proton beam pulsing before bulk boiling of the mercury and thus may have a lower short term mercury release. However, the double-wall failure has another effect that must be considered—opening up an additional pathway for release of mercury and/or spallation products through the core vessel pressure relief line. As discussed in Sect. 3.1, the core vessel has a pressure relief line that actuates at 2 atm of internal pressure. Cooling water spilled from the failed shroud and mercury spilled from the target plug could mix in the bottom of the core vessel. If the water is heated too greater than 100°C, this, combined with the existing ~1 atm internal pressure of He, could create enough internal pressure to actuate the core vessel relief path (it is TBD whether this will be a rupture disc and/or relief valve). The potential for additional source term will be bounded by considering how much water a 0.1 m^3 volume of mercury at 350°C can boil (this is the volume and temperature of mercury reached just before bulk boiling occurs in the target plug, as developed in Sect. F.1 of this appendix). The answer is that there is enough thermal energy in 0.1 m^3 of mercury at 350°C mercury to boil about 17 kg of water and that the mercury is cooled to 120°C in the process. At the shroud-cooling water flow rate of 2.4 kg/s (CDR Table 5.3-5), and assuming that 100% of the shroud-cooling flow is lost through the postulated failure point, it would take about 7 s for this much water to flow into the core vessel. The corresponding volume would raise the core vessel's ~10 m^3 of internal free volume to a pressure too greater than 2 atm, so the relief path would actuate. Evaluating the volume of steam effluent at the 1 atm post-venting pressure leads to an estimated vented volume of about 31 m^3. The amount of mercury vapor that would be in this amount of steam is bounded by assuming that the water vapor is saturated with mercury at a temperature of 120°C (saturation pressure of water at the actuation pressure of the core vessel relief path). Very little else but mercury vapor would be transported by this path because the relatively open region at the top of the core vessel provides a volume for low-velocity separation of any gross entrained droplets of mercury and because (see also Sect. 3.1 of this appendix) the vent path is equipped with appropriate filtration and/or demisting features. Since the mercury saturation density at 120°C is 7.9 g mercury/m^3, the total mass of mercury vapor vented with the steam is 31 m^3 * 7.9 g/m^3= 245 g mercury. This is less than the prompt release estimated above for the case where bulk boiling of the mercury is assumed to occur. Therefore, it is concluded that failure of the water-cooled shroud would not increase the short term release estimated in Sect. 2.1 of this appendix.

The effect on long-term release can be estimated by assuming that the normal core vessel purge rate (10 m^3/100 h) continues after the accident, venting 120°C helium saturated with mercury vapor (saturation density of 7.9 g/m^3). This would release 19 g mercury per day, which is small in comparison to the long-term hot cell release estimated above.

Rather than debate whether these short- and long-term core vessel releases would occur instead of—or in addition to—the hot cell releases, they are assumed to occur in addition to the hot cell releases. The total estimated release source term for this event, therefore, has been increased to include the core vessel vent path.

3.0 RELEASE AND TRANSPORT OF OTHER THAN MERCURY RADIONUCLIDES

Besides the radioactive and nonradioactive mercury radionuclides, a range of spallation and activation products are present in the mercury. The great majority of these are nonvolatile because of their low or zero vapor pressures in the temperature range of interest (i.e., up to the boiling point of mercury). The exception to this would be any gaseous spallation products present in the mercury or any volatile nuclides such as iodine, for example. A significant inventory of gaseous nuclides is not present in the mercury before the accident because there is a continuous helium purge that removes these as they are generated. The gaseous nuclides removed include hydrogen (e.g., tritium), noble gases, and possibly some iodine(see Sect. 3.2, below). Accidents of the HOG treatment system can release the gaseous nuclides, and they are discussed in Chap. 4 of this document.

3.1 NONVOLATILE SOLIDS

Most of the spallation products are soluble in the mercury and will remain well below their solubility limits through the lifetime of the facility. The insoluble spallation products would either settle out into the bottom of the reservoir tank or would be removed by filtration. If the mercury boils in an accident, neither soluble nor insoluble spallation products would vaporize because of their very low vapor pressures (unlike iodine, discussed below). A few of the spallation product nuclides (i.e., Cs, In, Cd, Sn, I, Tl, and Pb) have melting points below the boiling point of mercury. With the exception of I (addressed as a special case in the subsection below), the amount released would be very small, however, because the boiling points for these same elements are typically over 1000°C, giving them very low vapor pressures at the mercury boiling point. The amount of nonvolatile solids released from a brief period of boiling mercury is concluded to be negligible. See also spallation product transport discussions in Sect. 3.1 and Exhibit C of this document.

Although inherent transport mechanisms are not effective for nonvolatile solids at mercury's boiling temperature, entrainment of mercury droplets in flowing gases should be considered. For the 4-MW case, a short period of vigorous bulk boiling occurs in the target plug, so it is possible that the vapor released to the mercury enclosure could entrain some small droplets of unvaporized mercury that would (being unvaporized) contain spallation products. However, there could not be an efficient droplet formation and transport process because of the high surface tension and density of mercury. The mercury enclosure is not ventilated at a high rate (residence time of air is greater than 5 min in the mercury enclosure). Furthermore, a pre-filter or demister section incorporated into the mercury enclosure ventilation should eliminate any mercury mist droplets that are created. Any droplets that do not settle out or that get past the pre-filter section would then be drawn into the ventilation ductwork and could be transported to the HEPA filters. There, the mercury droplets would be caught by the HEPA filter medium. Due to the inherent barriers against mist droplet formation (mercury density, surface tension), opportunity for droplets to settle out in the mercury enclosure (very low velocity except in exit pipe), and installed liquid and solids removal stages in the ventilation exhaust system (mist eliminator, HEPA filters), it is concluded that negligible transport of solid nonvolatile spallation/activation products would occur.

For the 1-MW configuration, there was no period of bulk boiling, so there would be no opportunity to create small airborne droplets of mercury as discussed above for the 4-MW configuration.

3.2 IODINE

The iodine produced in the mercury by the proton beam will combine chemically with the mercury to form Hg_2I_2. This is a stable compound at the normal hot leg temperature of 110°C, so the iodine will not be released immediately from any mercury that is spilled, providing it is not heated above normal temperatures first. However, after a spill, exposure to oxygen in air could displace the iodine, thereby freeing it to be released.

If the mercury boils in an accident (which it does in the accident analyzed above), the temperature will reach about 360°C and the Hg_2I_2 should be assumed to decompose, releasing iodine rapidly (mainly in the form of gaseous HgI_2). To ensure a conservative source term for this event, the iodine present in the ~0.1 m^3 of mercury that is postulated to reach the boiling point is assumed to release its iodine immediately. This 0.1 m^3 of mercury is ≤14% of the total mercury, so the fractional release of iodine during the early part of the accident would be bounded as 14% of the total iodine inventory. This number will be applied to both the 1-MW or the 4-MW case because, although the 1-MW case did not experience boiling, its temperature does come close to the boiling point.

Following the short-term release of I, it must be assumed that I will continue to be released because of oxidation of Hg-2I2 in spilled mercury. This would be a slow process, but is assumed to be complete after 30 d. For this particular event (loss of flow with consequent mercury vessel window failure), only 33% of the mercury leaks from the mercury cooling system, so it would be adequate for this particular accident sequence to postulate that a total of only 33% of the I is eventually released to the air. However, in order to make this source term applicable to similar events that might be initiated by mercury boundary failure (instead of having the mercury boundary fail as a result of the failure of two beam cut-off systems), and which could (for a leak at the bottom of the system) spill all the mercury, the iodine source term is increased to be consistent with total spillage of mercury and oxidation of all the Hg_2I_2 to release the entire iodine inventory over a period of 30 d.

4.0 SOURCE TERM SUMMARY: RELEASES TO ENVIRONMENT, WORST CASE BEYOND-DESIGN-BASIS ACCIDENT

The fractional releases are given in the following tables for a 1-MW and 4-MW target configuration. Since the releases are calculated in the previous subsections, above, in terms of mass of mercury released, it is necessary to divide by the total mercury inventory to calculate the release fraction(s). The conceptual design has a nominal 1 m^3 volume (13.6E6 kg of mercury), but continuing design activity has led to smaller volumes; a value of 10,000 kg of mercury should adequately bound the intended decrease in mercury volume.

Table F.2. Beyond-design-basis accident source term summary

Radionuclide category	Fractional release of total inventory		
	Short term (~10 min)	First 7 d	7 d through 30 d
	1-MW target configuration–fractional releases		
Hg	6.6E–5	0.8E–2	3.0E–3
Iodine	1.40E–1	2.0E–1	6.6E–1
Nonvolatile solids	Negligible	Negligible	Negligible
	4-MW target configuration–fractional releases		
Hg	1.83E–3	0.8E–2	3.0E–3
Iodine	1.4E–1	2.0E–1	6.6E–1
Nonvolatile solids	Negligible	Negligible	Negligible

APPENDIX D

LETTERS OF CONSULTATION ON PROTECTED SPECIES AND CULTURAL RESOURCES

D. LETTERS OF CONSULTATION ON PROTECTED SPECIES AND CULTURAL RESOURCES

This appendix presents the letters of consultation concerning protected species and cultural resources for the four proposed SNS sites that were sent out by the Department of Energy (DOE), and the responses received from the agencies concerned. Agencies/individuals contacted include the affected States' Fish and Wildlife Services, Department of Environmental Conservation, and the U.S. Army Corps of Engineers (when applicable) concerning threatened and endangered species. Also contacted were the States' Historic Preservation Officers concerning cultural resources. The letters of consultation are presented in the following order:

Site	Letter Addressed To	Subject	Reply Addressed To
ORNL	James Widlak U.S. Fish and Wildlife Service	Threatened & Endangered (T&E) Species	James L. Elmore U.S. Department of Energy
	Joseph Garrison TN Historical Commission	Cultural Resources	Ray T. Moore Department of Energy
	Reginald G. Reeves Department of Environment and Conservation	T&E Species	No Reply
	Lt. Col. Christopher Young U.S. Army Corps of Engineers	T&E Species	James L. Elmore U.S. Department of Energy
LANL	Jennifer Fowler-Propst U.S. Fish and Wildlife Service	T&E Species	G. Thomas Todd U.S. Department of Energy
	Lynne Sebastian Historic Preservation Division	Cultural Resources	No Reply
ANL	Benjamin Tuggle U.S. Fish and Wildlife Service	T&E Species	Michael Flannigan U.S. Department of Energy
	Anne E. Haaker Illinois Historic Preservation Agency	Cultural Resources	No Reply
BNL	Nancy Davis Ricci NYS Dept. of Environmental Conservation	T&E Species	K. Dean Helms U.S. Department of Energy
	Sherry Morgan U.S. Fish and Wildlife Service	T&E Species	K. Dean Helms U.S. Department of Energy
	Julian Adams NYS Office of Parks, Rec. & Historic Preservation	Cultural Resources	No Reply

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ORNL CONSULTATION LETTERS

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Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

September 18, 1997

Mr. James C. Widlak
Fish and Wildlife Service
United States Department of Interior
446 Neal Street
Cookeville, Tennessee 38501

Dear Mr. Widlak:

INFORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE NATIONAL SPALLATION NEUTRON SOURCE

The U.S. Department of Energy (DOE) proposes to site, construct, and operate the National Spallation Neutron Source (NSNS) and is currently preparing an environmental impact statement (EIS), pursuant to the National Environmental Policy Act (NEPA) on this Federal action. The proposed NSNS facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities to allow ongoing and expanded programs of neutron research. The proposed site for the NSNS is the DOE-owned Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The alternative sites under consideration include three other DOE-owned laboratories: Argonne National Laboratory, Argonne, Illinois; Brookhaven National Laboratory, Brookhaven, New York; and Los Alamos National Laboratory, Los Alamos, New Mexico.

The proposed NSNS would produce short pulses of neutrons for use in materials research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. Once the spallation process is completed and the neutron pulse is produced, the neutrons would be slowed to useful energy levels and guided onto samples of the materials being studied where the interactions of the neutrons and the specimens would be measured and analyzed, thus revealing information on the structure, properties, and behavior of the test material.

The proposed location of the NSNS at ORNL is on Chestnut Ridge, just west of Chestnut Ridge Road originating from the 7000 area of ORNL (see enclosed figure). The general terrain along

Mr. James C. Widlak -2- September 18, 1997

this ridge provides sufficient area for and burial of the linear accelerator portion of the NSNS. This site is close to utilities (electrical, water, and gas), is easily accessible via the existing road, lies close to a storage area for backfill material and spoils (the West Borrow Area), and is close to ORNL. The land cover is primarily oak-hickory forest.

Surveys for listed species, primarily associated with tributaries to Bear Creek, have been undertaken in the recent past and have identified several State of Tennessee listed species in Natural Area 52 and Habitat area 3, including *Collinsonia verticillata* (Whorled horse-balm) *Hydrastis canadensis* (Golden seal), *Panax quinquifolius* (Ginseng), and *Platanthera flava* var. *herbiola* (Tubercled rein-orchid). ORNL ecologists are surveying the proposed NSNS site for listed species to update previously collected data.

This letter is intended to serve as informal consultation under Section 7 of the Endangered Species Act. In this regard, DOE requests an updated list of protected species and habitat on and in the vicinity of the proposed NSNS site and solicits your recommendation and comments about the potential effects of this proposed action. Your input will be used in the preparation of the environmental impact statement . A reply by the end of October would be appreciated.

If you need further information on this request, please do not hesitate to call me at (423) 576-0938.

Sincerely,

James L. Elmore

James L. Elmore, Ph.D.
Alternate NEPA Compliance Officer

Enclosure

cc w/o enclosure:
D. Wilfert, ER-111, FEDC
D. Bean, EASI

United States Department of the Interior

FISH AND WILDLIFE SERVICE
446 Neal Street
Cookeville, Tennessee 38501

September 26, 1997

Dr. James L. Elmore
U.S. Department of Energy
P.O. Box 2001
Oak Ridge, Tennessee 37831

Re: National Spallation Neutron Source

Dear Dr. Elmore:

Thank you for your letter and enclosures of September 18, 1997, regarding the proposed project in Roane County, Tennessee. The Fish and Wildlife Service (Service) has reviewed the information submitted and offers the following comments.

According to our records, the following federally listed or proposed endangered or threatened species may occur in the project impact area:

Gray bat - Myotis grisescens (E)
Slender chub - Hybopsis cahni (T)
Yellowfin madtom - Noturus flavipinnis (T)
Red-cockaded woodpecker - Picoides borealis (E)
Spotfin chub - Hybopsis monacha (T)
American hart's tongue fern - Phyllitis scolopendrium var. americana (T)
Virginia spiraea - Spiraea virginiana (T)

The species records provided are based on the proposed location of your project. Freshwater mussel records have not been provided because your proposed project is not in the immediate vicinity of the Clinch River.

You should assess potential impacts and determine if the proposed project may affect the species. A finding of "may affect" could require initiation of formal consultation. We recommend that you submit a copy of your assessment and finding to this office for review and concurrence.

Information available to the Service does not indicate that wetlands exist in the vicinity of the proposed project. However, our wetland determination has been made in the absence of a field inspection and does not constitute a wetland delineation for the purposes of Section 404 of the Clean Water Act or the wetland conservation provisions of the Food Security Act. The Corps of Engineers or the Natural Resources Conservation Service should be contacted if other evidence, particularly that obtained during an on-site inspection, indicates the potential presence of wetlands. Our current assumption is that the proposed project will not be in the immediate vicinity of Bear Creek.

Thank you for the opportunity to comment on this action. If you have any questions, please contact Allen Robison of my staff at 615/528-6481.

Sincerely,

Lee A. Barclay

Lee A. Barclay, Ph.D.
Field Supervisor

Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

December 9, 1997

Mr. Joseph Garrison
Tennessee Historical Commission
Department of Environment and Conservation
701 Broadway
Nashville, Tennessee 37243-0442

Dear Mr. Garrison:

NATIONAL HISTORIC PRESERVATION ACT, SECTION 106 COMPLIANCE; SPALLATION NEUTRON SOURCE (SNS), ROANE AND ANDERSON COUNTIES TENNESSEE

Enclosed are a project summary, maps, and an archeological reconnaissance survey for the proposed project. The proposed project would be located along the southern slope of Chestnut Ridge within the Oak Ridge National Laboratories (ORNL), approximately midway between the Y-12 Plant and the main ORNL facilities in Roane and Anderson Counties, Tennessee. Based on the enclosed archeological reconnaissance survey prepared by DuVall and Associates, Department of Energy Oak Ridge Operations (DOE ORO) has determined that the proposed project would have no effect on historical, archeological, or cultural resources included or eligible for inclusion in the National Register of Historic Places. This determination is included with the Project Summary. With your concurrence in this determination, DOE ORO's responsibilities for compliance with Section 106 of the National Historic Preservation Act will be completed for this project. If you have questions or need additional information related to this proposed project please call me at (423) 576-9574.

Sincerely,

Ray T. Moore
DOE ORO Cultural Resources
Management Coordinator

Enclosure

cc w/enclosure:
EC Document Center K-25

cc w/o enclosure:
See Page 2

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TENNESSEE HISTORICAL COMMISSION
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
2941 LEBANON ROAD
NASHVILLE, TN 37243-0442
(615) 532-1550

December 29, 1997

Mr. Ray T. Moore
Department of Energy
Post Office Box 2001
Oak Ridge, Tennessee 37831

RE: DOE, ARCHAEOLOGICAL ASSESSMENT, SPALLATION NEUTRON SOURCE, OAK RIDGE, ROANE AND ANDERSON COUNTIES,

Dear Mr. Moore:

At your request, our office has reviewed the above-referenced archaeological survey report in accordance with regulations codified at 36 CFR 800 (51 FR 31115, September 2, 1986). Based on the information provided, we find that the project area contains no archaeological resources eligible for listing in the National Register of Historic Places.

Therefore, this office has no objection to the implementation of this project. If project plans are changed or archaeological remains are discovered during construction, please contact this office to determine what further action, if any, will be necessary to comply with Section 106 of the National Historic Preservation Act.

Your cooperation is appreciated.

Sincerely,

Herbert L. Harper

Herbert L. Harper
Executive Director and
Deputy State Historic
Preservation Officer

HLH/jmb

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Department of Energy

Oak Ridge Operations Office
P.O. Box 2001
Oak Ridge, Tennessee 37831—

December 29, 1997

Mr. Reginald G. Reeves, Director
Division of Natural Heritage
State of Tennessee
Department of Environment and Conservation
401 Church Street
Nashville, Tennessee 37243-0443

Dear Mr. Reeves:

CONSULTATION CONCERNING STATE-LISTED SPECIES FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE

The U.S. Department of Energy (DOE) proposes to site, construct, and operate the Spallation Neutron Source (SNS) and is currently preparing an environmental impact statement (EIS), pursuant to the National Environmental Policy Act (NEPA), on this federal action. The proposed SNS facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities to allow ongoing and expanded programs of neutron research. The proposed site for the SNS is the DOE-owned Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. The alternative sites under consideration include three other DOE-owned laboratories: Argonne National Laboratory, Argonne, Illinois; Brookhaven National Laboratory, Brookhaven, New York; and Los Alamos National Laboratory, Los Alamos, New Mexico.

The proposed SNS would produce short pulses of neutrons for use in materials research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. Once the spallation process is completed and the neutron pulse is produced, the neutrons would be slowed to useful energy levels and guided onto samples of the materials being studied where the interactions of the neutrons and the specimens would be measured and analyzed, thus revealing information on the structure, properties, and behavior of the test material.

Mr. Reginald G. Reeves
Page 2

The proposed location of the SNS at ORNL is on Chestnut Ridge, just west of Chestnut Ridge Road originating from the 7000 area of ORNL (see attached figure). The general terrain along this ridge provides sufficient area for and burial of the linear accelerator portion of the SNS. This site is close to utilities (electrical, water, and gas), is easily accessible via the existing road, lies close to a storage area for backfill material and spoils (the West Borrow Area), and is close to ORNL. The land cover is primarily oak-hickory forest.

Surveys for listed species, primarily associated with tributaries to Bear Creek, have been undertaken in the recent past and have identified several State of Tennessee listed species in Natural Area 52 and Habitat area 3, including *Collinsonia verticillata* (Whorled horse-balm) *Hydrastis canadensis* (Golden seal), *Panax quinquifolius* (Ginseng), and *Platanthera flava* var. *herbiola* (Tubercled rein-orchid). ORNL ecologists are surveying the proposed SNS site for listed species to update previously collected data.

This letter is intended to serve as a request for an updated list of state-protected species that may occur on and in the vicinity of the proposed SNS site and to solicit your recommendations and comments about the potential effects of this proposed action. Your input will be used in the preparation of the environmental impact statement . A reply by the end of January would be appreciated.

If you need further information on this request, please do not hesitate to call me at (423) 576-0938.

Sincerely,

James L. Elmore, Ph.D.
Alternate NEPA Compliance Officer

Enclosure

cc w/o enclosure:
D. Wilfert, ER-111, FEDC, Room 146
D. Bean, EASI, 663 Emory Valley Road, Oak Ridge, TN 37830
D. Arakawa, ER-112, ORNL Site Office, Bldg. 4500N, Room 0224

Department of Energy

Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831—

August 12, 1998

Lieutenant Colonel Christopher Young
Nashville District Engineer
U.S. Army Corps of Engineers
P.O. Box 1070
Nashville, Tennessee 37202

Dear Colonel Young:

CONSULTATION UNDER SECTION 404 OF THE CLEAN WATER ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE

The U.S. Department of Energy (DOE) proposes to site, construct, and operate the Spallation Neutron Source (SNS) facility, and is currently preparing an environmental impact statement (EIS), pursuant to the National Environmental Policy Act (NEPA) on this federal action. The proposed SNS facility would consist of a proton accelerator system, a spallation target, appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The EIS will include discussion of potential impacts at four alternative locations for the SNS, all DOE-owned laboratories: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee; Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory (LANL), Los Alamos, New Mexico; and Brookhaven National Laboratory (BNL), Upton, New York.

The proposed SNS would produce short pulses of neutrons for use in materials and biomedical research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. The neutrons would then be slowed to useful energy levels, and guided to samples of the materials being studied. The interactions of the neutrons and the specimens would be measured and analyzed, revealing information on the structure, properties, and behavior of the test material.

Construction of the SNS at ORNL would involve the taking of two small palustrine emergent wetlands on the Chestnut Ridge construction site (see Figures 4.1.2.1-1 and 4.1.5.2-1 from the preliminary draft EIS). These two wetlands have a combined area of 0.12 acres (0.05 ha). One of these small wetlands is an emergent wetland in an isolated depression (WOM14 on Figure 4.1.5.2-1). It is adjacent to another small wetland swale that lies immediately adjacent to

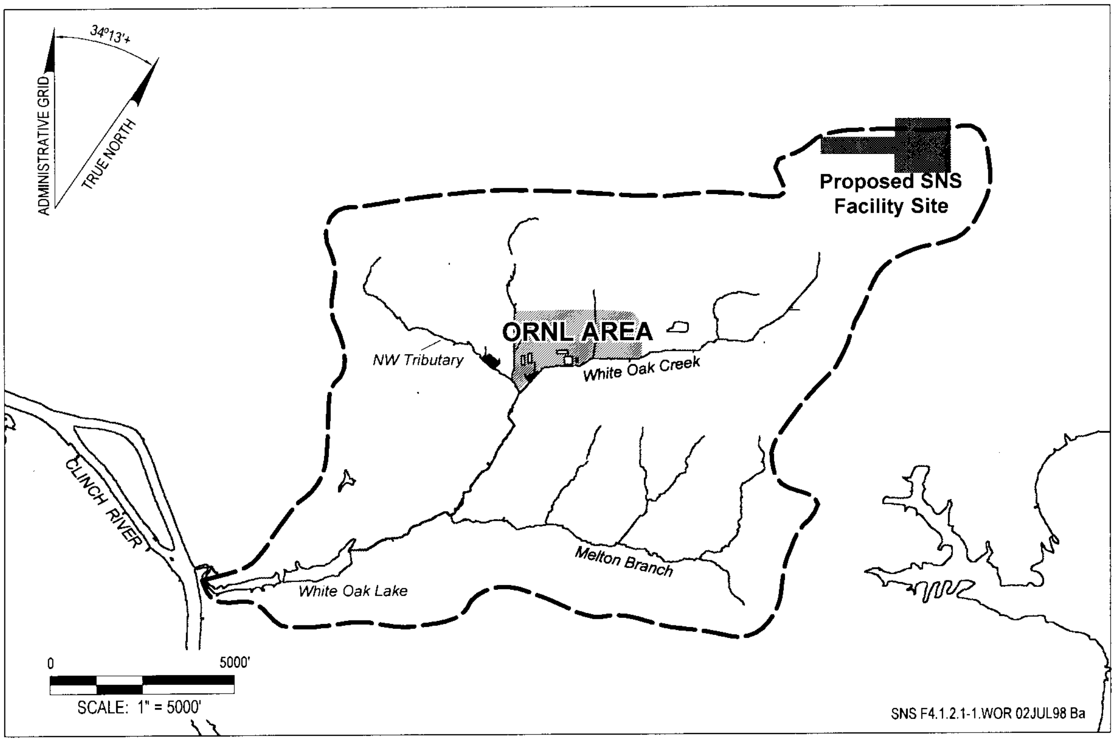

Figure 4.1.2.1-2. White Oak Creek drainage.

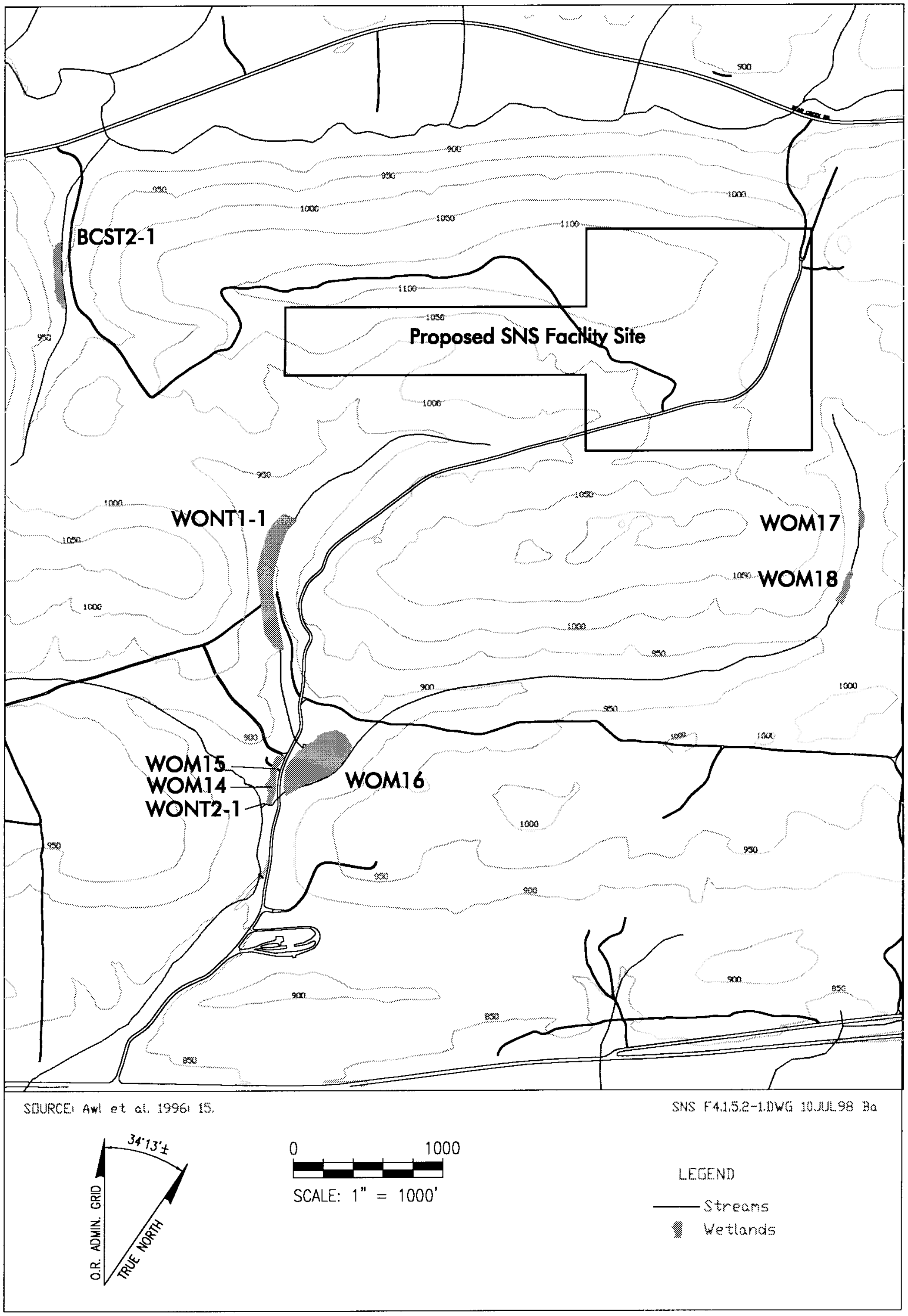

Figure 4.1.5.2-1. Wetland areas within and adjacent to the proposed SNS site.

Lieutenant Colonel Christopher Young 2

Chestnut Ridge Road near where it crosses White Oak Creek (WOM15). The depression does not appear to have a surface outlet to the swale or to nearby White Oak Creek. Upgrades needed to Chestnut Ridge Road and the laying of a gas pipeline would encroach on these areas and require the taking of the 0.12 acres of wetlands. A third wetland (WOM16) with an area of 1.6 acres (0.65 ha) could receive increased runoff and siltation during construction activities.

The purpose of this letter is to initiate consultation concerning permitting requirements under Section 404 of the Clean Water Act. It appears that these activities could be performed under nationwide permit number 26. Please advise as to whether this activity would be covered by a nationwide permit or if an individual permit would be needed. Also, include in your reply what types and extent of mitigation, if any, might be required. Any other comments on the Section 404 aspects of the project would be appreciated. I would be most grateful if you could reply by the end of August.

If you need further information on this request, please do not hesitate to call me at (423)576-0938.

Sincerely,

James L. Elmore, PhD
Alternate NEPA Compliance Officer

Enclosure

cc w/enclosure:
Dave Wilfert, ER-111
Dave Bean, EASI
Tim Joseph, SE-32
Clarence Hickey, ER-83

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1070
NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO

August 25, 1998

Regulatory Branch

Subject: Proposed Siting, Construction, and Operation of the Spallation Neutron Source Facility

James L. Elmore, PhD
Department of Energy
Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831

Dear Dr. Elmore:

We have received your letter requesting information concerning permit requirements for wetland impacts that may occur as a result of the subject work. Your letter states that upgrades to Chestnut Ridge Road and the placement of a gas pipeline would encroach upon approximately 0.12 acres of wetlands.

As we discussed on the phone today, the work would likely be covered under a nationwide permit (NWP). NWP 26 is scheduled to expire at the end of this year; however, there are NWP's that cover minor road crossings and utility line discharges.

Until detailed plans of the activities requiring a DA permit are received, we are not able to determine which NWP would apply or if an individual permit would be necessary. Also, mitigation requirements, if any, would have to be determined at that time.

If you have any question regarding this matter, please contact me at the above address, telephone(615)736-5183.

Sincerely,

Bradley N. Bishop
Project Manager
Construction-Operations Division

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LANL CONSULTATION LETTERS

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E Withers

Department of Energy
Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

DEC 08 1997

Ms. Jennifer Fowler-Propst
State Supervisor
U. S. Fish and Wildlife Service
Ecological Services
2105 Osuna Road, NE
Albuquerque, NM 87113

Dear Ms. Fowler-Propst:

The Department of Energy (DOE) is preparing an Environmental Impact Statement (EIS) for the siting, construction, and operation of the Spallation Neutron Source (SNS) Facility. This proposed facility would consist of a proton accelerator system, a spallation target, and appropriate experimental areas, laboratories, offices, and support facilities for neutron research, including parking areas. The EIS will include discussion of potential impacts at four alternative locations for the SNS: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee; Argonne National Laboratory, Argonne, Illinois; Brookhaven National Laboratory, Upton, New York; and Los Alamos National Laboratory (LANL), Los Alamos, New Mexico. At LANL, the site location identified as most suitable for this type of facility lies within Technical Area 70 along a mesa top about equidistant from Ancho Canyon to the southwest and an unnamed canyon to the northeast. The rims of both canyons would lie about one-quarter mile away from the facility site, with the Rio Grande being located to the east about 1.2 miles, and State Road 4 being located about one-quarter mile to the west. The vegetation in the proposed SNS site area is dominated by piñon-juniper woodlands with scattered juniper savannas.

Existing site information is being used for the analysis of alternatives presented in the Draft SNS EIS. If LANL is chosen as the preferred location for this facility, an in-depth analysis of the site would be performed, which would include the preparation of a Biological Assessment and consultation with the U. S. Fish and Wildlife Service (Service). In the initial stages of analysis, the species being considered for this Los Alamos County site and their current legal status are as follows:

- *Falco peregrinus anatum* (American peregrine falcon) - endangered
- *Strix occidentalis lucida* (Mexican spotted owl) - threatened
- *Empidonax traillii extimus* (Southwestern willow flycatcher) - endangered
- *Haliaeetus leucocephalus* (Bald eagle) - threatened
- *Falco peregrinus tundrius* (Arctic peregrine falcon) - threatened
- *Grus americana* (Whooping crane) - endangered
- *Mustela nigripes* (Black-footed ferret) - endangered

Jennifer Fowler-Propst 2 DEC 08 1997

The site includes foraging habitat for the American peregrine falcon and foraging and roosting habitat for the bald eagle. The nearest identified peregrine falcon nesting habitat is within White Rock Canyon about 1.2 miles from the site. Wintering bald eagles forage and roost within White Rock Canyon and its connecting canyons, including Ancho Canyon.

We request that the Service review this list for completeness of species considered and the accuracy of legal status in light of any changes in listing under the Endangered Species Act that may have taken place during the last year. Please either then concur with this list or supply us with an updated list.

We would like to thank the Service for its continued support and assistance in our LANL National Environmental Policy Act and Endangered Species Act compliance efforts. For your information and planning purposes, the current estimate for having a Draft LANL Sitewide EIS available for stakeholder review is the February 1998 time frame. It is expected that the Sitewide Biological Assessment will be delivered to your office before that time for your review and concurrence with our determination.

Sincerely,

G. Thomas Todd
Area Manager

LAAME:3EW-100

cc:
J. Elmore, ORNL
E. Withers, LAAME, LAAO
R. Enz, Scientech, LAAO
J. Huchton, ESH-20, LANL, MS-M887

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 761-4525 Fax: (505) 761-4542

January 7, 1998

Cons. #2-22-98-I-096

G. Thomas Todd, Area Manager
U.S. Department of Energy
Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, NM 87544

Dear Mr. Todd:

This responds to your letter dated December 8, 1997, requesting a list of species federally listed or proposed to be listed as endangered or threatened. The Department of Energy (DOE) is preparing an Environmental Impact Statement for the siting, construction, and operation of the Spallation Neutron Source (SNS) Facility. The proposed facility would consist of a proton accelerator system, a spallation target, and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The proposed site location identified as most suitable for this type of facility lies within Technical Area 70 along a mesa top about equidistant from Ancho Canyon to the southwest and an unnamed canyon to the northeast. The rims of both canyons lie about one-quarter mile away from the facility site. The vegetation in the proposed SNS site area is dominated by pinon-juniper woodlands with scattered juniper savannas.

Due to staffing constraints, we are unable to develop site specific species lists for your action. However, we have enclosed a list of Federally endangered, threatened, and candidate species, and species of concern potentially occurring in Los Alamos County, New Mexico. Note that the Arctic peregrine falcon (Falco peregrinus tundrius) is listed as endangered, not threatened as indicated in your letter. Under the Endangered Species Act (Act), it is the responsibility of the Federal action agency or its designated representative to determine whether the proposed action "may affect" any listed or proposed species.

Candidates are those species for which the U.S. Fish and Wildlife Service (Service) has sufficient information on their biological status and threats to propose them as endangered or threatened, but for which issuance of a proposed rule is precluded by work on higher priority species. Species of concern include those for which further biological research and field study are needed to resolve their conservation status. Candidate species and species of concern have no legal protection under the Act and are included in this document for planning purposes only. However, the Service is

G. Thomas Todd, Area Manager 2

concerned and would appreciate receiving any status information that is available or gathered on these species.

Wetlands, riparian vegetation, and the above listed species' sensitive habitat(s) should also be protected. If adverse impacts cannot be avoided, we would appreciate discussing your project in more detail.

We suggest you contact the New Mexico Department of Game and Fish and the New Mexico Energy, Minerals and Natural Resources Department for information concerning fish, wildlife, and plants of State concern.

For further communication on this project, please refer to consultation #2-22-98-I-096. If we can be of further assistance, please contact Yvette Truitt of my staff at (505) 761-4525 ext. 120.

Sincerely,

Jennifer Fowler-Propst
Field Supervisor

Enclosure

cc: (wo/enc)
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals and Natural Resources Department, Forestry and Resources Conservation Division, Santa Fe, New Mexico

Species List
Los Alamos County
January 7, 1998

Los Alamos

Big free-tailed bat, Nyctinomops macrotis (=Tadarida m., T. molossa), SC
Black-footed ferret, Mustela nigripes, E
Goat Peak pika, Ochotona princeps nigrescens, SC
Long-legged myotis, Myotis volans, SC
New Mexican meadow jumping mouse, Zapus hudsonius luteus, SC
Occult little brown bat, Myotis lucifugus occultus, SC
Spotted bat, Euderma maculatum, SC
American peregrine falcon, Falco peregrinus anatum, E
Arctic peregrine falcon, Falco peregrinus tundrius, E (S/A)
Bald eagle, Haliaeetus leucocephalus, T
Ferruginous hawk, Buteo regalis, SC
Mexican spotted owl, Strix occidentalis lucida, T
Loggerhead shrike, Lanius ludovicianus, SC
Northern goshawk, Accipiter gentilis, SC
Southwestern willow flycatcher, Empidonax traillii extimus, E
White-faced ibis, Plegadis chihi, SC
Whooping crane, Grus americana, XN
Flathead chub, Platygobio (=Hybopsis) gracilis, SC
Jemez Mountains salamander, Plethodon neomexicanus, SC

Index

E	=	Endangered
PE	=	Proposed Endangered
PE w/CH	=	Proposed Endangered with critical habitat
T	=	Threatened
PT	=	Proposed Threatened
PT w/CH	=	Proposed Threatened with critical habitat
PCH	=	Proposed critical habitat
C	=	Candidate Species
SC	=	Species of Concern
S/A	=	Similarity of Appearance
*	=	Introduced population
XN	=	Nonessential experimental

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Protected and sensitive species found on the LANL, as reported in the site-wide EIS for LANL.

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
		ANIMAL SPECIES		
American Peregrine Falcon (*Falco peregrinus anatum*)	Endangered	Threatened	• Uses the juniper savannah, pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Requires cliffs for nesting	• Forages on LANL. Nests and forages on adjacent lands
Whooping Crane (*Grus americana)*	Endangered	Endangered	• Requires rivers and marshes • Roosts on sand bars	• Migratory visitor along the Rio Grande and Cochiti Lake
Southwestern Willow Flycatcher (*Empidonax traillii extimus*)	Endangered	Endangered	• Requires riparian areas and vegetation • Requires dense riparian vegetation	• Potential presence on LANL and White Rock Canyon • Potential nesting area on LANL • Present in Jemez Mountains • Present in riparian zone near Española
Bald Eagle (*Haliaeetus leucocephalus)*	Threatened	Threatened	• Rivers and lakes	• Observed as a migratory and winter resident along the Rio Grande and on adjacent LANL lands
Mexican Spotted Owl (*Strix occidentalis lucida*)	Threatened	Sensitive (informal)	• Mixed conifer, ponderosa pine • Prefers tall, old-growth forest in canyons and moist areas for breeding • Forages in forests, woodlands, and rocky areas	• Breeding resident on LANL, LAC, BNM, and SFNF lands • Critical habitat designated on SFNF lands
Jemez Mountain Salamander (*Plethodon neomexicanus)*	Species of Concern	Threatened	• Uses the mixed-conifer forest vegetation zone • Requires north-facing, moist slopes	• Permanent resident on LANL, LAC, BNM, and SFNF lands

Protected and sensitive species found on the LANL, as reported in the site-wide EIS for LANL (continued).

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
Baird's Sparrow (*Ammodramus bairdii*)	Species of Concern	Threatened	• Uses the pinyon-juniper woodland, ponderosa pine forest and mixed-conifer forest vegetation zones	• Observed on SFNF lands
Spotted Bat (*Euderma maculatum*)	Species of Concern	Threatened	• Uses the pinyon-juniper woodland, ponderosa pine forest, and spruce-fir forest vegetation zones • Requires riparian areas • Roosts in cliffs near water	• Permanent resident on BNM and SFNF lands • Seasonal resident on LANL
New Mexico Jumping Mouse (*Zapus hudsonius luteus*)	Species of Concern	Threatened	• Uses the mixed-conifer and spruce-fir forest vegetation zones • Requires riparian areas • Requires water nearby	• Permanent resident on LAC and SFNF lands • Overwinters by hibernating
Flathead Chub (*Platygobio gracilis*)	Species of Concern	Unlisted	• Requires access to perennial rivers	• Permanent resident of the Rio Grande between Española and the Cochiti Reservoir
Ferruginous Hawk (*Buteo regalis*)	Species of Concern	Unlisted	• Uses the juniper savannah and pinyon-juniper woodlands vegetation zone	• Observed as a breeding resident on LAC, LANL, BNM, and SFNF lands
Northern Goshawk (*Accipiter gentilis*)	Species of Concern	Sensitive (informal)	• Uses the mixed-conifer, ponderosa pine, spruce-fir forest vegetation zones	• Observed as a breeding resident on LAC, LANL, BNM, and SFNF lands
White-Faced Ibis (*Plegadis chihi*)	Species of Concern	Unlisted	• Requires perennial rivers and marshes	• Summer resident and migratory visitor on the Rio Grande and SFNF lands

Protected and sensitive species found on the LANL, as reported in the site-wide EIS for LANL (continued).

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
Loggerhead Shrike (*Lanius ludovicianus*)	Species of Concern	Unlisted	• Uses the juniper savannah, pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones	• Observed on LAC, BNM, and SFNF lands
Big Free Tailed Bat (*Nyctinomops macrotis)*	Species of Concern	Sensitive (informal)	• Uses the juniper savannah, pinyon-juniper woodland, and ponderosa pine forest, and mixed conifer forest vegetation zones • Roosts on cliffs	• Migratory visitor on LAC, BNM, and SFNF lands
Fringed Myotis (*Myotis thysanodes)*	Species of Concern	Sensitive (informal)	• Uses the juniper savannah, pinyon juniper woodland, ponderosa pine forest vegetation zones • Roosts in caves and buildings	• Observed on LANL, BNM, and SFNF lands
Long-Eared Myotis (*Myotis evotis)*	Species of Concern	Sensitive (informal)	• Uses the ponderosa pine forest, mixed-0conifer, and spruce-fir forests vegetation zones • Roosts in dead ponderosa pine trees	• Summer resident on LANL, LAC, BNM, and SFNF lands
Long-Legged Myotis (*Myotis volans*)	Species of Concern	Sensitive (informal)	• Uses the pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts in dead conifer trees	• Summer resident on LANL, LAC, BNM, and SFNF lands
Small-Footed Myotis (*Myotis ciliolabrum*)	Species of Concern	Sensitive (informal)	• Uses the juniper savannah, pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts in cliffs and caves	• Observed on LANL, BNM, and SFNF lands • Overwinters by hibernating
Yuma Myotis (*Myotis yumanensis*)	Species of Concern	Sensitive (informal)	• Uses the juniper savannah and pinyon-juniper woodland forest vegetation zones • Roosts in cliffs and caves near water	• Summer resident on LANL, LAC, and SFNF lands

Protected and sensitive species found on the LANL, as reported in the site-wide EIS for LANL (continued).

SPECIES	FEDERAL STATUS/ SPECIES OF CONCERN	STATE STATUS	HABITAT NEEDS	COMMENTS
Occult Little Brown Bat (*Myotis lucifugas occultus*)	Species of Concern	Sensitive (informal)	• Uses the pinyon-juniper woodland and ponderosa pine forest vegetation zones • Requires riparian areas • Forages over water	• Observed on SFNF lands
Pale Townsend's Big-eared Bat (*Plecotus townsendii pallescens*)	Species of Concern	Sensitive (informal)	• Uses the pinyon-juniper woodland, ponderosa pine forest, and mixed-conifer forest vegetation zones • Roosts in caves	• Observed on LANL and BNM lands • Overwinters by hibernating
Goat Peak Pika (*Ochotona princeps nigrescens*)	Species of Concern	Sensitive (informal)	• Uses the mixed-conifer and spruce-fir forests vegetation zones • Requires boulder piles and rockslides	• Observed on LAC and BNM lands
Gray Vireo (*Vireo vicinior*)	Unlisted	Threatened	• Uses riparian area in the juniper savannah and pinyon-juniper forests vegetation zones	• Observed on LAC, BNM, and SFNF lands
PLANT SPECIES				
Wood Lily (*Lilium philadelphicum L.* var. *andium)* (Nutt. Ker)	Unlisted	Endangered	• Grows in the ponderosa pine forest, mixed-conifer, and spruce-fir forests vegetation zones • Requires moist soil	• Observed on LAC, BNM, and SFNF lands
Yellow Lady's Slipper Orchid (*Cyprepedium calceolus L.* var. *Pubescens* (Willd.) Correll)	Unlisted	Endangered	• Requires riparian areas • Grows in the mixed-conifer forest vegetation zones • Requires moist soil	• Observed on BNM lands
Helleborine Orchid (*Epipactis gigantea* Dougl.)	Unlisted	Rare and sensitive	• Requires riparian areas • Grows in the juniper savannah and pinyon-juniper woodland forests vegetation zones • Requires springs, seeps, or other wet areas	• Observed on LAC lands

Note: This listing was developed with information and guidance provided by biologists from LANL; the FWS; the USFS; the NPS; the National Biological Service; the NMDGF; the New Mexico Energy, Minerals, and Natural Resources Department; and the New Mexico natural Heritage Program, as well as consultations with independent consultants and reviews of the technical literature.

Department of Energy
Albuquerque Operations Office
Los Alamos Area Office
Los Alamos, New Mexico 87544

JUN 2 5 1998

Dr. Lynne Sebastian
State Historic Preservation Officer
Historic Preservation Division
228 East Palace Avenue, 3rd Floor
Santa Fe, NM 87503

Dear Dr. Sebastian:

The U.S. Department of Energy (DOE) is proposing to site, construct, and operate the Spallation Neutron Source (SNS) facility and is currently preparing a Draft Environmental Impact Statement (EIS) for this proposal pursuant to the National Environmental Policy Act (NEPA). This letter is to inform you of DOE's engagement in this decision-making process, which could potentially affect Los Alamos National Laboratory (LANL). The proposed SNS facility would consist of the construction and operation of a proton accelerator system, a spallation target, and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The Draft EIS will include discussion of potential impacts for siting the SNS facility at four alternative DOE laboratory locations: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee (the contemplated Preferred Alternative); Argonne National Laboratory (ANL), Argonne, Illinois; Brookhaven National Laboratory (BNL), Upton, New York; and LANL, Los Alamos, New Mexico.

The proposed location of the SNS at LANL is within Technical Area 70 (TA-70). The site is located on a mesa flanked by Ancho Canyon 0.27 mi (0.47 km) to the southwest and a small unnamed canyon an equal distance to the northeast. The Rio Grande is located about 1.2 mi (1.9 km) to the east of the site and State Road 4 is about 0.22 mi (0.35 km) to its west. Elevations range from 6,410 feet (1,954 m) to 6,490 feet (1,978 m). The total Area of Potential Effect is estimated to be about 110 acres and includes a 100-foot buffer around the construction site. To date, about 65 percent of the proposed SNS site area has been surveyed for historical, archeological, and cultural resources using linear pedestrian transects spaced 16-33 feet (5-10 m) apart. Five archeological sites have been identified that are deemed to be eligible for inclusion in the National Register of Historic Places under Criterion D. These sites are either single- or double-room field houses, or two- to eight-room pueblos from either the Coalition, Early Coalition, or Classic time periods.

Dr. Lynne Sebastian 2 JUN 2 5 1998

If DOE decides to select LANL as the preferred site for the SNS, rather than ORNL as is now currently contemplated, a comprehensive survey for cultural resources will be completed for the TA-70 LANL site. We will then engage in full and complete consultation with your office under Section 106 of the National Historic Preservation Act.

If you have any questions regarding this project, please call Dean Triebel at (505) 665-6353 or Elizabeth Withers at (505) 667-8690.

Sincerely,

C S Przybylek

C. S. Przybylek
Acting Area Manager

LAAME:3EW-109

cc:
Dave Wilfert
Oak Ridge National Laboratory
Bethel Valley Road
Oak Ridge, TN 37831
Dean Triebel, LAAME, LAAO
Tony Ladino, ESH-20, LANL, MS-M887

ANL CONSULTATION LETTERS

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Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

DEC 11 1997

Mr. Benjamin Tuggle
Field Supervisor
U.S. Fish and Wildlife Service
Chicago Illinois Field Office
1000 Hart Road-Suite 180
Barrington, Illinois 60010

Dear Mr. Tuggle:

SUBJECT: INFORMAL CONSULTATION UNDER SECTION 7 OF THE ENDANGERED SPECIES ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE

The U.S. Department of Energy (DOE) proposes to site, construct, and operate Spallation Neutron Source (SNS) and is currently preparing an Environmental Impact Statement (EIS), pursuant to the National Environmental Policy Act on this Federal action. The proposed SNS Facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The EIS will include discussion of potential impacts at four alternative locations for the SNS, all DOE-owned laboratories: Oak Ridge National Laboratory, Oak Ridge, Tennessee; Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory, Los Alamos, New Mexico; and Brookhaven National Laboratory, Upton, New York. This letter pertains to the potential site located at ANL.

The proposed SNS would produce short pulses of neutrons for use in materials and biomedical research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. The neutrons would be slowed to useful energy levels, and guided to samples of the materials being studied. The interactions of the neutrons and the specimens would be measured and analyzed, revealing information on the structure, properties, and behavior of the test material.

DEC 11 1997

Mr. Benjamin Tuggle - 2 -

The proposed location of the SNS at ANL is in the 800 Area in the northwest corner of the Laboratory (see enclosed figure). There are several areas of wetlands and floodplains that may be affected by construction of the SNS, however, impacts could probably be mitigated. According to our information, there would be no involvement of habitat for State or Federally-listed threatened or endangered species. I have enclosed a description of the ecological resources based on a recent biological survey of the site performed by ANL.

This letter serves as informal consultation under Section 7 of the Endangered Species Act. In this regard, DOE requests an updated list of protected species and habitat on and in the vicinity of the proposed SNS site and solicits your recommendation and comments about any potential effects this proposed action may have. Your input will be used in the preparation of the EIS. Reply at your earliest convenience would be appreciated.

If you need further information on this request, please do not hesitate to call W. S. White, of my staff, at (630) 252-2101.

Sincerely,

Michael J. Flannigan, Director
Safety and Technical Services

Enclosure:
As Stated

cc: D. Wilfert, OR, w/o encl.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Chicago Illinois Field Office
1000 Hart Road – Suite 180
Barrington, Illinois 60010
708/381-2253

IN REPLY REFER TO:
FWS/AES-CIFO

December 23, 1997

Michael Flannigan
U.S. Department of Energy
Chicago Operations Office
9600 South Cass Avenue
Argonne, IL 60439

Dear Mr. Flannigan:

This is in response to your letter dated December 11, 1997 requesting information on endangered or threatened species and Informal Consultation in accordance with Section 7 of the Endangered Species Act of 1973, as amended. The request was pertaining to the proposed siting, construction, and operation of a spallation neutron source at Argonne National Laboratory (ANL). Three other alternative sites in other parts of the country are also being investigated.

We have reviewed the information included with your letter. It is not clear if all of the resources described therein are within the "800 Area" or if they are throughout the ANL site. Of the habitats described, the wetlands and mature oak woodlands would have the most ecological value and thus potential impacts to these communities would be of the greatest concern to this Office. The only federally listed species that may be affected by the project is the Hine's emerald dragonfly (*Somatochlora hineana*). As you noted, this species does not occur within the project site but is in the vicinity. Further specifics of the project would be needed before a determination could be made as to the likelihood of adverse impacts to this species from the project. As with other recent consultations regarding projects at Argonne, the primary concern would relate to potential groundwater impacts. As more information becomes available through the development of an Environmental Impact Statement we would be happy to review it to make a definitive determination.

Thank you for the opportunity for input and consultation early in your evaluation and planning process. If you have any questions, please contact Mr. Jeff Mengler at 847/381-2253, ext. 226.

Sincerely,

for John D. Rogner
Acting Field Supervisor

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Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

DEC 12 1997

Ms. Anne E. Haaker
Deputy State Historic Preservation Officer
Illinois Historic Preservation Agency
Old State Capitol
Springfield, Illinois 62701

Dear Ms. Haaker:

SUBJECT: CONSULTATION UNDER SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE

The U.S. Department of Energy (DOE) proposes to site, construct, and operate Spallation Neutron Source (SNS) and is currently preparing an Environmental Impact Statement (EIS), pursuant to the National Environmental Policy Act on this Federal action. The proposed SNS Facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The EIS will include discussion of potential impacts at four alternative locations for the SNS, all DOE-owned laboratories: Oak Ridge National Laboratory, Oak Ridge, Tennessee; Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory, Los Alamos, New Mexico; and Brookhaven National Laboratory, Upton, New York. This letter pertains to the potential site located at ANL.

The proposed SNS would produce short pulses of neutrons for use in materials and biomedical research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. The neutrons would be slowed to useful energy levels, and guided to samples of the materials being studied. The interactions of the neutrons and the specimens would be measured and analyzed, revealing information on the structure, properties, and behavior of the test material.

DEC 12 1997

Ms. Anne Haaker - 2 -

The proposed location of the SNS at ANL is in the 800 Area in the northwest corner of the Laboratory (see enclosed material). Within the general vicinity of this site, nine archaeological sites have been recorded. One site (11-Du-203) is eligible for listing on the *National Register of Historic Places*, four sites (11-Du-208, 11-Du-295, 11-Du-296, and 11-Du-297) have been determined not eligible, and four sites (11-Du-201, 11-Du-207, 11-299, and 11-Du-300) remain to be evaluated for their eligibility status. None of the nine sites are directly within the footprint of the proposed facility but will be considered in the EIS due to their proximity to the preferred site. It is likely that, at a minimum, the site nearest the footprint (11-Du-207) would require an eligibility determination.

This letter serves as consultation under Section 106 of the National Historic Preservation Act. Your input will be used in the preparation of the EIS. Please reply at your earliest convenience.

If you need further information on this request, please do not hesitate to call W. S. White, of my staff, at (630) 252-2101.

Sincerely,

Michael J. Flannigan, Director
Safety and Technical Services

Enclosure:
As Stated

cc: D. Wilfert, OR, w/o encl.

BNL CONSULTATION LETTERS

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Department of Energy
Brookhaven Group
Building 464
P.O. Box 5000
Upton, New York 11973

JUN - 1 1998

Ms. Nancy Davis Ricci
Information Services
New York Natural Heritage Program
New York State Department of Environmental Conservation
700 Troy-Schenectady Road
Latham, NY 12110-2400

Dear Ms. Ricci:

SUBJECT: REQUEST FOR CONSULTATION UNDER SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE

This letter is intended to serve as our request for informal consultation under Section 7 of the Endangered Species Act.

The U.S. Department of Energy (DOE) proposes to site, construct, and operate the Spallation Neutron Source (SNS) and is currently preparing an Environmental Impact Statement (EIS), pursuant to the National Environmental Policy Act (NEPA) on this federal action. The proposed SNS facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The EIS will include discussion of potential impacts at four alternative locations for the SNS, all DOE-owned laboratories: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee; Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory (LANL), Los Alamos, New Mexico; and Brookhaven National Laboratory (BNL). Upton, New York.

The proposed SNS would produce short pulses of neutrons for use in materials and biomedical research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. The neutrons would then be slowed to useful energy levels, and guided to samples of the materials being studied. The interactions of the neutrons and the specimens would be measured and analyzed, revealing information on the structure, properties, and behavior of the test material.

Ms. N. Ricci - 2 - JUN - 1 1998

With regards to Brookhaven National Laboratory, the proposed location of the SNS at BNL is the central portion of the site, adjacent to the Relativistic Heavy Ion Collider (RHIC), (Site #1 on the enclosed site selection report). DOE requests an updated list of protected species and habitat on and in the vicinity of the proposed SNS site at BNL and solicits your recommendation and comments about the potential effects of this proposed action. Your input will be used in the preparation of the final environmental impact statement.

If you need further information on this request, please do not hesitate to call Jerry Granzen of my staff at (516) 344-4089.

Sincerely,

K. Dean Helms
Executive Manager

Enclosure:
As stated

cc: D. Bean, EAS, w/encl.
D. Wilfert, OR, w/encl.
M. Butler, BHG, w/encl.
K. Brog, BNL, w/encl.
M. Bebon, BNL, w/encl.
M. Schaffer, BNL, w/encl.
T. Sperry, BNL, w/encl.

New York State Department of Environmental Conservation
Division of Fish, Wildlife & Marine Resources
Wildlife Resources Center – New York Natural Heritage Program
700 Troy-Schenectady Road, Latham, New York 12110-2400
Phone: (518) 783-3932 FAX: (518) 783-3916

John P. Cahill
Commissioner

June 12, 1998

K. Dean Helms
U.S. Dept. Of Energy
Brookhaven Group
Bldg, 464, PO Box 5000
Upton, NY 11973

Dear Mr. Helms:

We have reviewed the New York Natural Heritage Program files with respect to your recent request for biological information concerning the Environmental Impact Statement for the proposed construction of the Spallation Neutron Source facility, four areas as indicated on your enclosed maps, located in the Town of Brookhaven, Suffolk County.

Enclosed is a computer printout covering the area you requested to be reviewed by our staff. The information contained in this report is considered sensitive and may not be released to the public without permission from the New York Natural Heritage Program.

Our files are continually growing as new habitats and occurrences of rare species and communities are discovered. In most cases, site-specific or comprehensive surveys for plant and animal occurrences have not been conducted. For these reasons, we can only provide data which have been assembled from our files. We cannot provide a definitive statement on the presence or absence of species, habitats or natural communities. This information should not be substituted for on-site surveys that may be required for environmental assessment.

This response applies only to known occurrences of rare animals and/or significant wildlife habitats. Please contact the appropriate NYS DEC Regional Office, Division of Environmental Permits, at the address enclosed for information regarding any regulated areas or permits that may be required (e.g., regulated wetlands) under State Law.

If this proposed project is still active one year from now we recommend that you contact us again so that we may update this response. Kindly address your requests to the above address,

Sincerely,

Carole L. Flood Information Services
NY Natural Heritage Program

Encs
cc: Reg. 1, Wildlife Mgr.
Reg. 1, Fisheries Mgr.
Peter Nye, ESU, Delmar

NATURAL HERITAGE REPORT on RARE SPECIES and ECOLOGICAL COMMUNITIES

Prepared 10 JUN 1998 by NY Natural Heritage Program, NYS DEC, Latham, New York.

Records with a PRECISION value of "S" are known to be in a location which may be impacted by the proposed action.
Records with a PRECISION value of "M" may possibly occur within the project area in appropriate habitat.
This report contains SENSITIVE information which should be treated in a sensitive manner -- Please see cover letter.

page 1

REFER TO THE USERS GUIDE FOR EXPLANTIONS OF CODES, RANKS, AND FIELDS.

* LOCATION SCIENTIFIC NAME & Common Name	NY LEGAL STATUS & HERITAGE RANK	FEDERAL STATUS	PRECISION & ACRES	EORANK & LAST SEEN	GENERAL HABITAT AND QUALITY	TOWN(S) & DETAILED LOCATION	USGS TOPO QUAD LAT & LONG	OFFICE USE
* KENTS POND								
RHYNCHOSPORA INUNDATA Drowned horned rush VASCULAR PLANT	ENDANGERED G4 S1		M	F 1922	GROWING IN WATER AWAY FROM SHORE.	RIVERHEAD. KENT POND BARRENS.	WADING RIVER 40 53 10 N 72 50 28 W	4007287 272
* RIDGE								
IRIS PRISMATICA Slender blue flag VASCULAR PLANT	UNPROTECTED G4G5 S2		M	H 1871	RICH MEADOWS.	BROOKHAVEN. RIDGE, RICH MEADOWS.	MIDDLE ISLAND 40 53 08 N 72 53 30 W	4007288 19
* UPTON								
ERYNNIS MARTIALIS Mottled dusky wing BUTTERFLY or SKIPPER	UNPROTECTED G4 S1S3		M	H 1965	MEADOW.	BROOKHAVEN. BROOKHAVEN NATIONAL LABORATORY. MEADOW.	MORICHES 40 51 50 N 72 52 04 W	4007277 40
ERYNNIS PERSIUS PERSIUS Persius dusky wing BUTTERFLY or SKIPPER	UNPROTECTED G4T2 SH		M	H 1966	PINE OAK FOREST.	BROOKHAVEN. BROOKHAVEN NATIONAL LABORATORY. TAKEN IN PINE OAK FOREST.	MORICHES 40 51 50 N 72 52 04 W	4007277 40

NATURAL HERITAGE REPORT on RARE SPECIES and ECOLOGICAL COMMUNITIES

Prepared 10 JUN 1998 by NY Natural Heritage Program, NYS DEC, Latham, New York.

Records with a PRECISION value of "S" are known to be in a location which may be impacted by the proposed action.
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This report contains SENSITIVE information which should be treated in a sensitive manner -- Please see cover letter.

REFER TO THE USERS GUIDE FOR EXPLANTIONS OF CODES, RANKS, AND FIELDS.

* LOCATION

SCIENTIFIC NAME & Common Name	NY LEGAL STATUS & HERITAGE RANK	FEDERAL STATUS	PRECISION & ACRES	EORANK & LAST SEEN	GENERAL HABITAT AND QUALITY	TOWN(S) & DETAILED LOCATION	USGS TOPO QUAD LAT & LONG	OFFICE USE
PHYSALIS VIRGINIANA Virginia ground-cherry VASCULAR PLANT	UNPROTECTED G5 SH		M	H 1929	DRY FIELD.	BROOKHAVEN. DRY FIELD, CAMP UPTON, LONG ISLAND (UPTON).	MORICHES 40 51 50 N 72 52 04 W	4007277 40

5 Records Processed

NATURAL HERITAGE REPORT on RARE SPECIES and ECOLOGICAL COMMUNITIES

Prepared 10 JUN 1998 by NY Natural Heritage Program, NYS DEC, Latham, New York.

Records with a PRECISION value of "S" are known to be in a location which may be impacted by the proposed action.
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This report contains SENSITIVE information which should be treated in a sensitive manner -- Please see cover letter.

page 1

REFER TO THE USERS GUIDE FOR EXPLANTIONS OF CODES, RANKS, AND FIELDS.

* LOCATION SCIENTIFIC NAME & Common Name	NY LEGAL STATUS & HERITAGE RANK	FEDERAL STATUS	PRECISION & ACRES	EORANK & LAST SEEN	GENERAL HABITAT AND QUALITY	TOWN(S) & DETAILED LOCATION	USGS TOPO QUAD LAT & LONG	OFFICE USE
* BROOKHAVEN NATIONAL LABORATORY								
PLATANTHERA CRISTATA Crested fringed orchis VASCULAR PLANT	THREATENED G5 S1		S 1	E? 1984	WET PINE BARRENS.	BROOKHAVEN. FROM NW CORNER OF FILTRATION PLANT AT BROOKHAVEN NATIONAL LAB, GO 0.55 MI NNW.	WADING RIVER 40 53 07 N 72 51 32 W	4007287 280
* CRESCENT BOW DRIVE POND								
AMBYSTOMA TIGRINUM Tiger salamander AMPHIBIAN	ENDANGERED G5 S3		S 1	C 1994	A SMALL, NATURAL POND WITH WATER DEPTH OF 3 FEET, BOTTOM SEDIMENT OF SILTY MUD ON TOP OF SAND, AND PH 4.3-4.8. ASSOCIATED SPECIES: PSEUDACRIS CRUCIFER. BASED ON GLOBAL SPECS OF JANUARY 1993.	BROOKHAVEN. ON BROOKHAVEN NATIONAL LABORATORY PROPERTY AT THE SOUTH END OF CRESCENT BOW DRIVE AND LOCATED BETWEEN CRESCENT BOW DRIVE AND PLEASANT VIEW DRIVE.	WADING RIVER 40 53 27 N 72 51 51 W	4007287 47 ESU
* KENTS POND								
RHYNCHOSPORA INUNDATA Drowned horned rush VASCULAR PLANT	ENDANGERED G4 S1		M	F 1922	GROWING IN WATER AWAY FROM SHORE.	RIVERHEAD. KENT POND BARRENS.	WADING RIVER 40 53 10 N 72 50 26 W	4007287 272

NATURAL HERITAGE REPORT on RARE SPECIES and ECOLOGICAL COMMUNITIES

Prepared 10 JUN 1998 by NY Natural Heritage Program, NYS DEC, Latham, New York.

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REFER TO THE USERS GUIDE FOR EXPLANTIONS OF CODES, RANKS, AND FIELDS.

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AMBYSTOMA TIGRINUM Tiger salamander AMPHIBIAN	ENDANGERED G5 S3		S	CD 1994	A SMALL, NATURAL POND ALONG THE PECONIC RIVER WITH WATER DEPTH OF 1-1.5 FEET, HARD MUD BOTTOM SUBSTRATE WITH EMERGENT SEDGE VEGETATION AND PH 4.5. ASSOCIATED SPECIES: RANA SYLVATICA, PSEUDACRIS CRUCIFER, BUFO WOODHOUSII FOWLERI. BASED ON GLOBAL SPECS OF JANUARY 1993.	BROOKHAVEN. ON BROOKHAVEN NATIONAL LABORATORY PROPERTY, SMALL POND ALONG THE PECONIC RIVER ON THE W SIDE OF A SERVICE ROAD S OF CRESCENT BOW DRIVE.	WADING RIVER 40 53 09 N 72 51 46 W	4007281 50 ESU
* PLEASANT VIEW DRIVE POND								
AMBYSTOMA TIGRINUM Tiger salamander AMPHIBIAN	ENDANGERED G5 S3		S	CD 1994	A SMALL, NATURAL POND WITH WATER DEPTH OF 3+ FEET, BOTTOM SEDIMENT OF SILT/MUCK AND PH 4.4. SMALL MATS OF FLOATING ALGAE. ASSOCIATED SPECIES: RANA SYLVATICA, CLEMMYS GUTTATA. BASED ON GLOBAL SPECS OF JANUARY 1993.	BROOKHAVEN. ON BROOKHAVEN NATIONAL LABORATORY PROPERTY JUST S OF THE SOUTH END OF PLEASANT VIEW DRIVE.	WADING RIVER 40 53 21 N 72 52 02 W	4007287 49 ESU

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ERYNNIS PERSIUS PERSIUS Persius dusky wing BUTTERFLY or SKIPPER	UNPROTECTED G4T2 SH		M	H 1966	PINE OAK FOREST.	BROOKHAVEN. BROOKHAVEN NATIONAL LABORATORY. TAKEN IN PINE OAK FOREST.	MORICHES 40 51 50 N 72 52 04 W	4007277 40
PHYSALIS VIRGINIANA Virginia ground-cherry VASCULAR PLANT	UNPROTECTED G5 SH		M	H 1929	DRY FIELD.	BROOKHAVEN. DRY FIELD, CAMP UPTON, LONG ISLAND [UPTON].	MORICHES 40 51 50 N 72 52 04 W	4007277 40

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* BROOKHAVEN BARRENS ROADSIDE								
DESMODIUM CILIARE Little-leaf tick-trefoil VASCULAR PLANT	THREATENED G5 S2S3		M	E 1985	DRY PINE BARRENS ROADSIDE. ASSOC. SPECIES: AGALINIS SETACEA, EUPATORIUM ALHUM AND LESPEDEZA REPENS. NEED MORE INFORMATION TO ASSIGN A-D RANK.	BROOKHAVEN. FROM THE JUNCTION OF MIDDLE ISLAND MORICHES, MORICHES-YAPHANK, AND MANORVILLE ROADS, THE SITE EXTENDS E AND N AND IS DEFINED BY MANORVILLE ROAD. PLANTS OCCUR ALONG ROADSIDE AT EDGE OF PINE BARRENS.	MORICHES 40 50 25 N 72 51 50 W	4007277 51
LESPEDEZA STUEVEI Velvety lespedeza VASCULAR PLANT	RARE G4? S2		M	E 1985	DRY PINE BARRENS ROADSIDE. ASSOC. SPECIES: AGALINIS SETACEA, EUPATORIUM ALHUM AND LESPEDEZA REPENS. NEED MORE INFORMATION TO ASSIGN A-D RANK.	BROOKHAVEN. FROM THE JUNCTION OF MIDDLE ISLAND MORICHES, MORICHES-YAPHANK, AND MANORVILLE ROADS, THE SITE EXTENDS E AND N AND IS DEFINED BY MANORVILLE ROAD. PLANTS OCCUR ALONG ROADSIDE AT EDGE OF PINE BARRENS.	MORICHES 40 50 25 N 72 51 50 W	4007277 51
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SIGNIFICANT HABITATS

DATE : 06/10/98

REPORT ID#	NAME OF AREA	TYPE OF AREA	COUNTY	TOWN OR CITY	QUADRANGLE	LATITUDE (DEG MIN SEC)	LONGITUDE (DEG MIN SEC)
SW 52-562	Peconic River and Drainage	Freshwater River	Suffolk	Brookhaven	Moriches	40 54 08	72 48 13
SW 52-576	Smith Estate Ponds	Tiger Salamander Ponds	Suffolk	Brookhaven	Bellport	40 51 42	72 54 25
SW 52-578	Water Tank Pond	Tiger Salamander Pond	Suffolk	Brookhaven	Moriches	40 51 07	72 51 44

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
DIVISION OF ENVIRONMENTAL PERMITS REGIONAL OFFICES

REGION	COUNTIES	NAME	ADDRESS AND PHONE NO.
Region 1	Nassau Suffolk	Robert Greene Permit Administrator	Loop Road, Bldg. 40 SUNY Stony Brook, NY 11790-2356 (516) 444-0365
Region 2	New York City	George Danskin Permit Administrator	Hunters Point Plaza 4740 21st Street Long Island City, NY 11101-5407 (718) 482-4997
Region 3	Dutchess Orange Putnam Rockland, Sullivan Ulster, Westchester	Margaret Duke Permit Administrator	21 South Putt Corners Road New Paltz, NY 12561-1696 (914) 256-3059
Region 4	Albany Columbia Delaware Greene, Montgomery, Otsego Rensselaer, Schenectady, Schoharie	William J. Clarke Permit Administrator	1150 N. Westcott Road Schenectady, NY 12306-2014 (518) 357-2234
Region 5	Clinton Essex Franklin Fulton, Hamilton Saratoga, Warren, Washington	Richard Wild Permit Administrator	Route 86 Ray Brook, NY 12977 (518) 897-1234
Region 6	Herkimer Jefferson Lewis Oneida, St. Lawrence	Randy Vaas Permit Administrator	State Office Building 317 Washington Street Watertown, NY 13601 (315) 785-2246
Region 7	Broome Cayuga Chenango Cortland, Madison, Onondaga Oswego, Tioga, Tompkins	Ralph Manna, Jr. Permit Administrator	615 Erie Blvd. West Syracuse, NY 13204-2400 (315) 426-7439
Region 8	Chemung Genesee Livingston Monroe, Ontario, Orleans Schuyler, Seneca, Steuben Wayne, Yates	Albert Butkas Permit Administrator	6274 East Avon-Lima Road Avon, NY 14414 (716) 226-2466
Region 9	Allegany Cattaraugus Chautauqua Erie, Niagara, Wyoming	Steven Doleski Permit Administrator	270 Michigan Avenue Buffalo, NY 14203-2999 (716) 851-7165

USERS GUIDE TO NY NATURAL HERITAGE DATA

New York Natural Heritage Program, 700 Troy-Schenectady Road, Latham NY 12110-2400 phone: (518) 783-3932

NATURAL HERITAGE PROGRAM: The Natural Heritage Program is an ongoing, systematic, scientific inventory whose goal is to compile and maintain on the rare plants and animals native to New York State, and significant ecological communities. The data provided in the report facilitate sound plann conservation, and natural resource management and help to conserve the plants, animals and ecological communities that represent New York's natural herit.

DATA SENSITIVITY: The data provided in the report are ecologically sensitive and should be treated in a sensitive manner. The report is for your in-ho use and should not be released, distributed or incorporated in a public document without prior permission from the Natural Heritage Program.

NATURAL HERITAGE REPORTS (may contain any of the following types of data):
COUNTY NAME: County where the occurrence of a rare species or significant ecological community is located.
TOWN NAME: Town where the occurrence of a rare species or significant ecological community is located.
USGS 7 ½' TOPOGRAPHIC MAP: Name of 7.5 minute US Geological Survey (USGS) quadrangle map (scale 1:24,000).
LAT: Centrum latitude coordinate of the location of the occurrence. Caution: latitude & longitude must be used with PRECISION (e.g. the location of occurrence with M (minute) precision is not precisely known & is thought to occur within a 1.5 mile radius of the latitude/longitude coordinates).
LONG: Centrum longitude coordinate of the location of the occurrence. See also LAT above.
PRECISION: S - seconds: location known precisely. (within a 300' or 1-second radius of the latitude and longitude given.
M - minutes: location known only to within a 1.5 mile (1 minute) radius of the latitude and longitude given.
G - general: location known to within a 5 mile radius of the latitude and longitude given.
SIZE (acres): Approximate acres occupied by the rare species or significant ecological community at this location.
SCIENTIFIC NAME: Scientific name of the occurrence of a rare species or significant ecological community.
COMMON NAME: Common name of the occurrence of a rare species or significant ecological community.
ELEMENT TYPE: Type of element (i.e. plant, animal, significant ecological community, other, etc.)
LAST SEEN: Year rare species or significant ecological community last observed extant at this location.
EO RANK: Comparative evaluation summarizing the quality, condition, viability and defensibility of this occurrence. Use with LAST SEEN and PRECISION
A-E = Extant: A=excellent, B=good, C=marginal, D=poor, E=extant but with insufficient data to assign a rank of A - D.
F = Failed to find. Did not locate species, but habitat is still there and further field work is justified.
H = Historical. Historical occurrence without any recent field information.
X = Extirpated. Field/other data indicates element/habitat is destroyed and the element no longer exists at this location.
? = Unknown.
Blank = Not assigned.

NEW YORK STATE STATUS (animals): Categories of Endangered and Threatened species are defined in New York State Environmental Conservation Law section 11-0535. Endangered, Threatened, and Special Concern species are listed in regulation 6NYCRR 182.5.
E = Endangered Species: any species which meet one of the following criteria:
1) Any native species in imminent danger of extirpation or extinction in New York.
2) Any species listed as endangered by the United States Department of the Interior, as enumerated in the Code of Federal Regulations 50 CFR 17.11.
T = Threatened Species: any species which meet one of the following criteria:
1) Any native species likely to become an endangered species within the foreseeable future in NY.
2) Any species listed as threatened by the U.S. Department of the Interior, as enumerated in the Code of the Federal Regulations 50 CFR 17.11.
SC = Special Concern Species: those species which are not yet recognized as endangered or threatened, but for which documented concern exists for their continued welfare in New York. Unlike the first two categories, species of special concern receive no additional legal protection under Environmental Conservation Law section 11-0535 (Endangered and Threatened Species).
P = Protected Wildlife (defined in Environmental Conservation Law section 11-0103): wild game, protected wild birds, and endangered species of wildlife.
U = Unprotected (defined in Environmental Conservation Law section 11-0103): the species may be taken at any time without limit; however a license to take may be required.
G = Game (defined in Environmental Conservation Law section 11-0103): any of a variety of big game or small game species as stated in the Environmental Conservation Law; many normally have an open season for at least part of the year, and are protected at other times.

NEW YORK STATE STATUS (plants): The following categories are defined in regulation 6NYCRR part 193.3 and apply to NYS Environmental Conservation Law section 9-1503.
(blank) = no state status
E = Endangered Species: listed species are those with:
1) 5 or fewer extant sites, or
2) fewer than 1,000 individuals, or
3) restricted to fewer than 4 U.S.G.S. 7 ½ minute topographical maps, or
4) species listed as endangered by U.S. Department of Interior, as enumerated in Code of Federal Regulations 50 CFR 17.11.
T = Threatened: listed species are those with:
1) 6 to fewer than 20 extant sites, or
2) 1,000 to fewer than 3,000 individuals, or
3) restricted to not less than 4 or more than 7 U.S.G.S. 7 and ½ minute topographical maps, or
4) listed as threatened by U.S. Department of Interior, as enumerated in Code of Federal Regulations 50 CFR 17.11.
R = Rare: listed species have:
1) 20 to 35 extant sites, or
2) 3,000 to 5,000 individuals statewide.
U = Unprotected
V = Exploitably vulnerable: listed species are likely to become threatened in the near future throughout all or a significant portion of their range within the state if causal factors continue unchecked.

NEW YORK STATE STATUS (communities): At this time there are no categories defined for communities.

continued on next page

Department of Energy
Brookhaven Group
Building 464
P.O. Box 5000
Upton, New York 11973

JUN - 1 1998

Ms. Sherry Morgan, Field Supervisor
U.S. Fish and Wildlife Service
3817 Luker Highway
Cortland, NY 13045

Dear Ms. Morgan:

SUBJECT: REQUEST FOR CONSULTATION UNDER SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE

This letter is intended to serve as our request for informal consultation under Section 7 of the Endangered Species Act.

The U.S. Department of Energy (DOE) proposes to site, construct, and operate the Spallation Neutron Source (SNS) and is currently preparing an Environmental Impact Statement (EIS), pursuant to the National Environmental Policy Act (NEPA) on this federal action. The proposed SNS facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The EIS will include discussion of potential impacts at four alternative locations for the SNS, all DOE-owned laboratories: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee; Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory (LANL), Los Alamos, New Mexico; and Brookhaven National Laboratory (BNL), Upton, New York.

The proposed SNS would produce short pulses of neutrons for use in materials and biomedical research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. The neutrons would then be slowed to useful energy levels, and guided to samples of the materials being studied. The interactions of the neutrons and the specimens would be measured and analyzed, revealing information on the structure, properties, and behavior of the test material.

Ms. S. Morgan - 2 - JUN - 1 1998

With regards to Brookhaven National Laboratory, the proposed location of the SNS at BNL is the central portion of the site, adjacent to the Relativistic Heavy Ion Collider (RHIC), (Site #1 on the enclosed site selection report). DOE requests an updated list of protected species and habitat on and in the vicinity of the proposed SNS site at BNL and solicits your recommendation and comments about the potential effects of this proposed action. Your input will be used in the preparation of the final environmental impact statement.

If you need further information on this request, please do not hesitate to call Jerry Granzen of my staff at (516) 344-4089.

Sincerely,

for

K. Dean Helms
Executive Manager

Enclosure:
As stated

cc: D. Bean, EAS, w/encl.
D. Wilfert, OR, w/encl.
M. Butler, BHG, w/encl.
K. Brog, BNL, w/encl.
M. Bebon, BNL, w/encl.
M. Schaffer, BNL, w/encl.
T. Sperry, BNL, w/encl.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
3817 LUKER ROAD
CORTLAND, NY 13045

June 15, 1998

Mr. K. Dean Helms
Executive Manager
Department of Energy
Brookhaven Group
Building 464, P.O. Box 5000
Upton, NY 11973

Attention: Mr. Jerry Granzen

Dear Mr. Helms:

This responds to your letter of June 1, 1998, requesting information on the presence of endangered or threatened species in the vicinity of the proposed Spallation Neutron Source at the Brookhaven National Laboratory in the Town of Brookhaven, Suffolk County, New York. The information will be used in the preparation of an environmental impact statement.

Except for occasional transient individuals, no Federally listed or proposed endangered or threatened species under our jurisdiction are known to exist in the project impact area. Therefore, no Biological Assessment or further Section 7 consultation under the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 et seq.) is required with the U.S. Fish and Wildlife Service (Service). Should project plans change, or if additional information on listed or proposed species becomes available, this determination may be reconsidered. A compilation of Federally listed and proposed endangered and threatened species in New York is enclosed for your information.

The above comments pertaining to endangered species under our jurisdiction are provided pursuant to the Endangered Species Act. This response does not preclude additional Service comments under the Fish and Wildlife Coordination Act or other legislation.

For additional information on fish and wildlife resources or State-listed species, we suggest you contact:

New York State Department
of Environmental Conservation
Region 1
Building 40, SUNY
Stony Brook, NY 11794
(516) 444-0200

New York State Department
of Environmental Conservation
Wildlife Resources Center - Information Serv.
New York Natural Heritage Program
700 Troy-Schenectady Road
Latham, NY 12110-2400
(518) 783-3932

National Wetlands Inventory (NWI) maps may or may not be available for the project area. However, while the NWI maps are reasonably accurate, they should not be used in lieu of field surveys for determining the presence of wetlands or delineating wetland boundaries for Federal regulatory purposes. Copies of specific NWI maps can be obtained from:

Cornell Institute for Resource Information Systems
302 Rice Hall
Cornell University
Ithaca, NY 14853
Telephone: (607) 255-4864

Work in certain waters and wetlands of the United States may require a permit from the U.S. Army Corps of Engineers (Corps). If a permit is required, in reviewing the application pursuant to the Fish and Wildlife Coordination Act, the Service may concur, with or without stipulations, or recommend denial of the permit depending upon the potential adverse impacts on fish and wildlife resources associated with project implementation. The need for a Corps permit may be determined by contacting Mr. Joseph Seebode, Chief, Regulatory Branch, U.S. Army Corps of Engineers, 26 Federal Plaza, New York, NY 10278 (telephone: [212] 264-3996).

If you require additional information please contact Michael Stoll at (607) 753-9334.

Sincerely,
Mark W. Clough
ACTING FOR

Sherry W. Morgan
Field Supervisor

Enclosure

cc: NYSDEC, Stony Brook, NY (Environmental Permits)
NYSDEC, Latham, NY
COE, New York, NY

2

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES IN NEW YORK

Common Name	Scientific Name	Status	Distribution
FISHES			
Sturgeon, shortnose*	*Acipenser brevirostrum*	E	Hudson River & other Atlantic coastal rivers
REPTILES			
Turtle, bog	*Clemmys muhlenbergii*	T	Albany, Columbia, Dutchess, Genesee, Orange, Oswego, Putnam, Seneca, Ulster, Wayne, and Westchester Counties
Turtle, green*	*Chelonia mydas*	T	Oceanic summer visitor coastal waters
Turtle, hawksbill*	*Eretmochelys imbricata*	E	Oceanic summer visitor coastal waters
Turtle, leatherback*	*Dermochelys coriacea*	E	Oceanic summer resident coastal waters
Turtle, loggerhead*	*Caretta caretta*	T	Oceanic summer resident coastal waters
Turtle, Atlantic ridley*	*Lepidochelys kempii*	E	Oceanic summer resident coastal waters
BIRDS			
Eagle, bald	*Haliaeetus leucocephalus*	T	Entire state
Falcon, peregrine	*Falco peregrinus*	E	Entire state - re-establishment to former breeding range in progress
Plover, piping	*Charadrius melodus*	E	Great Lakes Watershed
		T	Remainder of coastal New York
Tern, roseate	*Sterna dougallii dougallii*	E	Southeastern coastal portions of state
MAMMALS			
Bat, Indiana	*Myotis sodalis*	E	Entire state
Cougar, eastern	*Felis concolor couguar*	E	Entire state - probably extinct
Whale, blue*	*Balaenoptera musculus*	E	Oceanic
Whale, finback*	*Balaenoptera physalus*	E	Oceanic
Whale, humpback*	*Megaptera novaeangliae*	E	Oceanic
Whale, right*	*Eubalaena glacialis*	E	Oceanic
Whale, sei*	*Balaenoptera borealis*	E	Oceanic
Whale, sperm*	*Physeter catodon*	E	Oceanic
MOLLUSKS			
Snail, Chittenango ovate amber	*Succinea chittenangoensis*	T	Madison County
Mussel, dwarf wedge	*Alasmidonta heterodon*	E	Orange County - lower Neversink River

* Except for sea turtle nesting habitat, principal responsibility for these species is vested with the National Marine Fisheries Service.

1 Region 5 - 11/04/97 - 2 pp.

FEDERALLY LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES IN NEW YORK (Cont'd)

Common Name	Scientific Name	Status	Distribution
BUTTERFLIES			
Butterfly, Karner blue	*Lycaeides melissa samuelis*	E	Albany, Saratoga, Warren, and Schenectady Counties
PLANTS			
Monkshood, northern wild	*Aconitum noveboracense*	T	Ulster, Sullivan, and Delaware Counties
Pogonia, small whorled	*Isotria medeoloides*	T	Entire state
Swamp pink	*Helonias bullata*	T	Staten Island - presumed extirpated
Gerardia, sandplain	*Agalinis acuta*	E	Nassau and Suffolk Counties
Fern, American hart's-tongue	*Asplenium scolopendrium* var. *americana*	T	Onondaga and Madison Counties
Orchid, eastern prairie fringed	*Platanthera leucophea*	T	Not relocated in New York
Bulrush, northeastern	*Scirpus ancistrochaetus*	E	Not relocated in New York
Roseroot, Leedy's	*Sedum integrifolium* ssp. *Leedyi*	T	West shore of Seneca Lake
Amaranth, seabeach	*Amaranthus pumilus*	T	Atlantic coastal plain beaches
Goldenrod, Houghton's	*Solidago houghtonii*	T	Genesee County

E=endangered T=threatened P=proposed

Department of Energy
Brookhaven Group
Building 464
P.O. Box 5000
Upton, New York 11973

JUN - 1 1998

Mr. Julian Adams, Program Analyst
New York State Office of Parks, Recreation, and
Historic Preservation
Field Service Bureau
Peebles Island, P.O. Box 189
Waterford, New York 12188-0189

Dear Mr. Adams:

SUBJECT: **REQUEST FOR CONSULTATION UNDER SECTION 106 OF THE NATIONAL HISTORIC PRESERVATION ACT FOR THE PROPOSED SITING, CONSTRUCTION, AND OPERATION OF THE SPALLATION NEUTRON SOURCE**

This letter is intended to serve as our request for consultation under Section 106 of the National Historic Preservation Act (NHPA).

The U.S. Department of Energy (DOE) proposes to site, construct, and operate the Spallation Neutron Source (SNS) and is currently preparing an Environmental Impact Statement (EIS), pursuant to the National Environmental Policy Act (NEPA) on this federal action. The proposed SNS facility would consist of a proton accelerator system, a spallation target and appropriate experimental areas, laboratories, offices, and support facilities for neutron research. The EIS will include discussion of potential impacts at four alternative locations for the SNS, all DOE-owned laboratories: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee; Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory (LANL), Los Alamos, New Mexico; and Brookhaven National Laboratory (BNL), Upton, New York.

The proposed SNS would produce short pulses of neutrons for use in materials and biomedical research. This would be accomplished through the "spallation" process wherein (1) subatomic particles, called protons, are accelerated to very high energies; (2) the high energy protons are "bunched" into a compact group; (3) the bunched, high energy protons are directed onto a target made of a high atomic number material, in this case mercury; and (4) the collision of the protons with the target produces a pulse of neutrons from the target material. The neutrons would then be slowed to useful energy levels, and guided to samples of the materials being studied. The interactions of the neutrons and the specimens would be measured and analyzed, revealing

JUN 1 1998

Mr. J. Adams - 2 -

information on the structure, properties, and behavior of the test material.

With regards to Brookhaven National Laboratory, the proposed location of the SNS at BNL is the central portion of the site, adjacent to the Relativistic Heavy Ion Collider (RHIC), (Site #1 on the enclosed site selection report).

We request that your office provide a determination of potential impacts to historic resources for the potential siting of SNS at Brookhaven National Laboratory. If you need further information on this request, please do not hesitate to call Jerry Granzen of my staff at (516) 344-4089.

Sincerely,

Robert L Davis for

K. Dean Helms
Executive Manager

Enclosure:
As stated

cc: D. Bean, EAS, w/encl.
D. Wilfert, OR, w/encl.
M. Butler, BHG, w/encl.
K. Brog, BNL, w/encl.
M. Bebon, BNL, w/encl.
M. Schaffer, BNL, w/encl.
T. Sperry, BNL, w/encl.

APPENDIX E

ECOLOGICAL RESOURCE SURVEY

REPORTS AND SUMMARIES

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E. ECOLOGICAL RESOURCE SURVEY REPORTS AND SUMMARIES

The reports contained in this appendix provide additional details on the existing environment at the proposed sites for the SNS at Oak Ridge National Laboratory, Los Alamos National Laboratory, and Brookhaven National Laboratory. The preparers of this FEIS sent a detailed request for information to each of the sites. As part of this request, each site was directed to conduct a surveillance level survey for federal- and state-protected species, wetlands, and cultural resources at the proposed SNS site. The results of these surveys, as well as information specific to each of the proposed sites, are presented in these reports.

No report from Argonne National Laboratory is included in this appendix. The information received from this laboratory was not in a format that could easily be included in the appendix. All of the pertinent information has been included in Chapter 4 of the FEIS.

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ECOLOGICAL RESOURCE SURVEYS FOR THE PROPOSED NATIONAL SPALLATION NEUTRON SOURCE SITE ON THE OAK RIDGE RESERVATION:

1. POTENTIAL HABITAT FOR FEDERAL AND STATE LISTED ANIMAL AND PLANT SPECIES
2. JURISDICTIONAL WETLANDS

22 April 1997

Prepared for:
Enterprise Advisory Services, Inc.

Prepared by:
JAYCOR
B. Rosensteel
D. Awl
J. Mitchell
L. Pounds

In Response to:
Contract No. PO 01-00110

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

Ecological resource surveys were conducted on and adjacent to the proposed site of the National Spallation Neutron Source (NSNS) on the Oak Ridge Reservation (ORR), Oak Ridge, Tennessee, by the staff of JAYCOR Environmental in March, August, and September, 1997. The ORR is managed by Lockheed Martin Energy Systems, Inc. for the U.S. Department of Energy (DOE). The site includes approximately 290 acres (117 ha) along Chestnut Ridge and is located in Roane and Anderson Counties in the Ridge and Valley Province of Tennessee.

The ecological surveys performed were:

1. Reconnaissance surveys for potential habitat of state- and/or federally-listed plant and animal species, and;

2. A survey for jurisdictional wetlands.

2.0 THREATENED AND ENDANGERED (T&E) SPECIES

2.1 INTRODUCTION

The objectives of the plant and animal surveys were to determine the vegetation communities and types of habitat that exist on the proposed site for the NSNS and adjacent land, and to report potential habitat for state and federally protected terrestrial and aquatic species.

The federal Endangered Species Act of 1973 (ESA) requires that DOE consider the impacts of its actions on plant and animal species which are listed by the U.S. Fish and Wildlife Service (FWS) as threatened or endangered and on areas designated or proposed for designation as critical habitat. The FWS recommends that federal agencies also consider species that are candidates for listing during environmental planning since candidate species may eventually be listed. The National Environmental Policy Act also requires that federally-funded projects avoid or mitigate impacts to listed species.

Plant species listed by the Tennessee Department of Environment and Conservation are also provided limited protection by the Tennessee Rare Plant Protection and Conservation Act of 1985. This act protects listed plant species from removal or destruction without the consent of the landowner. DOE supports the protection of state-listed species on the ORR.

The Tennessee Wildlife Resources Agency lists fish and wildlife species which are threatened, endangered or in need-of-management in Tennessee. These species are protected by state laws and the knowing destruction of these animals and their habitat are prohibited.

For many protected species, the presence or absence of potential habitat can be easily determined. Other protected species, however, may not have overly strict or narrow habitat requirements or may use more than one habitat type and these species present a more challenging task when trying to identify potential habitat. In addition to this uncertainty is the fact that species do not always occur where there is suitable habitat. Thus, even though we have listed those species for which there appears to be suitable habitat on the site, the actual presence or absence of these species should be verified through systematic surveys prior to site development activities. Surveys for threatened and endangered species should be conducted during the proper sampling season to increase the probability of documenting species present.

2.2 T&E FISH AND WILDLIFE HABITAT EVALUATION METHODOLOGY

Existing data, aerial photos, forestry compartment maps and other information were reviewed to identify areas of potential habitat for state and federally protected (T&E) species. Field surveys were conducted during early

September to identify habitats present and to consider areas as potential habitat for protected species. Surveys included the areas to be developed, access roads, corridors, streams, and property adjacent to the site.

After reviewing information on the site and conducting field surveys, potential habitat for state and federal species was delineated. Species considered were those with previous records on the ORR (Mitchell et al. 1996) and those species with distribution ranges that include the ORR. Habitats were divided into categories and species known to occur in these habitats were considered as potentially occurring on the site.

2.3 T&E FISH AND WILDLIFE RESULTS

The major habitat types on the site are upland forest and pine forest. Upland forest encompasses those areas with mixed deciduous trees located on well-drained sites. It has at least three strataX canopy, and understory or shrub layer, and ground cover. Canopy trees include tulip poplar (*Liriodendron tulipifera*), chestnut oak (*Quercus prinus*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), hickories (*Carya* spp.), and American beech (*Fagus grandifolia*) in varying combinations depending on slope and aspect. The understory and shrub layer contains sapling and pole sized trees of the canopy species, and flowering dogwood (*Cornus florida*). The ground cover consists of seedlings of canopy and understory species, ferns, and various herbaceous plants.

The pine forest habitat is composed of almost pure pine stands. The most predominant stands are those of planted loblolly pines (*Pinus taeda*). The trees are in rows, the canopy is closed, the substrate consists almost entirely of a thick mat of pine needles, and there is scarce understory, shrub layer, or ground cover vegetation. Small stands of white pine (*Pinus strobus*), shortleaf pine (*Pinus echinata*), and virginia pine (*Pinus virginiana*) were found on the site.

Other important habitat types exist on the area but represent a relatively small percentage of the total site area. These habitats include utility corridors, riparian forest, and wetland.

Important water resources were found on the site. Tributaries forming on the south side of the ridge and flowing into White Oak Creek may provide habitat for several species including the southeastern shrew, mole salamander and four-toed salamander. Seasonal pools and sinkholes have been documented on the site during current and previous surveys. Pools and sinkholes should be inventoried during late winter and early spring to verify presence or absence of T&E species.

Surveys were conducted for habitat of T&E fish. There appears to be no habitat suitable for those species which have been previously documented on the ORR or for other T&E fish known to occur in the region.
No suitable habitat was identified on or adjacent to the site for any federally listed T&E species. Suitable habitat was found for species listed as threatened or in-need-of-management by the State of Tennessee, or as federal species of concern. While in-need-of-management species are protected by state law, federal species of concern are not given formal protection by the Endangered Species Act. Nonetheless, it is wise to consider these species

during planning because they could be upgraded to threatened or endangered status in the future. If these species are eventually listed, it is important to consult with the FWS to determine impacts on these species. Systematic surveys of these potential habitat areas during the appropriate verification time-frames would be necessary to confirm the presence or absence of T&E species at specific locations on site.

Previous studies have provided some indication of which protected species may occur on the site (Mitchell et al. 1996). Table 2-1 provides a list of species which potentially occur on the site, their preferred habitat, and status. Suitable habitat was located for nine species listed by the State of Tennessee as in-need-of-management, one species listed as State Threatened, and one federally listed species of concern. Figure 2-1 illustrates the locations of potential habitat for each of these T&E species. Each T&E species with the potential to occur on the site is discussed below.

2.3.1 Sharp-shinned Hawk

The sharp-shinned hawk is considered an uncommon permanent resident on the ORR. This species may nest in woods bordered by open country and has been seen during the nesting season on the ORR (Mitchell et. al 1996). Powerline corridors on the site provide potential nesting habitat for this hawk. Summer records on the ORR were reported by Krumholz (1954) , Howell (1958), Hardy (1991), and Mitchell et al. (1996).

2.3.2 Cooper's Hawk

The Cooper's Hawk is also an uncommon permanent resident of the ORR. This species prefers mixed woodlands bordered by open country and has been observed during the nesting season in nearby areas. Powerline corridors on the site may provide suitable nesting habitat for this bird. Summer records were reported by Krumholz (1954) and Mitchell et al. (1996).

2.3.3 Cerulean Warbler

Although this bird is rare in the Ridge and Valley Province, it should be considered a possible nester in the area. There are no recent nesting records on the ORR. This bird prefers mature hardwood forests as is represented by some of the hardwood stands on Chestnut Ridge. Summer records were reported by Anderson and Shugart (1974) and Howell (1958). Mitchell et al. (1996) has reported spring and fall records for this species.

2.3.4 Grasshopper Sparrow

This species is an uncommon summer resident in the Ridge and Valley Province. This bird prefers areas of grassy fields and farmlands. Some areas along the powerline corridors within the NSNS boundary may provide suitable nesting habitat for this bird. Summer records have been reported on the ORR by Howell (1958) , Kroodsma (1987), and Mitchell et al. (1996).

Table 2-1. Protected vertebrate species with potential habitat on the NSNS site, their preferred habitats, and federal or state protection status.

Species	Habitat on NSNS and Status	Preferred Habitat
Sharp-shinned hawk (*Accipter striatus*)	Power line corridors In Need-of-Management	Mixture of woods and open country
Cooper's hawk (*Accipiter cooperii*)	Powerline corridors In Need-of-Management	Mixed woods with openings
Cerulean Warbler (*Dendroica cerulea*)	Mature hardwood forest on ridgetop Federal Species of Concern	Mature hardwood forests
Grasshopper Sparrow (*Ammodramus savannarum*)	Powerline corridors In Need-of-Management	Grassy fields and farmlands
Yellow-bellied sapsucker (*Sphyrapicus varius*)	Possible in most areas except pine stands In Need-of-Management	Open deciduous woods
Rafinesque's big-eared bat (*Plecotus rafinesquii*)	Abandoned building along C-17 Road In Need-of-Management	Unoccupied man-made structures and caves
Southeastern shrew (*Sorex longirostris*)	Pine plantations and tributaries In Need-of-Management	Pine woods and stream banks
Northern Pine Snake (*Pituophis m. melanoleucus*)	Ridgetops and powerline corridors State Threatened	Pine woods, dry ridges, and old fields
Eastern Slender Glass Lizard (*Ophisaurus attenuatus longicaudus*)	Ridgetops and powerline corridors In Need-of-Management	Dry upland areas, brushy cut-over woodlands
Mole salamander (*Ambystoma talpoideum*)	Depression with temporary pools In Need-of-Management	Moist low-lying woodland areas with ponds
Four-toed salamander (*Hemidactylium scutatum*)	Tributaries of White Oak Creek In Need-of-Management	Hardwood forest wetlands

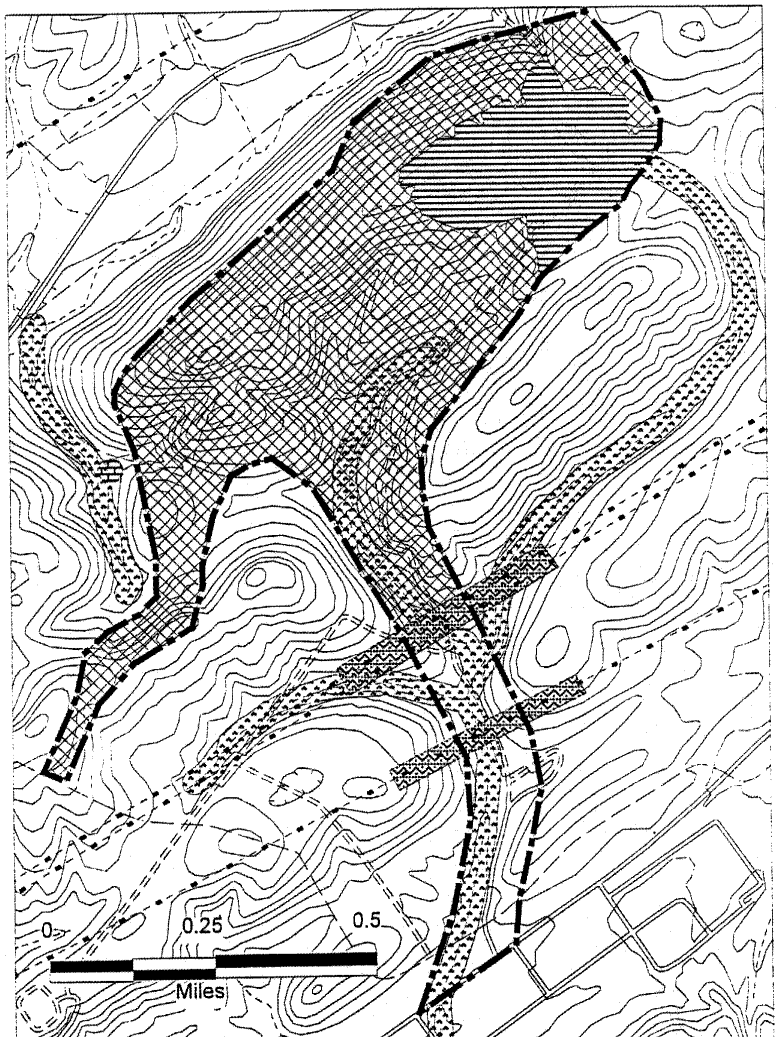

Fig.2-1. Potential habitat areas for T&E animal species within the proposed NSNS site.

Base Data:
ORNL Shared Data Initiative (SDI)

Map Composition:
September, 1997
D.Awl
JAYCOR Environmental

LEGEND

- ABANDONED HOUSE [Rafinesque's Big-eared Bat]
- DECIDUOUS WOODS/MIXED PINE HARDWOOD [Northern Pine Snake, Eastern Slender Gl
- PINES [Southeastern Shrew, Northern Pine Snake]
- POWERLINE RIGHT-OF-WAYS [Eastern Slender Glass Lizard, Northern Pine Snake, Shar
- WATER RESOURCES [Southeastern Shrew, Mole Salamander, Four-toed Salamander]
- NSNS Site Boundary

2.3.5 Yellow-bellied Sapsucker

This bird prefers open deciduous woods and is a common winter resident on the ORR. Suitable habitat for this species can be found throughout the site with the exception of pine woods. This species has been reported on the ORR previously by Krumholz (1954), Hardy (1991), and Mitchell et al. (1996).

2.3.6 Rafinesque's Big-eared Bat

There are no current records for the big-eared bat on the ORR, however, the Reservation has not been thoroughly surveyed for bats. This bat prefers unoccupied man-made structures and caves for roosting. A old homesite is located on the C-17 road along the western boundary of the site. Although the building is not structurally intact, it does provide potential habitat for bats.

2.3.7 Southeastern Shrew

The southeastern shrew was found in many locations across the ORR by Mitchell et al. (1996). This shrew has been found in a variety of habitat types and may occur along spring branches or tributaries and along White Oak Creek on the site. Previous records for this species on the ORR were documented by Dunaway and Kaye (1961), Howell and Dunaway (1958), Smith (1976) and Mitchell et al. (1996).

2.3.8 Northern Pine Snake

The pine snake prefers sandy pine woods, dry mountain ridges and old field habitats. This species has not been documented on the ORR in recent years. However, records are difficult to obtain because of the burrowing nature of this animal. The Chestnut Ridge area along the ridge top and powerline right-of-way may provide suitable habitat for this species. This snake was documented on the ORR by Krumholz (1954).

2.3.9 Eastern Slender Glass Lizard

Currently their are no documented records for this species on the ORR. This species prefers dry upland areas and brushy cut-over woodland. The distribution range for this species includes the NSNS site and there may be suitable habitat for this species along the ridges and powerline corridors.

2.3.10 Mole Salamander

The mole salamander prefers areas of moist low-lying woodlands or wetland habitats. This species may occur on the NSNS site if the sinkhole and low-lying areas form semi-permanent pools in the winter months. This salamander has not been previously documented on the ORR.

2.3.11 Four-toed Salamander

This salamander prefers areas of hardwood forest wetland associated with sphagnum moss. However, this amphibian has been documented on the ORR in wet areas where sphagnum moss was not present (Mitchell et al.1996). This species may occur near tributary streams and along White Oak Creek.

2.4 T&E PLANT HABITAT EVALUATION METHODOLOGY

Most of the proposed NSNS site had not previously been surveyed for T&E plants, defined here as vascular plant species listed for protection by the Federal or the Tennessee State Government (Awl et al. 1996). On-site exploratory level surveys for potential T&E plant habitat at the proposed NSNS site were conducted March 11, 1997, by Deborah Awl, and August 28 and September 11 and 15, 1997, by Larry Pounds.

2.5 T&E PLANT RESULTS

The proposed NSNS site contains the following vegetation types and landscape elements associated with the occurrence of T&E plants on the ORR: deciduous forests, mixed deciduous and pine forests, over-mature/successional pine plantations, wetlands and stream bottoms, limestone outcrops, springs and seeps. The site encroaches on an Environmental Research Park designated Natural Area (NA52, Bear Creek Spring Area; Awl et al, 1996), and three TNC Preliminary Conservation Sites* (BSR2-10, BSR3-16, and Landscape Complex 1; TNC, 1995). Additionally, the forest area on the south-east facing slope of Chestnut Ridge drains toward ecologically sensitive streams and wetlands in NA55 (Chestnut Ridge Springs Area), ARA6 (Upper White Oak Creek), BSR3-22, and BSR4-3. This forest provides significant landscape connectivity between NA52 and NA55. Parts of this forest may be incorporated into NA55 due to its hydrologic relationship and the recently verified presence of T&E plants.

Ten T&E plant species were recognized as potentially occurring within the proposed NSNS site (Table 2-2). Two T&E plant speciesXPink ladys-slipper [*Cypripedium acaule*] and American ginseng [*Panax quinquifolius*]Xwere verified in three locations on site during this survey (fig.2-2). An additional species verified on site during previous surveys, *Carex howei*, was removed from protection status by the State of Tennessee in 1997. Of the remaining species potentially occurring on the site, two are classified as having high potential for occurrence, while the remaining six are classified as having low potential for occurrence. Systematic surveys of these potential habitat areas during the specified verification time-frames would be necessary to confirm the presence or absence of T&E species at specific locations on site.

Table 2-2. T&E plant species potentially occurring within the proposed NSNS site.

Species	Common name	Habitat on ORR	Status*	Verification Time Frame	Potential for Occurrence Within the Proposed NSNS Site
Cypripedium acaule	Pink lady's-slipper	Dry to rich woods	E-CE	Apr.-July	Verified on site
Delphinum exaltatum	Tall larkspur	Barrens and woods	(C2), E	Aug.-Sept.	High
Fothergilla major	Mountain witchalder	Woods	T	Apr.-May	Low
Hydrastis canadensis	Golden seal	Rich woods	S-CE	April-July	Low
Juglans cinerea	Butternut	Slope near stream	(C2), T	no time frame	Low
Lilium canadense	Canada lily	Moist woods	T	June-July	High
Liparis loeselii	Fen orchis	Forested wetland	E	May-July	Low
Panax quinquifolius	Ginseng	Rich woods	S-CE	May-Oct.	Verified on site
Platanthera flava var. herbiola	Tuberculed rein-orchid	Forested wetland	T	May-Aug.	Low
Platanthera peramoena	Purple fringeless orchid	Wet meadow	T	July-Aug.	Low

*Status based on 1997 TN State List:

(C2) Special Concern, was listed under the formerly used C2 candidate designation. More information needed to determine status.
E Endangered in Tennessee.
T Threatened in Tennessee.
S Special Concern in Tennessee.
-CE Status due to commercial exploitation.

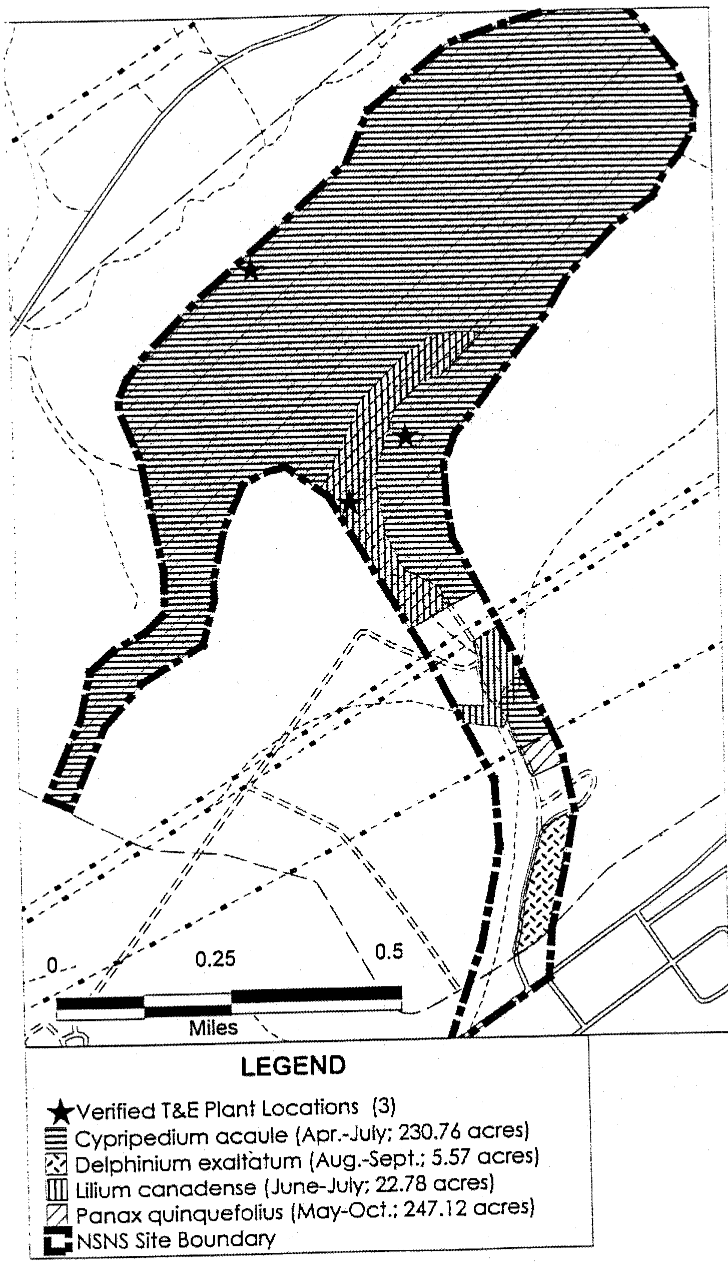

Fig. 2-2. T&E Plant locations and potential habitat areas within the proposed NSNS site.

Base Data:
ORNL Shared Data Initiative (SDI)

Map Composition:
September, 1997
D.Awl
JAYCOR Environmental

3.0 WETLAND SURVEY

Executive Order 11990, Protection of Wetlands dated May 24, 1977 requires federal agencies to avoid, to the extent possible, adverse impacts associated with the destruction and modification of wetlands and to avoid direct and indirect support of wetlands development wherever there is a practicable alternative. In accordance with U. S. Department of Energy (DOE) Regulations for Compliance with Floodplains/Wetlands Environmental Review Requirements (Subpart B, 10 CFR 1022.11), a survey was conducted in September 1997 to identify wetlands on the proposed site for the National Spallation Neutron Source (NSNS) on the Oak Ridge Reservation, Oak Ridge, Tennessee.

3.1 WETLAND IDENTIFICATION METHODOLOGY

3.1.1 The U. S. Army Corps of Engineers Wetland Delineation Methodology

As required by the Energy and Water Development Appropriations Act of 1992, wetlands are identified using the criteria and methods set forth in the Wetlands Delineation Manual [U.S. Army Corps of Engineers (USACE) 1987]. USACE defines wetlands as: "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

The USACE lists three characteristics that are diagnostic of wetlands: (1.) The vegetation is characterized by a prevalence of macrophytes typically adapted to wetland soil and hydrological conditions; (2) the substrate is undrained hydric soil; and (3) the area is inundated either permanently or periodically at depths less than 2 m (6.6 ft.), or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

3.1.1.1 Hydrophytic vegetation

USACE (1987) defines hydrophytic vegetation as “the sum total of macrophytic plant life that occurs in areas where the frequency and duration of inundation or soil saturation produce permanently or periodically saturated soils of sufficient duration to exert a controlling influence on the plant species present.” The U.S. Fish and Wildlife Service (Reed 1988) has developed a classification system that assigns species to wetland indicator classes according to the frequency with which a species occurs in a wetland (Table 3-1). If more than 50% of the vegetation in each strata (i.e., canopy, sapling/shrub, vines, herbaceous) have an indicator status of obligate (OBL), facultative wetland (FACW), and/or facultative (FAC), the vegetation is classified as hydrophytic. A positive (+) or negative (-) sign following any of the facultative indicator categories indicates, respectively, a frequency toward the higher end of the category (more frequently found in wetlands) or the lower end of the category (less frequently found in wetlands).

Table 3-1. Plant indicator classifications and frequency of occurrence in wetlands.

Classification	Occurrence in Wetlands(%)

Obligate Wetland	> 99
Facultative Wetland	67B99
Facultative	34B66
Facultative Upland	1B33
Upland	< 1

Source: P. B. Reed. 1988. National List of Plant Species That Occur in Wetlands: Tennessee. USFWS Biological Report NERC-88/18.42. U.S. Fish and Wildlife Service, Washington, D.C.

3.1.1.2 Hydric soils

Hydric soils are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in a major part of the root zone. The following indicators are used to determine whether a given nonsandy soil meets the definition and criteria for hydric soils: The presence of organic soils, sulfidic material, aquic or peraquic moisture regime, iron and manganese concretions, and/or gleyed soil or a soil with a low chroma color and mottles.

Munsell Soil Color Charts (Kollmorgen Instrument Corp. 1992) are used to determine soil colors. The Munsell notation for color consists of separate notations for hue, value, and chroma. The hues are R (red), YR (yellow-red), and Y (yellow) and refer to the soil color in relation to the primary colors (red, yellow, and blue). The hues are further defined by the numbers 2.5, 5.0, 7.5, and 10 preceding the hue designation. The numbers indicate the gradation from red through yellow within each hue, with 2.5 being more red and 10 being more yellow. The value notation refers to the lightness of the hue, and ranges from 0 (absolute black) to 10 (absolute white). Chroma refers to the strength, or saturation, of the color, and ranges from 0 (neutral gray) to 8. In writing Munsell color notations, the sequence is always hue, value, and chroma. For instance, 10YR 5/2 indicates a soil on the yellow end of the yellow-red hue, with a value of 5 (mid-range) and a chroma of 2. Each Munsell notation corresponds to a color. For example, 10YR 5/2 is grayish-brown. Mineral hydric soils have one of the following features in the horizon immediately below the A-horizon, or between 0 and 25.6 cm (10 in.), whichever is shallower: 1) a matrix chroma of 2 or less in mottled soils or 2) a matrix chroma of 1 or less in unmottled soils.

3.1.1.3 Wetland hydrology

Of the three technical criteria, wetland hydrology is generally the least exact. Field indicators are useful for confirming wetland presence but are unreliable for delineating precise wetland boundaries. Indicators of wetland hydrology include recorded data (e.g., aerial photographs, soil surveys, floodplain delineations) and field evidence such as drainage patterns (surface scouring, absence of leaf litter, eroded soil, and drift lines), sediment deposition, watermarks, visual observation of either inundation or saturated soils or both, and oxidized rhizospheres.

3.2 WETLAND CLASSIFICATION

The wetlands identified in this survey were classified according to the system developed by Cowardin et al.

(1979) for wetland and deepwater habitats of the United States. This hierarchical system describes wetlands and deepwater habitats by system, class, and subclass. Additional modifiers are added for water regime, chemistry, soil, and disturbances. The systems are marine, estuarine, riverine, lacustrine, and palustrine. The marine and estuarine systems are oceanic and coastal and thus do not occur on ORR. The lacustrine and riverine systems encompass freshwater lakes and rivers/streams respectively. The palustrine system includes nontidal wetlands dominated by trees, shrubs, persistent emergents, and/or emergent mosses or lichens and includes vegetated wetlands traditionally called by such names as marsh, swamp, bog, fen, and pond.

The palustrine system includes five classes which are vegetated, and are thus considered as wetlands under the USACE definition (1987): (1) aquatic bed (dominated by submerged or floating plants), (2) mossBlichen, (3) emergent (dominated by herbaceous plants that rise above the water surface), (4) scrubBshrub (dominated by shrubs and saplings), and (5) forested. Subclasses of the vegetated classes indicate differences in vegetative form, such as broad-leaved or needle-leaved, deciduous or evergreen, and persistent (species that normally remain standing at least until the beginning of the next growing season) or nonpersistent (plants that fall to the surface of the substrate or below the surface of the water at the end of the growing season). Water regime modifiers include temporarily flooded (A); saturated (B); seasonally flooded (C); semi-permanently flooded (F), and permanently flooded (H).

3.3 FIELD SURVEY

Existing maps, reports, and other information sources were consulted to determine potential and known wetland locations (i.e., stream bottoms, floodplains, topographic depressions, other surface water features). The potential and known wetland locations were field surveyed on between September 5 and 18, 1997 by Barbara Rosensteel. The survey areas were:

1.) White Oak Creek bottomland from Bethel Valley Road to the head of the stream;
2.) White Oak Creek north tributary 2 (WONT2) from White Oak Creek to the site boundary;
3.) White Oak Creek north tributary 1 (WONT1): The entire stream bottom and subdrainages;
4.) Bear Creek south tributary 2 (BCST2): The stream bottom from Bear Creek Road to the head of the stream.

The wetland boundaries identified during this survey were not physically marked (i.e., with flagging or stakes) in the field and were not located by engineering (e.g., civil) survey or other ground location method (i.e., Global Positioning System). Therefore, the wetland boundaries are approximate and the areal sizes are estimates. The accuracy of the size estimates is limited by the large scale and 20-foot elevation contours of the site map available for wetland mapping.

3.4 FINDINGS AND DISCUSSION

3.4.1 Wetland Survey Findings

Eight wetland areas were identified in and near the boundary of the proposed NSNS site (Table 3-2). Five of the wetlands are in the White Oak Creek watershed and are fully or partially within the site boundary. Two wetland areas were identified in the upper reach of White Oak Creek upstream of the powerline ROW, which is outside of the site boundary. One wetland area is in the riparian zone of Bear Creek south tributary 4 which is downslope of the site boundary. The wetlands are shown in Figure 3-1. Data sheets which include vegetation, soils, and hydrology data for each of the wetlands are in Appendix 1.

Table 3-2. Jurisdictional wetlands identified on and adjacent to the proposed NSNS site.

Wetland	Watershed	Estimated Area (acres)	Wetland Class	Within the proposed site boundary
WOM14	White Oak Creek	0.03	PEM1	YES
WOM15	White Oak Creek	0.09	PEM1F	YES
WOM16	White Oak Creek	1.60	PFO1C	YES
WOM17	White Oak Creek	0.15	PFO1C	NO
WOM18	White Oak Creek	<0.03	PEM1C	NO
WONT1-1	White Oak Creek	2.7	PFO1C	YES
WONT2-1	White Oak Creek	<0.01	PEM1	YES
BCST2-1	Bear Creek	0.35	PFO1C/PEM1C	NO

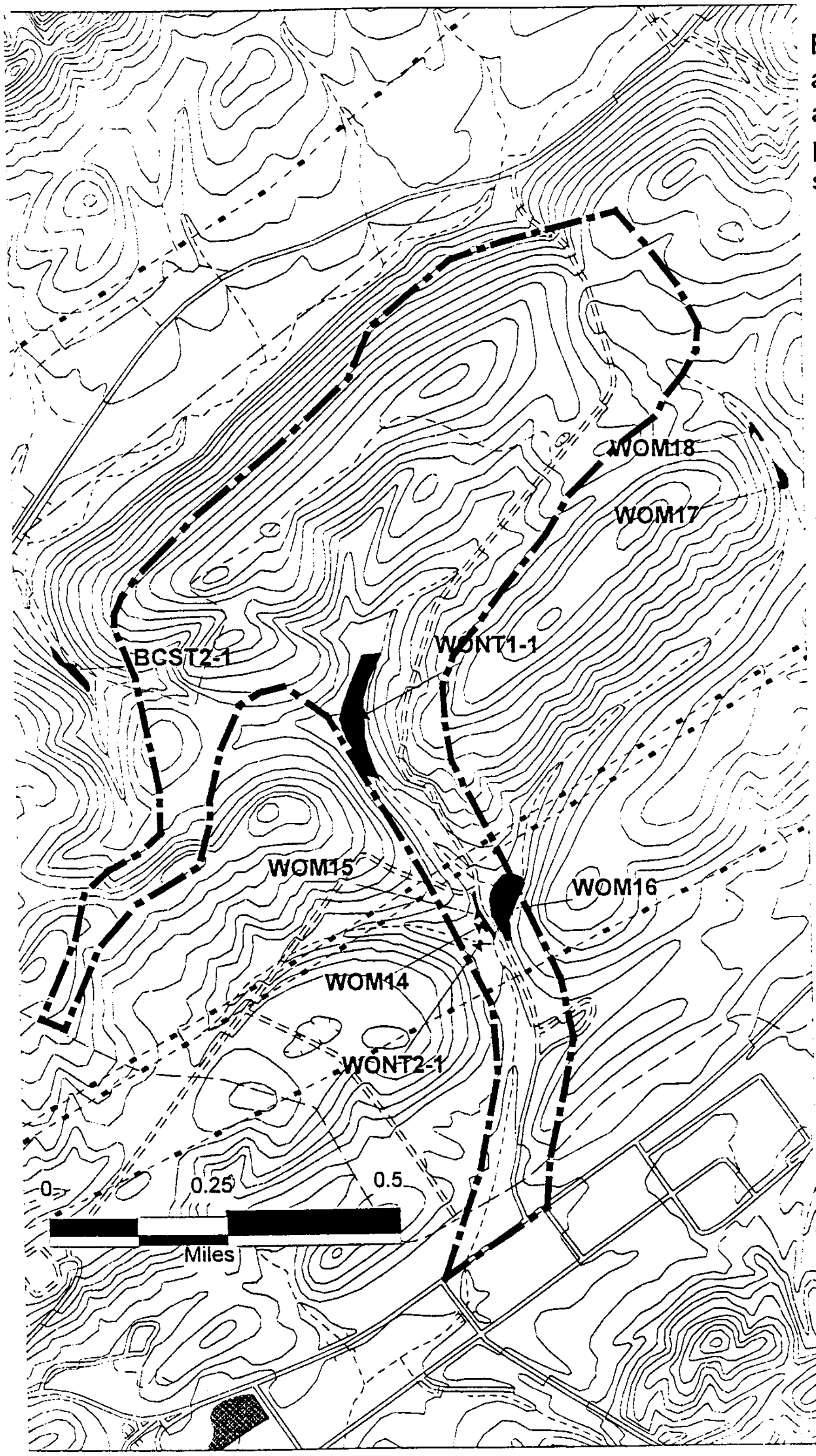

Fig.3-1. Wetland areas within and adjacent to the proposed NSNS site.

LEGEND

- Wetlands
- NSNS Site Boundary

Base Data:
ORNL Shared Data Initiative (SDI)

Map Composition:
September, 1997
D.Awl
JAYCOR Environmental

A small emergent wetland (WONT2-1) was identified along White Oak Creek north tributary 2. An old road, currently unused and overgrown, crosses the tributary near it's confluence with White Oak Creek. The emergent wetland has developed in a low spot in the road where it crosses the stream (although a culvert is present at the crossing). Surface runoff and seasonal flood waters collect in and flow through the wetland area. Species in the wetland include smartweed (*Polygonum* sp.; OBL or FACW), false nettle (*Boehmeria cylindrica*; FACW), microstegium (*Microstegium vimineum*; FAC+), and sedges (*Carex* spp.; OBL or FACW). This wetland area is estimated to be less than 0.01 acre in size and appears to be fully within the site boundary.

An emergent wetland swale (WOM15) is immediately adjacent to Chestnut Ridge Road near the White Oak Creek crossing. The swale begins at a spring. The spring discharge flows through a swale on the side of the road and empties into White Oak Creek. Shrubs such as alder (*Alnus serrulata*; FACW+) and elderberry (*Sambucus canadensis*; FACW-) are growing along one side of the swale. The swale is vegetated with numerous OBL and FACW species including watercress (*Nasturtium officinale*; OBL), great lobelia (*Lobelia siphilitica*; OBL), cardinal flower (*Lobelia cardinalis*; OBL), turtlehead (*Chelone glabra*; OBL), smartweed (*Polygonum* sp.; OBL or FACW), and sedges (*Carex* spp.; OBL). The estimated size of the wetland is less than 0.1 acre. It is fully within the site boundary.

An emergent wetland (WOM14) was identified in an isolated depression. The depression is adjacent to the wetland swale (WOM15), but is separated from it by a vegetated berm. The berm may have been made during road construction. The depression does not appear to have a surface outlet to the swale or to White Oak Creek. There was no water in the depression on the day of the survey, but it is likely that it holds precipitation and surface runoff during the winter and spring and during periods of rain in the summer. The soil had hydric characteristics. Species included a fescue (*Festuca arundinaceae*), false nettle (*Boehmeria cylindrica*; FACW), smartweed, Frank's sedge (*Carex frankii*; OBL), and other sedges. The estimated size of this wetland area is less than 0.03 acre. This wetland is fully within the site boundary.

A forested wetland (WOM16) was identified in a seep area along White Oak Creek immediately adjacent to the east side of Chestnut Ridge Road. This wetland area had initially been designated a Research Park Reference Area, but is now within Research Park Natural Area 55. *Carex leptalea* and *Bartonia paniculatum*, two species that are uncommon in east Tennessee, occur in this wetland. Dominant or common plant species in this wetland include sycamore (*Platanus occidentalis*; FACW-), red maple (*Acer rubrum*; FAC), green ash (*Fraxinus pennsylvanica*; FACW), spicebush (*Lindera benzoin*; FACW), microstegium, false nettle, cardinal flower, bugleweed (*Lycopus virginicus*; OBL), smartweed, and hog peanut (*Amphicarpa bracteata*; FAC). The estimated size of this wetland is 1.6 acres. Most or all of this wetland is within the site boundary.

A forested wetland (WOM17) and a small, fringe, emergent wetland (WOM18) were identified in the upper reach of White Oak Creek. The forested wetland occurs in a seep area that appears to contribute a significant portion of the baseflow of upper White Oak Creek during this time of year. The stream channel was dry upstream from the ROW for about half the length of this portion of the stream. Upstream of this dry reach, there was flowing water that was contributed by springs and seeps along this part of the stream bottom. The stream channel was once again dry in the uppermost reach a short distance upstream of WOM18. Water levels in these headwater streams would be expected to be at or near their lowest level at this time of year. At other times of year, the entire stream channel would be expected to have flowing water.

The dominant vegetation species in WOM17 included sweetgum, red maple, ironwood, smartweed (*Polygonum punctatum*;), cardinal flower, microstegium, false nettle, and poison ivy (*Toxicodendron radicans*; FAC). The area was saturated and there was flowing water in surface channels. The approximate size of this wetland area is around 0.10 acre. This wetland is outside of the site boundary.

WOM18 consists of a narrow fringe (2' -3' wide) of emergent wetlands on the edge of the stream channel. This section of stream contained flowing water. Dominant species included microstegium, cardinal flower, smartweed, bugleweed, and sensitive fern (*Onoclea sensibilis*; FACW). The approximate size is less than 0.01 acre.

A forested wetland (WONT1-1) is located in the riparian zone of White Oak Creek north tributary 1 (WONT1). This tributary drainage is in Natural Area 55. The tributary is located in a forested drainage on the west side of Chestnut Ridge Road north of the powerline right-of-way (ROW). The stream crosses the powerline, flows through a culvert under Chestnut Ridge Road, and empties into White Oak Creek in the WOM16 wetland area south of the powerline ROW. The wetland is located along the middle reach of the stream. The size of the wetland area is roughly 2.5 acres. This wetland area is fully within the site boundary.

The primary water source for this wetland is groundwater in the form of perennial seeps and a seasonal high water table. Overbank flooding is a seasonal, but not a sustaining, source of water. Dominant species include sycamore, red maple, sweetgum (*Liquidambar styriciflua*; FAC), green ash, bugleweed, cardinal flower, and cinnamon fern (*Osmunda cinnamomea*; FACW). At a perennial seep which spread out over a wide area, the dominant species included smartweed, watercress, bugleweed, cutgrass (*Leersia oryzoides*; OBL), leathery rush (*Juncus coriaceous*; FACW), avens (*Geum* sp.; FACW- or FAC), and sticktights (*Bidens* sp.; OBL or FACW).

In the riparian zone of Bear Creek south tributary 4 are three small areas of forested wetlands and emergent wetlands at streamside seeps. These three areas are close together along the stream and were combined into one wetland area (BCST2-1) for purposes of mapping and description. The approximate size of the wetland area is 0.3 acre. It is downslope of, but not within, the site boundary. Dominant species include green ash, red maple, spicebush, microstegium, poison ivy, woodreed (*Cinna arundinacea*; FACW), and Virginia knotweed (*Tovara virginiana*; FAC).

3.4.2 Functional Assessment

The following section provides a brief description of the wetland functions that could be performed by the on-site wetlands. A qualitative assessment of these functions in the on-site wetlands was based on best professional judgement. A thorough wetland functional assessment is outside of the scope of the current work.

Wetland functions are physical, chemical, and biological processes or attributes of wetlands that are vital to the integrity of the wetland system (Adamus et al. 1991). Wetland functions include groundwater recharge and discharge, floodflow alteration, sediment stabilization, nutrient removal and transformation, sediment and toxicant retention, production export, and provision of wildlife and aquatic species habitat. Not all functions will be performed in every wetland. The factors that affect the performance of wetland functions are numerous and include geographic and topographic location; wetland position in the watershed; and physical, chemical, and biological characteristics of the wetland.

Wetland functions, as described by Adamus et al. (1991), include the following ones that could be present in headwater wetlands:

Floodflow Alteration - Floodflow alteration is the process by which peak flows from runoff, surface flow, groundwater interflow and discharge, and precipitation enter a wetland and are stored or delayed from their downstream movement. In order to provide effective storage, a wetland must not be filled to capacity with surface water. However, in developed watersheds, in the lower reaches of watersheds, and in watersheds with little wetland acreage, many wetlands become quickly saturated and filled to capacity (Adamus et al. 1991). The wetlands in the headwater areas on the site probably have limited influence on peak flows downstream because of their limited water storage capacity and small size in relation to the drainage area.

Nutrient Removal and Transformation - Nutrient removal and transformation includes the storage of nutrients (primarily macronutrients nitrogen and phosphorus) within the sediment or plant substrate, the transformation of inorganic nutrients to their organic forms, and the transformation and removal of nitrogen (Adamus et al. 1991).

The nitrogen and phosphorus loadings to the wetlands in undeveloped, forested headwater areas and other areas upstream of human activities would tend to be low; thus the opportunity for nutrient removal would be limited in the on-site wetlands. Nutrient transformation, such as denitrification of nitrogen introduced in groundwater and precipitation and conversion into organic forms, probably occurs to some degree in most of the wetlands on-site.

Sediment and Toxicant Retention - Sediment and toxicant retention is the process by which suspended solids and adsorbed contaminants are retained and deposited in a wetland. Toxicants can include heavy metals, radionuclides, pesticides, and other toxic organics (i.e., solvents and polychlorinated biphenyls). Toxicant retention is associated with sediment retention because many toxicants adsorb to solids and thus will be removed from the water column when the solids settle out. In the wetland, the toxicants can be permanently or temporarily sequestered in the sediments and in plant tissue, transferred to the atmosphere through volatilization, biochemically transformed to intermediate compounds that are less or more toxic than the parent compound, or completely mineralized to carbon dioxide and water. Sediments and associated toxicants can also be resuspended and exported from the wetland in subsequent flooding events (Adamus et al. 1991).

Because of their position in a relatively undisturbed forested headwater area, the opportunity for the sediment and toxicant reduction function to be expressed in the on-site wetlands is small. The value of this function, if it occurs, may be greatest in wetlands WOM16, WONT1-1, and BCST2-1 because of larger area and greater capacity (relative to the other on-site wetlands) for longer-term water retention and sediment settling.

Production Export - Production export refers to the flushing of organic material from the wetland to downstream or adjacent waters. Another mechanism of production export is insect emergence and consumption by vertebrates that travel out of the wetland.

The production export function may be a significant in the on-site wetlands and to the downstream aquatic system. Visual observations of the wetland and floodplain areas and the adjacent upland areas suggest that primary productivity in the shrub and herbaceous strata is greater in the wetlands, but it is not known if this translates into high production export from the sites.

Wildlife Diversity - Wildlife diversity is defined as the support of a notably great on-site diversity and abundance of wetland-dependent birds (Adamus et al. 1991). However, the focus on birds should not imply that other wildlife species, such as many furbearers (mink), other mammals (e.g., shrews), many amphibians, and some reptiles (e.g., bog turtles, water snakes), are any less important or dependent on wetlands. Therefore, wildlife diversity includes all wildlife species that are wetland-dependent or that may use wetlands on a daily, seasonal, or intermittent basis. Wildlife species present on the ORR that use wetlands include raccoons, mink, beaver, turtles, salamanders, frogs, and bird species such as the Louisiana waterthrush.

Functions provided by the wetlands found in and adjacent to the proposed NSNS site include the provision of wildlife habitat, including amphibian breeding habitat, nutrient transformation, and organic material production and export. These areas also provide plant species diversity by supporting numerous plant species that will only grow in saturated conditions. These species include great lobelia, cardinal flower, turtlehead, smartweeds, cinnamon fern, some species of orchids, and various sedges.

4.0 SUMMARY

Ecological resource surveys were conducted on the proposed site of the National Spallation Neutron Source (NSNS) on the Oak Ridge Reservation (ORR), Oak Ridge, Tennessee, by the staff of JAYCOR Environmental in March, August, and September 1997. Reconnaissance surveys for potential habitat of state- and/or federally-listed plant and animal species, and surveys for jurisdictional wetlands were conducted.

Suitable habitat was located for nine animal species listed by the State of Tennessee as in-need-of-management, one species listed as State Threatened, and one federally listed species of concern. There appears to be no habitat suitable for any fish species that have been previously documented on the ORR or for other T&E fish known to occur in the region.

The actual presence or absence of the species for which potential habitat was found should be verified through scientific surveys prior to site development activities. Surveys for threatened and endangered species should be conducted during the proper sampling season to increase the probability of documenting animals present.

On-site exploratory level surveys for potential T&E plant habitat at the proposed NSNS site were conducted in March, August, and September 1997. Ten T&E plant species were recognized as potentially occurring within the proposed NSNS site. Two T&E plant speciesXpink ladys-slipper [*Cypripedium acaule*] and American ginseng [*Panax quinquifolius*]X were verified on site during this survey. Systematic surveys of these potential habitat areas during the specified verification time-frames would be necessary to confirm the presence or absence of T&E species at specific locations on site.

The site encroaches on an Environmental Research Park designated Natural Area (NA52) and three TNC Preliminary Conservation Sites* (BSR2-10, BSR3-16, and Landscape Complex 1). The forest area on the south-east facing slope of Chestnut Ridge drains toward ecologically sensitive streams and wetlands in NA55 (Chestnut Ridge Springs Area), ARA6 (Upper White Oak Creek), BSR3-22, and BSR4-3.

A wetland survey was conducted in September 1997. Jurisdictional wetlands were identified following the U.S. Army Corps of Engineers criteria. A total of eight wetlands were identified in (5 wetlands) and adjacent to (three wetlands) the site. The estimated size of the wetlands ranges from <0.01 acre to 2.7 acres. The functions that are likely to be performed by the on-site wetlands include nutrient transformation, production and export of organic material, production of invertebrates, and wildlife habitat, as well as providing plant species diversity.

Within the site boundary, one forested wetland (WOM16), an emergent wetland in a spring-fed swale (WOM15), and a small emergent wetland area in an isolated depression (WOM14) are adjacent to Chestnut Ridge Road at the White Oak Creek crossing. A small emergent wetland (WONT2-1) is in a low elevation area in an old road bed that crosses White Oak Creek north tributary 2. A forested wetland (WONT1-1) is located in the middle reach of White Oak north tributary 1 which is in the drainage to the west of Chestnut Ridge Road. Outside of the site boundary, a forested wetland (WOM17) and a fringe, emergent wetland (WOM18) were identified in the upper reach of White Oak Creek. An area of forested wetland and emergent wetland at streamside seeps was identified in the bottomland of Bear Creek south tributary 2 outside of the site boundary.

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APPENDIX 1:

WETLAND FIELD DATA SHEETS

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Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation			
State: TN **Wetland ID: WOM14** **Description: Emergent wetland in a depression in a prior disturbed area**		**County: Roane / Anderson** **Wetland Class: PEM1A**	**Date: 5 Sept 1997**
VEGETATION **Dominant Species: Trees and shrubs**	**Indicator Status**	**Dominant Species: Herbaceous**	**Indicator Status**
None		*Festuca arundinacea*	FAC-
		Boehmeria cylindrica	FACW
		Carex frankii	OBL
		Eupatorium fistulosum	FAC+
		Eupatorium coelestinum	FAC
		Sedges	OBL, FACW, or FAC
% of species that are OBL, FACW, and/or FAC: 100 **Hydrophytic Vegetation: YES**			
SOILS **Matrix**	**Mottles**	**Texture/Other**	
10YR 5/1	7.5YR 4/6	sandy silt loam / mottles are few and faint	
Hydric Soils: YES **Basis: Matrix chroma and presence of mottles**			
HYDROLOGY **Inundated: NO** **Saturated: YES** **Other indicators: Patches of bare soil indicating ponded water**		**Depth to standing water: None** **Depth to saturated soil: Surface**	
Wetland Hydrology: YES **Basis: Evidence of ponding; Moist soil following several weeks without significant rainfall**			
Atypical Situation: NO **Normal Circumstances: Possibly a manmade situation**			
Wetland Determination:	**Wetland: YES**	**Nonwetland**	
Comments: The depression in which the wetland occurs is separated from Chestnut Ridge Road and the wetland swale / spring by a vegetated berm that appears to be manmade. The depression does not have a surface outlet for water. Determined by: B. A. Rosensteel, PWS, JAYCOR			

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN **County: Roane / Anderson** **Date: 5 Sept 1997**
Wetland ID: WOM15 **Wetland Class: PEM1F**
Description: Emergent wetland in a spring run channel along Chestnut Ridge Road

VEGETATION Dominant Species: Trees and shrubs	**Indicator Status**	**Dominant Species: Herbaceous**	**Indicator Status**
Alnus serrulata	FACW	*Nasturtium officinale*	OBL
Sambucus canadensis	FACW-	*Lobelia siphilitica*	OBL
		Chelone glabra	OBL
		Carex lurida	OBL
		Mentha piperita	FACW
		Carex vulpinoidea	OBL
		Polygonum sp.	OBL or FACW
		Eupatorium fistulosum	FAC+
		Vernonia sp.	Depends on species

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS Matrix	**Mottles**	**Texture/Other**
10YR 4/1		Stony, silty sand
10YR 5/1		Silty clay

Hydric Soils: YES
Basis: Matrix chroma

HYDROLOGY
Inundated: YES **Depth to standing water: 4" in boring on bank of swale**
Saturated: YES **Water in spring run channel was 2"+ deep**
Depth to saturated soil: At surface
Other indicators: Water was flowing through the swale from a perennial spring
Wetland Hydrology: YES

Atypical Situation: NO
Normal Circumstances: YES

Wetland Determination: **Wetland: YES** **Nonwetland**

Comments: This wetland should not be confused with a roadside runoff ditch, although it probably does carry storm runoff. The water source is a perennial spring.

Determined by: B. A. Rosensteel, PWS, JAYCOR

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN | **County: Roane / Anderson** | **Date: 5 Sept 1997**
Wetland ID: WOM16 | **Wetland Class: PFO1C**
Description: Forested wetland along White Oak Creek on upstream side of Chestnut Ridge Road

VEGETATION Dominant Species: Trees and shrubs	Indicator Status	Dominant Species: Herbaceous	Indicator Status
Platanus occidentalis	FACW-	*Microstegium vimineum*	FAC+
Acer rubrum	FAC	*Boehmeria cylindrica*	FACW
Fraxinus pennsylvanica	FACW	*Lobelia cardinalis*	OBL
Alnus serrulata	FACW	*Lycopus virginicus*	OBL
		Polygonum sp.	OBL or FACW
		Leersia oryzoides	OBL
		Amphicarpa bracteata	FAC
		Juncus coriaceous	FACW
		Carex spp.	OBL or FACW

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS Matrix	Mottles	Texture/Other
1.) 5/N	10YR 3/3	Stony, sandy silt loam - Saturated
2.) 10YR 5/1		Gravelly silt loam - Dry
3.) 10YR 5/1	7.5YR 4/6	Sandy silt loam - Saturated

Hydric Soils: YES
Basis: Matrix chroma and mottles

HYDROLOGY
Inundated: NO
Saturated: YES, except at outer edges
Other indicators: Presence of seeps
Depth to standing water: 12-13"
Depth to saturated soil: At surface except at the outer edges of the wetland.

Wetland Hydrology: YES

Atypical Situation: NO
Normal Circumstances: YES

Wetland Determination: **Wetland: YES** **Nonwetland**

Comments:

Determined by: B. A. Rosensteel, PWS, JAYCOR

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN **County: Roane / Anderson** **Date: 5 Sept 1997**
Wetland ID: WONT2-1
Wetland Class: PEM1
Description: Emergent wetland in an old road bed where the tributary stream crosses

VEGETATION **Dominant Species:** **Trees and shrubs**	**Indicator Status**	**Dominant Species: Herbaceous**	**Indicator Status**
None		*Microstegium vimineum*	FAC+
		Boehmeria cylindrica	FACW
		Polygonum sp.	OBL or FACW
		Geum sp.	FACW- or FAC
		Carex spp.	OBL or FACW

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS **Matrix**	**Mottles**	**Texture/Other**

Unable to obtain a soil sample with the hand-held soil auger because the substrate primarily consists of the former compacted, gravel roadbed.

Hydric Soils: Inconclusive
Basis:

HYDROLOGY
Inundated: NO **Depth to standing water:**
Saturated: YES **Depth to saturated soil:**
Other indicators: Surface flow channels

Wetland Hydrology: YES

Atypical Situation: YES.
Normal Circumstances:

Wetland Determination: **Wetland: YES** **Nonwetland**

Comments: If soil has hydric characteristics, it would not be an atypical situation because all three criteria would be met. The wetland may have developed as a result of past development.

Determined by: B. A. Rosensteel, PWS, JAYCOR

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN **County: Roane / Anderson** **Date: 5 Sept 1997**
Wetland ID: WONT1-1 **Wetland Class: PFO1C**
Description: Forested wetland in an area of seeps. One seep area is dominated by herbaceous species

VEGETATION **Dominant Species: Trees and shrubs**	**Indicator Status**	**Dominant Species: Herbaceous**	**Indicator Status**
Liquidambar styriciflua	FAC+	*Microstegium vimineum*	FAC+
Acer rubrum	FAC	*Cinna arundinacea*	FACW
Alnus serrulata	FACW+	*Lobelia cardinalis*	OBL
Lindera benzoin	FACW	*Toxicodendron radicans*	FAC
		Nasturtium officinale	OBL
Herbaceous		*Juncus coriaceous*	FACW
Geum sp.	FACW- or FAC	*Lycopus virginicus*	OBL
Osmunda cinnamomea	FACW+	*Bidens* sp.	OBL, FACW or FAC
		Leersia oryzoides	OBL

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS **Matrix**	**Mottles**	**Texture/Other**
10YR 6/2	7.5YR 5/8	Silt loam

In flowing seep area, the substrate is a very stony, gravelly, sand. In one sample: 3" of an organic silty sand underlain by a gray silty sand with dark brown/ black organic streaking.

Hydric Soils: YES
Basis: Matrix chroma and mottles; Sandy layer with organic streaking; Inundation in seep areas

HYDROLOGY
Inundated: YES (in seep areas)
Saturated: YES (in seep areas)
Other indicators: surface flow features
Depth to standing water: Above surface in seep areas; no water in soil borings at upstream edges of wetland area
Depth to saturation: At surface in seep areas; soil is dry in some upstream and outer edges of wetland

Wetland Hydrology: YES

Atypical Situation:
Normal Circumstances: YES

Wetland Determination: **Wetland: YES** **Nonwetland**

Comments: The areas near the wetland margins and in upstream sections had soils with hydric characteristics, but there was no saturation of the soils on the day of the survey. This is not unexpected during the dry season when there had been no significant rainfall for several weeks.

Determined by: B. A. Rosensteel, PWS, JAYCOR

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN **County: Roane / Anderson** **Date: 16 Sept 1997**
Wetland ID: BCST2-1 **Wetland Class: PFO1C; PEM1C**
Description: An area of forested wetland and small emergent wetlands at seeps

VEGETATION Dominant Species: Trees and shrubs	Indicator Status	Dominant Species: Herbaceous	Indicator Status
Fraxinus pennsylvanica	FACW	*Microstegium vimineum*	FAC+
Acer rubrum	FAC	*Lycopus virginicus*	OBL
Liquidambar styriciflua	FAC+	*Tovara virgininana*	FAC
Carpinus caroliniana	FAC	*Cinna arundinacea*	FACW
Lindera benzoin	FACW	*Cryptotaenia canadensis*	FAC+
		Lobelia cardinalis	OBL
		Toxicodendron radicans	FAC

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS Matrix	Mottles	Texture/Other
10YR 6/1	7.5YR 4/6 and 4/4	Silt loam / Manganese concretions

Hydric Soils: YES

Basis: Matrix chroma and mottles

HYDROLOGY
Inundated: In some areas **Depth to standing water: At or near surface near stream channel; None in riparian zone.**
Saturated: Yes
Other indicators: ____________ **Depth to saturated soil: At surface ____________**

Wetland Hydrology: YES

Atypical Situation:
Normal Circumstances: YES

Wetland Determination: **Wetland: YES** **Nonwetland**

Comments: Area subject to flooding. Parts of the wetland that occur on alluvial deposits in the stream were inundated on the day of the survey. The remainder of area was not inundated, but soils were saturated.

Determined by: B. A. Rosensteel, PWS, JAYCOR

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN **County: Roane / Anderson** **Date: 18 Sept 1997**
Wetland ID: WOM17 **Wetland Class: PFO1C**
Description: A seep area in a forested riparian zone

VEGETATION

Dominant Species: Trees and shrubs	Indicator Status	Dominant Species: Herbaceous	Indicator Status
Acer rubrum	FAC	*Microstegium vimineum*	FAC+
Liquidambar styriciflua	FAC+	*Lycopus virginicus*	OBL
Carpinus caroliniana	FAC	*Lobelia cardinalis*	OBL
		Toxicodendron radicans	FAC
		Polygonum sp.	OBL or FACW
		Boehmeria cylindrica	FACW

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS

Matrix	Mottles	Texture/Other
10YR 5/1	7.5YR 4/6 and 4/4	Gravelly silt loam

Hydric Soils: YES
Basis: Matrix chroma and mottles

HYDROLOGY
Inundated: In some areas **Depth to standing water: not recorded**
Saturated: Yes **Depth to saturated soil: At surface**
Other indicators: ______________________

Wetland Hydrology: YES

Atypical Situation:
Normal Circumstances: YES

Wetland Determination:	Wetland: YES	Nonwetland

Comments: Area subject to flooding. Parts of the wetland that occur on alluvial deposits in the stream were inundated on the day of the survey. The remainder of area was not inundated, but soils were saturated.

Determined by: B. A. Rosensteel, PWS, JAYCOR

Wetland Delineation Data Sheet

Project site: Proposed site for National Spallation Neutron Source on the Oak Ridge Reservation
State: TN **County: Roane / Anderson** **Date: 18 Sept 1997**
Wetland ID: WOM18 **Wetland Class: PEM1C**
Description: Emergent wetland in a narrow band on edge of stream channel

VEGETATION Dominant Species: Trees and shrubs	**Indicator Status**	**Dominant Species: Herbaceous**	**Indicator Status**
None		*Microstegium vimineum*	FAC+
		Lycopus virginicus	OBL
		Lobelia cardinalis	OBL
		Onoclea sensibilis	FACW
		Boehmeria cylindrica	FACW

% of species that are OBL, FACW, and/or FAC: 100
Hydrophytic Vegetation: YES

SOILS Matrix	**Mottles**	**Texture/Other**
10YR 6/1	7.5YR 4/6 and 4/4	Gravelly silt loam

Hydric Soils: YES
Basis: Matrix chroma and mottles

HYDROLOGY
Inundated: No **Depth to standing water: Within a few inches of surface**
Saturated: Yes **Depth to saturated soil: At surface**
Other indicators:

Wetland Hydrology: YES

Atypical Situation:
Normal Circumstances: YES

Wetland Determination:	**Wetland: YES**	**Nonwetland**

Comments: Area subject to flooding. Parts of the wetland that occur on alluvial deposits in the stream were inundated on the day of the survey. The remainder of area was not inundated, but the soil was saturated.

Determined by: B. A. Rosensteel, PWS, JAYCOR

LA-UR-97-3095
Approved for public release; distribution is unlimited

Title: Spallation Neutron Source (SNS)
Alternate Siting Study
Preliminary Environmental Information Document for
Los Alamos National Laboratory

Author(s): Todd Haagenstad

Technical Staff Member
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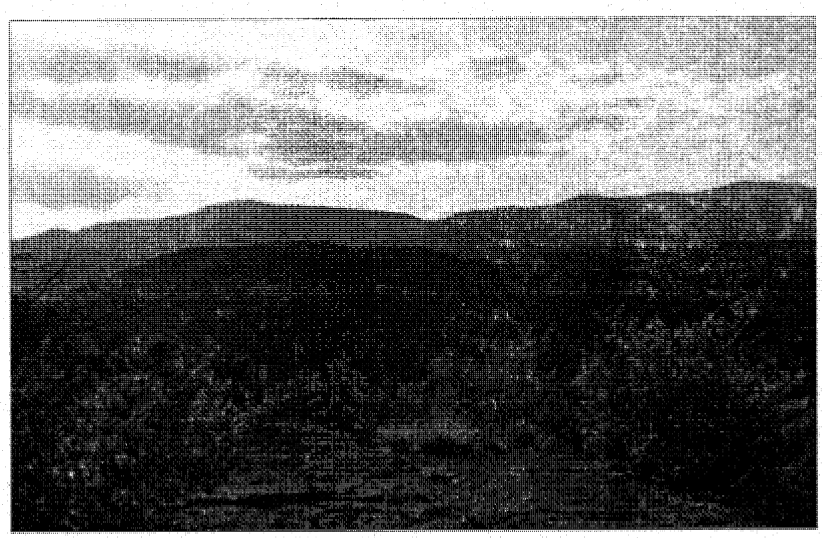
Los Alamos National Laboratory
Los Alamos, NM 87545

Submitted to: US Department of Energy
Oak Ridge Operations Office
June 5, 1998



Los Alamos
NATIONAL LABORATORY
Los Alamos, New Mexico 87545

Table of Contents

Figures:

Tables:

1.0 INTRODUCTION

This Preliminary Environmental Information Document (PEID) has been prepared and submitted by the Ecology group (ESH-20) at Los Alamos National Laboratory (LANL) as closure of a task performed in response to a request from the Department of Energy (DOE) Oak Ridge Operations Office in Oak Ridge, Tennessee. The DOE Oak Ridge Operations Office asked LANL to provide technical support in preparing an Environmental Impact Statement (EIS) for the proposed Spallation Neutron Source (SNS) facility. Through a mutual agreement with the DOE Oak Ridge Operations Office, ESH-20 has provided this PEID as closure on this task; no additional site assessment, analysis, or documentation is required.

In the SNS EIS, DOE's "preferred alternative" is to construct and operate the SNS facility at Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. DOE has also completed a process that identified suitable alternatives to the preferred alternative, and LANL was subsequently selected as one of three alternative sites. In support of this process, LANL conducted a siting study that analyzed the feasibility of constructing and operating the SNS facility at one of four different locations within LANL. Of the four potential locations, LANL has recommended analyzing a remote site located in the southeastern region of the reservation within Technical Area 70 (TA-70). The site evaluation process considered the following information in implementing the steps used to select one recommended LANL site:

- A list of the SNS facility physical design parameters
- The inventory of candidate LANL sites based on attributes and constraints
- Determination of the candidate site with the best attributes and least restrictions to accommodate the SNS facility

The information presented in this PEID is designed to provide preliminary information regarding the affected environment descriptions for the LANL alternative portion of the SNS facility EIS. This PEID presents current and existing preliminary environmental information regarding the LANL region, LANL, and the proposed SNS facility site at TA-70. Information regarding threatened or endangered species, wetlands, and cultural resources is based on recent surveys and site assessments. The individual sections of the document are intended to provide preliminary information that addresses resource topics identified as important in developing the SNS facility EIS.

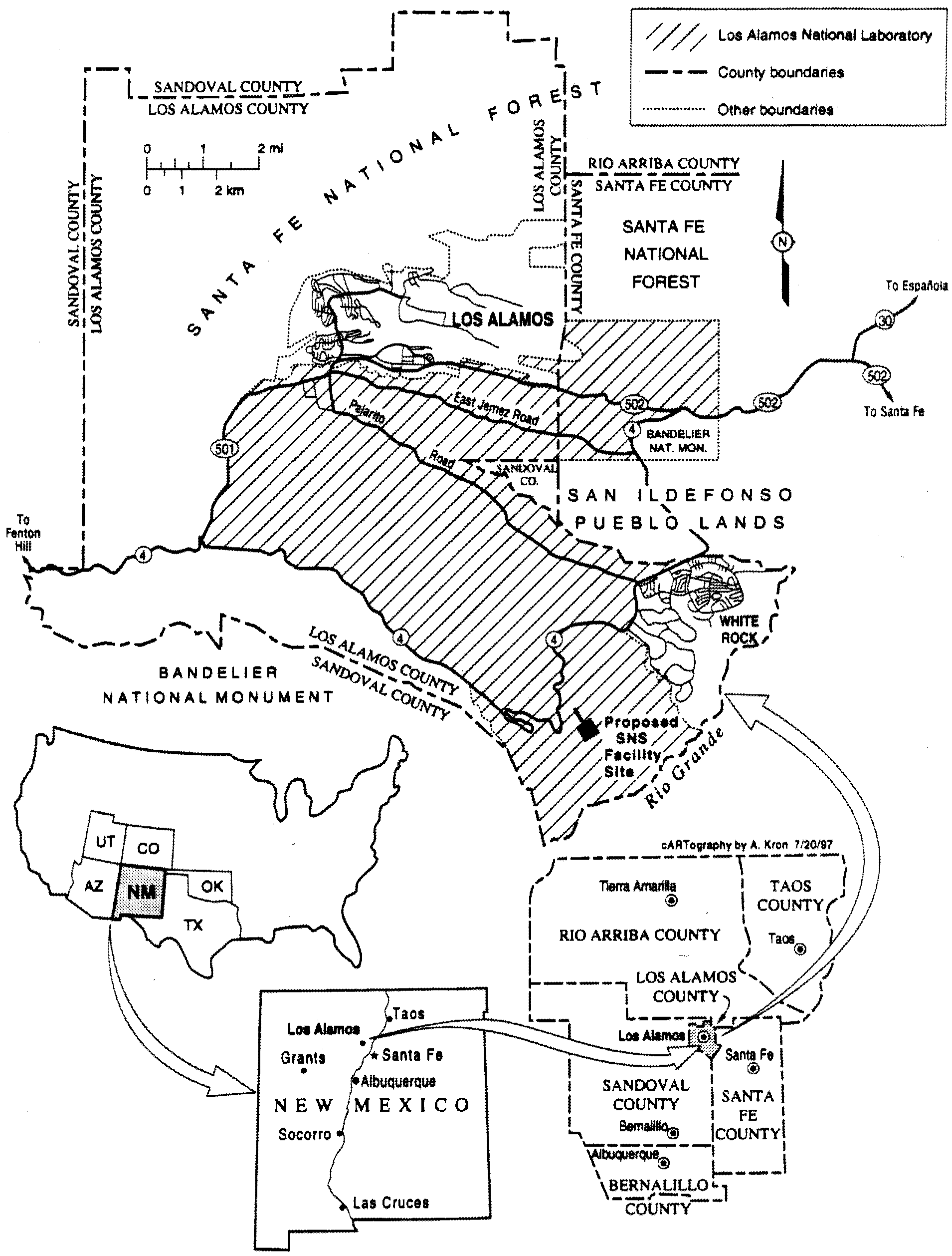
2.0 GENERAL SITE DESCRIPTION

LANL is a government-owned, contractor-operated multidisciplinary research facility that is located on 43 mi^2 (111 km^2) of land in north-central New Mexico approximately 60 mi (100 km) north of Albuquerque. It comprises a significant portion of Los Alamos County and extends into Santa Fe County (Figure 2-1).

Commercial and residential development in Los Alamos County is confined primarily to several mesa tops lying north of the core LANL facility, in the case of the Townsite, or southeast, in the case of White Rock and Pajarito Acres communities. The lands surrounding the Los Alamos County are largely undeveloped wooded areas with large tracts located to the north, west, and south of LANL administered by the U.S. Forest Service (Santa Fe National Forest), the National Park Service (Bandelier National Monument), and the Bureau of Land Management (to the east). The San Ildefonso Pueblo borders LANL to the east. The industrially developed acreage at LANL consists of approximately 30 active Technical Areas (TAs).

Recreational resources such as hiking trails, parks, and athletic facilities are abundant in Los Alamos County. Recreational opportunities such as camping, fishing, and hunting (U. S. Forest

Figure 2-1: Regional location of Los Alamos National Laboratory



Service lands) are available on the surrounding Federal lands. In 1976, the US Energy Research and Development Administration designated LANL as a National Environmental Research Park (NERP), which is used by the national scientific community as an outdoor laboratory to study the impacts of human activities on the Southwest woodland ecosystems existing at the site.

Four publicly accessible vehicle routes convey traffic to and from LANL (Figure 2-2). State Road 502 (Main Hill Road) is heavily used by commuter traffic from Santa Fe and Española. State Roads 4 and 501 provide access to LANL for small communities to the west of LANL. East Jemez Road and Pajarito Road are DOE owned and provide public access to many of the TAs at LANL. In addition to private vehicles, DOE and LANL employee and government vehicles contribute extensively to the volume of traffic on each of these roadways.

The proposed SNS facility site is located within TA-70 in the southeastern region of LANL (Figure 2-2). This is a remote and undeveloped area of LANL, situated less than 0.22 mi (.35 km) east of State Road 4. The area is situated at an elevation of approximately 6,445 ft (1,965 m) and located within a piñon-juniper woodlands with scattered juniper savannas. The mesa top is bordered by an unnamed canyon to the north, Ancho Canyon to the south, and White Rock Canyon and the Rio Grande to the east. The mesa top is unfenced and open to the public for recreational hiking and sight-seeing.

3.0 ENVIRONMENTAL FEATURES AND RESOURCES

This section of the PEID describes important environmental features and resources within the LANL region and proposed SNS facility site. The features and resources described in this section have been identified as important in developing the preliminary LANL-specific discussion in the SNS facility EIS.

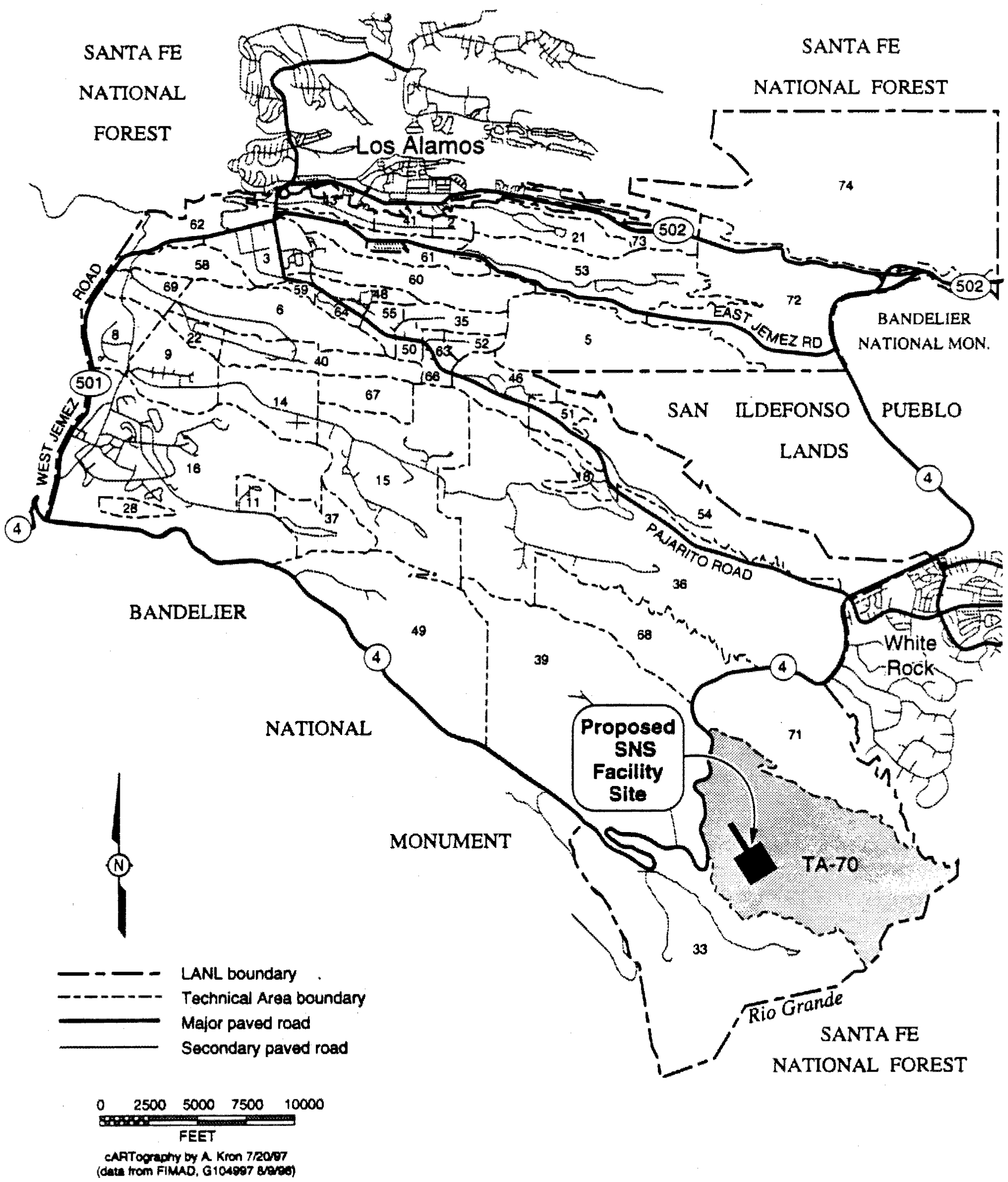
3.1 Land Use

Approximately 88 percent of the land in Los Alamos County is owned by the Federal government, including holdings controlled by DOE, the Department of Agriculture (Santa Fe National Forest), and the Department of the Interior (Bandelier National Monument). About 12 percent of the land in Los Alamos County is in private or local government ownership. Most of the private land has been developed and is a mix of residential, commercial, and industrial uses.

The majority of land within the LANL boundary has been designated as an environmental research and buffer zone. The next largest land use designation has been reserved for high explosives research and development and testing. The remaining areas of LANL are designated for use in experimental science, special nuclear materials research and development, physical support and infrastructure, waste management, and administrative and technical services.

Currently, the proposed SNS facility site is used as an environmental research and buffer zone for LANL operations. This site is remote, unoccupied, and mostly undeveloped except for an existing 115-kV electrical transmission line. Although land use policy and planning is under consideration at LANL, according to the 1990 LANL Site Development Plan, the existing land use is designated as "an undeveloped buffer area...reserved for future large-scale experimental science." The area surrounding the proposed SNS facility site has likewise been designated as an "environmental research/buffer" (LANL 1990). The proposed SNS facility site and the adjacent LANL buffer areas are not fenced. The site is open for use by the general public, and includes several unpaved paths and trails used for recreational hiking.

Figure 2-2: Location of the proposed SNS facility at Los Alamos National Laboratory



3.2 Visual Resources

The LANL region includes spectacular scenery. The orientation and geographic features of the Pajarito Plateau provide a dramatic circular view of landscapes ranging from arid desert grasslands to alpine and subalpine mountains. Looking southward from most locations at LANL, one can see the Sandia Mountains near Albuquerque, and the upper Rio Grande Valley and the Sangre de Cristo Mountains can be seen eastward and northward. The Jemez Mountains can be viewed directly west of the Pajarito Plateau. The elevation gradient from the Rio Grande to the Jemez Mountains is 12 mi (20 km), and the Pajarito Plateau is composed of a series of finger-like mesas separated by deep canyons running east to west from the Jemez Mountains towards the Rio Grande. This dramatic variation creates fascinating landscape features and supports many biologically diverse ecosystems.

The proposed SNS facility site is currently a remote and undisturbed piñon-juniper woodlands. The site is visible from State Road 4 traveling from Bandelier National Monument toward White Rock. The site is not visible from White Rock or from popular recreational use areas within Bandelier National Monument. Further visual resources analyses would be required to determine the visibility of the site from other potentially sensitive view sheds and locations within the region.

Based on a subjective assessment of the proposed SNS site, facility workers would have access to views of the Rio Grande valley and Sangre de Cristo Mountains to the northeast, east, and southeast, and could see the Jemez Mountains to the east. The Sandia Mountains near Albuquerque could be seen southward, and a mesa-top, piñon-juniper woodlands could be seen in the area surrounding the proposed SNS facility site.

3.3 Geology

3.3.1 Structure, Faults, and Fractures

The LANL site is located on the Pajarito Plateau, which is composed of very thick deposits of volcanic ash and ejected material collectively referred to as Bandeilier Tuff. On the Pajarito Plateau, the Bandelier Tuff consists of the Otowi and Tshirege members that were formed by cataclysmic eruptions from the Jemez Mountains 1.6 and 1.2 million years ago, respectively. This tuff includes ash fall, ash fall pumice, and rhyolite tuff, and ranges from welded to nonwelded. The tuff is more than 1000 ft (300 m) thick in the western part of the plateau near the Jemez Mountains, and thins to about 260 ft (80 m) at the eastern edge of the plateau above the Rio Grande.

Surface geology at the site proposed for the SNS facility is characteristic of the lower elevation mesa tops at LANL. The site has a gentile 20-degree slope from the northwest to the southeast towards White Rock Canyon and the Rio Grande. The surface of the mesa top is composed of bare tuff bedrock with interspersed areas of soil. The bedrock at this site is referred to as the Puye Formation; the specific depth of this formation at the proposed SNS site has not yet been determined.

There are two prominent canyons located adjacent to the site; Ancho Canyon, is located 0.27 mi (0.47 km) to the southwest, and an unnamed canyon is located 0.27 mi (0.47 km) to the northeast. The canyon slopes and bottoms adjacent to the site contain a variety of loose soils, cobble, and larger boulders from mass wasting of the canyon edges. The ground is considered stable at the site, and liquefaction and mass movement are generally not considered an issue.

3.3.2 Seismicity

The status and history of seismology within LANL and the surrounding region are the subject of ongoing and new investigations. Several prehistoric faults, running generally north and south along the base of the Jemez Mountains, transect the LANL site. The most prominent fault within this region is the Pajarito Fault. This fault and other regional faults are the subject of ongoing studies that are not yet conclusive. LANL researchers are in the process of updating a 1994 study that defined the extent and prehistoric activity of the regional faults. Final data regarding the history, frequency, magnitude, and probability of seismic activity at LANL are not yet available.

3.3.3 Soils

Large areas of soil are not common within the proposed SNS facility site. The majority of the site consists of exposed tuff bedrock with soils accumulated in low spots or along bedrock outcrops. Surface deposits on the mesa top include locally derived soils and, in places, a thin cover of fine-grained eolian sediment. The soil that does occur on the site has been identified as a Hackroy sandy loam. Based on current knowledge of soils at LANL, there are no prime farmlands within or directly adjacent to the proposed SNS facility site.

3.4 Climate

3.4.1 General Climate

The LANL region has a temperate, semiarid mountain climate that is strongly influenced by elevation and topography. The Pajarito Plateau has four distinct seasons. Precipitation occurs primarily during the summer and winter seasons. Los Alamos County has a semiarid, temperate mountain climate. This climate is characterized by seasonal, variable rainfall with precipitation rates ranging from 10 to 20 in. (25 to 51 cm) per year. Average minimum and maximum temperatures, based on 19- and 15-year means for the community of Los Alamos, have dropped as low as -18 F (-28 C) and have reached as high as 95 F (35 C). The average mean annual precipitation rate for Los Alamos from 1961 to 1990 was approximately 19 in. (48 cm).

3.4.2 Severe Weather

Thunderstorms are common at LANL, with 61 occurring in an average year. A thunderstorm day is defined as a day in which either a thunderstorm occurs or thunder is heard nearby. Most thunderstorm days occur during July and August, the so-called monsoon season. During this time of year, large-scale southerly and southeasterly winds bring moist air into New Mexico from the Gulf of Mexico and the Pacific Ocean. The combination of moist air, strong sunshine, and warm surface temperatures encourages the formation of afternoon and evening thundershowers, especially over the Jemez Mountains. No tornadoes have been reported to touch down in Los Alamos County.

Lightning in LANL can be frequent and intense during some thunderstorms. Because lightning can cause occasional brief power outages, lightning protection is an important design factor for most facilities at LANL and the surrounding area.

Hail is also very common at LANL during the so-called monsoon season. In fact, the area around Los Alamos has the most frequent hailstorms in New Mexico. Typically, the hailstones have diameters of about 0.25 in. (0.6 cm), with a few somewhat larger. Some storms produce measurable accumulations on the ground. Rarely, hailstorms cause significant damage to property and plants.

Large-scale flooding is not common in New Mexico. However, flash floods from heavy thunderstorms are possible in susceptible areas, such as arroyos, canyons, and low spots. Severe flooding has never been observed in Los Alamos. Light-to-moderate flooding is possible in the spring from snowmelt, although snowmelt flooding is usually confined to the larger rivers in New Mexico.

3.5 Air Quality

Air quality is a measure of the amount and distribution of potentially harmful pollutants in ambient air. The Environmental Protection Agency (EPA) has identified six criteria pollutants: carbon monoxide, lead, ozone, sulfur dioxide, nitrogen oxides, and particulate matter. The presence of forests and irregular and complex terrain in the Los Alamos area affects atmospheric dispersion of pollutants. The terrain and forests create an aerodynamically rough surface, forcing increased horizontal and vertical turbulence and other dispersion. The dispersion generally decreases at lower elevations where the terrain becomes smoother and less vegetated. The canyons surrounding LANL channel the airflow, which also limits dispersion. The frequent clear skies and light winds typical of the summer season cause daytime vertical air dispersion.

Los Alamos County, LANL, and the proposed SNS facility site are remote from major metropolitan areas and major sources of pollution. Air quality is better than ambient air quality standards set by EPA and the New Mexico Environment Department (NMED). All radioactive and nonradioactive air emissions are in compliance with the Clean Air Act and the New Mexico Air Quality Control Act (LANL 1996a).

LANL is subject to regulation under the following Federal and State air quality statutory requirements: National Emissions Standards for Hazardous Air Pollutants (NESHAP); National Ambient Air Quality Standards; New Source Performance Standards; Stratospheric Ozone Protection (SOP); and Operating Permit Program. All of these regulations, with the exception of radionuclide NESHAP and SOP, have been adopted by the State of New Mexico as part of a State Implementation Plan. The State of New Mexico Environmental Improvement Bureau, as provided by the New Mexico Air Quality Control Act, regulates air quality through a series of air quality control regulations in the New Mexico Administrative Code. These regulations are administered by NMED and define a series of permits that are issued for specific LANL operations.

3.6 Surface Water Resources

Surface water in the LANL area occurs primarily as short-lived or intermittent reaches of streams. Perennial springs on the flanks of the Jemez Mountains supply base flow into upper reaches of some canyons, but the volume is insufficient to maintain a constant surface flow across the entire length of LANL before being depleted by evaporation, transpiration, and infiltration. Runoff from heavy thunderstorms or heavy snowmelt reaches the Rio Grande several times a year in some of the major canyon system drainages within LANL. Effluents from sanitary sewage, industrial waste treatment plants, and cooling-tower blowdown enter some canyons at rates sufficient to maintain surface flows for varying distances.

There are no permanent surface water resources within 0.25 mi (0.44 km) of the proposed SNS facility site. The drainages in Ancho Canyon and the unnamed canyon are classified as intermittent riverine wetlands by the US Fish and Wildlife Services' National Wetlands Inventory. These dry and sandy drainages (arroyos) occasionally contain water after snowmelt or heavy rainstorm events. Riparian vegetation is supported in some portions of these arroyos.

Although a formal floodplain assessment has not been completed for the proposed SNS facility at LANL, the proposed SNS site does not appear to be within a 50- or 100-year floodplain.

3.7 Groundwater Resources

Groundwater in the LANL area occurs in three modes: (1) water in shallow alluvium in canyons, (2) perched water (a body of groundwater above a less permeable layer that is separated from the underlying main body of groundwater by an unsaturated zone), and (3) the main aquifer of the LANL area. Perched groundwater may occur within the Bandelier Tuff in the western portion of LANL just east of the Jemez Mountains. The source of this perched groundwater may be infiltration from streams discharging from the mouths of canyons along the mountain front and underflow of recharge from the Jemez Mountains. The main aquifer within the LANL area serves as the Los Alamos County municipal water source. Depth to the main aquifer is about 1,000 ft (300 m) beneath the mesa top in the central portion of the Pajarito Plateau. At this location, the main aquifer is separated from alluvial and perched waters by about 350 to 620 ft (110 to 190 m) of tuff and volcanic sediments with low (less than 10 percent) moisture content.

The main aquifer below the Pajarito Plateau has not officially been designated as a sole-source aquifer (class 1). However, according to specifications within the Clean Water Act, the aquifer meets all of the criteria for a sole-source aquifer. The aquifer is currently designated as a class 2 aquifer or high-quality drinking water.

LANL has not conducted a depth to groundwater assessment at the proposed SNS facility site; however, a groundwater monitoring well located directly adjacent and parallel to TA-70 indicates that the depth to the main aquifer is approximately 840 ft (257 m). The depth to groundwater at the bottom of Ancho Canyon along the southern edge of TA-70 is 600 ft (184 m).

LANL has conducted groundwater monitoring annually for several years as part of a groundwater protection program. Results of groundwater monitoring are reported annually in LANL's Environmental Surveillance Report. LANL has recently developed, and is in the early stages of implementing, a new site-wide groundwater monitoring program. The program will involve the installation of several new, strategically located, groundwater monitoring wells.

3.8 Ecological Resources

3.8.1 Terrestrial

The proposed project area and its surroundings are located on the Pajarito Plateau on the east-central edge of the Jemez Mountains. The plateau is composed of layers of volcanic sedimentary rocks, and is dissected into a number of narrow mesas by southeast-trending canyons. Most of these canyons support intermittently flowing streams. The stream drainages ultimately descend into White Rock Canyon and converge with the Rio Grande near the eastern boundary of LANL. The Rio Grande is the only permanently flowing river near the project area.

Three major vegetation zones have been identified within the boundaries of LANL; juniper savannas at the lowest elevations in White Rock Canyon, piñon-juniper woodlands at intermediate elevations on the mesas, and ponderosa pine forests at higher elevations on the mesas. Mixed-conifer forests also occur on the north-facing slopes of some canyons. Riparian zones occur in many of the drainages and along the Rio Grande. Wetlands of varying sizes also occur throughout LANL, particularly in the canyons.

LANL evaluated landscapes within a 0.25-mi (0.44-km) radius of the proposed project site, using a Geographic Information System (GIS) and site surveys. The preferred site is located on a mesa flanked by Ancho Canyon 0.27 mi (0.47 km) to the southwest and a small unnamed drainage an equal distance to the northeast. To the southeast, the Rio Grande flows through nearby White Rock Canyon, at a distance of approximately 1.2 mi (1.9 km) from the preferred site. The site is located 0.22 mi (0.35 km) to the east of State Road 4; a two-lane paved road (see Figure 2-1). Elevations within the proposed project area range from 6,410 ft (1,954 m) to 6,490 ft (1,978 m).

The vegetation in the proposed project area is dominated by piñon-juniper woodlands, with scattered juniper savannas. Additionally, much of the land in and bordering the adjacent canyons is bare rock. Overstory plant species include piñon (*Pinus edulis*) and one-seed juniper (*Juniperus monosperma*). Scattered grasses, primarily blue grama (*Bouteloua gracilis*), shrubs, and forbs are found in the understories. In sites where bedrock is near the soil surface, the most common shrubs include wavy-leaf oak (*Quercus undulata*), hedgehog prickly pear (*Opuntia erinacea*), and sticky rabbitbrush (*Chrysothamnus viscidiflorus*). In areas with deeper soils, big sagebrush (*Artemisia tridentata*) is common. Forbs on both deep and shallow soils include greenthread (*Thelesperma trifidum*), golden aster (*Chrysopsis villosa*), thelypody (*Thelypodium wrightii*), and trailing fleabane (*Erigeron flagellaris*).

3.8.2 Unique or Rare Communities

No unique or rare biological communities have been identified within LANL or within the proposed SNS facility project area.

3.8.3 Wildlife

Lists of species found to be occurring in the proposed project area are located in Foxx (1996). Rocky Mountain elk (*Cervus elaphus nelsoni*) use piñon-juniper woodlands for wintering habitat and some year-round use. Mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), grey fox (*Urocyon cinereoargenteus*), rock squirrel (*Spermophilus variegateus*), and desert cottontail (*Sylvilagus auduboni*) are common mammals. Common bird species include common raven (*Corvus corax*), scrub jay (*Aphelocoma coerulescens*), piñon jay (*Gymnorhinus cyanocephalus*), plain titmouse (*Parus inornatus*), and ash-throated flycatcher (*Myiarchus cinerascens*).

3.8.4 Special Uses and Designations

In 1976 when LANL was identified as Los Alamos Scientific Laboratory, the DOE designated the site a NERP. LANL remains a NERP site. The preferred site is currently open to the public for some recreational non-motorized uses, including hiking and picnicking.

3.8.5 Aquatic Biota

The canyons adjacent to TA-70 and the proposed SNS facility site contain some surface water. Lists of aquatic biota found within the general area can be found in Foxx (1996). There are no aquatic areas within 0.25 mi (0.44 km) of the proposed project site. Lists of aquatic biota within the general area can be found in Foxx (1996).

3.8.6 Research and Monitoring

Current monitoring programs at LANL include local and regional surveys of air quality and surface and groundwater quality. These projects at LANL involve monitoring for radionuclides and contaminants in soil, flora, and fauna, as well as estimating potential human dose exposures to radioactivity. Annual surveys are conducted for breeding birds and all threatened or endangered species that may occur on the Laboratory (LANL 1996a). Previous floristic surveys have been conducted near the proposed project site. In 1991, a biological assessment that included the proposed project area was initiated. This study was completed in 1996 (Foxx 1996).

3.9 Wetlands

The drainages in Ancho Canyon, 0.27 mi (0.47 km) to the southwest, and in an unnamed canyon, 0.27 mi (0.47 km) to the northeast, of the project area are classified as intermittent riverine wetlands by the National Wetlands Inventory. These dry and sandy drainages (arroyos) occasionally contain water after snowmelt or heavy rainstorm events. Riparian vegetation is supported in some portions of these arroyos.

3.10 Threatened and Endangered Species

Potential threatened and endangered species at LANL are listed in Table 3-1. The habitat within the proposed project area is unsuitable for Mexican spotted owl (*Strix occidentalis lucida*), black-footed ferret (*Mustela nigripes*), and southwestern willow flycatcher (*Empidonax traillii extimus*). Therefore, these species were dismissed from consideration. The proposed project area includes foraging habitat for American peregrine falcon (*Falco peregrinus anatum*) and foraging and roosting habitat for bald eagle (*Haliaeetus leucocephalus*). Previous survey results indicate that the area surrounding the preferred site is unlikely to receive concentrated use from peregrine falcons for foraging, and that nesting habitat was marginal. The nearest identified peregrine falcon nesting habitat is in White Rock Canyon, approximately 1.2 mi (1.9 km) from the preferred site. Wintering bald eagles forage and roost within White Rock Canyon and connecting canyons, including Ancho Canyon. Additionally, bald eagles, whooping cranes (*Grus americana*), American peregrine falcon (*Falco peregrinus anatum*), and Arctic peregrine falcon (*Falco peregrinus tundrius*) may use White Rock Canyon as a migration route.

Table 3-1: Threatened and Endangered Species Potentially Occurring on LANL

Species	Scientific Name	Habitat Associations
American peregrine falcon	*Falco peregrinus anatum*	Nests on cliff faces. Forages in all habitat types within LANL.
Whooping crane	*Grus americana*	Migrates along Rio Grande in White Rock Canyon.
Southwestern willow flycatcher	*Empidonax traillii extimus*	Inhabits riparian areas with established willow stands.
Black-footed ferret	*Mustela nigripes*	Inhabits established prairie dog towns.
Arctic peregrine falcon	*Falco peregrinus tundrius*	Potentially migrates along the Rio Grande in White Rock Canyon.
Bald eagle	*Haliaeetus leucocephalus*	Inhabits riparian areas along permanent water ways such as lakes and rivers.
Mexican spotted owl	*Strix occidentalis lucida*	Inhabits multistoried mixed conifer and ponderosa pine forests.

3.11 Cultural Resources

3.11.1 Background

Los Alamos County, including LANL, is rich in cultural resources that include archeological sites, historic buildings and sites, and Traditional Cultural Properties (TCPs). As required under Executive Order 13007, the four Accord Pueblos with whom DOE has formal agreements (Cochiti, Jemez, Santa Clara, and San Ildefonso) and the Mescalero Apache, have been asked to identify any sacred or TCP issues that may apply to various locations throughout LANL. The TCP data are considered extremely sensitive data, and are under the control of the DOE Albuquerque Field Office in Albuquerque, New Mexico.

For the purpose of cultural resources assessment in this PEID, a "site" is defined as a location where a significant human activity has occurred. The visible indications of such behavior may include (but not be limited to) bedrock mortars, game traps, petrogylphs, steps and roads, water-catching devices as well as habitations, terraces, shrines, and artifact scatters. For an artifact scatter to be defined as a site, the artifacts present must be indicative of purposeful human use of the area, that is, they must be present in either variety, quantity, or integrity of location to show that the area in which they are located is a loci of cultural activity. In general, all artifact scatters are considered as sites unless they, by their topographical situation, have obviously been transported by natural environmental forces away from clearly defined sites. Artifact scatters that are associated with clearly defined sites will be included in descriptions of the parent site. Artifacts located during survey, which do not meet these criteria, have been noted and described as isolated occurrences (IOs). For example, lone projectile points, artifacts washed downslope from obvious nearby sites and pot drops (potsherds obviously derived from the same vessel) have not been recorded as sites but as IOs. The area of potential effect (APE) for the SNS project contains numerous IOs, mostly lithic debris collecting in shallow drainages. These were not recorded as separate sites and are likely to be the result of moderate to severe erosion in the APE as well as a diffuse prehistoric use of the area.

3.11.2 Survey Results

Approximately 65 percent of the proposed SNS facility site, or APE, was surveyed for cultural resources. The total APE was estimated to be 70 ac (28 ha), including a 100-ft (30.5-m) buffer area around the project. The survey was accomplished by linear pedestrian transects spaced 16-33 ft (5-10 m) apart. All cultural features were noted and entered into a computerized database and GIS. A total of 5 archaeological sites were found in the 70 acres surveyed. The site number, site type, size, cultural affiliation, and National Register eligibility, are found in Table 3-2.

Table 3-2: Cultural Resource Assessment Survey Results

Laboratory of Anthropology Site Number	Field Site Number	Site Type	Site Size	Time Period	National Register Eligibility
LA12676-B	Parp-34	Field House	1-2 rooms	Coalition	Yes Criterion D
LA12676-C	Parp-33/L-153	Pueblo	8-10 rooms	Early Coalition	Yes Criterion D
(not assigned)	L-154	Pueblo	2-4 rooms	Classic	Yes Criterion D
LA6786	LA6786	Pueblo	6-8 rooms	Early Coalition	Yes Criterion D
(not assigned)	L-155	Field House	1 room	Classic	Yes Criterion D

3.12 Socioeconomic Environment

3.12.1 General Description

A socioeconomic assessment focuses on the social, economic, and demographic characteristics of an area. The socioeconomic environment can be affected by changes in employment, income, and population, which, in turn, can affect area resources such as housing, community services, and infrastructure.

Preliminary figures for 1995 indicated that Los Alamos County had an estimated population of 18,604 (Sunwest 1996, preliminary figure for 1995). Statistics for population, housing, and public infrastructure are based on the region of influence (ROI), a three-county area in which approximately 90 percent of LANL employees reside. This figure includes University of California, Johnson Controls, Inc., and Protection Technology of Los Alamos employees only; residence and employment figures do not include contract labor, affiliates, or special program guests. The ROI includes the counties of Los Alamos (with 50.4 percent of LANL employees), Rio Arriba (21.0 percent), and Santa Fe (18.3 percent) (LANL 1997). The ROI experienced a population growth of approximately 13.6 percent between 1990 and 1995, with a 1995 total population of about 172,000 persons (Sunwest 1996). Preliminary estimates indicate that by the year 2000, population in the ROI is expected to be approximately 195,000 persons (projection is based on figures in Sunwest 1996).

In January 1996, LANL employed approximately 8,936 persons in the ROI accounting for 10.4 percent of the total ROI employment (85,721) (LANL 1996b and Sunwest 1996). Nonagricultural employment in New Mexico increased by 4.9 percent in 1995; Los Alamos and Santa Fe counties had a 2.9 percent increase. Unemployment in the ROI for 1995 was 5.76 percent (Sunwest 1996). Information regarding employment status within the ROI for 1995-1997 is not available at this time.

3.12.2 Housing

The number of vacant housing units in the ROI increased from approximately 4,358 units in 1980 to 6,872 units in 1990, a 58 percent increase in ten years (BER 1992). In the year 2000 there would be about 10,858 total vacant units if current trends continue, however, more current figures are not available at this time.

3.12.3 Public Services

Los Alamos County is responsible for residential and commercial distribution of gas, water, electricity, and sewer services to the community on the north side of Los Alamos Canyon Bridge. DOE currently owns and operates all utilities on the south side of Los Alamos Canyon Bridge on LANL property. DOE also owns and operates the Los Alamos County-wide water production and distribution system. Transfer or lease of the water production system to Los Alamos County is being contemplated. The utilities usage and capacity are presented in Table 3-3.

In 1985, DOE and Los Alamos County agreed to pool their electrical generating and transmission resources and to share costs based on usage. Electrical power sources for the Los Alamos Resource Pool include a number of coal, natural gas, and hydroelectric power generators throughout the western United States. As needed, power can also be generated locally at LANL's TA-3 power plant that has an approximately 9- to 12-MW maximum output. Although power generation at the various sources is not a problem, regional and contractual electrical power transmission limitations have affected the amount of power available for DOE, LANL, and Los Alamos County.

Preliminary estimates indicate that approximately 3,550 students are enrolled in Los Alamos public schools (19 percent of Los Alamos County's population) (LAPS 1997). The ratio of uniformed police officers to residents is currently 1 to 581 (LAPD 1997). The ratio of uniformed firemen to residents is 1 to 177.

Most of the revenue (approximately 73.6 million dollars) generated by Los Alamos County in fiscal year 1996 (June 1995 through July 1996) can be broken down as follows: 53 percent from utilities, 15 percent from gross receipts tax, 11 percent from the DOE fire contract, 7 percent from investment income, 4 percent from DOE assistance payments, and 4 percent from property taxes. The remaining revenue comes from other taxes, other service charges, and other intergovernmental sources (LA Finance Department 1997).

In October 1996, the President signed the Energy and Water Development Appropriations Act of 1997 authorizing a lump sum payment to Los Alamos County of about 22.6 million dollars. This payment is a buyout of DOE assistance payments in compliance with the Atomic Energy Commission Act. The last monthly assistance payment was made in June 1997. On April 15, 1997, Los Alamos County received the largest portion of the buyout money, 17.6 million dollars. The remaining 5 million dollars is subject to future transfers of DOE facilities to Los Alamos County, including the water system and the airport.

Table 3-3: Utilities: Usage and Capacity

Utilities	LANL	Los Alamos County
Electrical	peak Los Alamos Resource Pool usage per hour - 76 MW[c] (LANL metered usage – 366,158 MWh per year[a]) peak Los Alamos Resource Pool capacity - (maximum output per hour) - 104 to 119 MW	peak Los Alamos Resource Pool usage per hour - 76 MW[c] (County metered usage - 87,139 MWh per year[b]) peak Los Alamos Resource Pool capacity - (maximum output per hour) - 104 to 119 MW
Water	usage- 262,955,000 gallons per year[a] (*995,284,670 liters*) capacity- 1,406,058,000 gallons yearly production[a] (*5,321,929,500 liters*) [includes both the LANL and County water supply] (DOE water rights - 5,541.3 ac-ft/year* from main aquifer. DOE can buy an additional 1,200 ac-ft/year from San Juan-Chama Transmountain Diversion Project[d])	usage- 970,195,000 gallons per year[b] (*3,672,188,000 liters*) capacity- see LANL water capacity
Natural Gas	usage- 1,365,996 million Btu per year[a] capacity (contractual)- 10,000 million Btu per day or 3,650,000 million Btu per year[a]	usage- 1,059,420 million Btu per year[b] capacity (contractual)- 10,101 million Btu per day or 3,686,865 million Btu per year[e]

a Information from Jerome Gonzales, LANL FSS-8, personal communication, 4/16/97.

b Information from John Arrowsmith, Los Alamos County Utility Department, Final Sales Revenue Report: Electric, Gas, and Water (County FY96).

c Information from Mark Hinrichs, LANL FSS-8, personal communication, 5/9/97; FY 96 Los Alamos Resource Pool data (numbers reflect combined LANL and County peak usage per hour).

d Information from Timothy Glasco, Los Alamos County Utility Department, personal communication, 4/15/97, and Jerome Gonzales, LANL, FSS-8, personal communication, 4/23/97.

e Information from Los Alamos County's Utility Department for County FY96, Chris Ortega, personal communication, 4/15/97.

* 1,805,909,670 gallons per year or 6,835,368,100 liters per year

3.12.4 Transportation

Highways provide the primary access to LANL and the rest of Los Alamos County from the Rio Grande Valley, Santa Fe, and Albuquerque. Los Alamos has no bus or rail connections, but commuter air service is available between Los Alamos and Albuquerque. Slightly less than half of the employees at LANL commute from Santa Fe, Española, and other areas in the region.

Highway access to the Los Alamos County is by State Road 4 from the west and State Road 502 from the east. There are four main access points to LANL, which convey about 40,000 average daily trips (ADTs). They are Diamond Drive across the Los Alamos Canyon bridge (28,000 ADTs), Pajarito Road (8,000 ADTs), East Jemez Road (6,000 ADTs), and State Road 4/West Jemez Road from the west (1,000 ADTs).

The proposed SNS facility site can be accessed from State Road 4 via a primitive dirt road through a three-strand barbed wire fence with a locked gate. State Road 4 is used by LANL employees accessing experimental sites in the southern and southeastern reaches of LANL. The general public uses State Road 4 to access the Jemez Mountains, White Rock, and Bandelier National Monument. The traffic on the section of State Road 4 between White Rock and Bandelier National Monument is generally considered to be light, however, the road may receive slightly more use during the summer tourist season (May through September).

3.13 Ambient Noise

Noise is defined as unwanted sound. Sound is a form of energy that travels as invisible pressure vibrations in various media, such as air. The auditory system of the human ear is specialized to sense the sound vibrations. Noise is categorized into two types: *Steady-State Noise* which is characterized as longer duration and lower intensity such as a running motor and *Impulse or Impact Noise* which is characterized by short duration and high intensity such as the detonation of high explosives. The intensity of sound is measured in decibel (dB) units. In sound measurements relative to human auditory limits, the decibel scale is modified into an A-Weighted Frequency scale (dBA).

Noise measured at LANL is primarily from occupational exposures. These measurements take place inside buildings and are made using personal noise dosimeters and instruments. Occupational exposure data are compared against an established Occupational Exposure Limit (OEL). LANL defines the OEL administratively as noise to which a worker may be exposed for a specific work period without probable adverse effects on hearing acuity. The OEL for steady-state and impulse or impact noise at the Laboratory is based on U. S. Air Force Regulation 161-35, "Hazardous Noise Exposure," which has been adopted by DOE. The maximum permissible OEL for steady-state noise is 84 dBA for each 8-hour work period. The OEL for impulse/impact noise is not fixed because the number of impacts allowed per day would vary depending on the dBA of each impact. LANL Action Levels for steady-state noise and impulse/impact noise are 80 dBA for each 8-hour day and 140 dBA, respectively. The Action Levels trigger the implementation of a personnel hearing conservation program.

Environmental noise exposure is measured outside of buildings. The sound levels measured vary and are dependent on the generator. The following are typical examples of sound levels (dBA) generated by barking dogs (58), sport events (74), local cars (63), aircraft overhead (66), children playing (65), and birds chirping (54). LANL sources of environmental noise consist of background sound, vehicular traffic, routine operations, and periodic high-explosive testing. Measurements of environmental noise in and around LANL average around 80 dBA. Some measurements have been made to evaluate environmental impacts from operational and high-explosive detonation noise. For example, the peak noise level measured at one of LANL's explosives test facilities from a 20-lb (9-kg) trinitrotoluene (TNT) explosion ranged from 140 to 148 dBA at a distance of 750 ft (229 m).

The values from limited ambient environmental sampling in Los Alamos County are within the expected sound levels (55 dBA) for outdoors in residential areas. Background sound levels at the White Rock community ranged from 38 to 51 dBA (Burns 1995) and 31 to 35 dBA at the entrance of Bandelier National Monument (Vigil 1995). The minimum and maximum values for Los Alamos County in this study were 40 dBA and 96 dBA, respectively.

Ambient noise levels at the proposed SNS facility site have not been recorded. However, given the remoteness of the site and the distance from industrialized or populated areas, the ambient noise levels are generally considered low. Test shots conducted within the explosives testing areas west of the site may be vaguely heard on occasion.

3.14 Radiation Environment

The radiation environment at LANL and the surrounding communities is continuously monitored and characterized. These results are reported in annual LANL environmental surveillance reports (LANL 1996a). Air emissions are routinely sampled at locations on LANL property, along the DOE boundary perimeter, and in more distant areas that serve as regional background stations. Atmospheric concentrations of radioactive nuclides (radionuclides) are measured to estimate internal radiation doses. Thermoluminescent dosimeters are used to determine external penetrating radiation doses in the area. Background dose estimates are subtracted from the measured values to determine the effective dose equivalents (EDE) to the public outside the site boundary and at the nearest residence. The EDE is a term for the estimated radiation dose to the whole body that would result from a dose to any one or more body organs.

The radiation environment at LANL consists of both (1) natural background radiation and induced background levels of radioactivity in the surrounding communities and (2) the workers' radiation environment within their work areas. All individuals are subject to some irradiation although they may not work with radioactive substances. The annual average EDE from background and induced radiation for 1995 to nearby residents in Los Alamos and White Rock was 349 mrem and 336 mrem, respectively (LANL 1996a). The average EDE attributable to 1995 LANL operations was 0.5 mrem and 0.2 mrem for residents in Los Alamos and White Rock, respectively (LANL 1996a). The maximum annual dose to a potentially exposed member of the public from 1995 LANL operations is estimated to be approximately 2.3 mrem per yr. DOE's public dose limit is 100 mrem per yr EDE from all pathways, and the dose received through the air pathway is restricted by EPA's dose standard of 10 mrem per year. Table 3-4 summarizes the various estimated annual exposures to the public associated with LANL operations during 1995. The annual average EDE from background and induced radiation for the proposed SNS facility site has not been specifically calculated as part of this PEID.

Table 3-4: Summary of Annual Effective Dose Equivalents for 1995

Dose Source	Maximum Dose to an Individual[a,b]	Average Dose to Nearby Residents; Los Alamos and White Rock		Collective Dose to Population within 50 mi (80 km) of LANL[b]
Dose Attributable to LANL Operations	2.3 mrem	0.5 mrem	0.2 mrem	3.2 person-rem
Background Dose	349 mrem	349 mrem	336 mrem	82,000 person-rem

a Maximum dose to an individual is the dose to any individual at or outside LANL where the highest dose rate occurs (i.e., residence north of TA-53).

b Doses reported are average doses.

Source: (LANL 1996a)

3.15 Waste Management and Environmental Restoration

3.15.1 Waste Management

LANL and Los Alamos County have established procedures for maintaining compliance with applicable laws and regulations for collecting, storing, processing, and disposing of industrial and municipal solid waste. LANL's solid sanitary waste is disposed of at the Los Alamos County landfill, which is operated by Los Alamos County on DOE property within LANL. Preliminary estimates indicate that LANL disposes of an average of about 31,270 yd^3 (23,910 m^3) of solid waste annually at the County landfill (DOE 1996). Current preliminary estimates indicate that this landfill has an expected use life of about 15 more years. Trash from commercial companies in Los Alamos County is collected in County trucks on a regular, and special request, basis and disposed of at the County landfill. In 1996, about 20,000 yd^3 (15,300 m^3) of commercial trash was disposed of at the County landfill. Rubble from LANL, the County, contractors, and individuals is accepted at the County landfill. In 1996, 15,600 tons (14,200,000 kg) of rubble were disposed of at this location. Los Alamos County also maintains a separate location at the landfill for construction debris that is available for reuse by individuals or companies. In 1996, about 5,870 tons (5,340,000 kg) of construction debris were disposed of at the County landfill. Another location within the Los Alamos County landfill is used to process green waste such as tree limbs, brush, leaves, and grass. This material is shredded and some of it is composted on-site. The processed materials are available to the public, schools, County, and LANL for use as a ground cover or soil conditioner. About 13,200 yd^3 (10,100 m^3) of green waste was disposed of at the County landfill in 1996 (LAC 1996).

LANL operates a low-level waste disposal area at TA-54 for the management of radioactive wastes generated by LANL activities. There is no permitted treatment, storage, and disposal facility in New Mexico for radioactive waste generated by commercial companies, hospitals, and universities. Envirocare Inc., a facility in Utah, may accept radioactive waste from these types of generators.

Los Alamos County operates two sanitary wastewater treatment facilities, one in White Rock and one in Bayo Canyon. The latter sewage treatment plant processes the sewage from Los Alamos Townsite. Nearly all of the sanitary wastewater generated at LANL goes to the LANL Sanitary Wastewater Systems Consolidation (SWSC) plant at TA-46. Table 3-5 shows the preliminary estimates of volume of sewage processed each day at these three sewage treatment plants and the capacity of the three plants.

Table 3-5: Sanitary Sewer Usage and Capacity

Facility	Usage (gal per day)	Capacity (gal per day)	Usage (liters per day)	Capacity (liters per day)
Bayo Canyon Sewage Treatment Plant[a]	900,000	1,370,000	3,400,000	5,200,000
White Rock Sewage Treatment Plant[a]	500,000	820,000	1,900,000	3,100,000
LANL SWSC Plant[b]	400,000	600,000	1,350,000	2,300,000

a Information from Keith Schwertfeger, Los Alamos County Utility Department, telephone conversation with Ellen McGehee, Ecology Group, Los Alamos National Laboratory, April 15, 1997.

b Information from Ed Hoth, Utilities and Infrastructure Group, Los Alamos National Laboratory, telephone conversation with Ellen McGehee, Ecology Group, Los Alamos National Laboratory, April 16, 1997.

The Bayo Canyon sewage treatment plant is operating below capacity and could handle more sewage per day. There are, however, other constraints on the sanitary system as a whole, such as the size of existing pipes and the capabilities of existing lift stations.

The SWSC plant is operating below capacity as shown in Table 3-5. The sewage from different parts of TA-3 is collected and merged before it goes to the SWSC plant at TA-46. The size of these existing pipes limits the amount of sewage that can be handled from TA-3 and, as a result, the TA-3 portion of LANL's sewer system is operating close to capacity.

These sanitary waste treatment systems are all a considerable distance from the proposed SNS facility site. Further analysis and planning is required in order to establish the feasibility of using these systems in support of the operation of the proposed SNS facility.

3.15.2 Environmental Restoration

The Environmental Restoration (ER) Project at LANL is part of a national effort by DOE to clean up the facilities involved in its past or present weapons production program. The goal of this effort is to ensure that DOE's past operations do not threaten human or environmental health and safety. The ER Project is governed primarily by the RCRA, which addresses the day-to-day operations of hazardous waste management, treatment, storage, and disposal facilities; establishes a permitting system; and sets standards for all hazardous-waste-producing operations at these facilities. Under this law, LANL must have a permit to operate its facilities (LANL Permit is NM 0890010515). RCRA, as amended by the Hazardous and Solid Waste Amendments (HSWA) in 1984, prescribes a specific corrective action process for all potentially contaminated sites. The ER Project is investigating all sites that may have been contaminated by past operations to determine the nature and extent of any contamination. It is also exploring possible measures for cleaning up contamination and selecting and implementing remedies at these sites.

DOE provides the broad definition of activities undertaken by the ER Project at LANL. Budgets, schedules, and many procedural requirements for the ER Project have been set by DOE. DOE is accountable to two regulatory agencies: The EPA, Region 6, and the NMED. As required by the HSWA Module of LANL's permit to operate under RCRA, the ER Project established a Records-Processing Facility as the repository for all its documentation. The facility collects, organizes, indexes, stores, and protects all relevant information for use by all ER Project participants and stakeholders, including DOE, EPA, NMED, and the public. The references cited in this section can be found at the Records-Processing Facility or the LANL Community Reading Room; both are in Los Alamos.

EPA has the primary responsibility for developing, promulgating, and enforcing regulations to implement RCRA and HSWA, although it may delegate, and has delegated all of its regulatory authority to NMED. Whenever there is a need to change information in the HSWA Module, LANL and DOE prepare a proposal to the regulators to modify the permit, such as a Class III modification to remove a potential release site (PRS) from the list in the HSWA Module and take no further clean-up action on the PRS. Before a PRS can be removed from the HSWA permit, a Class III permit modification must be proposed to the regulator. Other changes in the permit also require a Class III permit modification.

Solid Waste Management Units (SWMUs) are potentially contaminated sites that are listed in the HSWA Module of LANL's RCRA Operating Permit. In addition, there are other sites that have been identified as areas of concern but that are not in the HSWA Module. The general term for all potentially contaminated sites is potential release sites (PRSs).

If approved, the PRS is removed from further consideration by the ER Project. If not approved, the ER Project proposes further actions that may include characterization, a corrective measures study, a clean-up plan, an interim action, or a best management practice. No PRS is removed from the HSWA module until the regulators approve no further action. While it is expected that construction would not occur within the lateral extent of a PRS still listed in the HSWA module, it is possible that any necessary remediation may be complicated by the presence of buildings or other infrastructure in the vicinity.

A LANL RCRA Facility Investigation conducted within and surrounding the proposed SNS facility site, determined that the site does not include any SWMUs or PRSs (LANL 1992).

4.0 Cumulative Impacts

This section considers a preliminary assessment of the potential sources of cumulative impacts resulting from the construction and operation of the proposed SNS facility, as well as other reasonably foreseeable future actions within and adjacent to the site. The sources of cumulative impacts on the environment result in the incremental effect of an action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions. Sources of cumulative impacts can be associated with individually minor, but collectively significant, actions taking place over a period of time (40 CFR 1508.7).

Past activities within and directly adjacent to the proposed SNS facility site have been limited to use by the public for general recreational uses such as day hikes and sightseeing. For several decades the area has not open to public vehicular traffic, however, there are a few primitive access roads that have been used by Federal personnel for occasional access. Approximately 40 years ago, the federal agency now referred to as the DOE, constructed a single 115-kV electrical transmission line. A portion of this transmission line crosses what is now the proposed SNS facility site.

Current activities within and directly adjacent to the proposed SNS facility site are very limited. The site continues to be used by the public for general recreational uses such as day hikes and sightseeing. Public vehicular traffic remains restricted at the site. The activities associated with the maintenance and operation of the 115-kV electrical power transmission line are anticipated to remain unchanged from previous conditions. Non-Federal construction projects or other similar activities are not expected to occur at the site under the current DOE ownership.

The only reasonably foreseeable DOE action at the proposed SNS facility site is the proposed construction and operation of a 345 kV-designed electrical power transmission line that would parallel the existing 115-kV transmission line that currently transects the proposed site. Although this proposed transmission line would be a 345 kV-designed system, it would be operated at 115 kV within the reasonably foreseeable future. Although the DOE is preparing an Environmental Impact Statement that considers an action to transfer selected parcels of LANL land to local Native American Indian tribes and Los Alamos County, the proposed SNS facility site is not within a parcel being considered for transfer.

Acknowledgements

We sincerely acknowledge the support of several members of the Ecology group staff in preparing and producing this preliminary report. Much of the information provided represents the combined and on-going effort of the following Ecology group NEPA Team members: Tony Ladino, Jocelyn Mandell, Ellen McGehee, Mary Mullen, Peggy Powers, Ruben Rangel, Barbara Sinha, and Patrick Valerio. The Cultural Resources survey data and other information was provided by Beverly Larson, Kari Garcia, Steve Hoagland, and Gerald Martinez. The Biological Resources survey data and information was provided by Randy Balice and Leslie Hansen. The final editing of this preliminary report was provided by DOE Oak Ridge SNS EIS Team members David Wilfert and David Bean, the DOE Los Alamos Area Office NEPA Compliance Office Elizabeth Withers, and LANL Ecology group members Tony Ladino and Hector Hinojosa. Finally, the cover page was designed and produced by LANL Ecology group member Kim Nguyen Gunderson.

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NSNS SITE SURVEY

BIOLOGICAL ASSESSMENT

The proposed site for the National Spallation Neutron Source (NSNS) at Brookhaven National Laboratory was surveyed on January 5, 8, 10 and 13, 1998. The site (Attachment 1) was subdivided into Area A, the narrow portion, and Area B, the wider portion. The dimensions of the site are approximately 1,000 m x 500 m. Ten stations for detailed site inspections were established. Stations 1-4 were located in Area A while Stations 5-10 were located in Area B. In addition, the ~45 m buffer zone surrounding the site was surveyed. The study consisted of a visual inspection of the dominant vegetation types and a consideration of the possibility of the site harboring threatened and/or endangered species.

SITE DESCRIPTION

The site is located on the Ronkonkoma Moraine and consists of undulating morainal topography of relatively low relief with erratics present throughout. The elevation of the area is approximately 25 m with a total relief of ~9 m. The area of greatest relief is in the southernmost portion of the site. The site contains no areas of unusual geomorphology.

VEGETATIONAL COMMUNITIES

The southern portion of Area 1 (Stations 1-3) consists of a stand of white pine (*Pinus strobus*) apparently planted during the 1930s, most likely as a Civilian Conservation Corps project. Communities composed of planted white pine are common in Suffolk County.

Within this area, at Stations 1-3, are scattered self-sown pitch pine (*Pinus rigida*). The understory is sparse due to shade and pine needle litter, and consists of huckleberry (*Gaylussacia* sp.) with lesser amounts of blueberry (*Vaccinium* sp.). Occasional oaks (*Quercus* sp.) are found along the edges of the firebreaks and lanes in this area.

The white pines appear to have been planted only at Stations 1, 2, and a portion of Station 3. The remainder of Station 3 (approximately 50%) and all of Station 4 consists of a native oak-pine woodland.

There is evidence of extensive disturbance associated with operations at Camp Upton during the First World War. These disturbed areas include an extensive system of trenches, as well as a complex of deep pits and banks that are found within Area A and in the adjacent buffer zone. Mounded disturbed areas formed in the course of trenching operations are vegetated by large white pines. The fact that these areas were disturbed during WW I is based on the presence of the white pine planted in the 1930s, which are presently overgrowing the trenches, pits, etc.

In the vicinity of the pits and banks (Station 1, Area A) there is an assemblage of species not found elsewhere in either Area A or B. These include the introduced ornamental shrubs, Japanese barberry (*Berberis thunbergii*) and jetbead (*Rhodotypos scandens*), as well as black locust (*Robinia pseudoacacia*). The native red maple (*Acer rubrum*), wild black cherry (*Prunus serotina*), and grape (*Vitis* sp.) are also present. The presence of these species may be due to the somewhat moister conditions within the deep pits.

In the more open areas along the firebreaks and lanes throughout Area A the vegetation primarily consists of broomsedge (*Schizachyrium* sp.), sedges (*Carex* spp.), including the Pennsylvania sedge (*C. pensylvanica*) and lichens (*Cladina* sp.).

The remainder of the entire area (Stations 5-10) is composed of either pine-oak or oak-pine communities. In the pine-oak community pitch pine may compose as much as 90% of the total, while in the oak-pine communities the oaks predominate. The only obvious recruitment of new individuals is along the edges of the firebreaks and lanes where pitch pine saplings are common.

The oaks inhabiting the entire site (Areas A and B) are predominantly scarlet oak (*Q. coccinea*) and white oak (*Q. alba*), with the scarlet oak the most common. The understory in Stations 5-10 is huckleberry and blueberry with occasional individuals of scrub oak (*Q. ilicifolia*) and, rarely, highbush blueberry (*V. corymbosum*).

The northwest portion of Station 9 approaches the wetlands associated with the headwaters of the Peconic River. The community structure in this section shifts abruptly from the upland vegetation of pitch pine, white and scarlet oak to a wetland vegetation of red maple, tupelo (*Nyssa sylvatica*), swamp azalea (*Rhododendron viscosum*) and sweet pepperbush (*Clethra alnifolia*). Widely dispersed, large individual pitch pine also occur in this area.

In severely disturbed portions of Area B, where the subsoils were exposed, monospecific stands of young pitch pines are found. In addition, a borrow pit approximately one hectare in area at Station 10 is exclusively occupied by a mature stand of pitch pines.

PROTECTED NATIVE PLANTS

Protected native plants in New York State are placed in four categories by the N.Y.S.D.E.C.: 1) Endangered, 2) Threatened, 3) Exploitably Vulnerable and 4) Rare.

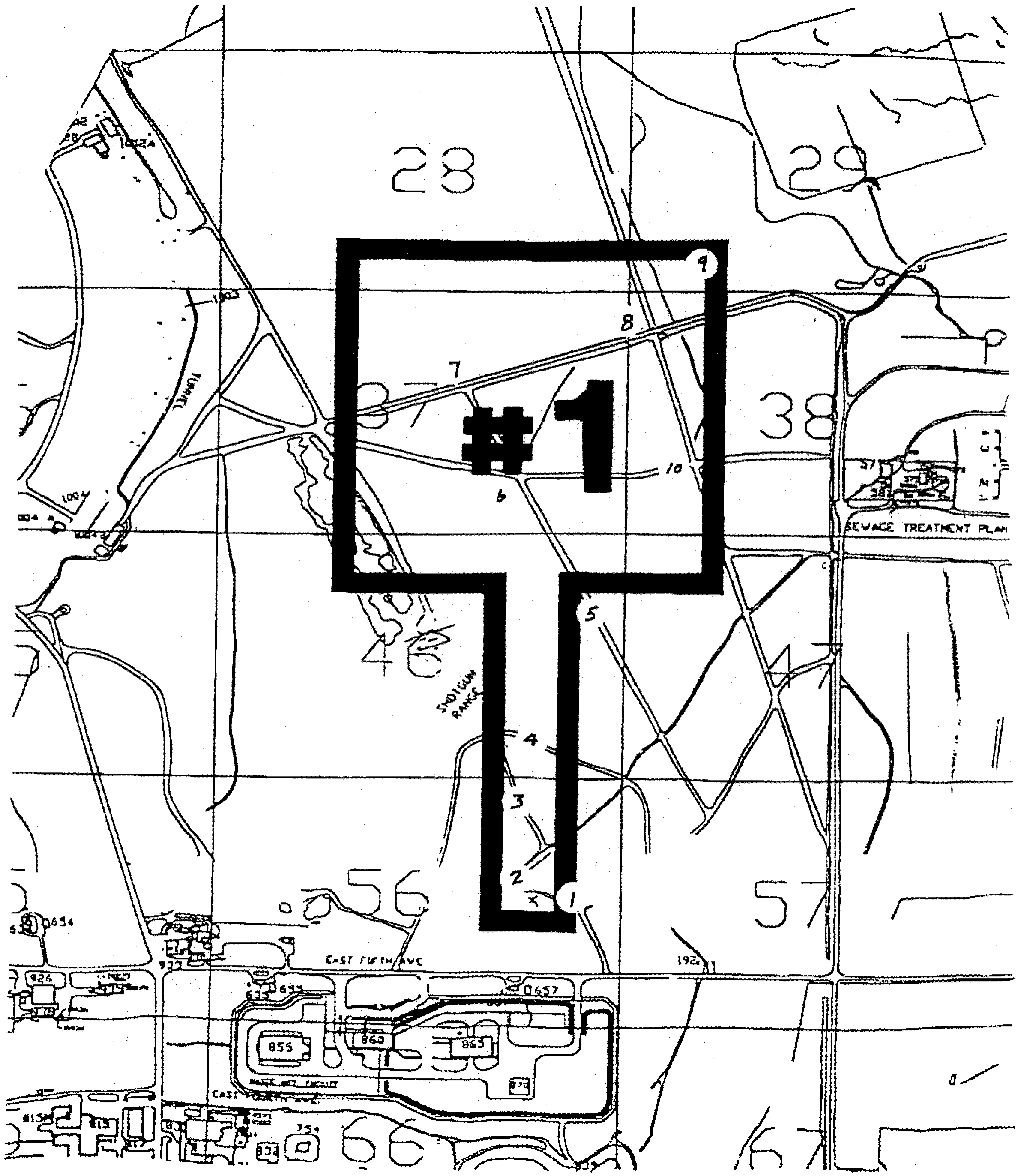
No rare, endangered or threatened species were noted during this survey. The following exploitably vulnerable species were observed on the site:

SPECIES	STATION
spotted wintergreen (*Chimaphila maculata*)*	4
bayberry (*Myrica pensylvanica*)*	6
swamp azalea (*Rhododendron viscosum*)*	9

*none of the above are uncommon on Long Island

The northwest portion of Station 9 approaches wetlands associated with the Peconic River. This area may be suitable habitat for the tiger salamander (*Ambystoma tigrinum tigrinum*) which is endangered in New York State, the spotted salamander (*A.maculatum*), a species of special concern, and the marbled salamander (*A. opacum*), the status of which is unknown in the state.

It is to be noted that this survey was conducted in mid-winter which prevents a complete evaluation of the possible presence of protected native plants on the site. However, all of the communities noted on the site proposed for the NSNS are common on Long Island.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SEWAGE TREATMENT PLANT
SHOTGUN RANGE
EAST FIFTH AVE
EAST FOURTH AVE
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APPENDIX F

DESCRIPTIONS OF ORNL RESEARCH PROJECTS IN THE WALKER BRANCH WATERSHED

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F. DESCRIPTIONS OF ORNL RESEARCH PROJECTS IN THE WALKER BRANCH WATERSHED

This appendix includes a response from the Oak Ridge National Laboratory (ORNL) regarding research land use on the Walker Branch Watershed. It includes brief descriptions of current and future research projects in the watershed area.

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March 13, 1998

Mr. Tracy C. Brown
Enterprise Advisory Services, Inc.
663 Emory Valley Road
Oak Ridge, Tennessee 37830-7751

Dear Mr. Brown:

Attached is our response to your questions regarding research land use on Walker Branch Watershed. You will note that our response in integrally linked, in the case of many projects, with determinations that will result from your information gathering with Ray Hosker and his people at NOAA/ATDD, and the modeling that I understanding your folks are doing in conjunction with them. We would appreciate the opportunity to be kept informed of modeling results as they are available, so that we might reevaluate current issues on the basis of that information.

This information reflects input and review from Drs. Amthor, Garten, Hanson, Huston, and Mulholland, all principal investigators on Walker Branch projects, and from Drs. Hildebrand, Jacobs, Loar, and myself on the Environmental Sciences Division management team.

Thank you for this opportunity to provide input to the NEPA process.

Sincerely,

David S. Shriner, Ph.D.
Head, Ecological Sciences Section
ENVIRONMENTAL SCIENCES DIVISION

DSS:lkm

Attachment

cc: J. S. Amthor
J. E. Cleaves
C. T. Garten
P. J. Hanson
S. G. Hildebrand
R. P. Hosker
M. A. Huston
G. K. Jacobs
J. M. Loar
P. J. Mulholland
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ornl - *Bringing Science to Life*

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Brief Description of Current Research Projects in the Walker Branch Watershed

General Comments

Walker Branch Watershed (WBW) is one of the Nation's leading long-term environmental monitoring and research sites, with greater than 30 years of record of hydrology, primary productivity, and soil chemistry measurements that serve as the baseline for quantifying forest ecosystem response to changes in climate and atmospheric deposition associated with energy technologies. The WBW is a core component of the Oak Ridge National Environmental Research Park, an ORNL user facility, which hosts researchers from numerous other federal agencies and universities who conduct research on the watershed's projects in conjunction with ORNL scientists. One of the key collaborations, is the long-term partnership with forest micrometeorologists of the NOAA Atmospheric Turbulence and Diffusion Division in Oak Ridge, and additional input should be solicited from the NOAA staff. As a general statement, evaluation of the long-term effects of SNS operation is limited by uncertainties associated with the availability of quantitative information related to SNS thermal, water vapor, and trace gas emissions, and issues such as the means by which algae associated with the cooling towers will be controlled, and possible chemical loading associated with algaecidal measures. Also unknown are issues such as the effects of large paved surfaces as a potential heat sink, or source of volatile organic compounds.

In summary, Walker Branch Watershed is a research facility whose value transcends the lifetime of individual projects, and whose value increases exponentially with time, due to the limited number of long-term sites with comparable data records. Those effects of greatest concern are those which might potentially alter the long-term record at the site in such a way as to make it less valuable. To some extent, at least, opportunity for follow-on research based on current project results could be affected, if pre- and post-SNS startup data on WBW were unable to be compared. The most important of the potential impacts of SNS siting that we can identify with the information currently available are those related to the long-term atmospheric and deposition measurements at the NOAA Tower and National Atmospheric Deposition Program sites on the WBW. A critical assumption for the watershed-scale research on biogeochemical cycling and ecosystem process-related research on the watershed is that the NADP monitoring site is representative of the entire watershed area. Because of the location of these monitoring stations with respect to the proposed SNS, it is possible that the spatial representativeness of these sites would be altered, requiring additional monitoring on the watershed to quantify the level of impact and to recalibrate watershed-level inputs. Additionally, there is uncertainty associated with potential impacts to the groundwater hydrology of the Walker Branch Catchment through the possibility of construction impacts on subsurface communication of hydrologic systems under the ridge, which could impact the long-term streamflow record if it were to occur.

Current Research

1. **Throughfall Displacement Experiment (TDE)**. This major experiment for the DOE Program for Ecosystem Research involves forest stand-level experiments that are being used to understand the mechanisms of forest ecosystem response to changes in regional rainfall that may result from a warming global climate. This work focuses on belowground tree response, and mechanisms of whole plant water use, carbon utilization and drought tolerance of the deciduous forest tree species which make up the forest at the experimental site. Objectives of this project are to test for the occurrence of these mechanisms at the stand level, to determine which tree species/genera exhibit the greatest adaptive potential by the use of these mechanisms, and to determine whether the survival of various tree species is enhanced by these adaptive mechanisms.

   - affected by SNS construction? No.
   - affected by SNS operation? Not expected to be. Important uncertainty is spatial extent and magnitude of water vapor and temperature impacts of cooling towers.
   - affected by SNS closure? No.

2. **Long-Term Ecological Measurements of Ecosystem Response**. Measurements of hydrologic inputs and outputs, forest biomass and species composition, and soil chemistry have been made on WBW over the past 30 years. These long-term measurements are being made to quantify the response of the forest ecosystem to changes in climate and atmospheric deposition that are expected to occur. Specific measurements being made include precipitation volume and chemistry, dry deposition quantity and chemistry, vegetation biomass and species composition, soil chemistry, streamflow, and stream water chemistry. These measurements support DOE's (1) local, regional, and global research, and (2) environmental restoration activities (baseline measurements). The measurements are also used to test and extrapolate results from the Walker Branch climate change experiment (TDE) to the ecosystem and watershed scales. These measurements will provide the catchment-scale input/output budgets for new process-level research on nitrogen cycling and retention in the forest and stream ecosystems of Walker Branch. Wet and dry deposition measurements are part of the long-term, 200 site National Atmospheric Deposition Program, National Trends Network (NADP/NTN), and the associated Mercury Deposition Network (MDN) and Atmospheric Integrated Research Monitoring Network (AIRMON) sites. The mercury deposition monitoring site is one of 18 such sites nationwide, while the AIRMON site is one of nine. The Walker Branch NADP/NTN site is approaching 20 years of continuous operation as a precipitation chemistry monitoring station.
   - affected by SNS construction?
     — potentially, by dust deposition - NADP/NTN, MDN, AIRMON
     — hydrology- potentially, if construction impacts subsurface systems.
     — productivity - No

- affected by SNS operation?
  - NADP/NTN, MDN, AIRMON - potentially, if results in change in amount of wet deposition at site because of water from cooling tower.
  - hydrology, productivity - Not expected to be impacted unless fog events are very frequent.
  - will chemicals/algaecides be used to maintain cooling towers?
- affected by SNS closure? No.

3. **Terrestrial Feedbacks to Regional Hydrologic Budgets**. Walker Branch Watershed is one of five primary sites for this work. This project seeks to enhance understanding of the contributions of closed-canopy, deciduous forest stands to local/regional hydrologic budgets. We are establishing a distributed set of instrumented forest plots across the Ohio-Tennessee watershed for continuous, multi-year monitoring of climate variables, soil water conditions, and tree and forest stand evapotranspiration. Measurements at these sites will be used to derive mechanistic relationships between total canopy conductance and environmental variables, and to test models of atmosphere-soil-plant hydrologic flux. The research will provide critical, multi-year data on temporal and spatial dynamics of terrestrial evapotranspiration and multi-depth soil water dynamics for upland hardwood forest ecosystems. These data will resolve the range of day-to-day and site-to-site variability in evapotranspiration to be expected throughout much of the eastern United States. The data from this project will also be shared with research groups of the GEWEX Continental-scale International Project (GCIP) to enhance the data bases against which they can test macro- and mesoscale climate models.

- affected by SNS construction? No.
- affected by SNS operation? No.
  - project completed before operation begins; follow-up measurements may or may not be comparable
- affected by SNS closure? No.

4. **Nitrogen Uptake, Retention, and Cycling in Stream Ecosystems: An Intersite ^{15}N Tracer Experiment**. The work being conducted in Walker Branch involves: (1) short-term (several hours) injections of a conservative tracer and application of a transient storage model to define hydrodynamic characteristics, (2) short-term injections of nutrients (NH_4, NO_3, PO_4) to determine relative uptake lengths of different nutrients and potential N deficiency, (3) whole-stream measures of gross primary productivity (GPP) and community respiration (R) to define stream metabolic characteristics, and (4) long-term (6 weeks) additions of $^{15}NH_4$ at tracer levels to measure temporal and spatial (longitudinal) dynamics of nitrogen uptake, retention, and cycling rates through the stream ecosystem. The Walker Branch experiment began in April 1997 and will continue for about one year. Data from the Walker Branch experiment will be used with data from similar experiments at eight other sites to test hypotheses concerning relationships

between N uptake, cycling, and turnover and stream hydrodynamics, chemistry, and metabolism.

- affected by SNS construction, operation, or closure? No. This project will be completed in FY 1999. Nitrogen dynamics is a long-term area of priority research for WBW.

5. **Development of Gene Probes for Nitrate Reduction in Environmental Media: A Tool to Evaluate Nitrogen Retention in Watersheds**. This research is developing and field testing molecular detection and quantification methods for assimilatory and dissimilatory nitrate reductase in environmental media (soils, aquatic sediments). Signature gene sequences for specific nitrate reductase types are being identified and used to amplify natural DNA and mRNA templates for quantification of biomass and activity. These methods will then be tested across natural gradients in nitrate availability in forest soils and stream sediments.

   - affected by SNS construction, operation, or closure? No; project completed in FY 1999.

6. **Experimental and Theoretical Studies on the Seasonal, Annual, and Inter-Annual Exchange of Water Vapor and Energy Exchange by a Temperate Forest Ecosystem in the Mississippi River Basin**. This project addresses a GCIP program objective to determine and explain seasonal, annual and inter-annual variability of water and energy cycles in the eastern portion of the Mississippi River basin. Our overarching goal is to use micrometeorological (eddy covariance), physiological (sap-flow) and hydrological (watershed) methods to quantify the seasonal and inter-annual rates of water vapor and energy exchange over a temperate, deciduous, broad-leaved forest, and ecosystem of major significance in the Mississippi River basin. This approach will allow us to study the impact of environmental, phenological, and ecological factors on the intra- and inter-annual variations of water vapor exchange at three important spatial scales, the tree, the canopy, and the watershed. In conjunction with this project, two coupled land-atmosphere energy exchange models are being developed and tested (CANVEG and INTRASTAND), that account for phenology and water deficits. Then, using a ten-year record of climate data, the roles of climate, phenology and leaf area are being examined on the year to year range of annual evaporation and energy balance partitioning.

   - affected by SNS construction, operation, or closure? No; project completes in FY 2000. Eddy covariance portion of project is done by NOAA/ATDD. Seek their comments on potential impact to eddy covariance measurements, as they are relevant to that portion of this project, as well, and would potentially affect follow-on work based on this line of investigation.

7. **Theoretical Studies of the Annual Exchange of CO_2 and Energy by a Temperate Forest Ecosystem**. A detailed model of deciduous forest ecosystem physiology and physics (LaRS) is being used to simulate responses of the forest near the NOAA/ATDD forest meteorology research site on Walker Branch Watershed to the environmental factors of air temperature, rainfall, wind speed, solar irradiance, atmospheric humidity, and atmospheric CO_2 concentration. The model simulations will be compared to independent measurements made at the research site. The model includes submodels of: leaf phenology and growth, bole growth, root growth, leaf respiration, bole respiration, root respiration, soil respiration, leaf photosynthesis, and photorespiration, soil surface evaporation, stomatal conductance, transpiration and root water uptake, soil surface sensible heat exchange, canopy sensible heat exchange, canopy radiation balance, soil surface radiation balance, vertical water transport within the soil profile, vertical heat transport within the soil profile, and ecosystem momentum exchange. The ultimate aim of model development and testing is to provide tools capable of realistically predicting terrestrial ecosystem responses to increasing atmospheric CO_2 concentration and any associated climate change. This capability is important because terrestrial ecosystem responses to global environmental change may be significant to the global carbon cycle and therefore, global climate.

- affected by SNS construction, operation, or closure? Potentially; Current project completed in FY 1999. However, a continuation proposal is anticipated. This work is linked to eddy covariance measurements conducted by NOAA/ATDD, and future work would potentially be impacted accordingly (seek NOAA/ATDD comments in this regard).

8. **Use of Multiscale Biophysical Models for Ecological Assessment: Applications in the Southeast**. Integrated biophysical models are being used to evaluate the predictable variability in four fundamental indicators of ecosystem condition: (1) spatial and temporal variation in primary productivity; (2) spatial variation in soil carbon and hydrologic storage capacity; (3) population size and dynamics of selected plant and animal species; and (4) bioaccumulation of lipophilic compounds in terrestrial and aquatic food webs. The basic physical models and model structure will be scale-independent, and applicable to scales ranging from first order watersheds to continents, with appropriate functional algorithms and parameterization. Implementations of the modeling system are being developed and tested at four spatial scales in the southeastern United States: $150km^2$, $2000km^2$, $150{,}000km^2$, and the entire southeast. Primary data collection for net primary productivity and soil carbon and nitrogen dynamics are being collected on Walker Branch Watershed.

- affected by SNS construction, operation, or closure? Not expected to be; current project completes in FY 1999, but follow-on work possible.

9. **Global Carbon Cycle Studies — Forest Soil Carbon Dynamics: Field Experiments and Model Validation**. Storage and properties of forest soil organic matter are being investigated along an elevation/climate gradient in the Southern Appalachian Mountains. Six sites, including Walker Branch Watershed on the ORNERP, were selected to span a range of temperature and moisture regimes, a range of soil N availability, and a range of forest community types. The sites were characterized with respect to differences in soil texture, pH, and aboveground carbon inputs. Soil moisture, air and soil temperatures, and the forest floor carbon dioxide flux were measured at regular intervals. Bulk soil carbon and nitrogen concentrations were measured to a depth of 30 cm. Patterns of abundance of ^{13}C in forest litter inputs, fine roots, and soil carbon at different depths were examined. Two climate variables are continuously monitored at each study site: (1) air temperature; and (2) soil temperature at a 10 cm soil depth. Between sampling intervals, throughfall is measured at each site as and indicator of precipitation inputs.

- affected by SNS construction, operation, or closure? No expected effects.

Brief Description of Future Research Projects in the Walker Branch Watershed

The projects listed below are of two categories above and beyond the continuation of projects listed as currently ongoing. The first of these categories is projects for which funding proposals are pending; and the second, a category of activities which are in Environmental Sciences Division Strategic Planning goals and objectives, but for which funding proposals do not yet exist.

Proposals Pending

1. **Ecosystem Effects of Climate Change: Experimental Alteration of the Spatio-Temporal Pattern of Net Primary Productivity in a Deciduous Forest Ecosystem**. This project proposes to experimentally simulate the large-scale effects of atmospheric changes on the net primary productivity (NPP) of an eastern deciduous forest and its streams, with a focus on the ecosystem impacts of changes in the spatial and temporal variability in NPP that we expect will result from the manipulation. The proposed experiment is a multi-disciplinary collaboration between Oak Ridge National Laboratory and the University of Tennessee, which is submitting a separate proposal that will address ecological responses to the NPP alteration. This proposal focuses on establishing and maintaining the experimental treatments and quantifying both the driving variables and ecosystem responses in order to develop a mechanistic understanding of ecosystem responses to climate change at the landscape scale. The experiment will alter the mean level and spatial variability of soil nitrogen and phosphorus in replicated forested catchments. All catchments on both Pine Ridge (3) and Chestnut Ridge (1, WBW) will have a northwest aspect, and extend from ridgetop to valley bottom.

- affected by SNS construction? Catchment on WBW potentially impacted by dry deposition input during construction from dust, primarily. Could impact spatial variability in the experimental area, an element of the experiment. Impacts will be quanitfiable and would be negligible if control and treatment areas are equally affected.

- affected by SNS operation? All sites depend on precipitation chemistry and amount data currently measured at WBW NADP site. Experiment is planned for up to 10 years, so could potentially be impacted if NADP site is affected by SNS operation (currently unknown). This is important, since the NADP site is currently assumed to be representative of the local terrain., If operation should result in a localized effect on that monitoring site, it would negate that assumption, and would also compromise the long-term value of the site's data. Other historical and inactive deposition monitoring sites exist on WBW. Those sites could be activated to test impacts of SNS construction and operation on our single active NADP site and to cross-calibrate that site, but this would require additional funds. To mitigate impacts on this proposed project, additional, more intensive monitoring sites would need to be added for the WBW and Pine Ridge catchments.

- affected by SNS closure? No.

2. <u>**Ecosystem Effects of Climate Change: Responses to Experimental Alteration of the Spatio-Temporal Pattern of Net Primary Productivity in a Deciduous Forest Ecosystem**</u>. This project will evaluate responses to altered NPP at several trophic levels in both the terrestrial and aquatic portions of the ecosystem. It will use recently-implemented methods for estimating Leaf Area Index (LAI) from LandSat imagery to quantify the spatiotemporal dynamics of canopy leaf area responses to variation in nitrogen and water across the experimental and control catchments (described above). Plant responses at the herbaceous, subcanopy, and canopy levels will be quantified using a combination of methods to measure structural components and patterns of NPP. Animal responses will be evaluated using forest floor, canopy, and stream invertebrates, as well as small mammal populations. This project is a companion to the one described above, and is interdependent on it.

   - affected by SNS construction, operation, or closure? See comments above.

3. <u>**Retention and Fate of Atmospheric Nitrogen Deposition in Forests: Tracer ^{15}N Addition Experiments in Forests of Contrasting Nitrogen Status**</u>. Retention and fate of atmospheric nitrogen deposition to forests will be studied by conducting pulse ^{15}N addition experiments in tow forests of contrasting nitrogen status; Walker Branch on the Oak Ridge National Environmental Research Park, a highly nitrogen deficient forest, and Noland Divide in the Great Smokey Mountains National Park, a nitrogen saturated forest. Tracer-level additions of ^{15}N as nitrate and as ammonium will be made to forest plots

during rainfall events in winter and again in summer each year for three years. Uptake and incorporation of ^{15}N in various ecosystem nitrogen pools will be measured over time following each ^{15}N addition. The research will test hypotheses dealing with mechanisms responsible for uptake and retention of nitrogen deposition and differences in retention and fate of N in forests of differing nitrogen status.

- affected by SNS construction, operation, or closure? Project depends on input characterizations from NADP site. This work will be completed by FY 2001, but long-term research on nitrogen dynamics in deciduous forest ecosystems is a priority area of research for WBW. Potential for impacts on follow-on research could be managed by additional, more intensive deposition monitoring.

4. **The Effect of Field-Scale Climate Manipulation on the Dynamics of Dissolved Organic Matter in Soil: Implications for Soil Carbon Pools**. Comparisons of paired control- and climate-manipulation regimes will assess differences in the concentration and chemical nature of dissolved organic matter (DOM) in soil and shallow groundwater, determine decomposition rates of DOM, measure differences in the flux of DOM mobilized from soil through storm flow, and evaluate the interactive effects of altered CO_2, precipitation, and temperature on the fate and transport of DOM in soil using the TDE and FACE sites. These data form the basis of innovative approaches to carbon management, in which soils would be managed to optimize processes favoring the sequestration of large pools of carbon with long turnover times.

- affected by SNS construction, operation, or closure? Not anticipated at the present time, pending better information on potential temperature, water vapor, and hydrologic impacts. Project completion scheduled for FY 2001, but soil carbon management is a priority area for long-term research initiatives on WBW.

Strategic Initiatives

In addition to the future projects above, the Environmental Sciences Division Strategic Plan identifies Large Scale Environmental Process Research as a priority area in the future of the Division. This priority is based, in large part on the historical record of research and understanding of the ecological processes regulating ecosystem structure and function on the Oak Ridge NERP, including WBW. The research park is the cornerstone for large field experimental campaigns for decades to come. Future initiatives will include:

- A Large-scale manipulation of the interacting stress factors associated with climate change: Temperature, precipitation, carbon dioxide, and nutrient status.

- A major initiative in belowground science; understanding the physical, biological , and chemical environment of the belowground ecosystem.

- Climate warming manipulations, terrestrial and aquatic.
- Nitrogen dynamics of a deciduous forest ecosystem.
- Soil carbon management, carbon sequestration in forest ecosystems.
- The baseline of research and monitoring activities on the WBW are intended to contribute to a new national, interagency program for long-term ecosystem monitoring, with the experimental catchments on the Oak Ridge NERP as an index site in that network.

At the present time, it is not possible to speculate on the potential affect that the SNS might have on these initiatives, however given the concern over atmospheric measurements, and uncertainties that currently exist, it is likely that there would be some level of effect of the SNS siting that would need to be assessed relative to these future initiatives.

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APPENDIX G

ATMOSPHERIC DISPERSION AND DOSE CALCULATIONS FOR NORMAL AND ACCIDENT CONDITIONS

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G. ATMOSPHERIC DISPERSION AND DOSE CALCULATIONS FOR NORMAL AND ACCIDENT CONDITIONS

G.1 INTRODUCTION

This appendix describes the data, methods, and assumptions used to estimate dose to workers and to the public from emissions of radioactive and toxic materials from the SNS. The steps in estimating dose are as follows:

- Identify and quantify emissions (source terms),
- Identify and select human exposure pathways,
- Analyze transport of contaminants through each exposure pathway, and
- Calculate dose.

This sequence of steps was repeated several times as new or more realistic data became available and assumptions refined. The purpose of these dose calculations is to provide reasonable but conservative dose estimates that allow impacts of the alternative actions analyzed in the FEIS to be compared.

The radionuclides that would be discharged into the environment by the SNS would be produced in spallation reactions initiated by the high-energy protons generated in the linac. These reactions occur in cascades or "stars" as fragments and neutrons from atomic nuclei struck by high-energy protons strike and react with other atoms until the energy of the initial collision is dissipated. The spectrum of radionuclides and the number of neutrons produced by spallation depend on the energy and intensity of the proton beam and the nature of the material it strikes.

The purpose of the mercury target is to generate neutrons by spallation. The radionuclides formed directly by spallation and by reactions with the neutrons in the target and surrounding materials are waste products. A small fraction of the particles in the beam would also escape from the confining magnetic fields and induce spallation reactions in the components and structures in the linac, beam storage, beam transfer tunnels, in the beam stops, and in the target areas.

Many of the spallation products are short-lived and some decay through a chain of radioactive atoms. Several of the products are isotopes of mercury with decay chains consisting mainly of relatively short-lived progeny that are not usually encountered in dose assessments. Several of these decay chains have progeny with half-lives somewhat longer than their parent and comparable to the time required to travel from the SNS to potential receptors. As a result, the radiological characteristics of a plume of these spallation products can change significantly as it moves through the environment.

G.2 Source Terms for Normal and Accident Conditions

This section provides a summary discussion of source terms for normal and accident conditions at the SNS and tables listing source terms for individual radionuclides. A report providing the details of the bases for these source terms is included as Appendix C of this FEIS.

G.2.1 Radionuclide Inventories

Radionuclide inventories used to derive source terms are based on a 1 MW beam power. Source terms for 4 MW operations assume that the specific activity (Ci/g, Ci/ml) of the materials released is four times the specific activity at 1 MW. Inventories for source terms for isotopes of mercury and iodine released from irradiated mercury assume that the SNS operates continuously at 1 MW beam power for 30 years with a single charge of mercury. Radionuclide inventories for source terms for other systems assume continuous operation at 1 MW for 1 year.

Both assumptions are conservative. When the particle beam is turned on, the activities of radionuclides begin to increase towards a “steady state” unique to each radionuclide and dependant on the beam power and intensity. Many nuclides reach a steady state after days, or even hours, of irradiation; however, some do not attain a steady state even after 30 years of continuous irradiation. The particle beam would be switched on and off many times over the 40-year life of the facility, and would be off much more than on; therefore, these inventories become increasingly conservative as the time necessary for a radionuclide to reach steady state increases. Inventories used to estimate source terms of specific radionuclides may be found in References 1 and 2 and in Appendix C of this FEIS.

G.2.2 Normal Conditions

Source terms for annual emissions of normal operations from the Tunnel Confinement Exhaust Stack and the Target Building Exhaust Stack are shown in Table G-1. The base source terms were provided by the Department of Energy (DOE) (DeVore 1998b; DeVore 1998a) and have been adjusted when necessary for particle beam power. With the exception of mercury releases from the target cell (discussed below), DOE reduced radionuclide inventories by an availability factor of 0.559. This factor assumes that the beam is on 85 percent of the 240 days per year that the SNS is projected to be in use.

Assumptions on facility design are presented in the Conceptual Design Report (ORNL 1997a). For upgrade from 1 MW to 4 MW, a linear scaling of off-gases from the cooling system and the target are anticipated. Off-gases from the beam stops and exhausts from the various tunnels through the Tunnel Confinement Exhaust do not scale linearly, because of specifics of the proposed upgrade design.

G.2.2.1 Tunnel Confinement Exhaust

Radionuclides discharged from the Tunnel Confinement Exhaust Stack are gases and concrete dust particles activated as a result of beam interactions in the tunnels. Only a few have half-lives as long as a few minutes. It was estimated that, on average, 28.5 seconds would elapse between activation and discharge of the air (DeVore 1998a). The source term shown in Table G-1 reflects this decay.

G.2.2.2 Target Building Exhaust

Source terms for releases from the Target Building Exhaust include the affects of radioactive decay ingrowth, off-gas treatment, and HEPA filtration.

Table G-1
Projected Annual Emissions of Radionuclides from SNS Facilities During Normal Operations.

	Target Building Exhaust (Ci)						Tunnel Confinement Exhaust (Ci)	
	Cooling Systems[a]		Target Off-Gas[a]		Beam Stops[b]		Linac, Ring, and Beam Transfer Tunnels[b]	
Nuclides[c]	**1 MW**	**4 MW**	**1 MW**	**4 MW**	**1 MW**	**4 MW**	**1 MW**	**4 MW**
H-3	2.76E-00	1.11E+01	2.24E+01	8.96E+01	2.39E-00	4.46E-00	1.22E-07	1.22E-07
He-6	0	0	0	0	0	0	1.50E-08	2.36E-08
Li-8	0	0	0	0	0	0	1.31E-08	1.73E-08
Be-7	3.14E-03	1.26E-02	0	0	0	0	0	0
Be-10	2.62E-10	1.05E-09	0	0	0	0	0	0
C-10	0	0	0	0	0	0	2.55E+01	4.04E+01
C-11	0	0	0	0	0	0	4.06E+01	6.04E+01
C-14	1.33E-01	5.31E-01	0	0	1.37E-02	2.56E-02	1.08E-04	1.08E-04
N-13	0	0	0	0	0	0	3.18E+02	4.83E+02
N-16	0	0	0	0	0	0	7.92E-00	1.15E+01
O-14	0	0	0	0	0	0	8.99E+01	1.33E+02
O-15	0	0	0	0	0	0	3.41E+02	5.19E+02
F-18	5.85E-10	2.34E-09	0	0	0	0	0	0
F-20	0	0	0	0	0	0	2.97E-02	2.97E-02
Ne-23	0	0	0	0	0	0	1.90E-02	1.90E-02
Na-22	2.07E-08	8.29E-08	0	0	0	0	1.12E-02	1.12E-02
Na-24	0	0	0	0	0	0	2.46E-00	2.46E-00
Mg-27	0	0	0	0	0	0	1.05E-01	1.05E-01
Al-26	3.99E-13	1.60E-12	0	0	0	0	1.69E-06	1.69E-06
Al-28	0	0	0	0	0	0	8.61E-00	8.61E-00
Al-29	0	0	0	0	0	0	2.70E-02	2.70E-02
Si-31	0	0	0	0	0	0	7.34E-01	7.34E-01
Si-32	2.78E-10	1.11E-09	0	0	0	0	0	0
P-32	3.43E-08	1.37E-07	0	0	0	0	0	0
P-33	1.85E-09	7.40E-09	0	0	0	0	0	0
S-35	9.03E-09	3.61E-08	0	0	0	0	0	0
Cl-36	5.58E-12	2.23E-11	0	0	0	0	1.81E-06	1.81E-06
Cl-38	0	0	0	0	0	0	5.21E-04	5.21E-04
Ar-37	1.26E+02	5.02E+02	0	0	2.50E+02	4.67E+02	3.81E-01	3.81E-01
Ar-39	1.46E-01	5.83E-01	0	0	2.06E-01	3.85E-01	1.27E-02	1.27E-02
Ar-41	0	0	0	0	0	0	9.70E-04	9.70E-04
Ar-42	7.87E-02	3.15E-01	0	0	2.66E-02	4.97E-02	1.05E-06	1.05E-06
K-38	0	0	0	0	0	0	7.02E-04	7.02E-04
K-40	2.90E-15	1.16E-14	0	0	0	0	3.15E-07	3.15E-07

Table G-1
Projected Emissions of Radionuclides from SNS Facilities During Normal Operations.
(Continued)

	Target Building Exhaust (Ci)						Tunnel Confinement Exhaust (Ci)	
	Cooling Systems[a]		Target Off-Gas[a]		Beam Stops[b]		Linac, Ring, and Beam Transfer Tunnels[b]	
Nuclides[c]	1 MW	4 MW	1 MW	4 MW	1 MW	4 MW	1 MW	4 MW
K-42	5.91E-13	2.37E-12	0	0	0	0	1.00E-00	1.00E-00
K-43	1.46E-12	5.85E-12	0	0	0	0	2.94E-04	2.94E-04
K-44	0	0	0	0	0	0	5.44E-04	5.44E-04
Ca-41	7.33E-11	2.93E-10	0	0	0	0	3.16E-03	3.16E-03
Ca-45	3.36E-08	1.35E-07	0	0	0	0	7.30E-01	7.30E-01
Ca-47	1.72E-10	6.90E-10	0	0	0	0	1.56E-03	1.56E-03
Ca-49	0	0	0	0	0	0	8.00E-02	8.00E-02
Sc-43	2.75E-22	1.10E-21	0	0	0	0	0	0
Sc-44	1.06E-21	4.23E-21	0	0	0	0	0	0
Sc-46	1.42E-07	5.70E-07	0	0	0	0	0	0
Sc-47	1.94E-08	7.77E-08	0	0	0	0	1.57E-03	1.57E-03
Sc-48	1.30E-09	5.19E-09	0	0	0	0	0	0
Sc-49	0	0	0	0	0	0	7.97E-02	7.97E-02
Ti-44	1.24E-08	4.97E-08	0	0	0	0	0	0
Ti-45	2.97E-26	1.19E-25	0	0	0	0	0	0
V-48	1.86E-06	7.45E-06	0	0	0	0	0	0
V-49	4.10E-06	1.64E-05	0	0	0	0	0	0
V-50	3.06E-22	1.22E-21	0	0	0	0	0	0
Cr-48	1.87E-10	7.49E-10	0	0	0	0	0	0
Cr-51	2.34E-04	9.35E-04	0	0	0	0	3.42E-04	3.42E-04
Mn-52	4.10E-06	1.64E-05	0	0	0	0	3.21E-05	3.21E-05
Mn-53	1.27E-10	5.07E-10	0	0	0	0	7.49E-09	7.49E-09
Mn-54	1.33E-05	5.30E-05	0	0	0	0	5.15E-03	5.15E-03
Mn-56	1.34E-28	5.35E-28	0	0	0	0	5.85E-03	5.85E-03
Fe-52	3.00E-14	1.20E-13	0	0	0	0	0	0
Fe-55	3.24E-04	1.29E-03	0	0	0	0	5.69E-01	5.69E-01
Fe-59	7.07E-06	2.83E-05	0	0	0	0	1.72E-02	1.72E-02
Fe-60	2.96E-13	1.18E-12	0	0	0	0	0	0
Co-55	4.87E-09	1.95E-08	0	0	0	0	0	0
Co-56	4.91E-05	1.96E-04	0	0	0	0	0	0
Co-57	1.15E-04	4.60E-04	0	0	0	0	0	0
Co-58	4.09E-05	1.64E-04	0	0	0	0	0	0
Co-60	5.11E-06	2.05E-05	0	0	0	0	0	0
Ni-56	1.03E-06	4.11E-06	0	0	0	0	0	0

Table G-1
Projected Emissions of Radionuclides from SNS Facilities During Normal Operations. (Continued)

	Target Building Exhaust (Ci)						Tunnel Confinement Exhaust (Ci)	
	Cooling Systems[a]		Target Off-Gas[a]		Beam Stops[b]		Linac, Ring, and Beam Transfer Tunnels[b]	
Ni-57	7.30E-07	2.92E-06	0	0	0	0	0	0
Ni-59	2.06E-06	8.23E-06	0	0	0	0	0	0
Ni-63	2.56E-04	1.02E-03	0	0	0	0	0	0
Ni-65	5.82E-26	2.33E-25	0	0	0	0	0	0
Cu-61	6.07E-25	2.43E-24	0	0	0	0	0	0
Cu-64	9.94E-14	3.98E-13	0	0	0	0	0	0
Sb-119	0	0	2.42E-02	9.67E-02	0	0	0	0
Te-119	0	0	1.67E-02	6.70E-02	0	0	0	0
Te-121	0	0	2.38E-02	9.53E-02	0	0	0	0
Te-123	0	0	1.61E-01	6.43E-01	0	0	0	0
I-121	0	0	4.96E-26	1.98E-25	0	0	0	0
I-122	0	0	5.22E-04	2.09E-03	0	0	0	0
I-123	0	0	4.43E-04	1.77E-03	0	0	0	0
I-124	0	0	5.69E-04	2.27E-03	0	0	0	0
I-125	0	0	3.91E-02	1.56E-01	0	0	0	0
I-129	0	0	3.58E-10	1.43E-09	0	0	0	0
I-130	0	0	1.76E-05	7.05E-05	0	0	0	0
Xe-122	0	0	1.04E-00	4.17E-00	0	0	0	0
Xe-123	0	0	1.72E-23	6.87E-23	0	0	0	0
Xe-125	0	0	1.18E-00	4.71E-00	0	0	0	0
Xe-127	0	0	8.05E+01	3.22E+02	0	0	0	0
Hg-192	0	0	1.19E-02	4.77E-02	0	0	0	0
Hg-193	0	0	4.84E-03	1.94E-02	0	0	0	0
Hg-194	0	0	2.25E-02	9.01E-02	0	0	0	0
Hg-195	0	0	1.21E-01	4.84E-01	0	0	0	0
Hg-197	0	0	3.60E-00	1.44E+01	0	0	0	0
Hg-203	0	0	3.29E-00	1.32E+01	0	0	0	0
Total	1.29E+02	5.15E+02	1.12E+02	4.50E+02	2.52E+02	4.72E+02	8.37E+02	1.26E+03

[a] DeVore 1998i.
[b] DeVore 1998h.
[c] Nuclides with activities of less than 1.0 x 10^{-30} Ci are not shown.

G.2.2.3 Cooling Water Systems

The source term for cooling water systems (DeVore 1998b) includes the contributions of D_2O and H_2O cooling water systems in the Target Building and H_2O cooling water systems in the beam stops. It includes two components: off-gas consisting of H-3 vapor and gaseous radionuclides, and mist from cooling water assumed to be at 90ºF. The mist was assumed to contain entrained activated metal corrosion products from the systems being cooled and to have the same radionuclide concentrations as the liquid low-level waste (see Section 4, Appendix C).

Mist eliminators in the system were assumed to have an efficiency of 70 percent. Emissions were assumed to occur over a 24-hour period, each time quarterly maintenance would be performed. Radionuclides emissions would be decayed for a total of 8 days before release (24 hours of emission evolution and 7 days hold-up in the decay tank). The total annual emissions are shown in Table G-1.

G.2.2.4 Beam Stop Emissions

Beam stop emissions were assumed to consist of activated air in the beam stop buildings and to be discharged via the gas decay tanks after 7 days total decay (DeVore 1998a). Emissions from cooling water systems in the beam stops are included in the previous source term.

G.2.2.5 Target Off-Gas Emissions

The source term for Target Off-Gas combines the tritium vapor, xenon gas, and mercury vapor in target off-gas with mercury vapor and mercuric iodide evaporating from mercury spilled in a target cell during target change-outs (DeVore 1998b). DOE assumed that iodine in the target would be chemically bound in non-volatile compounds of mercury.

Target off-gases would be collected and processed in the hot off-gas and off-gas decay systems. Air from the target cell would be vented through the cell ventilation system. The source term for mercury is based on its vapor pressure at –20º C, the temperature of the Mercury chiller/condenser, and off-gas system flow rate. The small quantity of mercury vapor that would not be condensed was assumed to decay for 7 days before release. The source term does not include the ingrowth of mercury progeny during this 7 days. Source terms for tritium and xenon were based on the quantities of these radionuclides generated in the first 10 seconds of irradiation. The quantities were corrected for decay of xenon and ingrowth of iodine over the 7 days required to fill a decay tank and the 7 additional days of decay before the tank would be discharged (DeVore 1998b). The tellurium and antimony progeny were assumed to be in equilibrium with their parents. It was assumed that HEPA filters and iodine absorbers would remove 99.95 percent of xenon progeny.

Mercury and mercuric iodide releases from the target cell were based on the vapor pressure of mercury at the temperatures and air flow rate in the cell. The mercury was assumed to be present as small droplets that accumulate each time the target mercury is replaced. The evaporation rate was based on the surface area of these droplets. It was assumed that there would be a 24-hour delay prior to each change-out to allow the system to cool completely and the short-lived radionuclides to decay. The availability factor was not applied to the target cell component.

Table G-2 Summary of SNS accident scenarios and source terms[a].

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
A. Accidents Involving the SNS Target or Target Components							
1	Loss of Particle Beam focus or directional control (Appendix C, Section 3.1)	Radionuclides and Hg in target	Heating of target by proton beam	a) Automatic beam cutoff system	Anticipated	None	None
				b) Operator manual beam cutoff	Extremely Unlikely	Bounded by Event 3b	Bounded by Event 3b
2	Major loss of integrity of Hg Target Vessel or piping (Appendix C, Section 3.2)	Radionuclides and Hg in target	Hg pump	a) Automatic beam cutoff system, Mercury enclosure	Unlikely	Percent Inventory Mercury Iodine 0.002 0.002 0.14 0.14 0.142 0.142	 Interval 0 - 10 min 10 min - 3 days
				b) None	Extremely Unlikely	Percent Inventory Mercury Iodine 0.015 0.015 0.19 33 0.038 67 0.243 100.	 Interval 0 - 10 min 10 min - 10 days 10 - 30 days
3	Loss of Hg flow in Target (Appendix C, Section 3.3)	Radionuclides and Hg in target	Heating of target by proton beam	a) Automatic beam cutoff system	Anticipated	None	None
				b) Operator manual beam cutoff	Beyond Extremely Unlikely	Bounded by Event 16	Bounded by Event 16

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
4	Loss of water flow in Hg Target Heat Exchanger (Appendix C, Section 3.4)	Radionuclides and Hg in target	Heating of target by proton beam	a) Automatic beam cutoff system	Anticipated	None	None
				b) Operator manual cutoff	Extremely Unlikely	Bounded by Event 3b	Bounded by Event 3b
5	Loss of water flow in Target Cooling Shroud (Appendix C, Section 3.5)	Radionuclides in target cooling water	Heating of target by proton beam	a) Automatic beam cutoff system	Anticipated	None	None
				b) Operator manual beam cutoff	Extremely Unlikely	Bounded by Event 8	Bounded by Event 8
6	Loss of water flow to Proton Beam Window (Appendix C, Section 3.6)	Radionuclides in cooling water	Heating of window by proton beam	a) Automatic beam cutoff system	Anticipated	None	None
				b) Operator manual beam cutoff	Extremely Unlikely	Bounded by Event 8	Bounded by Event 8
7	Loss of water flow to Target Component Cooling Loop (Appendix C, Section 7)	Radionuclides in cooling water	Heating of core vessel components by proton beam	a) Automatic beam cutoff system	Anticipated	None	None
				b) Operator manual cutoff	Unlikely	Bounded by Event 8	Bounded by Event 8

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
				c) None	Extremely Unlikely	Bounded by Event 16	Bounded by Event 16
8	Loss of integrity in Target Component Cooling Loop (Appendix C, Section 3.8)	Radionuclides in cooling water	Heating of core vessel components by proton beam	a) Stack monitor	Anticipated	Bounded by annual release limits	Bounded by annual release limits
				b) Complete evaporation (utility vault)	Anticipated	Gases + Mist + 150 L of D_2O	5 min 30 min
				c) Complete evaporation (core vessel)	Anticipated	18 L of D_2O	30 days
				d) Complete evaporation	Anticipated	Gases + Mist + 150 L of H_2O	5 min 30 min
9	Loss of integrity in Cryogenic Moderator (Appendix C, Section 3.9)	Hydrogen gas	Hydrogen pressure in moderator system	None	Extremely Unlikely	No radionuclides	Not specified
10	Loss of Core Vessel integrity (Appendix C, Section 3.10)	Activated air	Helium pressure in system	None	Unlikely	Not specified	Not specified
11	Loss of He flow to Core Vessel (Appendix C, Section 3.11)	Activated air	Helium pressure in system	None	Anticipated	Not specified	Not specified
12	Loss of Target Cell Ventilation (Appendix C, 3.12)	Mercury and radionuclides in Hg off-gas	Gaseous diffusion	None	Anticipated	Not specified	Not specified

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
13	Loss of Off-site Power (Appendix C, Section 3.13)	Not specified	None	See Events 1 through 12	Not specified	Bounded by Events 1 through 12	Bounded by Events 1 through 12
14	Fire (Appendix C, Section 3.14)	See Events 1 through 12	Heating and/or Events 1 through 12	See Events 1 through 12	Not specified	Bounded by Events 1 through 13	Bounded by Events 1 through 13
15	Natural Phenomena (Appendix C, Section 3.16)	Mercury and radionuclides in target, radionuclides in cooling water, activated air	Tornadoes and earthquakes	None	Unlikely	Bounded by Events 1 through 14	Bounded by Events 1 through 14
16	Beyond Design Basis Hg Spill (Appendix C, Section 3.17)	Radionuclides and Hg in target	a) Heating by 1-MW proton beam plus decay heat	None	Beyond Extremely Unlikely	Percent Inventory Mercury Iodine 0.0066 14.0 0.80 20.0 0.30 60.0 1.11 100.	 Interval 0 - 10 min 1 - 7 days 7 - 30 days
		Radionuclides and Hg in target	b) Heating by 4-MW proton beam plus decay heat	None	Beyond Extremely Unlikely	Percent Inventory Mercury Iodine 0.183 14.0 0.800 20.0 0.300 60.0 1.28 100.	 Interval 0 - 10 min 1 - 7 days 7 - 30 days
B. Accidents Involving SNS Waste Systems							
17	Hg Condenser Failure (Appendix C, Section 4.1.1)	Hg radionuclides in off-gas	Offgas blowers	None	Anticipated	13.7 g mercury	48 hours

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
18	Hg Charcoal Absorber Failure [e] (Appendix C, Section 4.1.2)	Hg radionuclides in offgas	Offgas blowers	Stack monitor	Unlikely	14.8 g mercury	10 days
19	He Circulator Failure (Appendix C, Section 4.2.1)	Tritium in offgas	Offgas blowers	Circulator replacement	Anticipated	1 day tritium production	24 hours
20	Oxidation of Getter Bed (Appendix C, Section 4.2.2)	Tritium in offgas	Offgas blowers	Bed replacement	Unlikely	1 day tritium production	24 hours
21	Combustion of Getter Bed (Appendix C, Section 4.3.1)	Tritium absorbed on bed, depleted uranium in bed	Combustion	Complete combustion	Extremely Unlikely	1 year tritium production, 200 g depleted uranium	1 hour
22	Failure of Cryogenic Charcoal Absorber [f] (Appendix C, Section 4.4.1)	Noble gases and iodine	Offgas blowers	System repair	Unlikely	1 day xenon production	24 hours
23	Valve sequence error in Tritium Removal System (Appendix C, Section 4.5.1)	Tritium accumulated in system	Offgas blowers	None	Unlikely	1 year tritium production	20 min
24	Valve sequence error in Offgas Decay System (Appendix C, Section 4.5.2)	Radionuclides accumulated in decay tank	Offgas blowers	None	Anticipated	7 days xenon accumulation (1 decay tank)	1 hour

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
25	Spill during filling of tanker truck for LLLW[g] Storage Tanks (Appendix C, Section 4.5.3)	Radionuclides in tank	Evaporation and diffusion	Tank vault and HEPA filters	Anticipated	0.00005% of contents of LLLW tank	1 hour
26	Spray during filling of tanker truck for LLLW[g] (Appendix C, Section 4.5.6)	Radionuclides in tank	Pressure in transfer pipe	Operator cutoff and HEPA filters	Anticipated	1.9 mil of LLLW	20 min
27	Spill during filling of tanker truck for Process Waste Storage Tanks[g] (Appendix C, Section 4.5.5)	Radionuclides in tank	Transfer pump	None	Anticipated	51,100 L Process Waste to surface water + 57 L to atmosphere	3.5 hours
28	Spray during filling of tanker truck for Process Waste[g] (Appendix C, Section 4.5.7)	Radionuclides in tank	Pressure in transfer pipe	Operator cutoff	Anticipated	28.4 L of Process Waste	20 min
29	Offgas Treatment pipe break (Appendix C, Section 4.6.1)	Radionuclides in target offgas	Cell ventilation blowers	Pipe repair	Unlikely	24 hours xenon production	24 hours
30	Offgas Compressor Failure (Appendix C, Section 4.6.2)	Radionuclides in target offgas	Cell ventilation blowers	Compressor repair	Unlikely	1 hour xenon production	1 hour

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
31	Offgas Decay Tank Failure (Appendix C, Section 4.6.3)	Radionuclides in target offgas	Cell ventilation blowers	None	Extremely Unlikely	7 days xenon accumulation	1 min
32	Offgas Charcoal Filter Failure (Appendix C, Section 4.6.4)	Iodine radionuclides in target offgas	Offgas blowers	None	Unlikely	7 days iodine production	24 hours
33	LLLW System piping failure (Appendix C, Section 4.6.5)	Radionuclides in waste	Pumping	Linac tunnel and HEPA filters	Unlikely	0.00005% of contents of LLLW tank	1 hour
34	LLLW Storage Tank Failure (Appendix C, Section 4.6.6)	Radionuclides in tank	Gravity	Tank vault and HEPA filters	Extremely Unlikely	0.00005% of contents of LLLW tank	1 hour
35	LLLW pump failure (Appendix C, Section 4.6.7)	Radionuclides in waste	Gravity	Backup pumps and pump containment	Anticipated	None	None
36	Process Waste System piping failure (Appendix C, Section 4.6.8)	Radionuclides in waste	Pumping	None	Anticipated	10% of annual flow (no airborne release specified)	1 year
37	Process Waste Storage Tank Failure (Appendix C, Section 4.6.9)	Radionuclides in tank	Gravity	Dike/sump	Extremely Unlikely	57 L to atmosphere	1 hour
38	Process Waste System pump failure (Appendix C, Section 4.6.10)	Radionuclides in waste	Gravity	Backup pumps and pump containment	Anticipated	None	None

Table G-2 Summary of SNS accident scenarios and source terms[a] - Continued.

ID	Event	Hazard	Driving Force	Barriers[b]	Frequency[c]	Source Term[d]	Duration
39	LLLW Transportation Accident [g] (Appendix C, Section 4.7.1)	Radionuclides in 800 gal LR-56 tanker truck	Collision/gravity	None	Extremely Unlikely 1.8×10^{-8}/trip 1.0×10^{-6}/year	800 gal LLLW (no airborne release specified)	24 hours
40	Process Waste Transportation Accident [g] (Appendix C, Section 4.7.2)	Radionuclides in 15,000 gal tanker truck	Collision/gravity	None	Unlikely 1.8×10^{-6} /trip 2.0×10^{-5}/year	15,000 gal process waste (no airborne release specified)	1 hour

[a] This table was compiled as a summary of information prepared by Lockheed Martin Energy Research (LMER) (refer to Sections 3.0 and 4.0 of Appendix C).

[b] The barriers listed are those that are assumed to prevent or terminate the release of radioactive or hazardous materials. Generally, one or more additional barriers such as HEPA filters or automatic alarms are present but have been ignored to increase the conservatism of the estimated source terms.

[c] Refer to Table 5.1.9-2 for the numerical ranges associated with accident frequencies categories.

[d] Source terms are expressed in units that are independent of power level. Except for Beyond Design Basis accidents (ID 16a, 16b), the radioactivity released in accidents at 4 MW is four times that released at 1 MW.

[e] Installation of sulfur-impregnated charcoal filters is being considered to serve as a "polishing filter" for the Mercury Condenser (refer to Event 17).

[f] Cryogenic charcoal absorbers are being considered as an alternative to the offgas compressor, decay storage tanks, and ambient temperature charcoal filters (see Events 24, 30, 31, and 32).

[g] Accidents involving tanker truckers are applicable for an SNS facility at ORNL where liquid wastes would be trucked to existing facilities for treatment but may not be applicable for a facility at LANL, ANL, or BNL. Frequencies may differ based on the size of tankers and distances traveled at the other sites.

G.2.3 Accident Conditions

A total of 40 accident scenarios are described in Appendix C and summarized in Table G-2. This is not an indication that the proposed SNS would be a particularly accident-prone facility, but is the result of the rigorous hazard analysis that DOE requires even for low-hazard facilities such as the proposed SNS. Since the proposed SNS is still in the conceptual design stage and dose estimates had not been made previously for these potential accidents, the full set of accident scenarios has been retained in this FEIS. Secondary stages of some accidents are conservatively assumed to last from 7 to 30 days, while in reality, administrative and emergency response actions would more probably terminate the release in a shorter time period.

The bases for the source terms used for accident conditions are discussed in Sections 3.0 and 4.0 of Appendix C of this FEIS. The source terms in Appendix C do not always explicitly show the activity of each radionuclide. This is done here in Tables G-3 through G-11 for accident scenarios that release radioactive materials to the atmosphere. Each table assigns an accident ID, identifies the section of Appendix C where the basis for the source term is discussed, lists the nature and frequency of occurrence of the accident event, lists the duration and total activities of each radionuclide released in each stage of the accident, and lists the total duration and activities for each accident.

All source terms discussed in this section would be released from the Target Building Exhaust Stack except for that for the LLLW pipe break in the linac tunnel (Tunnel Confinement Exhaust Stack) and all process waste source terms (ground-level releases assumed near the Target Building).

G.2.3.1 Mercury Spills

Table G-3 lists source terms for spills of irradiated mercury that could occur within the limits established by the design basis for the target system. The activities shown are for a beam power of 1 MW and would be four times greater at a beam power of 4 MW. Table G-4 lists source terms for beyond-design-basis spills at power levels of 1 MW and 4 MW. In addition to the 4:1 ratio in activities, the 4 MW source term assumes boiling of the mercury during the first stage of the accident (refer to Exhibit F of Appendix C). Both sets of source terms are bounding source terms for reasonably foreseeable mercury spills that could occur within or beyond the design basis.

The radionuclide activities shown in these tables reflect adjustment of the source terms from Appendix C to account for radioactive decay. Decay to the mid-point of the cumulative accident duration at the end of each phase was used to approximate the average release rate for each phase. Since the model for these source terms assumes that only mercury and mercuric iodide are volatile, their progeny are not included in the source terms; however, they were taken into account in the transport and dose calculations. (Sections G.4 and G.5).

G.2.3.2 Cooling Water System Leaks

Bounding source terms for accident involving leaks in the D_2O and H_2O cooling systems are listed in Table G-5. Leaks in the Utility Vault are assumed to be rapid (i.e., pipe breaks) so that dissolved gases would be released suddenly. The leak in the Core Vessel is assumed to be a slow leak so that dissolved gases are released at essentially the same rate as under normal conditions and can, therefore, be ignored. The activities shown correspond to the beginning of the release. Decay to the appropriate mid-points was performed during transport calculations.

G.2.3.3 Off-Gas Decay System Failures

Bounding source terms for accidents involving failures of the Off-Gas Decay System are listed in Table G-6. Cryogenic Charcoal failure is included here since the primary function of this device is to condense and hold relatively short-lived radionuclides until they decay. It is a alternative to the decay tanks. Source terms involving the Decay Tank (ID 24, 31) were assumed to occur immediately after the tank is filled. These source terms account for decay of xenon and ingrowth of iodine as the tank is filled and assume that tellurium and antimony progeny are in equilibrium with their iodine parents. All activities correspond to the beginning of the release. Decay during release is accounted for in the transport calculations.

G.2.3.4 Off-Gas Treatment System Failures

Tables G-7 through G-9 list bounding source terms for accidents involving failures of systems designed to remove mercury, tritium, and iodine from target off-gas. The Mercury Charcoal Absorber (Table G-7) is not currently part of the design but may be added if conditions warrant.

G.2.3.5 Liquid Low-Level Waste (LLLW) System Failures

Bounding source terms for failures of the LLLW System that result in releases to the atmosphere are listed in Table G-10. Sect. 4.5.4.1 of Appendix C explains the derivation of these source terms. All activities correspond to the beginning of the release. Decay during release is accounted for in the transport calculations.

G.2.3.6 Process Waste System Failures

Bounding source terms for failures of the Process Waste System that result in releases to the atmosphere are listed in Table G-11. All activities correspond to the beginning of the release. Decay during release is accounted for in the transport calculations.

G.2.3.7 Source Terms Not Considered

All of the source terms discussed in the preceding subsection are released directly to the atmosphere and were used in evaluating health impacts in this FEIS. Appendix C includes four accident scenarios that involve direct releases to soil. One of these accidents also includes a release to surface water as well as a release to air. The release to air was included. This subsection provides the basis for excluding these additional source terms from consideration.

Section 4.5.5 of Appendix C discusses an “anticipated” spill of the contents of a Process Waste Storage Tank. The airborne source term for this accident is included in Table G-11. The scenario also assumes that 13,500 gal of process waste overflows the curb around the tank, enters the retention basin, and enters the receiving stream. The discharge points of the retention basins at the other SNS alternative sites are not specified. Other accident scenarios assume that only members of the public beyond the ORR boundary and boundaries of the other sites would be exposed. In addition, this FEIS only considers exposures that are an immediate result of accidents (Section G.3). Accordingly, only the airborne source term applicable to all sites has been included in the health impacts assessment.

Table G-3
Source Terms for Design Basis Target Mercury Spill Scenarios.

ID [a]				2a				2b
Section [b]				3.2				3.2
Event				Spill Contained in Hg Enclosure				Spill Not Contained in Hg Enclosure
Probability [c]				Unlikely				Extremely Unlikely
Duration [d] **(sec)**	600	690,600	0	691,200	600	863,400	1,728,000	2,592,000
Nuclide	**Ci**	**Ci**	**Ci**	**Total Ci**	**Ci**	**Ci**	**Ci**	**Total Ci**
I-119	1.16E-04	0	0	1.16E-04	8.72E-04	0	0	8.72E-04
I-120	1.95E-04	5.54E-24	0	1.95E-04	1.46E-03	5.81E-27	0	1.46E-03
I-121	3.97E-04	6.65E-16	0	3.97E-04	2.98E-03	6.13E-17	0	2.98E-03
I-122	2.59E-04	0	0	2.59E-04	1.94E-03	0	0	1.94E-03
I-123	7.40E-04	3.45E-04	0	1.09E-03	5.55E-03	2.32E-02	1.13E-09	2.88E-02
I-124	3.39E-04	1.33E-02	0	1.37E-02	2.54E-03	2.72E+00	7.34E-01	3.46E+00
I-125	1.49E-03	9.92E-02	0	1.01E-01	1.11E-02	2.31E+01	3.98E+01	6.30E+01
I-126	6.75E-05	3.83E-03	0	3.89E-03	5.06E-04	8.55E-01	8.28E-01	1.68E+00
I-128	6.01E-05	0	0	6.01E-05	4.51E-04	0	0	4.51E-04
I-129	1.77E-10	1.24E-08	0	1.26E-08	1.33E-09	2.92E-06	5.93E-06	8.85E-06
I-130	3.37E-05	1.09E-05	0	4.46E-05	2.53E-04	6.68E-04	8.89E-12	9.21E-04
Hg-180	1.38E-29	0	0	1.38E-29	1.03E-28	0	0	1.03E-28
Hg-181	5.86E-25	0	0	5.86E-25	4.39E-24	0	0	4.39E-24
Hg-182	7.58E-11	0	0	7.58E-11	5.68E-10	0	0	5.68E-10
Hg-183	1.26E-11	0	0	1.26E-11	9.42E-11	0	0	9.42E-11
Hg-184	8.27E-06	0	0	8.27E-06	6.20E-05	0	0	6.20E-05
Hg-185	1.14E-04	0	0	1.14E-04	8.56E-04	0	0	8.56E-04
Hg-186	1.25E-03	0	0	1.25E-03	9.40E-03	0	0	9.40E-03
Hg-187	6.25E-03	0	0	6.25E-03	4.69E-02	0	0	4.69E-02
Hg-188	1.96E-02	0	0	1.96E-02	1.47E-01	0	0	1.47E-01
Hg-189	5.02E-02	0	0	5.02E-02	3.77E-01	0	0	3.77E-01
Hg-190	9.24E-02	0	0	9.24E-02	6.93E-01	0	0	6.93E-01
Hg-191	1.27E-01	0	0	1.27E-01	9.49E-01	0	0	9.49E-01
Hg-192	1.77E-01	1.42E-05	0	1.77E-01	1.33E+00	6.29E-07	1.96E-28	1.33E+00
Hg-193	2.06E-01	3.72E-07	0	2.06E-01	1.54E+00	6.37E-09	0	1.54E+00
Hg-194	2.26E-02	1.58E+00	0	1.61E+00	1.70E-01	2.15E+00	4.30E-01	2.75E+00
Hg-195	3.46E-01	2.91E-02	0	3.75E-01	2.59E+00	7.34E-03	8.67E-14	2.60E+00
Hg-197	2.32E+00	5.76E+01	0	5.99E+01	1.74E+01	6.03E+01	3.20E-01	7.81E+01
Hg-203	1.65E+00	1.09E+02	0	1.11E+02	1.24E+01	1.46E+02	2.37E+01	1.82E+02
Hg-205	4.10E-02	0	0	4.10E-02	3.07E-01	0	0	3.07E-01
Total	5.06E+00	1.68E+02	0	1.73E+02	3.80E+01	2.35E+02	6.58E+01	3.39E+02

[a] Accident identification number from Table 5.1.9-3.
[b] Section number of Appendix C of this FEIS.
[c] See Table 5.1.9-2 for numerical ranges corresponding to description.
[d] Time over which activity is released for an accident scenario. Release occurs in more than one phase for some scenarios.

Table G-4
Source Terms for Beyond Design Basis Target Mercury Spill Scenarios.

ID[a]				16a				16b
Section[b]				3.16				3.16
Event				Loss of Hg Flow/Delayed Beam Cutoff (1 MW)				Loss of Hg Flow/Delayed Beam Cutoff (4 MW)
Probability[c]				Reasonably Foreseeable				Reasonably Foreseeable
Duration[d] **(sec)**	600	604,200	1,987,200	2,592,000	600	604,200	1,987,200	2,592,000
Nuclide	**Ci**	**Ci**	**Ci**	**Total Ci**	**Ci**	**Ci**	**Ci**	**Total Ci**
I-119	8.14E-01	0	0	8.14E-01	3.26E+00	0	0	3.26E+00
I-120	1.36E+00	3.75E-19	0	1.36E+00	5.45E+00	1.50E-18	0	5.45E+00
I-121	2.78E+00	4.80E-12	0	2.78E+00	1.11E+01	1.92E-11	0	1.11E+01
I-122	1.81E+00	0	0	1.81E+00	7.25E+00	0	0	7.25E+00
I-123	5.18E+00	9.23E-02	1.69E-10	5.27E+00	2.07E+01	3.69E-01	6.77E-10	2.11E+01
I-124	2.37E+00	2.05E+00	5.83E-01	5.00E+00	9.48E+00	8.18E+00	2.33E+00	2.00E+01
I-125	1.04E+01	1.43E+01	3.85E+01	6.32E+01	4.16E+01	5.70E+01	1.54E+02	2.53E+02
I-126	4.73E-01	5.61E-01	7.54E-01	1.79E+00	1.89E+00	2.24E+00	3.01E+00	7.15E+00
I-128	4.21E-01	0	0	4.21E-01	1.68E+00	0	0	1.68E+00
I-129	1.24E-06	1.77E-06	5.84E-06	8.85E-06	4.95E-06	7.08E-06	2.34E-05	3.54E-05
I-130	2.36E-01	3.05E-03	1.16E-12	2.39E-01	9.45E-01	1.22E-02	4.65E-12	9.57E-01
Hg-180	4.54E-29	0	0	4.54E-29	5.04E-27	0	0	5.04E-27
Hg-181	1.93E-24	0	0	1.93E-24	2.14E-22	0	0	2.14E-22
Hg-182	2.50E-10	0	0	2.50E-10	2.77E-08	0	0	2.77E-08
Hg-183	4.15E-11	0	0	4.15E-11	4.60E-09	0	0	4.60E-09
Hg-184	2.73E-05	0	0	2.73E-05	3.03E-03	0	0	3.03E-03
Hg-185	3.76E-04	0	0	3.76E-04	4.17E-02	0	0	4.17E-02
Hg-186	4.14E-03	0	0	4.14E-03	4.59E-01	0	0	4.59E-01
Hg-187	2.06E-02	0	0	2.06E-02	2.29E+00	0	0	2.29E+00
Hg-188	6.46E-02	0	0	6.46E-02	7.17E+00	0	0	7.17E+00
Hg-189	1.66E-01	0	0	1.66E-01	1.84E+01	0	0	1.84E+01
Hg-190	3.05E-01	0	0	3.05E-01	3.38E+01	0	0	3.38E+01
Hg-191	4.18E-01	7.63E-29	0	4.18E-01	4.63E+01	3.05E-28	0	4.63E+01
Hg-192	5.84E-01	4.49E-04	9.14E-30	5.85E-01	6.48E+01	1.80E-03	3.65E-29	6.48E+01
Hg-193	6.79E-01	1.89E-05	0	6.79E-01	7.53E+01	7.56E-05	0	7.53E+01
Hg-194	7.47E-02	9.05E+00	3.39E+00	1.25E+01	8.28E+00	3.62E+01	1.36E+01	5.80E+01
Hg-195	1.14E+00	3.85E-01	5.49E-14	1.53E+00	1.26E+02	1.54E+00	2.20E-13	1.28E+02
Hg-197	7.66E+00	3.75E+02	1.71E+00	3.84E+02	8.49E+02	1.50E+03	6.85E+00	2.36E+03
Hg-203	5.45E+00	6.27E+02	1.83E+02	8.15E+02	6.04E+02	2.51E+03	7.31E+02	3.84E+03
Hg-205	1.35E-01	0	0	1.35E-01	1.50E+01	0	0	1.50E+01
Total	4.26E+01	1.03E+03	2.28E+02	1.30E+03	1.96E+03	4.11E+03	9.10E+02	6.98E+03

Table G-5
Source Terms for Target Cooling Water Systems Failures.

ID[a]			8b			8c			8d
Section[b]			3.8			3.8			3.8
Event			Heavy Water Leak in Utility Vault			Heavy Water Leak in Core Vessel			Light Water Leak in Utility Vault
Probability[c]			Anticipated			Anticipated			Anticipated
Duration[d] (sec)	300	1,800	2,100	2,592,000	0	2,592,000	300	1,800	2,100
Nuclide	**Ci**	**Ci**	**Total Ci**	**Ci**	**Ci**	**Total Ci**	**Ci**	**Ci**	**Total Ci**
H-3	1.88E+01	1.88E+02	2.06E+02	2.25E+01	0	2.25E+01	1.89E+00	1.88E+01	2.06E+01
Be-7	1.62E-03	0	1.62E-03	0	0	0	1.62E-03	0	1.62E-03
C-14	1.39E-05	0	1.39E-05	0	0	0	1.39E-05	0	1.39E-05
N-13	1.09E+02	0	1.09E+02	0	0	0	1.09E+02	0	1.09E+02
O-14	6.40E+00	0	6.40E+00	0	0	0	6.40E+00	0	6.40E+00
O-15	1.43E+02	0	1.43E+02	0	0	0	1.43E+02	0	1.43E+02
V-49	1.38E-05	0	1.38E-05	0	0	0	1.38E-05	0	1.38E-05
Mn-54	4.39E-05	0	4.39E-05	0	0	0	4.39E-05	0	4.39E-05
Fe-55	1.39E-03	0	1.39E-03	0	0	0	1.39E-03	0	1.39E-03
Fe-59	2.44E-06	0	2.44E-06	0	0	0	2.44E-06	0	2.44E-06
Co-56	5.24E-05	0	5.24E-05	0	0	0	5.24E-05	0	5.24E-05
Co-57	3.59E-04	0	3.59E-04	0	0	0	3.59E-04	0	3.59E-04
Co-58	3.68E-05	0	3.68E-05	0	0	0	3.68E-05	0	3.68E-05
Co-60	2.33E-05	0	2.33E-05	0	0	0	2.33E-05	0	2.33E-05
Ni-63	1.24E-03	0	1.24E-03	0	0	0	1.24E-03	0	1.24E-03
Total	2.77E+02	1.88E+02	4.65E+02	2.25E+01	0	2.25E+01	2.60E+02	1.88E+01	2.79E+02

Table G-6
Source Terms for Off-Gas Decay System Failure Scenarios.

ID[a]	22	24	29	30	31
Section[b]	4.4.1	4.5.2	4.6.1	4.6.2	4.6.3
Event	Cryogenic Charcoal Failure	Decay Tank Valve Sequence Error	Off-Gas Pipe Break	Off-Gas Compressor Failure	Decay Tank Failure
Probability[c]	Unlikely	Anticipated	Unlikely	Unlikely	Extremely Unlikely
Duration[d] **(sec)**	86,400	3,600	86,400	3,600	60
Nuclide	**Ci**	**Ci**	**Ci**	**Ci**	**Ci**
H-3	1.10E-01	7.69E-01	1.10E-01	4.58E-03	7.69E-01
C-10	4.38E-03	3.07E-02	4.38E-03	1.83E-04	3.07E-02
C-11	3.23E-01	2.26E+00	3.23E-01	1.35E-02	2.26E+00
C-14	1.62E-04	1.14E-03	1.62E-04	6.77E-06	1.14E-03
N-13	1.36E+00	9.51E+00	1.36E+00	5.66E-02	9.51E+00
N-16	1.23E-02	8.63E-02	1.23E-02	5.14E-04	8.63E-02
O-14	3.29E-01	2.30E+00	3.29E-01	1.37E-02	2.30E+00
O-15	6.14E+00	4.30E+01	6.14E+00	2.56E-01	4.30E+01
Ar-37	1.80E-01	1.26E+00	1.80E-01	7.51E-03	1.26E+00
Ar-39	1.78E-04	1.25E-03	1.78E-04	7.42E-06	1.25E-03
Ar-41	4.63E-03	3.24E-02	4.63E-03	1.93E-04	3.24E-02
Ar-42	9.59E-05	6.71E-04	9.59E-05	4.00E-06	6.71E-04
Sb-119	4.49E-07	3.23E+00	4.49E-07	1.87E-08	3.23E+00
Te-119	2.61E-03	3.23E+00	2.61E-03	1.09E-04	3.23E+00
Te-121	9.59E-07	1.69E+00	9.59E-07	4.00E-08	1.69E+00
Te-123m	4.58E-07	1.14E+01	4.58E-07	1.91E-08	1.14E+01
I-119	2.92E+01	3.23E+00	2.92E+01	1.22E+00	3.23E+00
I-120	6.11E-01	1.78E+00	6.11E-01	2.55E-02	1.78E+00
I-121	3.81E-01	1.69E+00	3.81E-01	1.59E-02	1.69E+00
I-122	2.64E+00	1.18E+01	2.64E+00	1.10E-01	1.18E+01
I-123	1.37E-01	1.14E+01	1.37E-01	5.71E-03	1.14E+01
I-125	4.74E-04	2.47E+01	4.74E-04	1.97E-05	2.47E+01
Xe-119	4.50E+02	3.23E+00	4.50E+02	1.87E+01	3.23E+00
Xe-120	4.26E+01	1.78E+00	4.26E+01	1.77E+00	1.78E+00
Xe-121	4.15E+01	1.69E+00	4.15E+01	1.73E+00	1.69E+00
Xe-122	9.62E+00	1.18E+01	9.62E+00	4.01E-01	1.18E+01
Xe-123	9.28E+01	1.14E+01	9.28E+01	3.87E+00	1.14E+01
Xe-125	3.52E+01	3.67E+01	3.52E+01	1.47E+00	3.67E+01
Xe-127	4.77E-01	3.17E+00	4.77E-01	1.99E-02	3.17E+00
Total	7.13E+02	2.03E+02	7.13E+02	2.97E+01	2.03E+02

Table G-7
Source Terms for Mercury Removal System Failure Scenarios.

ID [a]	17	18
Section [b]	4.1.1	4.1.2
Event	Hg Condensor Failure	Hg Charcoal Absorber Failure
Probability [c]	Anticipated	Unlikely
Duration [d] **(sec)**	172,800	864,000
Nuclide	**Ci**	**Ci**
Hg-184	1.20E-04	1.30E-04
Hg-185	1.91E-04	2.06E-04
Hg-186	5.25E-04	5.68E-04
Hg-187	1.11E-03	1.20E-03
Hg-188	2.47E-03	2.67E-03
Hg-189	4.29E-03	4.63E-03
Hg-190	5.43E-03	5.87E-03
Hg-191	6.84E-03	7.40E-03
Hg-192	9.01E-03	9.74E-03
Hg-193	9.77E-03	1.06E-02
Hg-194	5.71E-04	6.17E-04
Hg-195	1.77E-02	1.91E-02
Hg-197	1.18E-01	1.28E-01
Hg-203	8.46E-02	9.15E-02
Hg-205	3.64E-03	3.94E-03
Total	2.65E-01	2.86E-01

Table G-8
Source Terms for Tritium Removal System Failure Scenarios.

ID[a]	19	20	21	23
Section[b]	4.2.1	4.2.2	4.3.1	4.5.1
Event	He Circulator Failure	Oxidation of Tritium Getter Bed	Combustion of Tritium Getter Bed	Valve Sequence Error
Probability[c]	Anticipated	Unlikely	Extremely Unlikely	Unlikely
Duration[d] **(sec)**	86,400	86,400	3,600	1,200
Nuclide	**Ci**	**Ci**	**Ci**	**Ci**
H-3	4.58E-01	4.58E-01	4.00E+03	4.00E+03
U-234	0	0	1.25E-05	0
U-235	0	0	8.48E-07	0
U-236	0	0	3.88E-07	0
U-238	0	0	8.10E-05	0
Total	4.58E-01	4.58E-01	4.00E+03	4.00E+03

Table G-9
Source Term for Iodine Removal System Failure Scenario.

ID[a]	32
Section[b]	4.6.4
Event	Off-Gas Charcoal Filter Failure
Probability[c]	Unlikely
Duration[d] **(sec)**	86,400
Nuclide	**Ci**
I-119	2.92E+01
I-120	6.11E-01
I-121	3.81E-01
I-122	2.64E+00
I-123	1.37E-01
I-125	4.74E-04
Total	3.29E+01

Table G-10
Source Terms for Liquid Low-Level Waste System Failure Scenarios.

ID [a]	25	26	33	34
Section [b]	4.5.3	4.5.6	4.6.5	4.6.6
Event	Spill Filling Tanker Truck	Spray Filling Tanker Truck	Pipe Break in Linac Tunnel	Storage Tank Failure
Probability [c]	Anticipated	Anticipated	Unlikely	Extremely Unlikely
Duration [d] (sec)	3,600	1,200	3,600	3,600
Nuclide	**Ci**	**Ci**	**Ci**	**Ci**
H-3	4.96E-03	2.48E-02	4.96E-03	4.96E-03
Be-7	2.03E-05	1.01E-06	2.03E-05	2.03E-05
C-14	1.74E-07	8.71E-09	1.74E-07	1.74E-07
V-49	1.73E-07	8.65E-09	1.73E-07	1.73E-07
Mn-54	5.48E-07	2.74E-08	5.48E-07	5.48E-07
Fe-55	1.74E-05	8.68E-07	1.74E-05	1.74E-05
Fe-59	3.04E-08	1.52E-09	3.04E-08	3.04E-08
Co-56	6.55E-07	3.27E-08	6.55E-07	6.55E-07
Co-57	4.49E-06	2.24E-07	4.49E-06	4.49E-06
Co-58	4.60E-07	2.30E-08	4.60E-07	4.60E-07
Co-60	2.91E-07	1.46E-08	2.91E-07	2.91E-07
Ni-63	1.55E-05	7.73E-07	1.55E-05	1.55E-05
Total	5.02E-03	2.48E-02	5.02E-03	5.02E-03

Table G-11
Source Terms for Liquid Process Waste System Failure Scenarios.

ID[a]	27	28	37
Section[b]	4.5.5	4.5.7	4.6.9
Event	Storage Tank Failure	Spray Filling Tanker Truck	Spill Filling Tanker Truck
Probability[c]	Extremely Unlikely	Anticipated	Anticipated
Duration[d] **(sec)**	12,600	1,200	3,600
Nuclide	**Ci**	**Ci**	**Ci**
H-3	7.31E-05	3.66E-05	7.31E-05
Be-7	5.53E-05	2.77E-05	5.53E-05
C-14	5.01E-08	2.51E-08	5.01E-08
V-48	6.92E-09	3.46E-09	6.92E-09
V-49	4.52E-08	2.26E-08	4.52E-08
Cr-51	1.53E-08	7.65E-09	1.53E-08
Mn-52	1.40E-07	7.33E-09	1.40E-07
Mn-54	2.17E-12	1.09E-12	2.17E-12
Fe-55	5.94E-08	2.97E-08	5.94E-08
Fe-59	5.09E-06	2.54E-06	5.09E-06
Co-56	1.57E-07	7.87E-08	1.57E-07
Co-57	9.01E-07	4.50E-07	9.01E-07
Co-58	1.91E-06	9.53E-07	1.91E-06
Co-60	7.69E-07	3.84E-07	7.69E-07
Ni-59	0	2.56E-07	0
Ni-63	3.58E-08	1.79E-08	3.58E-08
Total	1.38E-04	6.90E-05	1.38E-04

Section 4.6.8 of Appendix C discusses an "anticipated" break of an underground process waste pipe that releases 10 percent of the annual volume of process waste underground. It is assumed that the leak is discovered after one year. The scenario does not postulate that the liquid released pools on the surface of the ground or enters the groundwater system or discuss the depth of soil over the release. Since there is no surface pooling, the radioactivity released could reach humans only via groundwater transport. Any radionuclides would move in the direction of groundwater flow. Tritium would migrate at the velocity of groundwater flow and C-14 at a somewhat slower rate. Migration of other radionuclides in the waste would move much more slowly and could require many years to reach a location where human exposure could occur. Most of these radionuclides would decay to negligible concentrations before such migration could occur.

Section 4.7.1 of Appendix C discusses a transportation accident involving the release of LLLW from the LR-56 tanker truck and Section 4.7.2 discusses a similar accident involving process waste. Both accidents assume a total loss of tanker contents but do not postulate airborne release. The LR-56 is essentially a DOT Type B transport package with a capacity of 800 gallons but is not certified as such in the United States. No radioactive material has ever been released in a transportation accident involving a certified Type B package. The process waste tanker has a capacity of 15,000 gallons and no special resistance to severe transportation accidents. Based on the annual number of trips, the LLLW accidents would be "extremely unlikely" and the process waste accident would be "unlikely." In the absence of an airborne source term, it is unlikely that humans would be accidentally exposed before the spill was immobilized and assessed, and any appropriate remedial actions taken.

G.3 Selection of Exposure Pathways

This section identifies the potential pathways for exposure of human to radioactive materials that would or could be released from the SNS and discusses the rationale for selecting these pathways. This information is also applicable to assessment of the toxic effects of exposures to mercury.

Summary

This FEIS evaluates health impacts of normal operations on the public based on four exposure pathways:

- Inhalation of radionuclides released to air.
- Immersion in air containing radionuclides released to air.
- Irradiation by radionuclides deposited on the ground surface after release to air.
- Ingestion of foods contaminated by radionuclides released to air.

Health impacts of normal operations on workers are evaluated based on the first three of these exposure pathways. Ingestion is not an occupational exposure and is not considered.

Health impacts of accident conditions on the public and on workers are evaluated based on immediate exposures (i.e., inhalation and immersion). Exposures involving buildup of radionuclides on the ground and transfer through the foodchain could be controlled by impoundment of foodstuffs and by remedial actions and are not considered.

Discussion

Radioactive materials released during normal and accident conditions may be released to air, soil, surface water, and/or groundwater. Each of these media have a number of primary and secondary exposure pathways that may be important. Which exposure pathways are important depends on the radiological characteristics of the radionuclides and the quantities of each released and on how the radionuclides would be diluted or concentrated as they are transferred from one medium or pathway to another.

All radioactive and toxic materials released to the environment during normal SNS operations are released to the atmosphere. The majority of the releases are continuous throughout the year. Under these conditions, the primary potential exposure pathways and groups exposed are:

- Inhalation of radionuclides released to air (workers, public),
- Immersion in air containing radionuclides released to air (workers, public), and
- Ingestion of foods contaminated by radionuclides released to air (public).

The ingestion pathway could include a number of sub-pathways. Radionuclides deposited on the surfaces of leafy plants could be absorbed by the plants and radionuclides deposited on the ground surface could be taken up by the roots of plants. Once in the plants, the radionuclides could be ingested by humans eating the plants, and/or eating animals that had eaten the plants, or by humans eating products such as milk or eggs from animals that had eaten the plants.

Potential secondary exposure pathways for releases to air involve radionuclides deposited on the ground surface. The pathways and the groups exposed are:

- Exposure to direct radiation from radionuclides deposited on the ground surface (workers, public),
- Inhalation of resuspended contaminated soil (workers, public), and
- Immersion in air containing resuspended contaminated soil (workers, public).

Doses from the secondary exposure pathways are usually much lower and often insignificant compared to doses from the primary pathways. The relative importance of the primary pathways to each other depends more directly on the specific radionuclides released.

These same potential exposure pathways exist for accidental releases; however, because accidental releases occur infrequently and over relatively short periods of time, the relative importance of pathways based on deposition of radionuclides on the ground surface is diminished. Radionuclides deposited on plants or the ground surface are removed by weathering and would not be replenished. In case of large accidental releases, the site emergency response plan may involve actions to prevent ingestion of contaminated foods and to remove contamination from the environment.

Based on these considerations, impacts of normal operations to the public were evaluated in this FEIS based inhalation, immersion, ingestion, and direct irradiation from the ground surface. These are the same exposure pathways considered in the widely used CAP88-PC computer program. For workers, ingestion is not an occupational exposure and was not considered. For exposures resulting from accident conditions, impacts to the public and to workers were evaluated based on inhalation and immersion. Pathways involving deposition of radionuclides were not considered.

G. 4 Environmental Transport

The assessment of health impacts in this FEIS is based on evaluation of the consequences of elevated and ground-level releases of radioactive and toxic materials from the SNS. The materials released would be transported through the environment by atmospheric dispersion. During dispersion, additional factors could affect the concentrations of contaminants in the air. These plume depletion mechanisms include dry deposition (“fallout”), wet deposition (“rainout” and “washout”), and radioactive decay.

A number of computer codes are available to calculate dispersion, deposition, and radioactive decay of radionuclides released to the atmosphere and many of these codes also calculate transport of deposited radionuclides through the food chain. CAP88-PC is a widely-used code that performs such calculations for continuous releases such as SNS emissions in routine operations. GENII and MACCS2 can perform these calculations for both continuous and short-duration releases that would occur during accidents. None of these codes contain decay chain data, biotic transfer factors, or dose conversion factors for some of the mercury, xenon, and iodine radionuclides and associated progeny produced in the mercury target, and it would not be practical to make the necessary modifications to the codes and their data files.

G.4.1 Undepleted Atmospheric Dispersion Factors

For normal conditions, a set of Microsoft Excel97 spreadsheet and Visual Basic macros were developed to implement a slightly modified version of the methodology used in CAP88-PC. This methodology is described in the code user guide (EPA 402-B-92-001). The documentation for AIRDOS-EPA, a mainframe predecessor of CAP88-PC, contains additional detail and a source code listing (EPA 520/1/79-009).

The CAP88-PC methodology implemented in this analysis uses a Gaussian plume model to calculate sector-averaged deleted ground-level concentrations in air and the ground deposition rates of radionuclides. The depletion mechanisms considered are radioactive decay and ingrowth, precipitation scavenging, and dry deposition. In-growth of progeny of radionuclides deposited on the ground and on plant surfaces are also considered. Concentrations in vegetation, beef, and milk consumed by humans are calculated using soil-to-plant, animal feed-to-milk, and animal feed-to-beef transfer factors. Intake of radionuclides by humans is calculated based on agricultural production data for the appropriate state and consumption rates of leafy vegetables, produce, milk, and beef.

The following modifications were made to the CAP88-PC methodology:

- Plume rise was conservatively assumed to be zero.
- Dose and risk calculations and data were replaced by updated dose conversion factors discussed in Section G.5.2 and risk factors recommended by the EPA.
- The CAP88-PC consideration of ingrowth of a small number of decay chains and the use of pre-calculated ingrowth factors in decay and buildup calculations were replaced with specific calculation of ingrowth of all decay chains.

- The time allowed for deposition and buildup of radionuclides was changed from 100 years to 40 years to match the operating life of the SNS.

- The maximally exposed individual was assumed to be a hypothetical individual located at the site boundary and to obtain all of his or her required dietary intake at this location. The CAP88-PC method of adjusting the relative amounts of food grown in a given segment, grown in the entire assessment area, and imported from outside the region that is ingested by the population in that segment was retained for population dose calculations.

- When calculating population doses, CAP88-PC determines the maximally exposed individual based only on results for segments that are specified in the population distribution as containing people. For this analysis, a hypothetical individual was placed in the sector where contamination would have the maximum impact on agricultural production in the region of the assessment [i.e., within 50 mi (80 km) of the site].

G.4.2 Depletion by Radioactive Decayand Biotic Transfer – Normal Operations

Site-specific joint frequency distributions in STAR format were used to calculate the wind speed frequencies and averages and the stability class frequencies required for the CAP88-PC methodology. Site-specific precipitation data and atmospheric lid heights were used in dispersion and deposition calculations. Dry deposition rates for particulates (0.035 m/sec), iodine (0.0018 m/sec), and gases (0 m/sec) listed in the CAP88-PC user's guide were used; however, a deposition velocity of 0.0006 m/sec (EPA 1997) was used for mercury.

The deposition rate for mercury is based on an extensive EPA assessment of mercury exposure (EPA 1997) that investigated atmospheric deposition of mercury. It found that the combined wet and dry deposition of elemental mercury vapor on the ground was very low and that approximately 5 to 10 percent of mercuric mercury (oxidized mercury) would be deposited within 100 km of the release point. It also found that elemental mercury was rarely absorbed by the leafy surfaces or root of plants. SNS source terms for normal emissions assume that all mercury would be released as elemental mercury vapor. Some accident scenarios do assume that iodine would be released as mercuric iodide, an oxidized mercury, but the amount of mercury released in this form would be many orders of magnitude less than the quantity of elemental mercury.

CAP88-PC biotic transfer factors were supplemented with data from ORNL-5786 (Baes 1984) and from http://risk.lsd.ornl.gov/cgi-bin/tox/TOX_9801. The CAP88-PC methodology uses transfer factors for vegetation consumed by humans based on the wet weight of the vegetation. ORNL-5786 contains factors based on dry weight but provides a conversion factor for adapting the data for use with CAP88-PC. Agricultural production data for Tennessee, New Mexico, Illinois, and New York were used in site-specific evaluations.

The analysis used CAP88-PC default values for fractions of vegetables, beef, and milk consumed by populations. Fractions assumed to be grown locally, in the assessment region, and imported were the CAP88-PC defaults for rural areas for ORNL and LANL and for urban areas for ANL and BNL. CAP88-PC consumption rates were also used. Site-specific populations distributions were used for the off-site public and for uninvolved workers.

G.4.3 Accident Conditions

Atmospheric dispersion calculations for short-term releases in accidents were performed using PAVAN Version 2.0, a computer code used by the U.S. Nuclear Regulatory Commission to evaluate ground-level concentrations of radioactive materials released in accidents at nuclear power plants (PNL 1982). PAVAN uses joint frequency distributions of wind speed and direction by stability class to calculate ground-level normalized atmospheric dispersion factors (χ/Qs) for short-term elevated and ground-level releases. The code does not consider plume rise, radioactive decay, or any other depletion process. The short-term χ/Qs are normalized ground-level concentrations at the plume centerline in each 22.5 degrees sector surrounding the site.

PAVAN uses several methods to deal with the fact that meteorological conditions during a given short-term release will vary from release to release. For this FEIS, direction-specific χ/Qs that would be exceeded no more than 0.5 percent of the total time were selected for short-term releases. PAVAN calculates sets of these χ/Qs for release durations of 0-2 hours, 0-8 hours, 8-24 hours, 1-4 days, and 4-30 days.

The wind speed, wind direction, and stability class data were for the most recent available one-year monitoring period from the meteorological monitoring station nearest to the preferred SNS location at each site. ORNL provided 1996 data measured at heights of 10 m and 60 m at the Y-12 Plant western meteorological tower. LANL provided 1996 data measured at height of 10 m at the Technical Area (TA)-53 tower. ANL provided 1997 data measured at a height of 60 m. BNL provided 1997 data measured at a height of 10 m. If 60 m data was available, it was used for elevated releases. Otherwise, 10 m data was used. PAVAN adjusts all wind speed data from the height of measurement to the height of release (10 m for ground-level releases). This is the same meteorological data used to evaluate atmospheric dispersion for normal operations.

For elevated releases, χ/Qs were calculated for 22.5 degree sectors centered on the principal compass directions. Distances spaced at increasing intervals from 100 m to 2 km were used for workers. Distances from each stack to the site boundary were used for the maximally exposed member of the public. Distances corresponding to those provided in off-site population distributions within 80 km of the site as provided by each site were used for the off-site populations calculation. Ground-level releases were assumed to occur near the Target Building Exhaust Stack. For uninvolved worker populations, χ/Qs were estimated by superimposing the 100-2000 m grid for individual workers on site maps. Worker populations in occupied structures were provided by ORNL and estimated for the other sites by querying electronic copies of site phone books.

The calculations for accident conditions used the durations and source terms shown in Tables G-3 through G-11 and selected χ/Qs appropriate to each phase. The releases were modeled as elevated releases from the appropriate SNS stack. The heights of these stacks would be 80 feet above grade. No adjustments were made for terrain height.

G.4.4 Depletion by Radioactive Decay – Accidental Releases

As discussed in Section G.3, exposure pathways involving deposition of radionuclides were not considered in evaluating accident impacts. This maximizes dose due to inhalation and immersion.

The half-lives of several of the radionuclides released during accidents are short compared to the duration of release and, in some cases, to the travel times in the region of interest. Accordingly, radioactive decay and ingrowth was considered both during release and transport. This involved calculations for as many as 245 radionuclides. Many of these radionuclides have half-lives comparable to their travel times from the SNS to a distance of 80 km. Thus, the concentration and dose were very sensitive to distance. Elevated releases travel some distance, usually a few hundred meters, before the plume reaches the ground. As a result, χ/Qs initially increase and then begin to decrease with distance. For the radionuclides that would be emitted by the SNS, the total activity in the plume decreases with distance but activities of a number of progeny increase to some steady state or peak and then decline. This behavior can cause shifts in the relative importance of exposure pathways as the plume traverses the region of interest.

Since average wind speeds are not uniform in all directions, the spreadsheet macros used average wind speeds specific to each direction at a given site to calculate "in-flight" decay. These average wind speeds were calculated from joint frequency distributions of height-adjusted wind speeds and direction by stability class calculated by PAVAN from the original joint frequency distributions for each site.

The depleted uranium component of the source term for a fire in the tritium getter bed was not decayed. The half-lives of the uranium isotopes and their progeny is such that the progeny that have high dose conversion factors relative to the parent uranium require several thousand years to in-grow to levels that would affect dose.

G.5 Dose Calculations

This section discusses the calculation of dose to workers and the public from exposure to SNS emissions by inhalation and immersion, the selection of dose conversion factors from available data, and the basis for estimating ingestion dose to the public for inhalation dose.

G.5.1 Inhalation and Immersion

$$Dose = \sum_{i=1}^{n} Q_i \times \frac{\chi}{Q} \times E \times \left(BR \times DCF_{inh_i} + DCF_{imm_i}\right)$$

The total dose (rem) during exposure period E to an individual at a given distance and direction from the source of an airborne release due to radionuclide concentrations in the environment is given by:
where:

Qi	=	Depleted source term (Ci/sec) for the i-th radionuclide
χ/Q	=	Atmospheric dispersion factor (sec/m3) for the given distance, direction, and release duration
E	=	Exposure period (sec)
BR	=	Breathing rate (m3/sec)
DCF_{inh}	=	Inhalation dose conversion factor for the i-th radionuclide (rem/Ci)

DCF_{imm} = Immersion dose conversion factor for the i-th radionuclide (rem/sec per Ci/ m^3)

For exposures to continuous releases, exposure periods are 8,760 hr/yr for the public and 2,000 hr/yr for workers. For short-term releases, the exposure period for the public is equal to the release duration. For workers, it is the number of hours worked during the release based on 8-hours shifts starting at the beginning of the release. Breathing rates are: 1.24×10^{-4} m^3/sec for the public and 3.33×10^{-4} m^3/sec for workers. Dose conversion factors for inhalation and immersion are listed in Table G-12 and discussed in Section G.5.2.

G.5.2 Selection of Dose Conversion Factors

Most dose assessments use dose conversion factors published by the U.S. Environmental Protection Agency in *Federal Guidance Report No. 11* (Eckerman et al 1988) for internal exposures and *Federal Guidance Report No. 12* (Eckerman and Ryman 1993) for external exposures. The factors are applicable to exposures received by workers and the public and are reflected in current dose limits enforced by EPA, DOE, and NRC. These reports were the primary source of the dose conversion factor used to prepare this FEIS; however, they do not include data for all of the mercury and iodine radionuclides or their progeny that are projected to be present in SNS emissions.

DOE undertook an effort to calculate the missing data. In doing so, it assessed the new internal and external dosimetry models being used by EPA to develop Federal Guidance Report No. 13 (Eckerman et al 1998). DOE staff at ORNL had performed similar calculations for the two previous Federal Guidance Reports. When completed, Federal Guidance Report No. 13 will provide coefficients to allow risk from exposures of the public to be estimated directly for radionuclide concentrations in environmental media. These coefficients will not be applicable to exposures of workers and, depending on the dose and dose rate, may not be applicable to exposures during accidents. The interim report does contain data for isotopes of mercury or iodine or their progeny beyond that found in the earlier reports.

Because the Federal Guidance Report No 13 data was not appropriate for this FEIS analysis, the ORNL staff developed inhalation and ingestion dose conversion factors for occupational and accident exposure to SNS mercury isotopes with half-lives of more than a few seconds and for SNS iodine isotopes. It also developed factors for immersion and ground plane exposures for the mercury and iodine isotopes (Eckerman 1998b). Dose conversion factors for internal exposures include the contributions of the progeny that are produced by decay in the body following the intake; however, unless the progeny have half-lives similar to or longer than the parent, separate factors are not usually calculated for direct intakes of the progeny. Several of the mercury decay chains do contain progeny with half-lives similar to or longer than the parent. DOE subsequently provided updated factors for mercury and these progeny (Eckerman 1998a).

Table G-12
Dose Conversion Factors Used to Estimate SNS Impacts under Normal and Accident Conditions

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
H-3	12.6 y	6.40E+01	0	0	6.40E+01
He-6	0.81 s	#N/A	#N/A	#N/A	#N/A
Li-8	0.84 s	#N/A	#N/A	#N/A	#N/A
Be-7	53.3 d	3.21E+02	8.73E-03	1.81E-04	1.28E+02
Be-8	0.00 s	#N/A	#N/A	#N/A	#N/A
Be-10	1.55E+06 y	3.54E+05	4.14E-05	1.52E-06	4.66E+03
B-12	0.20 s	#N/A	#N/A	#N/A	#N/A
B-13	0.02 s	#N/A	#N/A	#N/A	#N/A
C-10	19.3 s	#N/A	#N/A	#N/A	#N/A
C-11	20.4 m	1.22E+01	1.81E-01	3.74E-03	1.22E+01
C-14	5,870 y	2.09E+03	8.29E-07	5.96E-08	2.09E+03
N-12	0.01	#N/A	#N/A	#N/A	#N/A
N-13	9.97 m	#N/A	1.81E-01	3.74E-03	#N/A
N-16	7.13 s	#N/A	#N/A	#N/A	#N/A
N-17	4.17 s	#N/A	#N/A	#N/A	#N/A
O-14	1.18 m	#N/A	#N/A	#N/A	#N/A
O-15	2.04 m	#N/A	1.82E-01	3.74E-03	#N/A
O-19	26.9 s	#N/A	#N/A	#N/A	#N/A
F-18	1.83 h	8.36E+01	1.81E-01	3.74E-03	1.22E+02
F-20	11.0 s	#N/A	#N/A	#N/A	#N/A
Ne-23	37.2 s	#N/A	#N/A	#N/A	#N/A
Na-22	2.67 y	7.66E+03	4.00E-01	7.77E-03	1.15E+04

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Na-24	15.0 h	1.21E+03	8.07E-01	1.34E-02	1.42E+03
Mg-27	9.46 m	#N/A	#N/A	#N/A	#N/A
Al-26	7.59E+05 y	7.96E+04	5.03E-01	9.21E-03	1.46E+04
Al-28	2.24 m	#N/A	3.43E-01	5.99E-03	#N/A
Al-29	6.56 m	#N/A	#N/A	#N/A	#N/A
Si-31	2.62 H	2.23E+02	4.33E-04	1.11E-05	5.40E+02
Si-32	176 y	1.01E+06	1.94E-06	1.15E-07	2.18E+03
P-32	14.3 d	1.55E+04	3.66E-04	1.08E-05	8.77E+03
P-33	25.3 d	2.32E+03	3.05E-06	1.65E-07	9.18E+02
S-35	87.5 d	2.48E+03	8.99E-07	6.22E-08	7.33E+02
Cl-36	3.09E+05 y	2.19E+04	8.25E-05	2.49E-06	3.03E+03
Cl-38	37.2 m	1.34E+02	2.91E-01	4.96E-03	2.35E+02
Ar-37	35.0 d	#N/A	0	0	#N/A
Ar-39	276 y	#N/A	3.37E-05	1.25E-06	#N/A
Ar-41	1.82 h	#N/A	2.41E-01	4.44E-03	#N/A
Ar-42	33.7 y	#N/A	#N/A	#N/A	#N/A
Ar-43	5.37 m	#N/A	#N/A	#N/A	#N/A
K-38	7.64 m	#N/A	6.07E-01	1.08E-02	#N/A
K-40	1.31E+09 y	1.24E+04	2.98E-02	5.40E-04	1.86E+04
K-42	12.4 h	1.36E+03	5.40E-02	9.84E-04	1.13E+03
K-43	22.3 h	6.92E+02	1.73E-01	3.53E-03	7.70E+02
K-44	22.1 m	8.29E+01	4.40E-01	7.55E-03	1.73E+02

Table G-12
Dose Conversion Factors Used to Estimate SNS Impacts under Normal and Accident Conditions - Continued.

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Ca-41	1.06E+05 y	1.35E+03	0	0	1.27E+03
Ca-45	163 d	6.62E+03	3.19E-06	1.71E-07	3.16E+03
Ca-47	4.54 d	6.55E+03	1.98E-01	3.70E-03	6.51E+03
Ca-49	8.72 m	#N/A	6.40E-01	9.73E-03	#N/A
Sc-43	3.89 h	2.59E+02	1.95E-01	4.00E-03	7.62E+02
Sc-44	3.93 h	4.92E+02	3.89E-01	7.66E-03	1.43E+03
Sc-46	83.8 d	2.96E+04	3.69E-01	7.14E-03	6.40E+03
Sc-47	3.35 d	1.84E+03	1.90E-02	3.85E-04	2.23E+03
Sc-48	1.82 d	4.11E+03	6.22E-01	1.18E-02	7.25E+03
Sc-49	57.2 m	1.02E+02	7.14E-04	1.82E-05	2.52E+02
Ti-44	64.6 y	1.02E+06	2.05E-02	4.88E-04	2.31E+04
Ti-45	3.08 h	2.15E+02	1.55E-01	3.19E-03	5.99E+02
Ti-51	5.76 m	#N/A	#N/A	#N/A	#N/A
V-47	32.6 m	7.03E+01	1.77E-01	3.65E-03	1.75E+02
V-48	16.0 d	1.02E+04	5.37E-01	1.03E-02	8.58E+03
V-49	330 d	3.45E+02	0	0	6.14E+01
V-50	1.44E+17 y	#N/A	#N/A	#N/A	#N/A
V-52	3.74 m	#N/A	#N/A	#N/A	#N/A
Cr-48	21.6 h	8.77E+02	7.62E-02	1.57E-03	9.14E+02
Cr-49	42.3 m	7.25E+01	1.86E-01	3.85E-03	1.84E+02
Cr-51	27.7 d	3.34E+02	5.59E-03	1.14E-04	1.47E+02

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Cr-55	3.50 m	#N/A	#N/A	#N/A	#N/A
Cr-56	5.94 m	#N/A	#N/A	#N/A	#N/A
Mn-51	46.2 m	1.15E+02	1.78E-01	3.67E-03	2.78E+02
Mn-52	5.59 d	5.70E+03	6.36E-01	1.22E-02	7.59E+03
Mn-53	3.83E+06 y	5.00E+02	0	0	1.08E+02
Mn-54	312 d	6.70E+03	1.51E-01	3.00E-03	2.77E+03
Mn-56	2.58 h	3.77E+02	3.19E-01	5.85E-03	9.77E+02
Mn-57	1.42 m	#N/A	#N/A	#N/A	#N/A
Fe-52	8.28 h	2.19E+03	1.31E-01	2.69E-03	5.59E+03
Fe-53	8.51 m	#N/A	#N/A	#N/A	#N/A
Fe-55	2.80 y	2.69E+03	0	0	6.07E+02
Fe-59	44.5 d	1.48E+04	2.21E-01	4.14E-03	6.70E+03
Fe-60	1.54E+06 y	7.47E+05	7.22E-07	5.48E-08	1.52E+05
Fe-61	5.98 m	#N/A	#N/A	#N/A	#N/A
Co-55	17.5 h	2.09E+03	3.62E-01	7.14E-03	4.37E+03
Co-56	77.3 d	3.96E+04	6.77E-01	1.22E-02	1.26E+04
Co-57	272 d	9.07E+03	2.08E-02	4.26E-04	1.18E+03
Co-58	70.9 d	1.09E+04	1.76E-01	3.52E-03	3.58E+03
Co-60	5.41 y	2.19E+05	4.66E-01	8.70E-03	2.69E+04
Co-61	1.65 h	1.06E+02	1.46E-02	3.34E-04	2.63E+02
Co-62	1.50 m	#N/A	#N/A	#N/A	#N/A

Table G-12
Dose Conversion Factors Used to Estimate SNS Impacts under Normal and Accident Conditions - Continued.

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Co-63	27.4 s	#N/A	#N/A	#N/A	#N/A
Ni-56	6.08 d	4.03E+03	3.11E-01	6.14E-03	3.89E+03
Ni-57	1.48 d	1.89E+03	3.59E-01	6.66E-03	3.77E+03
Ni-59	77,900 y	1.32E+03	0	0	2.10E+02
Ni-63	103 y	3.10E+03	0	0	5.77E+02
Ni-65	2.52 h	2.42E+02	1.03E-01	1.91E-03	6.22E+02
Cu-60	23.7 m	6.92E+01	7.33E-01	1.34E-02	1.93E+02
Cu-61	3.33 h	1.87E+02	1.48E-01	3.02E-03	4.37E+02
Cu-62	9.74 m	#N/A	1.80E-01	3.70E-03	#N/A
Cu-64	12.7 h	2.77E+02	3.37E-02	6.92E-04	4.66E+02
Sb-119	1.59 d	1.25E+02	7.96E-04	8.03E-05	2.75E+02
Te-119	16.0 h	3.76E+02	1.36E-01	2.76E-03	6.46E+02
Te-119m	4.70 d	#N/A	#N/A	#N/A	#N/A
Te-121	16.8 d	1.91E+03	9.99E-02	2.11E-03	1.68E+03
Te-123	1.03E+13 y	1.05E+04	7.96E-04	7.22E-05	4.18E+03
Te-123m	120 d	1.06E+04	2.41E-02	5.29E-04	5.66E+03
I-119	19.1 m	5.18E+01	1.57E-01	3.23E-03	1.48E+02
I-120	1.35 h	3.69E+02	5.11E-01	9.47E-03	1.27E+03
I-121	2.12 h	1.02E+02	7.18E-02	1.51E-03	3.08E+02
I-122	3.63 m	1.27E+01	1.69E-01	3.48E-03	4.78E+01
I-123	13.3 h	2.78E+02	2.69E-02	6.14E-04	8.05E+02
I-124	4.81 d	1.64E+04	1.99E-01	3.89E-03	4.81E+04

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec Per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
I-125	59.0 d	1.93E+04	1.93E-03	1.58E-04	5.69E+04
I-126	13.1 d	3.65E+04	7.96E-02	1.65E-03	1.07E+05
I-128	25.0 m	4.85E+01	1.54E-02	3.24E-04	1.70E+02
I-29	1.61E+07 y	1.33E+05	1.41E-03	9.55E-05	3.91E+05
I-130	12.4 h	2.50E+03	3.85E-01	7.77E-03	7.27E+03
Xe-119	5.80 m	#N/A	#N/A	#N/A	#N/A
Xe-120	40.0 m	#N/A	7.18E-02	1.57E-03	#N/A
Xe-121	40.1 m	#N/A	3.38E-01	6.25E-03	#N/A
Xe-122	20.1 h	#N/A	9.10E-03	2.53E-04	#N/A
Xe-123	2.08 h	#N/A	1.12E-01	2.25E-03	#N/A
Xe-125	16.9 h	#N/A	4.40E-02	9.81E-04	#N/A
Xe-127	36.4 d	#N/A	4.63E-02	1.01E-03	#N/A
Yb-169	32.1 d	8.07E+03	4.77E-02	1.12E-03	3.00E+03
Yb-169m	46.0 s	#N/A	#N/A	#N/A	#N/A
Lu-168	5.50 m	#N/A	#N/A	#N/A	#N/A
Lu-169	1.42 d	1.35E+03	1.88E-01	3.65E-03	2.03E+03
Lu-169m	2.67 m	#N/A	#N/A	#N/A	#N/A
Lu-170	2.01 d	2.58E+03	4.74E-01	8.29E-03	4.55E+03
Lu-172	6.70 d	5.00E+03	3.42E-01	6.70E-03	5.66E+03
Lu-172m	3.70 m	#N/A	#N/A	#N/A	#N/A
Lu-173	1.40 y	2.25E+04	1.89E-02	4.74E-04	1.09E+03

Table G-12
Dose Conversion Factors Used to Estimate SNS Impacts under Normal and Accident Conditions - Continued.

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec Per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Hf-168	26.0 m	#N/A	#N/A	#N/A	#N/A
Hf-169	3.20 m	#N/A	#N/A	#N/A	#N/A
Hf-170	16.0 h	1.20E+03	9.32E-02	1.99E-03	2.12E+03
Hf-172	1.92 y	3.18E+05	1.50E-02	4.18E-04	4.48E+03
Hf-173	23.6 h	4.77E+02	6.85E-02	1.47E-03	1.00E+03
Hf-175	70.0 d	5.59E+03	6.25E-02	1.34E-03	1.82E+03
Ta-168	2.07 m	#N/A	#N/A	#N/A	#N/A
Ta-169	4.90 m	#N/A	#N/A	#N/A	#N/A
Ta-170	6.77 m	#N/A	#N/A	#N/A	#N/A
Ta-172	36.8 m	5.66E+01	2.81E-01	5.48E-03	1.59E+02
Ta-173	3.14 h	3.20E+02	1.02E-01	2.10E-03	7.84E+02
Ta-174	1.05 h	6.73E+01	1.10E-01	2.25E-03	1.96E+02
Ta-175	10.5 h	3.81E+02	1.68E-01	3.25E-03	9.07E+02
Ta-176	8.08 h	6.90E+02	4.14E-01	7.51E-03	1.12E+03
Ta-177	2.36 d	3.07E+02	9.36E-03	2.43E-04	4.51E+02
Ta-178	9.32 m	8.29E+01	#N/A	#N/A	2.93E+02
Ta-179	1.87 y	6.51E+03	4.03E-03	1.17E-04	2.73E+02
W-168	51.0 s	#N/A	#N/A	#N/A	#N/A
W-169	1.33 m	#N/A	#N/A	#N/A	#N/A
W-170	2.42 m	#N/A	#N/A	#N/A	#N/A
W-172	6.60 m	#N/A	#N/A	#N/A	#N/A
W-173	7.60 m	#N/A	#N/A	#N/A	#N/A

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
W-174	31.0 m	#N/A	#N/A	#N/A	#N/A
W-175	35.0 m	#N/A	#N/A	#N/A	#N/A
W-176	2.50 h	2.39E+02	2.60E-02	6.33E-04	3.60E+02
W-177	2.25 h	6.51E+01	1.58E-01	3.23E-03	2.48E+02
W-178	21.5 d	2.71E+02	1.71E-03	4.81E-05	1.02E+03
W-179	37.0 m	3.50E+00	6.77E-03	2.17E-04	1.01E+01
W-179m	6.40 m	#N/A	#N/A	#N/A	#N/A
W-181	122 d	5.00E+02	5.18E-03	1.46E-04	2.13E+02
Re-172	15.0 s	#N/A	#N/A	#N/A	#N/A
Re-172m	55.0 s	#N/A	#N/A	#N/A	#N/A
Re-173	1.98 m	#N/A	#N/A	#N/A	#N/A
Re-174	2.40 m	#N/A	#N/A	#N/A	#N/A
Re-175	5.88 m	#N/A	#N/A	#N/A	#N/A
Re-176	5.30 m	3.88E+01	1.91E-01	3.89E-03	8.40E+01
Re-177	14.0 m	2.39E+01	1.10E-01	2.18E-03	5.40E+01
Re-178	13.2 m	2.25E+01	2.25E-01	4.18E-03	5.77E+01
Re-179	19.5 m	#N/A	#N/A	#N/A	#N/A
Re-180	2.37 m	7.58E+00	2.10E-01	4.18E-03	7.39E+00
Re-181	19.8 m	9.16E+02	1.40E-01	2.88E-03	1.50E+03
Re-182m	12.7 h	#N/A	#N/A	#N/A	#N/A
Re-183	70.0 d	#N/A	#N/A	#N/A	#N/A
Os-172	19.2 s	#N/A	#N/A	#N/A	#N/A

Table G-12
Dose Conversion Factors Used to Estimate SNS Impacts under Normal and Accident Conditions - Continued.

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Os-173	16.0 s	#N/A	#N/A	#N/A	#N/A
Os-174	44.0 s	#N/A	#N/A	#N/A	#N/A
Os-175	1.40 m	#N/A	#N/A	#N/A	#N/A
Os-176	3.60 m	#N/A	#N/A	#N/A	#N/A
Os-177	2.80 m	#N/A	#N/A	#N/A	#N/A
Os-178	5.00 m	#N/A	#N/A	#N/A	#N/A
Os-179	6.50 m	#N/A	#N/A	#N/A	#N/A
Os-180	20.8 m	4.54E+01	5.77E-05	9.18E-06	5.44E+01
Os-181	1.75 h	6.71E+00	6.40E-02	1.32E-03	7.19E+00
Os-182	22.1 h	1.38E+03	7.44E-02	1.57E-03	2.44E+03
Os-183	13.0 h	9.72E+02	1.08E-01	2.28E-03	2.66E+03
Os-183m	9.89 h	#N/A	#N/A	#N/A	#N/A
Os-185	93.6 d	4.27E+03	1.22E-01	2.49E-03	1.77E+03
Os-186	2.05E+15 y	#N/A	#N/A	#N/A	#N/A
Os-189m	5.81 h	2.99E+01	3.92E-07	1.16E-07	6.70E+01
Ir-176	8.00 s	#N/A	#N/A	#N/A	#N/A
Ir-177	30.0 s	#N/A	#N/A	#N/A	#N/A
Ir-178	12.0 s	#N/A	#N/A	#N/A	#N/A
Ir-179	1.32 m	#N/A	#N/A	#N/A	#N/A
Ir-180	1.50 m	7.66E+00	1.58E-01	3.17E-03	6.83E+00
Ir-181	4.90 m	6.66E+01	7.59E-01	1.41E-02	5.67E+01
Ir-182	15.0 m	4.85E+01	2.41E-01	4.85E-03	1.28E+02
Ir-183	58.0 m	1.54E+02	2.11E-01	4.00E-03	3.03E+02

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Ir-184	3.08 h	2.30E+02	3.47E-01	6.73E-03	6.96E+02
Ir-185	14.4 h	6.56E+02	1.09E-01	2.04E-03	9.72E+02
Ir-186	16.6 h	1.20E+03	2.96E-01	5.70E-03	1.97E+03
Ir-186m	1.90 h	#N/A	#N/A	#N/A	#N/A
Ir-187	10.5 h	2.53E+02	5.66E-02	1.18E-03	3.99E+02
Ir-188	1.72 d	1.66E+03	3.96E-01	7.03E-03	2.75E+03
Ir-189	13.2 d	1.69E+03	1.15E-02	2.76E-04	8.12E+02
Pt-176	6.33 s	#N/A	#N/A	#N/A	#N/A
Pt-177	11.0 s	#N/A	#N/A	#N/A	#N/A
Pt-178	21.1 s	#N/A	#N/A	#N/A	#N/A
Pt-179	21.2 s	#N/A	#N/A	#N/A	#N/A
Pt-180	52.0 s	6.27E+00	0	0	3.92E+00
Pt-181	51.0 s	2.56E+01	1.17E+00	2.26E-02	2.04E+01
Pt-182	2.20 m	#N/A	#N/A	#N/A	#N/A
Pt-183	6.50 m	#N/A	#N/A	#N/A	#N/A
Pt-183m	43.0 s	#N/A	#N/A	#N/A	#N/A
Pt-184	17.3 m	5.05E+01	1.17E-01	2.48E-03	4.45E+01
Pt-185	1.18 h	2.47E+02	5.03E-01	1.02E-02	2.38E+02
Pt-186	2.00 h	1.95E+02	1.14E-01	2.36E-03	3.27E+02
Pt-187	2.35 h	2.18E+02	9.77E-02	2.02E-03	2.62E+02
Pt-188	10.2 d	6.48E+03	3.35E-02	7.33E-04	3.00E+03
Pt-189	10.9 h	5.76E+02	8.29E-02	1.73E-03	6.86E+02

Table G-12
Dose Conversion Factors Used to Estimate SNS Impacts under Normal and Accident Conditions - Continued.

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Pt-190	6.66E+11 y	#N/A	#N/A	#N/A	#N/A
Pt-191	2.80 d	6.14E+02	4.96E-02	1.10E-03	1.46E+03
Pt-193	51.4 y	2.27E+02	1.47E-06	4.40E-07	1.19E+02
Au-180	8.10 s	#N/A	#N/A	#N/A	#N/A
Au-181	11.4 s	#N/A	#N/A	#N/A	#N/A
Au-182	15.6 s	#N/A	#N/A	#N/A	#N/A
Au-183	42.0 s	#N/A	#N/A	#N/A	#N/A
Au-184	53.0 s	2.66E+00	0	0	2.24E+00
Au-185	4.25 m	7.03E+01	1.88E-01	3.81E-03	8.22E+01
Au-186	10.7 m	8.04E+01	3.67E-01	7.25E-03	1.77E+02
Au-187	8.40 m	5.68E+01	1.88E-01	3.52E-03	3.22E+02
Au-187m	2.30 s	#N/A	#N/A	#N/A	#N/A
Au-188	8.83 m	#N/A	#N/A	#N/A	#N/A
Au-189	28.7 m	1.47E+02	6.66E-01	1.33E-02	1.93E+02
Au-190	42.8 m	7.20E+01	4.37E-01	7.66E-03	1.23E+02
Au-191	3.17 h	1.46E+02	1.00E-01	2.09E-03	1.87E+02
Au-191m	0.92 s	#N/A	#N/A	#N/A	#N/A
Au-192	4.94 h	3.27E+02	3.59E-01	6.44E-03	6.22E+02
Au-193	17.6 h	2.89E+02	2.53E-02	5.66E-04	5.77E+02
Au-194	1.59 d	1.02E+03	1.96E-01	3.70E-03	1.88E+03
Au-195	186 d	1.30E+04	1.19E-02	2.90E-04	1.06E+03
Au-195m	30.5 s	#N/A	3.47E-02	7.14E-04	#N/A
Hg-180	3.00 s	#N/A	#N/A	#N/A	#N/A

Nuclide	Half Life	Inhalation Rem/Ci	Immersion Rem/sec per Ci/m3	Ground Plane Rem/sec per Ci/m2	Ingestion Rem/Ci
Hg-181	3.60 s	#N/A	#N/A	#N/A	#N/A
Hg-182	10.8 s	#N/A	#N/A	#N/A	#N/A
Hg-183	9.40 s	#N/A	#N/A	#N/A	#N/A
Hg-184	30.6 s	1.17E+02	1.03E-01	2.13E-03	3.06E+00
Hg-185	49.1 s	1.02E+03	0	0	1.66E+01
Hg-186	1.38 m	4.84E+01	6.99E-02	1.48E-03	2.56E+01
Hg-187	2.40 m	1.56E+03	7.73E-01	1.48E-02	1.05E+02
Hg-188	3.25 m	3.10E+01	3.54E-02	7.81E-04	3.68E+00
Hg-189	7.60 m	#N/A	#N/A	#N/A	#N/A
Hg-190	20.5 m	1.95E+02	3.05E-02	6.55E-04	6.39E+01
Hg-191	50.8 m	7.31E+02	2.62E-01	5.14E-03	1.61E+02
Hg-192	4.86 h	3.71E+03	4.66E-02	9.99E-04	8.28E+02
Hg-193	3.81 h	4.20E+03	3.22E-02	7.10E-04	3.09E+02
Hg-194	455 y	1.49E+05	2.56E-06	7.59E-07	5.13E+03
Hg-195	9.89 h	5.26E+03	3.40E-02	7.18E-04	3.63E+02
Hg-197	2.67 d	1.61E+04	9.84E-03	2.38E-04	8.67E+02
Hg-203	46.6 d	2.59E+04	4.18E-02	8.58E-04	1.99E+03
Hg-205	5.20 m	4.64E+01	9.21E-04	1.88E-05	3.09E+01
U-234	2.57E+05 y	1.32E+08	2.82E-05	2.77E-06	2.83E+05
U-235	7.40E+08 y	1.23E+08	2.66E-02	5.48E-04	2.66E+05
U-236	2.46E+07 y	1.25E+08	1.85E-05	2.41E-06	2.69E+05
U-238	4.70E+09 y	1.18E+08	1.26E-05	2.04E-06	2.55E+05

The dose conversion factors used in this FEIS for internal exposures are committed effective dose equivalents. Those used for external exposures are effective dose equivalents. The dose conversion factors listed in Table G-12 were selected from these four sources (Eckerman et al 1998; Eckerman 1998; Eckerman 1998b; Eckerman and Ryman 1993) using the following criteria in the order listed:

Inhalation

1. SNS updated DCFs (Eckerman et al 1998).

   - Mercury assumed to be elemental mercury vapor (Class V) based on EPA Mercury Study Report to Congress (PNL 1982) and DOE analysis of chemical forms emitted (Appendix C).

   - Iodine assumed to be Class F based on DOE analysis of the chemical forms emitted (Appendix C).

   - All others, maximum value for any class (Classes F, M, and S).

2. Federal Guidance Report No. 11.

   - Tritium (H-3) assumed be vapor (Class V).

   - Carbon (C) is maximum of value for organic, monoxide, and dioxide forms of carbon.

   - All others, maximum value (Classes D, W, and Y).

Immersion

1. SNS updated data (Eckerman 1998a).

2. Federal Guidance Report No. 12.

Ground Plane

1. SNS updated data (Eckerman 1998a).

2. Federal Guidance Report No. 12.

Ingestion (not used)

1. SNS updated data (Eckerman et al 1998), maximum value for any uptake factor category (f1).

2. Federal Guidance Report No. 11, maximum value for any uptake category (f1).

The classes referred to in these criteria (F, M, S and D, W, Y) are related to the rate an inhaled radionuclide is cleared from the lungs. Class V is a special class for vapors. The uptake factor (f1) is related to the fraction of the radionuclide transferred to blood in the small intestine. There may be several different uptake factors available for ingested radionuclides. This factor is also applicable to inhalation but has a single value for a given inhalation class.

The radionuclides listed in Table G-12 are all those that could reasonably be expected to be released from the SNS and their progeny. An entry of "0" in Table G-12 indicates that the radionuclide does not emit radiation that results in dose for the indicated exposure. An entry of #N/A indicates that no value was listed in the references used. This does not necessarily mean that the dose conversion factor is unknown. The radionuclide may not be absorbed by the body or may emit radiation that is too weak to travel through air to produce external exposure by immersion or standing on contaminated ground. The noble gas isotope Ar-37 is an example of both of the conditions. Ni-59 and Ni-63 are examples of radionuclides that if absorbed by inhalation or ingestion would cause internal exposure, but emit radiation too weak for external exposures to occur.

Toxic Materials Evaluations

This assessment uses Emergency Response Planning Guidelines (ERPGs) to provide estimates of concentration ranges where one might reasonably expect to observe adverse effects from exposure to toxic substances. The values derived for ERPGs are used for emergency planning purposes and are applicable to most individuals in the general population. The ERPG values are not regulatory exposure guidelines, and they do not incorporate the safety factors normally included in healthy worker exposure guidelines.

The ERPGs were developed by the American Industrial Hygiene Association to aid emergency planners and emergency responders in dealing with hazardous material incidents. The ERPG values are classified in three categories:

ERPG-1 Maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odor.

ERPG-2 Maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action.

ERPG-3 Maximum airborne concentration below which nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

In accident conditions at the SNS, the only hazardous materials anticipated to be released would be uranium and mercury. The uranium would be depleted uranium released during a fire and would be expected to be in the form of insoluble oxides (DOE, 1994). Under these conditions, radiological hazard would be limiting compared to the toxicity hazard (DOE, 1988). Accordingly, only radiological risk was evaluated. Mercury is not among the 69 chemicals for which ERPG values have been established. In such a situation, the DOE Emergency Management Advisory Committee, Subcommittee on Consequence Analysis and Protective Actions (SCAPA) have recommended Temporary Emergency Exposure Limits (TEELs). TEELs are interim, temporary or ERPG-equivalent exposure limits for 297 chemicals, including mercury, whose values have not been finalized as ERPGs. The TEEL levels for mercury (elemental and inorganic) adapted by SCAPA in 1996 include:

TEEL-0	0.05 mg/m^3
TEEL-1	0.075 mg/m^3
TEEL-2	0.1 mg/m^3
TEEL-3	10 mg/m^3

In this analysis, site-specific meteorology is used to estimate mercury concentrations at the position of the uninvolved worker (within 2000 m of the release point) and the maximum exposed individual of the general public (at the site boundary). The estimated concentrations are then compared to the mercury TEEL values in order to determine the anticipated consequences for comparison between alternative locations.

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APPENDIX H

FLOODPLAINS/WETLANDS ASSESSMENT OF POTENTIAL IMPACTS AT THE OAK RIDGE NATIONAL LABORATORY AND ARGONNE NATIONAL LABORATORY

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H. FLOODPLAINS/WETLANDS ASSESSSMENT OF POTENTIAL IMPACTS AT THE OAK RIDGE NATIONAL LABORATORY AND ARGONNE NATIONAL LABORATORY

This appendix presents a description of the wetlands located at Oak Ridge National Laboratory (ORNL) and Argonne National Laboratory (ANL) that could be impacted by construction and operation of the proposed Spallation Neutron Source, should one of the two sites be selected in the Record of Decision (ROD). This report describes the potential impacts to the wetlands at these sites and presents potential mitigation measures. It also describes the potential impacts on two floodplain areas on the ANL site.

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CONTENTS

ACRONYMS

ANL	Argonne National Laboratory
APS	Advanced Photon Source
BCST2	Bear Creek South Tributary 2
BNL	Brookhaven National Laboratory
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DOE	U.S. Department of Energy
FAC	Facultative
FACW	Facultative Wetland
FEIS	Final Environmental Impact Statement
HGM	Hydrogeomorphic Approach
LANL	Los Alamos National Laboratory
OBL	Obligate Wetland
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PEM1	Palustrine Emergent Wetland, Persistent Vegetation
PFO1	Palustrine Forested Wetland, Broad-leaved Deciduous
PSS1	Palustrine Scrub-Shrub, Broad-leaved Deciduous
SNS	Spallation Neutron Source
USACE	U.S. Army Corps of Engineers
WONT1	White Oak Creek North Tributary 1
WONT2	White Oak Creek North Tributary 2

1. INTRODUCTION

The Department of Energy (DOE) proposes to construct and operate an accelerator-based research facility called the Spallation Neutron Source (SNS). DOE has identified four siting alternatives for the proposed SNS. These are as follows:

- ORNL Alternative, Oak Ridge, Tennessee
- Los Alamos National Laboratory (LANL) Alternative, Los Alamos, New Mexico
- ANL Alternative, Argonne, Illinois
- Brookhaven National Laboratory (BNL) Alternative, Upton, New York

Executive Order 11990, *Protection of Wetlands*, dated May 24, 1977, requires federal agencies to avoid, to the extent possible, adverse impacts associated with the destruction and modification of wetlands and to avoid direct and indirect support of wetlands development wherever there is a practicable alternative. In accordance with DOE's implementing regulation for Executive Order 11990 (10 CFR 1022), this report addresses the potential individual and cumulative effects of actions in wetlands on the proposed SNS sites.

Executive Order 11988, *Floodplain Management*, requires federal agencies to ensure that potential effects of flood hazards and floodplain management are considered for actions undertaken in a floodplain and that floodplain impacts be avoided to the extent practicable. This report also addresses the potential impacts on two small floodplain areas on the proposed SNS site at ANL.

The proposed action has the potential to impact wetlands at the ORNL site and wetlands and two small floodplain areas at the ANL site. No wetlands or floodplains were identified on the proposed SNS sites at LANL or BNL. The proposed actions for each alternative are described in Chapter 3 of the Final Environmental Impact Statement (FEIS) for the SNS project. This report focuses only on those actions that have the potential to affect wetlands at the ORNL and ANL sites and the two small floodplain areas at the ANL site.

2. DESCRIPTION OF WETLANDS

2.1 INTRODUCTION

As required by the Energy and Water Development Appropriations Act of 1992, wetlands are identified using the criteria and methods set forth in the *Wetlands Delineation Manual* [U.S. Army Corps of Engineers (USACE) 1987]. USACE defines wetlands as: "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." The USACE lists three characteristics that are diagnostic of wetlands:

1. The vegetation is characterized by a prevalence of macrophytes typically adapted to wetland soil and hydrological conditions. Hydrophytic vegetation is considered to be present when greater than 50 percent of the vegetation in each strata have an indicator status of obligate wetland (OBL), facultative wetland (FACW), and/or facultative (FAC), according to the classification system reported by Reed (1988).

2. The substrate is undrained hydric soil. Hydric soils are soils that are saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions in a major part of the root zone.

3. The area is inundated either permanently or periodically at depths less than 2 m (6.6 ft.), or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation.

The wetlands described in this report have been classified according to the system developed by Cowardin et al. (1979). This hierarchical system describes wetlands by system, class, and subclass. Additional modifiers are added for hydrologic regime, soil, and disturbances. The wetlands on the ORNL and ANL sites are in the palustrine (P) system and are either forested (FO), scrub-shrub (SS), or emergent (EM). The number "1" following these designations indicates broad-leaved deciduous vegetation (in the FO and SS classes) and vegetation with parts that persist above ground after the growing season (in the EM class). Water regime modifiers that may apply to the wetlands described in this report include temporarily flooded (A), saturated (B), seasonally flooded (C), semi-permanently flooded (F), and permanently flooded (H).

2.2 WETLANDS ON THE PROPOSED SNS SITE AT ORNL

A report from a field survey conducted in September 1997 describes the wetlands on and adjacent to the proposed SNS site (Rosensteel et al. 1997). Eight wetland areas were identified. Seven of the wetlands [WOM14, WOM15, WOM16, WOM17, WOM18, White Oak Creek north tributary 1-1 (WONT1-1), White Oak Creek north tributary 2-1 (WONT2-1)] are in the White Oak Creek watershed and one, Bear Creek south tributary 2-1 (BCST2-1), is in the riparian zone of a first-order stream in the Bear Creek (BC) watershed. The wetlands are classified as palustrine forested, broad-leaved deciduous (PFO1), palustrine scrub-shrub, broad-leaved deciduous (PSS1), and palustrine emergent, persistent (PEM1). It is most likely that the hydrologic regimes of these wetlands are B (saturated) and A (temporarily flooded). One of the wetlands that is spring-fed may be semi-permanently (F) or permanently (H) flooded. Wetland locations are shown in Figure 2.2-1.

The boundaries of all of the wetlands, except for WOM17, WOM18, and BCST2-1, were delineated and located by a civil survey. Therefore, the areal sizes given for most of the delineated wetlands are accurate, while those for WOM17, WOM18, and BCST2-1 are estimated. The total area of wetlands in the survey area is 3.62 acres (1.46 ha), the majority of which [3.27 acres (1.32 ha)] are in the White Oak Creek watershed.

A 0.03-acre (0.01-ha) emergent wetland (WONT2-1) was identified along a tributary of White Oak Creek. An infrequently-used, grass-covered road bed crosses the tributary near its confluence with White Oak Creek. The emergent wetland includes a low spot in the road where it crosses the stream and a small alluvial area at the mouth of the stream. Surface runoff and seasonal stream flow collect in and flow through the wetland area. Species in the wetland include smartweed (*Polygonum* sp.), false nettle (*Boehmeria cylindrica*), microstegium (*Microstegium vimineum*, an invasive exotic grass species), and sedges (*Carex* spp.).

A 0.05-acre (0.02-ha) emergent wetland swale (WOM15) is immediately adjacent and parallel to Chestnut Ridge Road. Discharges from two springs flow through the swale and empty into White Oak Creek just downstream of the Chestnut Ridge Road culvert. Shrubs, including alder (*Alnus serrulata*) and elderberry (*Sambucus canadensis*), grow along one side of the swale. The swale is vegetated with numerous wetland species, including watercress (*Nasturtium officiniale*), great lobelia (*Lobelia siphilitica*), cardinal flower (*Lobelia cardinalis*), turtle head (*Chelone glabra*), smartweed (*Polygonum* sp.), and sedges (*Carex* spp.).

A 0.015-acre (0.006-ha) emergent wetland (WOM14) was identified in a manmade, isolated depression in an open area. This depression is near the wetland swale (WOM15) but separated

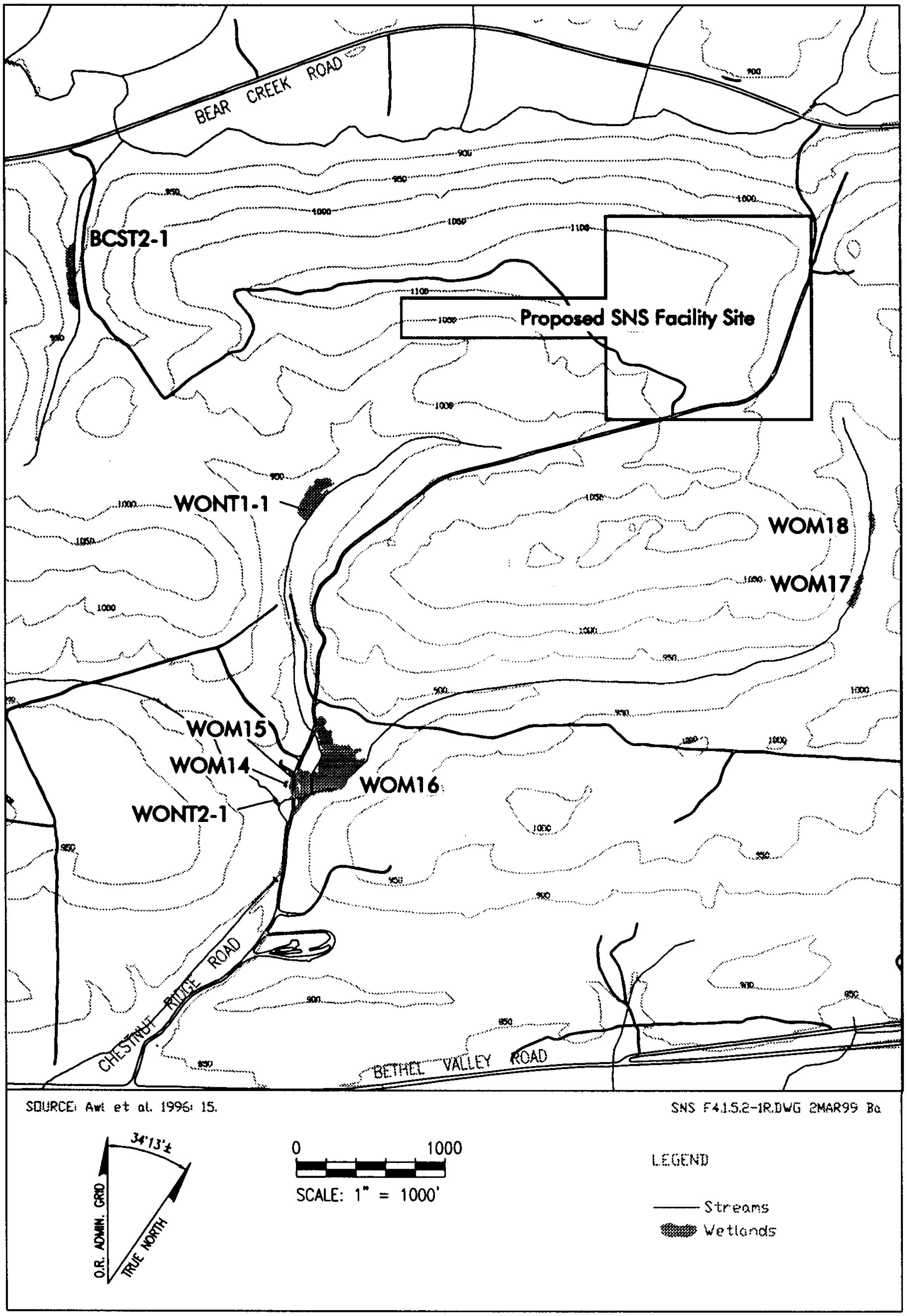

Figure 2.2-1. Wetland areas within and adjacent to the proposed SNS site at ORNL.

from it by a vegetated berm. The depression does not have a surface outlet to the swale or to White Oak Creek. There was no water in the depression on the day of the wetland survey or on follow-up visits in the summer of 1998, but it is possible that it holds precipitation and surface runoff for an undetermined period of time during the winter and spring. The soil has hydric characteristics. Species in this man-induced emergent wetland include fescue *(Festuca arundinaceae)*, false nettle, smartweed, Frank's sedge *(Carex frankii*), and other sedges.

A 2.36-acre (0.96-ha) forested wetland (WOM16) is located in a seep and spring area in the floodplain of White Oak Creek immediately adjacent to the east side of Chestnut Ridge Road. This wetland includes forested areas on both sides of White Oak Creek, a portion of a transmission line right-of-way, and a swale adjacent to Chestnut Ridge Road. Except at its upper end, this swale is separated from the rest of the wetland area by a 2-3 ft (0.6-0.9 m) high upland berm. The wetland includes floodplain area on both sides of White Oak Creek. Dominant or common plant species in this wetland include sycamore *(Platanus occidentalis*), red maple *(Acer rubrum*), green ash *(Fraxinus pennsylvanica*), spicebush *(Lindera benzoin*), sedges (*Carex* spp), watercress, microstegium, false nettle, cardinal flower, bugleweed *(Lycopus virginicus*), smartweed, and hog peanut *(Amphicarpa bracteata*). The primary hydrologic source is localized (seeps and springs) and diffuse groundwater discharge. Although this wetland is primarily an undisturbed forested wetland, the section in the transmission line right-of-way is more appropriately classified as a scrub-shrub/emergent wetland that is periodically disturbed by mowing. *Carex leptalea* and *Bartonia paniculatum*, two species that are uncommon in East Tennessee, occur in the forested part of wetland WOM16. This wetland area had initially been designated an Environmental Research Park Reference Area but is now within Environmental Research Park Natural Area 55 (Awl et al. 1996).

A small area of forested wetland (WOM17) [0.15 acres (0.06 ha)] and a small, emergent wetland (WOM18) [<0.03 acres (<0.012 ha)] were identified in the upper reach of White Oak Creek. WOM17 is a 0.15-acre (0.06-ha) wetland in a seep area that appears to contribute a significant portion of the summer and early fall base flow of a section of upper White Oak Creek. The stream channel immediately upstream and downstream of this wetland area was dry on the day of the survey. The soil was saturated, and there was flowing water in shallow, surface channels on the day of the survey. The dominant vegetation species in wetland WOM17 include sweetgum, red maple, ironwood, smartweed *(Polygonum punctatum)*, cardinal flower, microstegium, false nettle, and poison ivy *(Toxicodendron radicans*). WOM18 is a narrow fringe [2 to 3 ft wide (0.6 to 0.9 m)] of emergent wetlands on the edge of the stream channel. This section of stream contained flowing water. Dominant species in WOM18 include microstegium, cardinal flower, smartweed, bugleweed, and sensitive fem *(Onoclea sensibilis*).

A 0.63-acre (0.26-ha) forested wetland (WONT1-1) is located in the riparian zone of WONT1. This tributary is located in a forested drainage on the west side of Chestnut Ridge Road north of the transmission line right-of-way and is in Environmental Research Park Natural Area 55. Further downstream, the tributary crosses the power line, flows through a culvert under Chestnut Ridge Road, and empties into White Oak Creek in the WOM16 wetland. The wetland is located along the middle reach of the stream. The primary water source for this wetland is groundwater in the form of perennial seeps and a seasonal high water table. Overbank flooding may be an occasional, but not a sustaining, source of water. Dominant species include sycamore, red maple, sweetgum *(Liquidambar styraciflua*), green ash, bugleweed, cardinal flower, and cinnamon fern *(Osmunda cinnamomea*). At a perennial seep, which spreads out over a wide area, the dominant species include smartweed, watercress, bugleweed, cutgrass *(Leersia oryzoides*), leathery rush *(Juncus coriaceous*), avens *(Geum* sp), and tickseed sunflower *(Bidens* sp).

In the riparian zone of BCST2, there are three small areas of forested wetlands and emergent wetlands at streamside seeps. These three areas are close together along the stream and were combined into one wetland area (BCST2-1) for purposes of mapping and description. The approximate size of the wetland area is 0.35 acres (0.14 ha). It is downslope of, but not within, the site boundary. Dominant species include green ash, red maple, spicebush, microstegium, poison ivy, woodreed *(Cinna arundinacea*), and Virginia knotweed *(Tovara virginiana*).

2.3 WETLANDS ON THE PROPOSED SNS SITE AT ANL

A variety of wetland types, totaling approximately 17.3 acres (7 ha), occur in and around the proposed SNS site (Figure 2.3-1). Although most of these wetlands have been disturbed to some degree in the past, they continue to retain wetland value such as wildlife habitat and flood control.

A large wetland, approximately 4 acres (1.6 ha), lies in the northeast part of the proposed site. This wetland receives surface flows from an intermittent stream to the south and storm sewer drainage to the east. Surface water is generally present throughout the year within the stream channel and storm drainage. Areas not inundated are saturated within 12 in. (30 cm) of the surface for extended periods. Common cattail *(Typha latifolia)* is the dominant species in the eastern portion of the wetland and in the southern part of the stream channel, while reed canary grass *(Phalaris arundinacea)*, a non-native species, is dominant within most of the stream channel and much of the central portion. Although beavers had built a dam and lodge in this wetland in the past, they have not occupied this area since 1993.

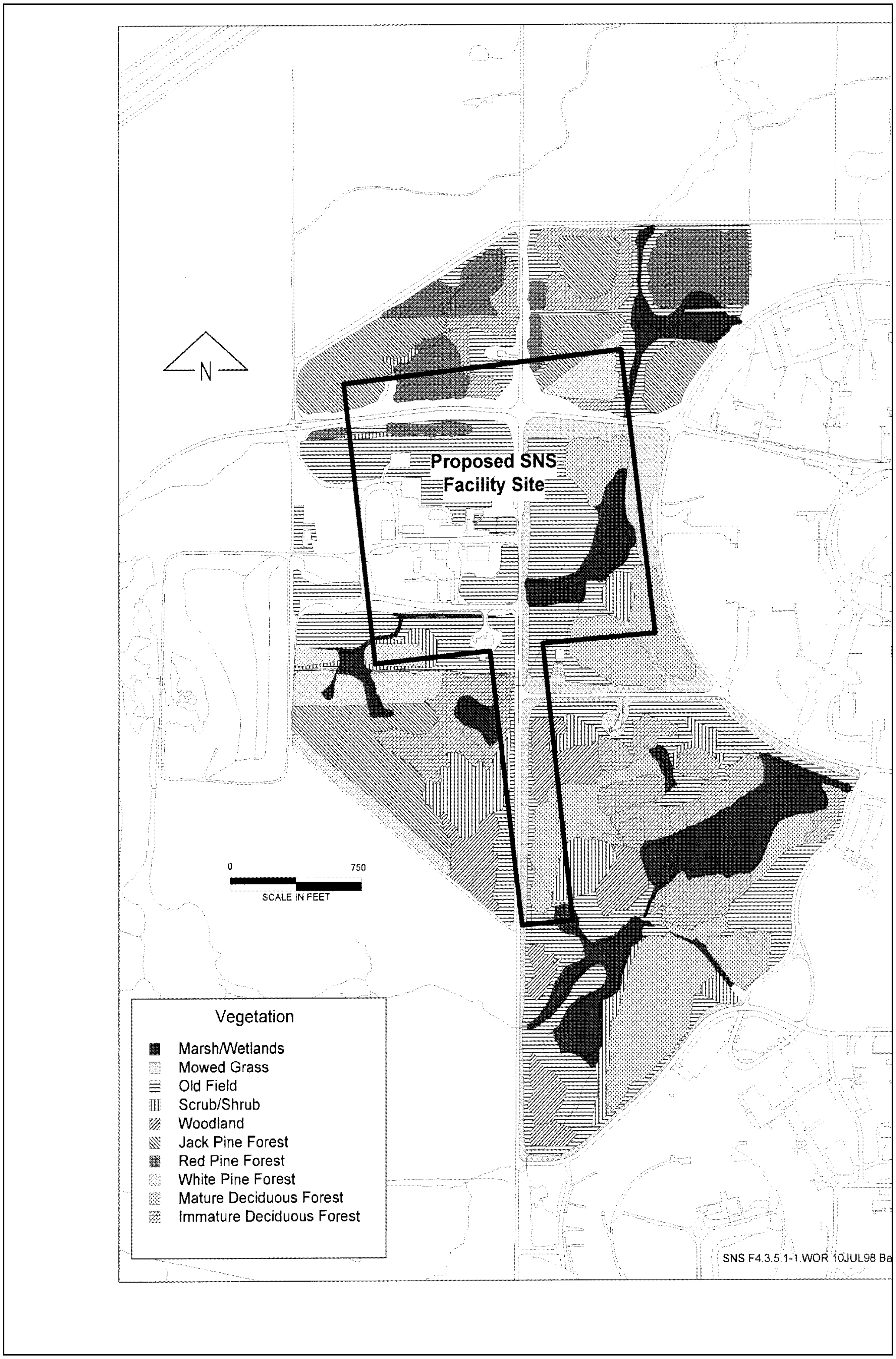

Figure 2.3-1. Vegetative cover at proposed ANL SNS site.

A 2.7-acre (1.1-ha) wetland in the eastern portion of the proposed site, almost totally within the footprint of the SNS, includes a small pond at the northern end. This wetland receives surface flows from storm sewer drainages to the east and west and an excavated channel to the west. Surface water is present throughout the year within the pond. The southwestern arm is inundated early in the growing season and generally has a narrow, shallow flow during dry months of the year. Most of this wetland, other than the pond, is dominated by narrow-leaf cattail *(Typha angustifolia).* Beavers also built a dam and lodge in this wetland, but they have not occupied this area since 1993.

A small, 0.4-acre (0.2-ha) wetland to the southeast of the proposed site receives surface water drainage from two nearby water towers. Drainage is present throughout the year and enters at the north end forming a shallow stream, which dissipates at the south end. The dominant species in this marshy wetland are common and narrow-leaf cattail.

A large wetland to the southeast of the proposed site contains surface water throughout the year that fluctuates in depth according to the level of a beaver dam at the northeast end. The area of this wetland is 7.5 acres (3.1 ha) and it receives surface flow from a small stream to the southwest (Freund Brook) and storm sewer drainages to the north. Lower water levels allow wetland plants to colonize areas that under higher levels support only submerged aquatic vegetation and nonrooted floating plants. The dominant species in this wetland are common and narrow-leaf cattail and common reed *(Phragmites australis).* Three state-listed endangered bird species have been observed at this wetland: great egret, black-crowned night heron, and pied-billed grebe.

A shallow area along Freund Brook lies immediately upstream of the previous wetland. Surface water is present throughout most of the year, although flows are sluggish during summer months. Dominant species along the muddy stream margin are large-flowered water plantain *(Alisma triviale),* rice cut-grass *(Leersia oryzoides),* lady's thumb *(Polygonum persicaria),* and marsh purslane *(Ludwigia palustris var americana).* A low marshy area along a tributary to the southeast of Freund Brook contains shallow surface water much of the year and supports rice cut grass, large-flowered water plantain, and river bulrush *(Scirpus fluviatilis).*

An 0.8-acre (0.3-ha) seasonally flooded wetland in the southern portion of the proposed site and within the SNS footprint is inundated early in the growing season, but surface water is absent by midsummer. Dominant species are wild mint *(Mentha arvensis var villosa),* smartweed, *(Polygonum* sp.), sedge *(Carex* sp.), and white grass *(Leersia virginica).* The wetland margin is lined by mature cottonwood and black willow *(Salix nigra)* trees. Hydrologic input is primarily groundwater discharge. However, a minor surface flow is received during the spring from an excavated channel to the northwest.

A 1.4-acre (0.6-ha) wetland system to the south includes a narrow channel receiving surface water from the landfill area on the west and storm sewer drainage on the north. The southern portion of the wetland is saturated early in the growing season but is seldom inundated. Surface water is present in the channel throughout the year downstream of the storm drain outlet. Common cattail is the dominant species in the channel, while dominants in the remainder include reed canary grass, swamp marigold *(Bidens aristosa)*, and sedges.

A small, 4,050-ft^2 (380-m^2) seasonal wetland occurs within a drainage ditch in the western portion of the proposed site. Surface water is present early in the growing season but is usually absent by late summer. Dominant species are narrow-leafed cattail, barnyard grass *(Echinochloa crusgalli*), common beggar's ticks *(Bidens frondosa),* and great bulrush *(Scirpus validus* var *creber).*

3. ONSITE WETLAND IMPACTS

3.1 INTRODUCTION

Scientists at the U.S. Army Engineer Waterways Experiment Station have developed the hydrogeomorphic (HGM) approach for assessing the functions of wetlands (Smith 1994). The HGM approach is intended primarily for use in meeting the requirements for project assessment under Section 404 of the Clean Water Act (CWA) and for determining mitigation requirements and success. The HGM regional guidebooks and assessment models for the classes and subclasses of wetlands present on ORNL and ANL land have not yet been developed. Therefore, the wetland assessments for the ORNL and ANL sites relied on the best professional judgement of wetland scientists with field experience and knowledge of the wetlands on these sites.

3.2 POTENTIAL WETLAND IMPACTS ON THE PROPOSED SNS SITE AT ORNL

Potential effects to wetlands during construction and operation of the proposed SNS include direct impacts, such as excavation and fill, and indirect impacts, which include erosion, sedimentation, scouring of the wetland substrate, and hydrologic alterations. Three of the wetland areas in the White Oak Creek watershed (WOM14, WOM15, and WOM16) will be directly impacted by the upgrade of Chestnut Ridge Road. There is potential for long-term, but indirect, impacts to two of the wetlands due to storm runoff from the access road (WOM16) and proximity to a retention basin (WONT1-1). Effects to the remaining four wetland areas (BCST2-1, WOM17, WOM18, and WONT2-1) would be minimal. These wetlands are not in areas that would be disturbed by construction of the proposed SNS. Proper control of runoff, especially during site preparation, would minimize effects on these wetland areas.

3.2.1 Proposed Road Construction

A total of 0.23 acres (0.09 ha) in wetlands WOM14, WOM15, and WOM16 would be filled for the upgrade of Chestnut Ridge Road. Wetland WOM14 will be completely filled. This small wetland [0.015 acres (0.006 ha)] is in an isolated, man-made depression that is temporarily saturated or flooded following precipitation. Because of its small size, isolation, and limited period of saturation, it is unlikely that wetland WOM14 performs wetland functions related to water quality or surface water flow. It may provide amphibian-breeding habitat, depending on the depth and duration of inundation in the breeding season. Plant species diversity is low and is comprised of species that are common in emergent wetlands on the Oak Ridge Reservation (ORR).

The southern half of WOM15 will be filled. WOM15 is a 0.05-acre (0.02-ha) emergent wetland swale that is immediately adjacent to Chestnut Ridge Road. This wetland begins at two springs at its northern edge and ends at White Oak Creek. The wetland supports a diverse assemblage of herbaceous species but does currently receive impacts from the existing road, including gravel, silt, and other constituents in road runoff. The functions performed by this wetland may include amphibian breeding habitat, sediment and contaminant reduction or removal, nutrient transformation and uptake, and production and export of dissolved and particulate organic material to White Oak Creek.

The southwest corner of WOM16, including a forested portion of the wetland on the south side of White Oak Creek and a portion of the roadside swale, will be filled for road construction. The functions that are most likely to be performed in wetland WOM16 include sediment retention, nutrient transformation and uptake, production and export of dissolved and particulate organic material, and provision of wildlife habitat. The seeps and springs that are within this wetland, along with the flow entering from WONT1, are major contributors to base flow in White Oak Creek. There is diffuse groundwater discharge, but no discrete seeps or springs, in the area to be filled.

3.2.2 Proposed Retention Basin

The proposed retention basin, that will hold stormwater runoff and cooling tower water discharges, would be located in the upper part of the WONT1 stream catchment. The basin is not expected to directly affect wetland WONT1-1 because it would not be located directly on the wetland. Indirect effects resulting from increased surface water inputs would not be expected because the retention basin water would be piped to a lower point in the White Oak Creek watershed, rather than released onsite. However, this wetland may be indirectly affected by the proximity of the retention basin. Potential impacts would include a change in plant community composition resulting from the creation of a forest edge and introduction of invasive, exotic plant species such as privet (*Ligustrum sinense*).

3.3 POTENTIAL WETLAND IMPACTS ON THE PROPOSED SNS SITE AT ANL

Potential effects on wetlands caused by construction of the SNS would include elimination of wetlands that would be in the SNS footprint and degradation of wetlands caused by activities outside of the wetlands, such as soil erosion, siltation, and sedimentation. Operational effects may occur from effluents released from the SNS. The assessment of potential effects on wetlands includes determining whether construction of the SNS would encroach on an existing wetland and evaluating the potential effects from increased runoff of water and effluents released from the SNS during operations.

A 1993 survey on the ANL land identified 35 wetlands totaling 44.6 acres (18.1 ha). Only wetlands greater than 17,655 ft^2 (500 m^2) were identified; thus, many smaller wetlands on the site may not be documented. One of the wetlands has since reverted to upland because of the breaching of an old beaver dam on Freund Brook. Many of the wetlands are seasonally inundated or saturated emergent wetlands, occurring in depressions or in stream riparian zones. Some of the larger wetlands have water on the surface for the entire growing season and at least three of them have water year-round. There are three forested wetlands on the site; however, the majority of site wetlands are emergent systems. The wetlands in and around ANL have a history of disturbance, initially from agriculture, and more recently from site development. Some of the wetlands now present may have been drained in the past for agriculture but have become restored as the drainage tiles have failed over time. Current disturbances include runoff from developed areas.

Approximately 3.5 acres (1.4 ha) of wetlands on the proposed SNS site lie within the proposed footprint and would be eliminated by construction activities. The wetlands that will be eliminated include a 2.7-acre (1.1-ha) emergent wetland area that also includes an open water area and a 0.8-acre (0.3-ha) seasonally flooded wetland. This represents approximately 20 percent of the wetlands on and in the vicinity of the proposed SNS site and approximately 7.8 percent of the total area of jurisdictional wetlands on ANL land.

The wetland functions that would be lost as a result include wildlife habitat, floodflow alteration, nutrient transformation, and organic material production and export. These wetlands provide habitat for area wildlife such as amphibians and wetland birds. The primary functions of these wetlands most likely include flood-flow alteration, wildlife habitat, nutrient transformation, and organic material production and export. The wetlands on ANL land provide habitat for many species, including great egret, black-crowned night heron, pied-billed grebe, red-winged blackbird, great blue heron, mallard ducks, Canada geese, muskrat, and beaver, as well as upland species such as raccoons, raptors, and some passerine bird species that utilize wetland food resources on an occasional basis. The flood-flow alteration and nutrient transformation functions may also be of primary importance. In a study in the Lake Wingra basin in Wisconsin, Loucks (1990) found that runoff from watersheds where shallow basin [temporarily flooded] wetlands have been filled or drained is about twice that estimated for the presettlement watershed, and that nutrient loadings to the receiving lake were increased.

4. CUMULATIVE IMPACTS

4.1 CUMULATIVE WETLAND IMPACTS ON THE ORR

The cumulative impact on wetlands of construction and operation of the SNS has been evaluated in the context of the total known wetland resources and functions on the ORR, and in the White Oak Creek and the Bear Creek watersheds, the two watersheds within which the SNS site would be located.

Data on wetlands in the White Oak Creek and Bear Creek watersheds come from several published and internally reported, unpublished surveys conducted in these areas between 1992 and 1996. Wetlands have been identified in a large portion of the ORR with the most complete surveys having been completed for the East Tennessee Technology Park [ETTP (Rosensteel and Awl 1995)], the Y-12 site (Rosensteel 1997), the western end of Bethel Valley (Rosensteel 1996), the watersheds of White Oak Creek and Bear Creek (Rosensteel 1996; Rosensteel and Trettin 1993), and a few smaller watersheds that drain directly to the Clinch River.

The total number of wetlands identified on the ORR to date is 424 with an estimated total area of 601.6 acres (243.5 ha). The wetlands range in estimated size from <0.02 acres (<0.01 ha) to 112.2 acres (45.4 ha). Wetland surveys have not been conducted across the entire reservation; thus, the total number and total area of wetlands on the ORR is larger than indicated here.

The majority of the wetlands are associated with areas of groundwater discharge in riparian zones in headwater areas. The largest wetland areas are in the lower Bear Creek and White Oak Creek floodplains, in the Poplar Creek watershed, in Clinch River embayments, and associated with beaver activity on tributary streams at several locations on the ORR. Many of the wetlands support populations of state- or federally-listed plant and wildlife species and represent wetland communities and habitats that are becoming increasingly uncommon in the ridge and valley physiographic province outside of the ORR due to development and other land uses.

The functions of the wetlands on the ORR include floodflow alteration; groundwater discharge; nutrient and contaminant transformation, uptake, and sequestration; sediment retention; wildlife habitat; rare species habitat; and maintenance of biological diversity. In a preliminary study of headwater riparian areas in the Bear Creek watershed on the ORR, Eisenbies (1996) findings indicated that the hydrogeochemical processes occurring in the wetlands were sufficient to alter soil/water chemistry and that the wetlands may be acting as nutrient sinks. Several threatened and endangered plant species found on the ORR, including fen orchid (*Liparis loeselii*), heavy sedge (*Carex gravida*), Howe's sedge (*Carex howei*), tubercled rein-orchid (*Platanthera flava* var. *herbiola*), purple fringeless orchid (*Platanthera peramoena*), and whorled mountain-mint (*Pycnanthemum verticillatum*) occur in wetlands (Awl et al. 1996). Protected vertebrate species that use wetland habitat and have recently been observed on the ORR include the southeastern shrew, four-toed salamander, great egret, northern harrier, little blue heron, and snowy egret (Mitchell et al. 1996). Rare vertebrate species that use wetland habitat and that have the potential to occur on the ORR include woodland jumping mouse, meadow jumping mouse, mole salamander, southern bog lemming, water shrew, common barn owl, king rail, and least bittern (Mitchell et al. 1996).

Current or proposed projects on the ORR that will have potential direct and indirect wetland impacts include the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Waste Disposal Facility in the Bear Creek Valley, CERCLA remediation projects in Melton Valley, and sections of Parcel ED-1 near the ETTP site in the Poplar Creek watershed. Proposed projects in the Bear Creek Valley are discussed in Section 4.1.1. Proposed projects in the Melton Valley are discussed in Section 4.1.2. Projects on the ORR outside of the Bear Creek and White Oak Creek watersheds are discussed in Section 4.1.3.

4.1.1 Bear Creek Watershed

There are 92 identified wetland areas, totaling 156.2 acres (63.2 ha), in the Bear Creek watershed. The wetlands range in size from 0.01 acres (0.02 ha) to 49.4 acres (20 ha) with a mean of 1.7 acres (0.69 ha). The majority of the wetlands occur in headwater positions in association with first-order streams. The largest wetland is in the Bear Creek floodplain just downstream of the gap through Pine Ridge.

Proposed projects in the Bear Creek Valley have the potential to impact several acres of headwater wetlands. The CERCLA Waste Disposal Facility and related remediation work in the adjacent Boneyard/Burnyard will eliminate several acres of headwater wetlands in the bottomlands of the Bear Creek headwater tributaries. It is expected that in-kind replacement in the form of wetland creation and/or restoration will be performed in the Bear Creek watershed to replace the wetland system and functions lost to construction. A programmatic wetland mitigation plan to cover all activities in the Bear Creek Valley is under development (DOE 1998c).

The SNS construction and operation is not expected to contribute to cumulative impacts in the Bear Creek watershed because no wetland fill or encroachment associated with the SNS will occur in the watershed.

4.1.2 White Oak Creek Watershed

There are at least one hundred and fifty-one (151) wetland areas in the White Oak Creek watershed, which includes the watershed of Melton Branch, a major tributary of White Oak Creek. The total acreage of wetlands is 101.6 acres (41.1 ha). The wetlands range in size from <0.02 acres to almost 24.7 acres (<0.01 ha to 9.96 ha) with a mean of 0.74 acres (0.3 ha). The majority of the wetlands are flow-through systems that occur in the relatively narrow bottomlands of headwater tributaries. The largest wetland area is a forested/scrub-shrub/emergent wetland complex in the White Oak Creek bottomland and White Oak Lake, located in the Melton Valley portion of the watershed between the ORNL main plant area and the dam at State Route 95.

Wetland impacts in the White Oak Creek watershed in recent years have been extremely limited due to successful efforts to completely avoid all wetland encroachment through resiting and reconfiguring of projects. In 1995 a small area of permitted (Tennessee Department of Environment and Conservation Rule 1200-4-7 et seq.) wetland disturbance occurred in a 1,000-ft^2 (28.3-m^2) area next to and in Melton Branch. The purpose of the activity was to clean accumulated sediments out of the area behind a weir to restore its function as a regulatory water quality monitoring site. Mitigation required as a permit condition consisted of restoration of vegetation in a roughly 900-ft x 25-ft (274.3-m x 7.6-m) area in the riparian zone of First Creek, which is a first-order tributary of White Oak Creek located in the ORNL main plant area.

The proposed remediation of contaminated soils and sediments in a large area of the White Oak Creek and Melton Branch Watershed has the potential to impact wetlands. The wetlands include forested wetlands in the White Oak Creek and Melton Branch bottomlands, scrub-shrub wetlands in the semi-permanently flooded portion of White Oak Lake, and emergent wetlands in White Oak Lake and in prior disturbed areas such as utility line rights-of-way and road sides.

Remediation activities in the Melton Valley portion of the White Oak Creek-Melton Valley watershed presents the potential for the largest area of wetland impacts. The White Oak Creek watershed in Melton Valley contains numerous contaminated sites over a 1,062-acre (430-ha) area (DOE 1998a). Contaminants include radioisotopes, volatile organic compounds, semivolatile organic compounds, and metals resulting from decades of use of Melton Valley as a primary waste disposal area for ORNL. The Feasibility Study for Melton Valley (DOE 1998a) identified six alternatives for site cleanup. Excluding the no-action alternative, the alternatives range from a minimum of 4.6 acres (1.9 ha) up to a maximum of 44.8 acres (18.1 ha) of wetland impacts (DOE 1998b). Depending on the alternative chosen, the impacts may include erosion and sedimentation; hydrologic alterations that could increase or decrease the area of wetland;

elimination of some wetlands through fill; and extensive floodplain and wetland excavation requiring vegetation removal and the excavation and removal of all contaminated soil and sediment.

Adding the top estimate of wetland disturbance in the Melton Valley Feasibility Study and the potential area of wetland fill proposed for the Chestnut Ridge Road upgrade on the SNS site, the potential cumulative acreage of wetland disturbance in the White Oak Creek watershed in the near-term is approximately 45_acres (18.3 ha). This represents 44.4 percent of the wetland area in the watershed. The majority of this (44.1 percent) is represented by the Melton Valley remediation project. The wetland fill associated with the Chestnut Ridge Road construction represents less than 0.5 percent of the total.

4.1.3 Oak Ridge Reservation

Current projects on the ORR that may have the potential to impact wetlands include Parcel ED-1. Outside of the projects in the Bear Creek and White Oak Creek watersheds that are already discussed, there are no known current or proposed projects on the ORR that have potential wetland impacts.

On Parcel ED-1, there are known wetlands in the Exclusion Area (a protected area around East Fork Poplar Creek). Because not all of the Exclusion Area was surveyed for wetlands, the Mitigation Action Plan for the lease of Parcel ED-1 (DOE 1996) states that prior to any activities in the Exclusion Area, a wetland survey is necessary to identify and delineate wetlands. No wetland encroachment on Parcel ED-1 is known or proposed at present.

The area of wetlands that may be impacted on the SNS site represents 0.04 percent of the known wetland area on the ORR. The area of wetland impacts on the SNS site was minimized to the extent possible given other site and construction constraints. The SNS construction and operations are not expected to contribute to cumulative wetland impacts on the ORR because the wetlands will be replaced through onsite or same-watershed wetland creation or restoration at a 1:1 ratio or greater.

4.2 CUMULATIVE WETLAND IMPACTS ON THE ANL

The cumulative impact assessment area includes ANL land and the 2,000+ acre Waterfall Glen Nature Preserve that surrounds the Reservation. There are at least 413.7 acres (167.4 ha) of wetlands in the Waterfall Glen Nature Preserve (Ludwig 1999). They include emergent wetlands, riverine marshes, and swamps. These wetlands have been protected in the preserve since the early 1970's.

Combining the wetland acreage at ANL [44.6 acres (18.1 ha)] and the Nature Preserve results in a total of 458.3 acres (185.5 ha) of wetlands on and in the vicinity of the laboratory. The wetlands that would be eliminated for SNS construction represent approximately 0.8 percent of the total wetland acreage and approximately 7.8 percent of the wetland acreage on ANL land.

In 1991, as part of the requirements of a USACE Nationwide General Permit, the creation of a 1.8-acre (0.73-ha) wetland and protection of a 1.1-acre (0.45-ha) wetland was initiated at ANL. The wetland creation and protection was required as mitigation for the filling of 1.8 acres (0.73 ha) of wetlands for construction of the Advanced Photon Source (APS). The mitigation replaced wetland acreage and functions; thus, the APS project resulted in no net loss of wetlands in the watershed.

There are currently no other projects underway or proposed on ANL land that would directly or indirectly impact wetlands.

5. MITIGATION

5.1 MITIGATION OF ONSITE AND CUMULATIVE IMPACTS ON THE ORR

Direct impacts to wetlands during construction would be mitigated by avoiding and minimizing wetland encroachment through modifications in the Chestnut Ridge Road alignment. The proposed alignment would cross White Oak Creek and associated wetlands at the same location as the existing crossing. The road alignment would be modified to impact the smallest possible area of wetlands and to avoid fragmentation of the largest wetland area, WOM16. The currently proposed road alignment for ORNL reflects a compromise based on various constraints, including the maximum allowable road grade, setbacks from White Oak Creek, the minimization of disturbance to hardwood forests, and wetland impact avoidance and minimization.

Indirect impacts on wetlands during construction of the SNS, including those resulting from increased runoff and erosion, will be avoided or minimized through implementation of proper construction techniques such as silt fencing and soil stabilization.

Indirect impacts during operation of the SNS would be avoided or reduced through the diversion of site runoff and cooling water to a downstream location, engineering controls such as vegetated swales or other stormwater controls, and if necessary and feasible, modifications in the location of the holding pond.

During operations, site runoff and cooling water would be collected in a retention basin and piped to a downstream reach of White Oak Creek south of Bethel Valley Road. This would avoid impacts to the wetlands from increased surface flows that would result from releasing the water into the upper White Oak Creek watershed. This would divert a certain amount of stormwater runoff from the downstream watershed. The diversion of stormwater from the upper part of the watershed is not expected to affect the wetlands because of their distance from the upper watershed (except for WONT1-1) and because all of the wetlands, with the exception of WONT2-1 and WOM14, are primarily groundwater-driven systems. Stormwater diversions would not affect WONT2-1 because it receives runoff from the WONT2 drainage that would not be affected by SNS construction or operation. Similarly, WOM14 receives surface runoff from a very small area surrounding the depression and would not be affected by diverted stormwater runoff from the upper watershed.

Increased runoff from Chestnut Ridge Road during operations could impact portions of WOM16. This potential impact could be eliminated or minimized by the diversion of road runoff into grassed swales or other stormwater control structures. These structures would function to reduce runoff velocity and remove sediments and other contaminants from storm runoff.

A potential indirect impact to WONT1-1 would be a change in plant community composition resulting from the opening of the canopy and the introduction of invasive, exotic species. This potential impact will be minimized by increasing the distance between the wetland and the retention basin berm to a reasonably practicable width.

In accordance with Section 404 of the federal CWA and the Tennessee State Aquatic Resources Alteration Permit program (Rules of the TDEC 1200-4 et seq.), permits would be required for road construction in the affected wetlands. Appropriate compensatory mitigation would be determined by the Tennessee Department of Environment and Conservation in consultation with the USACE, and it is expected that wetland functional replacement would be required in the same watershed at a 1:1 or greater ratio of acreage filled to acreage created or restored. At least one potential mitigation site exists in the immediate area in association with the existing springs at WOM15.

It is expected for all current and proposed projects on the ORR that direct wetland impacts would be avoided, if possible, and that unavoidable wetland impacts would be minimized to the extent possible. When wetland impacts cannot be avoided, appropriate federal and state permits authorizing direct wetland impact would be obtained, or for projects with categorical exclusions (CERCLA projects), all substantive requirements of the law would be met. In compliance with the provisions of these permits and with Executive Order 11990, *Protection of Wetlands*, wetlands would be restored or created in the same watershed, if possible, to replace the unavoidable loss of wetland acreage and functions.

5.2 MITIGATION OF ONSITE AND CUMULATIVE IMPACTS AT ANL

Although all four of the alternative sites for the SNS contain wetlands and streams, the selected site came the closest to meeting the site criteria established in the site selection process (refer to Appendix B, page B-79). Because of the many streams and marshes on ANL land, alternative sites considered for the proposed SNS would occupy similar or larger floodplains and wetlands areas. The site that was selected came the closest out of the four potential sites to meeting the site criteria. In comparison with the other alternative sites, the selected site does not contain either of the two primary streams (Freund Brook and Sawmill Creek), thus avoiding impacts to the wetlands that are in the floodplains and riparian zones of these streams. Alternative Site 1 contained small ponds, marshes, and the headwaters of Freund Brook with associated wetlands.

Alternative Site 3 contained Freund Brook, a pond, and associated wetlands. Alternative Site 4 contained Sawmill Creek and associated wetlands. The selection of the chosen alternative site does minimize wetland impacts to the extent that it does not include Freund Brook or Sawmill Creek with their associated wetlands and avoids impacts to any of the forested wetlands or wetlands with beaver colonies.

In accordance with Section 404 of the federal CWA, a permit from the USACE would be required for construction in these wetlands. As part of this permit, DOE would consult with the USACE on plans to mitigate this loss of wetlands. The most common mitigation for destruction of wetlands on ANL land is replacement (an equivalent area of wetland habitat created, preferably in the same watershed of the impacted wetlands). Because one of the wetlands that would be destroyed is relatively large, approximately 2.7 acres (1.1 ha), it would be difficult to locate a replacement wetland in the same watershed. One possibility that would be investigated would be enhancement of existing wetlands along Freund Brook.

Wetland areas in the vicinity of the proposed SNS site may be affected during construction. Proper construction techniques would be implemented to avoid or minimize the effects of increased stormwater flows, erosion, and sedimentation. In consultation with the USACE, DOE would develop a plan for the protection of these wetlands.

There are no projects currently proposed on ANL land, other than the SNS project, that would encroach on wetlands. Recent wetland disturbance and fill for the APS facility has been mitigated through the creation of a wetland and protection of an existing wetland. The wetlands in the surrounding Waterfall Glen Nature Preserve are in a protected area, and direct impacts to these wetlands would not be expected to occur at any time in the foreseeable future. If mitigated properly through the creation, restoration, or enhancement of wetlands in Sawmill Creek or a nearby watershed, the elimination of wetlands on the proposed SNS site is not expected to contribute to the cumulative loss of wetlands and wetland functions.

6. FLOODPLAINS AT ANL

The preferred site for the proposed SNS at ANL, called the 800 Area, is situated in the northwestern portion of the reservation. Because of the many streams and marshes within the ANL reservation, alternative sites considered for the proposed SNS would occupy similar or larger floodplains and wetlands areas.

At the proposed SNS site, the eastern edge of the SNS footprint overlies a portion of the 100-yr floodplain of an unnamed tributary to Sawmill Creek. This tributary originates in the 800 Area, connecting to Sawmill Creek north of ANL. In addition, the southern tip of the footprint overlies a portion of the 100-year floodplain of an unnamed tributary to Freund Brook. This tributary originates within the footprint of the proposed SNS and flows southeast to Freund Brook. Its confluence with Freund Brook is outside the footprint of the proposed SNS. The locations of these floodplain areas are shown in Figure 6-1.

Along the unnamed tributary of Sawmill Creek, construction of the proposed SNS would include filling and stabilizing those portions of the floodplains that are required for buildings and related structures. Hence, placement of the proposed SNS facility in the 800 Area location would require an alteration of drainage patterns and construction of storm drains and canals to direct storm flow to the retention basin. There are no high hazard areas, as defined in 10 CFR 1022, within this area of the proposed project. The affected areas are within the ANL boundaries. No private homes or commercial property would be impacted by flooding. If the ANL site is selected for construction of the SNS, the drainage pattern of the 800 Area would be altered. The potential impacts from this would be minimized by standard construction practices, including optimizing the placement of buildings to avoid the floodplain and the location of the retention basin. The retention basin would be sized to contain a 100-year flood and would serve to control runoff to this tributary and to replace lost capacity to control floodwater due to disruption of the floodplain. Because of the relatively small area of the 100-year floodplain, estimated to be approximately 5 acres (2 ha), that would be affected by construction, compared to the total drainage area of the watershed, and the inclusion of the retention basin to control runoff from the site, no downstream effects on floodplains are predicted from construction of the proposed SNS facility.

During operation of the SNS, 0.36 to 0.5 million gallons of discharge water per day, primarily from the cooling tower, would be discharged to the unnamed tributary of Sawmill Creek. All discharges from the SNS would be directed to the retention basin, thus normalizing the discharge of cooling tower blowdown water and runoff.

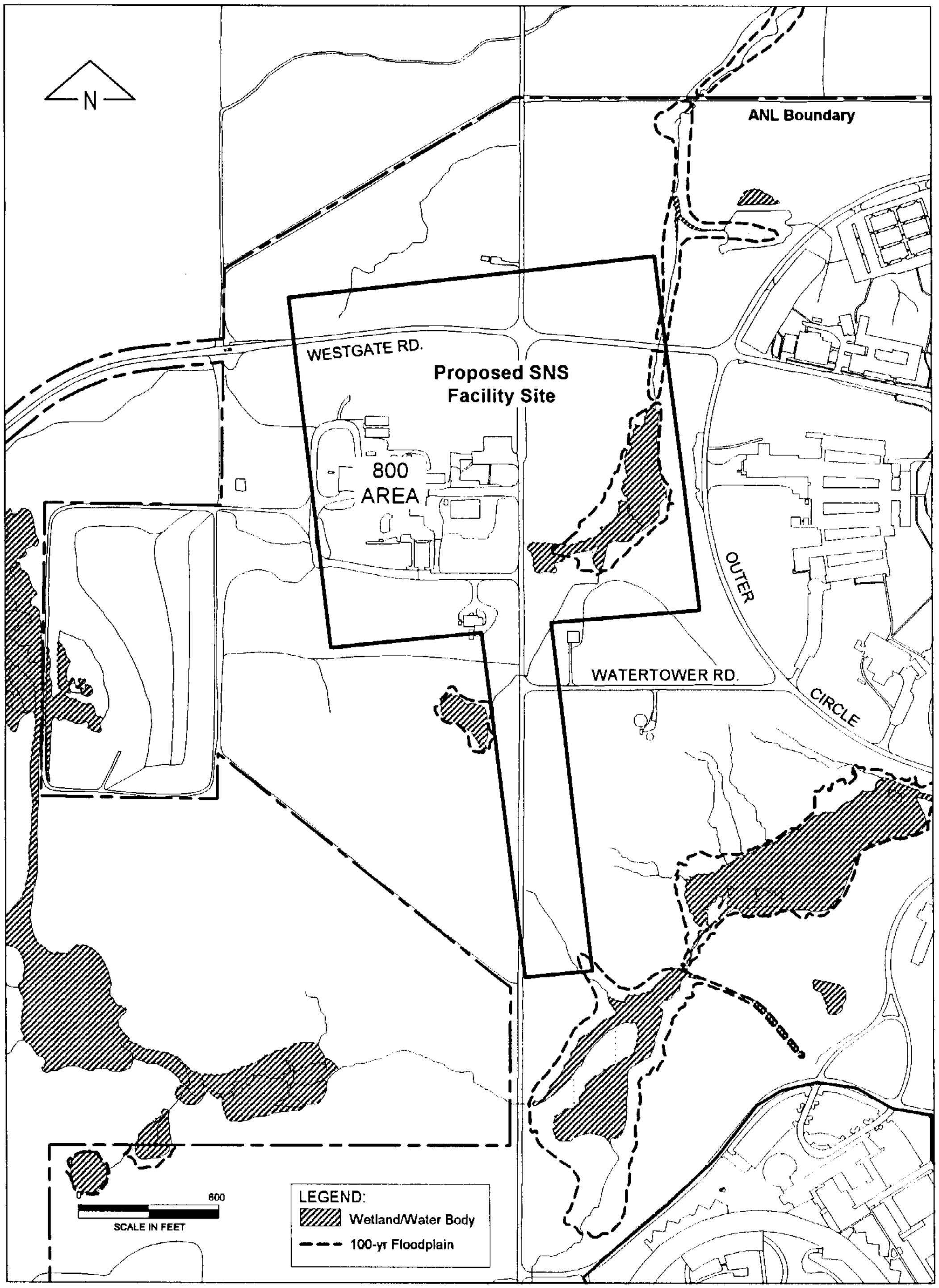

Figure 6-1. Floodplain areas on the proposed SNS site at ANL.

Along the unnamed tributary of Freund Brook, construction of the proposed SNS would include filling and stabilizing those portions of the floodplains that are required for buildings and related structures. It would also require an alteration of drainage patterns and construction of storm drains and canals to redirect stormwater flow to Freund Brook. The potential impacts of this would be minimized by standard construction practices, including optimizing the placement of buildings to avoid the floodplain. No high hazard areas are located within this area of the proposed project. Because the affected areas are within the ANL boundaries, no private homes or commercial property would be impacted by flooding. Less than 1 acre (0.40 ha) of the 100-year floodplain would be affected by construction. Because of its small size compared to the total drainage of the Freund Brook watershed and the early incorporation of drainage features during construction, no downstream effects on floodplains are expected from construction of the proposed SNS facility. Operations at the facility would not affect floodplains in the southern tip of the SNS site or downstream because no SNS cooling water would be discharged into Freund Brook.

Development in the floodplains of DuPage County is regulated by the *DuPage County Countywide Stormwater and Flood Plain Ordinance* (DuPage County Stormwater Management Committee and Environmental Concerns Department 1998). There is a question of the applicability of these regulations to DOE operations at ANL; however, because of the small area of floodplains involved and the minimal impacts that would be expected if ANL is selected for construction of the SNS, DOE expects to be in full compliance with these regulations.

7. CONCLUSIONS OF WETLANDS ASSESSMENT

DOE proposes to construct and operate an accelerator-based research facility called the Spallation Neutron Source (SNS). DOE has identified four siting alternatives for the proposed SNS. These are as follows:

- Oak Ridge National Laboratory (ORNL) Alternative, Oak Ridge, Tennessee
- Los Alamos National Laboratory (LANL) Alternative, Los Alamos, New Mexico
- Argonne National Laboratory (ANL) Alternative, Argonne, Illinois
- Brookhaven National Laboratory (BNL) Alternative, Upton, New York

Executive Order 11990, *Protection of Wetlands*, dated May 24, 1977, requires federal agencies to avoid, to the extent possible, adverse impacts associated with the destruction and modification of wetlands and to avoid direct and indirect support of wetlands development wherever there is a practicable alternative. In accordance with DOE's implementing regulations for EO 11990 (10 CFR 1022), the potential individual and cumulative effects of actions in wetlands on the proposed SNS sites were assessed for each of the proposed SNS sites.

The proposed action would impact wetlands at the ORNL and ANL sites. No wetlands were identified in the proposed SNS project sites at LANL or BNL.

Construction of the SNS will require the elimination of 0.23 and 3.5 acres (0.09 and 1.41 ha), of wetlands at the ORNL and ANL sites, respectively. The ORNL site direct impacts are associated with the upgrade of Chestnut Ridge Road. No wetlands are located in the facility footprint at the ORNL site. At the ANL site, the wetlands that will be eliminated are located in the footprint of the SNS facility.

Direct wetland impacts on the ORNL site will occur as a result of the upgrade of the existing Chestnut Ridge Road, which will be the main access road to the SNS facility, and utility lines that will be installed adjacent to the road. Important considerations in the alignment of the road upgrade were the requirements for the road grade to be less than 10%, and the maintenance of a buffer of at least 100 feet from White Oak Creek. Alternative alignments considered for the road upgrade included:

1. A route that would cross the hill on the east side of the existing road, curve back around to the north, and cross White Oak Creek some distance upstream from the existing crossing;

2. A second route that would also cross the hill on the east side of the existing road, but which would curve north almost immediately, crossing White Oak Creek just a few hundred feet upstream of the current crossing; and

3. A route that has a relatively limited deviation from the existing road alignment, but which crosses White Oak Creek at the same location as the existing road.

Alternatives 1 and 2 were rejected because they would involve clearing larger areas of forest than would otherwise be necessary, and would require a considerably longer distance, and thus cost, for road construction. In addition, alternative 2 would cross directly through the middle of the 2+ acre forested wetland and seep/spring area resulting in greater wetland impacts and possibly impacts to the hydrology of White Oak Creek. Alternative 3 minimizes impacts on wetland area and wetland functions, and reduces the amount of forest clearing, while meeting the road grade requirements. There will be direct impacts to 0.23 acres (0.09 ha) of wetlands which includes a small temporary wetland in an isolated manmade depression; a portion of an emergent wetland in a roadside spring run; and a small portion of a forested wetland next to the existing road.

On the ANL site, four alternative sites were evaluated for the SNS facility, one each in:

1. the 400 Area in the southwestern corner of the site;
2. the 800 Area in the northwestern corner of the site;
3. the 600 Area in the central area of the site; and
4. the East Area.

Because of the many streams and marshes on ANL land, alternative sites considered for the proposed SNS would occupy wetlands and streams similar or greater than that on the selected site. Alternative site 1 contained small ponds, marshes, and the headwaters of Freund Brook with associated wetlands. Alternative site 3 contained Freund Brook, a pond, and associated wetlands. Alternative site 4 contained Sawmill Creek and associated wetlands.

Direct wetland impacts have been minimized to the extent possible through the selection of alternative 2 because it avoids the two main streams on the Reservation and their associated wetlands. In comparison with the other alternative sites, the selected site does not contain either of the two primary streams on the ANL (Freund Brook and Sawmill Creek) and, thus, avoids impacts to the wetlands that are in the floodplains and riparian zones of these streams. The alternative 2 site also avoids impacts to any of the forested wetlands or wetlands with beaver colonies on the ANL site.

Indirect impacts during construction and operation, such as erosion, sedimentation, increased runoff, introduction of exotic species, and hydrologic alterations have the potential to affect additional wetland acreage on the ORNL and ANL sites. Indirect effects on wetlands will be avoided through implementation of proper construction techniques and other engineering controls designed to control stormwater runoff and water discharges during construction and operation. The distance between developed areas and wetlands will also be increased if possible to minimize the potential for hydrologic alterations and exotic species introductions.

In compliance with federal and state regulations protecting wetlands and Executive Order 11990, any unavoidable wetland impacts on the ANL and ORNL sites will be compensated through the restoration, creation, or enhancement of wetlands onsite or in the same watershed. The goals of creation, restoration, or enhancement will include the replacement or improvement of wetland functions. This will be achieved through careful site selection and site preparation to achieve the necessary hydrology, and modeling the wetland on high quality natural wetlands in the area. An additional goal of creation or restoration will be to ensure that the wetland has a connection to, or is not above some minimum distance from, other habitats and wetlands. This connectivity and proximity to other wetlands has been found to be important for maintaining regional wetland biodiversity in at least one important group of vertebrates, amphibians, and suggested to likely be important for other taxa including plants, microcrustaceans, and insects that use small wetlands (Semlitsch and Bodie 1998).

The preferred site for the proposed SNS at ANL, called the 800 Area, is situated in the northwestern portion of the reservation. Because of the many streams and marshes within the ANL reservation, alternative sites considered for the proposed SNS would occupy similar or larger wetlands areas.

8. FLOODPLAINS STATEMENT OF FINDINGS

This Floodplains Statement of Findings for Construction and Operation of the Spallation Neutron Source (SNS) was prepared in accordance with 10 CFR 1022. A notice of Floodplain and Wetlands Involvement was published in the *Federal Register* (63 FR 59292, November 3, 1998) and a Floodplain and Wetlands Assessment was incorporated into the Final Environmental Impact Statement.

The U.S. Department of Energy (DOE) proposes to construct and operate the SNS. The proposed SNS facility would consist of a proton accelerator system; spallation target; and appropriate experimental areas, laboratories, offices, and support facilities to allow ongoing and expanded programs of neutron research. DOE has identified four alternative sites for this project: Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee (the preferred alternative); Argonne National Laboratory (ANL), Argonne, Illinois; Los Alamos National Laboratory (LANL), Los Alamos, New Mexico; and Brookhaven National Laboratory (BNL), Upton, New York.

Two areas of the proposed SNS site at ANL lie within 100-year floodplains, and the proposed action would impact small portions of these floodplains. This action is proposed in these floodplain areas because there are no other potential sites at ANL that do not involve floodplains. No floodplains were identified on the proposed SNS project sites at ORNL, LANL, or BNL.

DOE evaluated the following four alternative locations for construction of the SNS at ANL (See Appendix B, Reports on the Selection of Alternative Sites for the SNS):

1. The 400 Area in the southwestern corner of the site
2. The 800 Area in the northwestern corner of the site
3. The 600 Area in the central area of the site
4. The East Area

The land within ANL contains many streams and marshes, and all four alternative sites considered for the proposed SNS involve floodplain encroachment. The 400 Area contains small ponds, marshes, and the headwaters of Freund Brook with associated wetlands. The 600 Area contains Freund Brook, a pond, and associated wetlands. The East Area contains Sawmill Creek and associated wetlands. The selection of the 800 Area site minimizes the potential impacts to floodplains because it avoids the two main streams on ANL land and their associated wetlands. In comparison with the other alternative sites, the selected site contains neither of the two primary streams on ANL (Freund Brook and Sawmill Creek) and, thus, avoids impacts to the associated floodplains.

At the proposed SNS site, the eastern edge of the SNS footprint overlies a portion of the 100-yr floodplain of an unnamed tributary to Sawmill Creek. This tributary originates in the 800 Area, connecting to Sawmill Creek north of ANL. In addition, the southern tip of the footprint overlies a portion of the 100-year floodplain of an unnamed tributary to Freund Brook. This tributary originates within the footprint of the proposed SNS and flows southeast to Freund Brook. Its confluence with Freund Brook is outside the footprint of the proposed SNS. The locations of these floodplain areas are shown in Figure 6-1.

Along the unnamed tributary of Sawmill Creek, construction of the proposed SNS would include filling and stabilizing those portions of the floodplains that are required for buildings and related structures. Hence, placement of the proposed SNS facility in the 800 Area location would require an alteration of drainage patterns and construction of storm drains and canals to direct storm flow to the retention basin. There are no high hazard areas, as defined in 10 CFR 1022, within this area of the proposed project. The affected areas are within the ANL boundaries. No private homes or commercial property would be impacted by flooding. If the ANL site is selected for construction of the SNS, the drainage pattern of the 800 Area would be altered. The potential impacts from this would be minimized by standard construction practices, including optimizing the placement of buildings to avoid the floodplain and the location of the retention basin. The retention basin would be sized to contain a 100-year flood and would serve to control runoff to this tributary and to replace lost capacity to control floodwater due to disruption of the floodplain. Because of the relatively small area of the 100-year floodplain, estimated to be approximately 5 acres (2 ha), that would be affected by construction, compared to the total drainage area of the watershed, and the inclusion of the retention basin to control runoff from the site, no downstream effects on floodplains are predicted from construction of the proposed SNS facility.

During operation of the SNS, 0.36 to 0.5 million gallons of discharge water per day, primarily from the cooling tower, would be discharged to the unnamed tributary of Sawmill Creek. All discharges from the SNS would be directed to the retention basin, thus normalizing the discharge of cooling tower blowdown water and runoff.

Along the unnamed tributary of Freund Brook, construction of the proposed SNS would include filling and stabilizing those portions of the floodplains that are required for buildings and related structures. It would also require an alteration of drainage patterns and construction of storm drains and canals to redirect stormwater flow to Freund Brook. The potential impacts of this would be minimized by standard construction practices, including optimizing the placement of buildings to avoid the floodplain. No high hazard areas are located within this area of the proposed project. Because the affected areas are within the ANL boundaries, no private homes or commercial property would be impacted by flooding. Less than 1 acre (0.40 ha) of the 100-year floodplain would be affected by construction. Because of its small size compared to the total drainage of the Freund Brook watershed and the early incorporation of drainage features during construction, no downstream effects on floodplains are expected from construction of the proposed SNS facility. Operations at the facility would not affect floodplains in the southern tip of the SNS site or downstream because no SNS cooling water would be discharged into Freund Brook.

Development in the floodplains of DuPage County is regulated by the *DuPage County Countywide Stormwater and Flood Plain Ordinance* (DuPage County Stormwater Management Committee and Environmental Concerns Department 1998). There is a question of the applicability of these regulations to DOE operations at ANL; however, because of the small area of floodplains involved and the minimal impacts that would be expected if ANL is selected for construction of the SNS, DOE expects to be in full compliance with these regulations.

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APPENDIX I

PROJECTED AIR QUALITY MODELING EFFECTS AT NOAA'S WALKER BRANCH MONITORING TOWER

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I. PROJECTED AIR QUALITY MODELING EFFECTS AT NOAA'S WALKER BRANCH MONITORING TOWER

1.0 BACKGROUND

National Oceanic and Atmospheric Administration (NOAA) has an ongoing research program within the Walker Branch Watershed investigating the ramifications of global climate change. As part of this research program, NOAA has been collecting information on CO_2 and heat flux across the forest canopy for approximately 5 years. This research program is expected to continue for many years.

DOE is proposing to construct and operate the Spallation Neutron Source (SNS), on the preferred location, Chestnut Ridge, that is approximately 1.5 km west of the NOAA research tower. The SNS will have mechanical draft cooling towers to dissipate excess heat and will use natural gas as a fuel for general space heating. This study is designed to provide a preliminary assessment of the potential impacts that the SNS may have in the quality of the data from the NOAA research tower. The overall study is designed to provide information on the impacts associated with water vapor in the cooling plume, and CO_2 and NO_x released from the combustion of natural gas.

2.0 AIR QUALITY MODEL

EPA's backbone air quality model, the Industrial Source Complex Short Term (ISCST3, version 97363) model, was chosen to assess the effects from the sources of concern at the SNS. The ISCST3 model is a complex, straight-line, steady-state Gaussian plume model that can be used to model a number of sources that might be present at a typical industrial facility.

The ISCST3 model accepts hourly meteorological data to define the conditions for plume rise, transport, diffusion, and deposition. Output from the model can take many forms; but, it generally consists of an echo of the input runstream, summary of all modeling inputs, and modeling results summarized in several requestable formats (U.S.E.P.A., 1995).

2.1 Model Input

Input to the ISCST3 model is of two basic types: (1) the input runstream file, and (2) the meteorological data file.

2.1.1 Input Runstream

This file contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options.

For this "Phase I" study two groups of sources were modeled: (1) the cooling towers for water vapor emissions, and (2) a group of ten (4 MW scenario) small boiler stacks located on various SNS structures for CO_2 and NO_x emissions.

The 13 adjacent cooling towers (cells) present were modeled as a single combined source with an overall water vapor emission rate of 350 gallons/minute and other stack parameters as supplied by Conventional Facilities Team personnel. The 10 boiler stacks were modeled as discrete point sources. Stack diameters and heights were provided as indicated previously, while exit velocities and temperatures were based upon an average value taken from boiler manufacture literature. Existing boiler emission rates were taken from AP42 (U.S.E.P.A., 1995) and are summarized below:

Combustion Products from Natural Gas-Fired Boilers at SNS		
Combustion Products	**Rate (lbs/mmcf)**[1]	**Rate (lbs/hr)**[2]
NO_x	100	3.48
CO_2	1.2E+05	4184

[1] Emission factors from EPA AP42 for commercial boilers (rating 0.3 to 10 mmBtu/hr)
[2] Based on cumulative output of 10 boilers at SNS with total heat load of 34,870,000 Btu/hr (0.0349 mmcf/hr).

Universal Traverse Mercator (UTM) coordinates, defining the location of each source in meters, were also provided to the model as well as source elevations. These locations along with source elevations were provided to the model. Input of source elevation data allows the model to perform intermediate and complex terrain calculations (via the incorporated COMPLEX I model). Complex terrain is defined as those receptor locations with elevations greater than a modeled stack top release elevation. For this study, only one receptor location was used (the NOAA monitoring tower location). This receptor also had a "flagpole" elevation (36 m) input that requests that the model provide concentrations 36 m from the ground elevation (where the instruments are located on the tower).

Building parameters were also input to the model to implement building downwash procedures. Other pertinent information input to the model included the use of "rural" wind profile exponents, vertical temperature gradients and mixing heights, and selection of the regulatory default option that sets a number of specific options to a selected default value.

2.1.2 Meteorological Data

Surface meteorological data supplied to the model consisted of one year (1991) of 15 minute averages for wind direction, mean wind speed, ambient temperature, solar radiation, and sigma-theta collected at NOAA's Walker Branch monitoring tower. Missing data were filled using data from additional nearby towers or by averaging surrounding period data for short missing periods. Solar radiation and sigma-theta are not used directly by the ISCST3 model but used (by the method indicated in Sect. 6.4.4.4. of U.S.E.P.A., 1987) to calculate stability category. This procedure was modified to reflect a surface roughness of 1.2 m and effective anemometer height of 9.1 m as suggested for the Walker Branch site by NOAA personnel.

A Fortran code was prepared to read these data, convert to the correct units when necessary, and write the values out to a new file in the correct format for ISCST3 use. Upper air data (mixing heights) were also taken from a preprocessed file of Knoxville/Nashville, TN 1991 surface/upper air data compiled from data downloaded from EPA's SCRAM bulletin board. Linear - interpolation was used to provide a mixing height for each 15-minute average from the 1-hour averages provided in the preprocessed file. All wind speeds less than 0.7 m/sec were considered a calm and set to zero (not processed by the model).

2.2 Model Output

Output from the ISCST3 model runs was somewhat different than normally expected in that the meteorological data utilized were 15-minute average data rather than 1-hour data. For this reason, while the model indicates 1 hour averages are output, the averages are actually 15-minute averages. The dates shown for the output concentrations are incorrect because they were being advanced by a factor of four. Additionally, since four times as much meteorological data are present as normal to an annual model run, four separate runs (each quarter year or approximately three months) were preformed to cover the entire year of Walker Branch, 15-minute data.

Actual model output consisted of 15-minute averages (in micrograms/cubic meter) of water vapor for the cooling tower and CO_2 and NO_x concentrations for the ten boiler stacks output at the monitoring tower location. The printed output consisted of a set of tables summarizing the maximum 50 concentrations for each of the modeled releases and two additional files listing the concentrations for every 15-minute period and every non-zero concentration, respectively. Approximately 80 – 85 percent of all projected concentrations at the tower are zeros (due mainly to wind direction not blowing from the sources toward the tower during that time).

ISCST3-projected maximums were 1.04 g/m³ for water vapor, 27,569 μg/m³ for CO_2 and 23 μg/m³ for NO_x. A copy of the ISCST3 output for the third quarter modeled is included in this appendix.

One important factor in considering the concentrations obtained is that these are conservative, probably worst-case, projections. The emission rates assume continuous, annual operation of all sources at full-rated capacity. The 350 gal/min emission rate for the cooling towers is for "droplet and vapor drag out." For modeling purposes, the assumption was made that this water is all vapor or aerosol. In reality, some larger droplets may be present and more may form as the plume travels downwind. These particles may condense or drop out before ever reaching the monitoring tower. The extent of this phenomena would probably be highly dependent upon local ambient meteorological conditions at any given time.

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CO STARTING
CO TITLEONE CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET
CO MODELOPT DFAULT CONC   RURAL
*** ave time is really 15 min per met data
CO AVERTIME 1
CO POLLUTID OTHER
CO TERRHGTS ELEV
CO FLAGPOLE
CO DCAYCOEF   0.000000E+00
CO RUNORNOT RUN
CO ERRORFIL ERRORS.OUT
CO FINISHED


SO STARTING
SO ELEVUNIT FEET

*** Source Location Cards:
***          SRCID SRCTYP        XS             YS             ZS

SO LOCATION CT1    POINT        743267.        3981595.       1040.0
*** COOLING TOWER
SO LOCATION S1C    POINT        742933.        3981537.       1039.5
***  FRONT END BLDG.
SO LOCATION S2C    POINT        743170.        3981701.       1054.0
*** KLYSTRON HALL
SO LOCATION S3C    POINT        743471.        3981795.       1088.0
*** RING SERVICE BLDG.
SO LOCATION S4C    POINT        743552.        3981865.       1041.0
*** RTBT SERVICE BLDG.
SO LOCATION S5C    POINT        743645.        3981965.       1038.5
*** TARGET BLDG.
SO LOCATION S6C    POINT        743239.        3981635.       1050.0
*** UTILITY BLDG.
SO LOCATION S7C    POINT        743347.        3981717.       1050.0
*** OFFICE BLDG.
SO LOCATION S8C    POINT        743567.        3982073.       1038.5
*** TARGET BLDG.
SO LOCATION S9C    POINT        743339.        3981977.       1088.0
*** RING SERVICE BLDG.
SO LOCATION S10C   POINT        743447.        3982027.       1041.0
*** RTBT SERVICE BLDG.
*** Source Parameter Cards:
*** POINT:   SRCID       QS            HS         TS         VS          DS
*** VOLUME:  SRCID       QS            HS       SYINIT     SZINIT
*** AREA:    SRCID       QS            HS        XINIT

*** WATER VAPOR EMISSIONS (350GPM) FROM COOLING TOWERS (13 COMBINED)
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SO SRCPARAM   CT1       22015.          7.52      304.80        9.8000     4.8800
*** CO2 EMISSIONS FROM 10 BOILER STACKS
SO SRCPARAM   S1C        55.2300       13.5600   480.0000      7.1800      .4064
SO SRCPARAM   S2C        43.1500        9.1400   480.0000      7.1800      .3048
SO SRCPARAM   S3C        55.2300        8.5300   480.0000      7.1800      .4064
SO SRCPARAM   S4C        28.2900       14.9300   480.0000      7.1800      .2540
SO SRCPARAM   S5C       102.73000      20.4200   480.0000      7.1800      .4064
SO SRCPARAM   S6C        37.4200        7.9200   480.0000      7.1800      .3048
SO SRCPARAM   S7C        19.6600       11.5800   480.0000      7.1800      .2040
SO SRCPARAM   S8C       102.73000      20.4200   480.0000      7.1800      .4064
SO SRCPARAM   S9C        55.2300        8.5300   480.0000      7.1800      .4064
SO SRCPARAM   S10C       28.2900        14.930   480.0000      7.1800      .2540

SO BUILDHGT CT1          7.52     7.52     7.52     7.52     7.52     7.52
SO BUILDHGT CT1          7.52     7.52     7.52     7.52     7.52     7.52
SO BUILDHGT CT1          7.52     7.52     7.52     7.52     7.52     7.52
SO BUILDHGT CT1          7.52     7.52     7.52     7.52     7.52     7.52
SO BUILDHGT CT1          7.52     7.52     7.52     7.52     7.52     7.52
SO BUILDHGT CT1          7.52     7.52     7.52     7.52     7.52     7.52
SO BUILDWID CT1         79.02    67.64    54.21    39.13    22.86    20.43
SO BUILDWID CT1         36.20    50.87    64.00    75.18    84.08    90.43
SO BUILDWID CT1         94.02    96.76    98.21    97.74    94.30    88.00
SO BUILDWID CT1         79.02    67.64    54.21    39.13    22.86    20.43
SO BUILDWID CT1         36.20    50.87    64.00    75.18    84.08    90.43
SO BUILDWID CT1         94.02    96.76    98.21    97.74    94.30    88.00

SO BUILDHGT S1C         10.52    10.52    10.52    10.52    10.52    10.52
SO BUILDHGT S1C         10.52    10.52    10.52    10.52    10.52    10.52
SO BUILDHGT S1C         10.52    10.52    10.52    10.52    10.52    10.52
SO BUILDHGT S1C         10.52    10.52    10.52    10.52    10.52    10.52
SO BUILDHGT S1C         10.52    10.52    10.52    10.52    10.52    10.52
SO BUILDHGT S1C         10.52    10.52    10.52    10.52    10.52    10.52
SO BUILDWID S1C         39.57    37.93    35.14    31.28    26.48    26.48
SO BUILDWID S1C         28.53    29.72    30.00    31.69    33.41    34.11
SO BUILDWID S1C         33.79    32.43    34.14    37.25    39.22    40.00
SO BUILDWID S1C         39.57    37.93    35.14    31.28    26.48    26.48
SO BUILDWID S1C         28.53    29.72    30.00    31.69    33.41    34.11
SO BUILDWID S1C         33.79    32.43    34.14    37.25    39.22    40.00

SO BUILDHGT S2C          6.10     6.10     6.10     6.10     6.10     6.10
SO BUILDHGT S2C          6.10     6.10     6.10     6.10     6.10     6.10
SO BUILDHGT S2C          6.10     6.10     6.10     6.10     6.10     6.10
SO BUILDHGT S2C          6.10     6.10     6.10     6.10     6.10     6.10
SO BUILDHGT S2C          6.10     6.10     6.10     6.10     6.10     6.10
SO BUILDHGT S2C          6.10     6.10     6.10     6.10     6.10     6.10
SO BUILDWID S2C        394.37   329.75   255.11   172.73    85.09    70.76
SO BUILDWID S2C        159.19   242.78   319.00   385.52   440.33   481.76
SO BUILDWID S2C        508.55   519.89   519.11   510.34   486.05   447.00
SO BUILDWID S2C        394.37   329.75   255.11   172.73    85.09    70.76
SO BUILDWID S2C        159.19   242.78   319.00   385.52   440.33   481.76
SO BUILDWID S2C        508.55   519.89   519.11   510.34   486.05   447.00
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SO BUILDHGT S3C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S3C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S3C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S3C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S3C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S3C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDWID S3C        33.19   32.38   30.58   27.85   26.25   29.31
SO BUILDWID S3C        32.21   34.12   35.00   34.82   33.57   31.31
SO BUILDWID S3C        28.10   24.20   26.58   29.64   31.80   33.00
SO BUILDWID S3C        33.19   32.38   30.58   27.85   26.25   29.31
SO BUILDWID S3C        32.21   34.12   35.00   34.82   33.57   31.31
SO BUILDWID S3C        28.10   24.20   26.58   29.64   31.80   33.00

SO BUILDHGT S4C        17.37   17.37   17.37    5.49    5.49    5.49
SO BUILDHGT S4C        17.37    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S4C         5.49    5.49    5.49    5.49    5.49   17.37
SO BUILDHGT S4C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S4C        17.37    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S4C         5.49    5.49    5.49    5.49    5.49   17.37
SO BUILDWID S4C       115.69  109.86  100.69   14.41   10.95   10.69
SO BUILDWID S4C        83.96   18.08   21.00   23.29   24.86   25.69
SO BUILDWID S4C        25.73   24.99   23.49   23.32   23.52  118.00
SO BUILDWID S4C       115.69  109.86  100.69   88.46   73.55   67.40
SO BUILDWID S4C        83.96   18.08   21.00   23.29   24.86   25.69
SO BUILDWID S4C        25.73   24.99   23.49   23.32   23.52  118.00

SO BUILDHGT S5C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S5C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S5C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S5C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S5C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S5C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDWID S5C       115.69  109.86  100.69   88.46   73.55   67.40
SO BUILDWID S5C        83.96   97.97  109.00  116.72  120.90  121.40
SO BUILDWID S5C       118.21  111.43  104.84  111.91  116.73  118.00
SO BUILDWID S5C       115.69  109.86  100.69   88.46   73.55   67.40
SO BUILDWID S5C        83.96   97.97  109.00  116.72  120.90  121.40
SO BUILDWID S5C       118.21  111.43  104.84  111.91  116.73  118.00

SO BUILDHGT S6C         4.88    4.88    4.88    4.88    4.88    4.88
SO BUILDHGT S6C         4.88    4.88    4.88    4.88    4.88    4.88
SO BUILDHGT S6C         4.88    4.88    4.88    4.88    4.88    4.88
SO BUILDHGT S6C         4.88    4.88    4.88    4.88    4.88    4.88
SO BUILDHGT S6C         4.88    4.88    4.88    4.88    4.88    4.88
SO BUILDHGT S6C         4.88    4.88    4.88    4.88    4.88    4.88
SO BUILDWID S6C        47.16   42.88   37.30   30.59   22.95   23.11
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SO BUILDWID S6C        31.09   38.12   44.00   48.54   51.61   53.11
SO BUILDWID S6C        52.99   51.26   49.30   51.09   51.32   50.00
SO BUILDWID S6C        47.16   42.88   37.30   30.59   22.95   23.11
SO BUILDWID S6C        31.09   38.12   44.00   48.54   51.61   53.11
SO BUILDWID S6C        52.99   51.26   49.30   51.09   51.32   50.00

SO BUILDHGT S7C         8.53    8.53    8.53    8.53    8.53    8.53
SO BUILDHGT S7C         8.53    8.53    8.53    8.53    8.53    8.53
SO BUILDHGT S7C         8.53    8.53    8.53    8.53    8.53    8.53
SO BUILDHGT S7C         8.53    8.53    8.53    8.53    8.53    8.53
SO BUILDHGT S7C         8.53    8.53    8.53    8.53    8.53    8.53
SO BUILDHGT S7C         8.53    8.53    8.53    8.53    8.53    8.53
SO BUILDWID S7C        51.21   54.85   56.84   57.09   55.61   55.50
SO BUILDWID S7C        58.94   61.41   62.00   60.71   57.58   52.69
SO BUILDWID S7C        46.26   41.42   44.11   45.45   45.42   46.00
SO BUILDWID S7C        51.21   54.85   56.84   57.09   55.61   55.50
SO BUILDWID S7C        58.94   61.41   62.00   60.71   57.58   52.69
SO BUILDWID S7C        46.26   41.42   44.11   45.45   45.42   46.00

SO BUILDHGT S8C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S8C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S8C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S8C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S8C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S8C        17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDWID S8C       113.02  106.61   96.96   84.36   69.20   68.80
SO BUILDWID S8C        83.87   96.40  106.00  112.38  115.34  114.80
SO BUILDWID S8C       110.77  103.37  103.96  111.40  115.45  116.00
SO BUILDWID S8C       113.02  106.61   96.96   84.36   69.20   68.80
SO BUILDWID S8C        83.87   96.40  106.00  112.38  115.34  114.80
SO BUILDWID S8C       110.77  103.37  103.96  111.40  115.45  116.00

SO BUILDHGT S9C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S9C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S9C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S9C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S9C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDHGT S9C         5.49    5.49    5.49    5.49    5.49    5.49
SO BUILDWID S9C        34.35   33.66   31.94   29.26   25.69   26.31
SO BUILDWID S9C        30.15   33.08   35.00   35.86   35.63   34.31
SO BUILDWID S9C        31.95   28.63   26.94   30.24   32.62   34.00
SO BUILDWID S9C        34.35   33.66   31.94   29.26   25.68   26.31
SO BUILDWID S9C        30.15   33.08   35.00   35.86   35.63   34.31
SO BUILDWID S9C        31.95   28.63   26.94   30.24   32.62   34.00

SO BUILDHGT S10C        5.49    5.49    5.49   17.37   17.37   17.37
SO BUILDHGT S10C       17.37   17.37   17.37   17.37   17.37   17.37
SO BUILDHGT S10C        5.49    5.49    5.49    5.49    5.49    5.49
```

```
SO BUILDHGT S10C        5.49     5.49     5.49    17.37    17.37    17.37
SO BUILDHGT S10C       17.37    17.37    17.37    17.37    17.37    17.37
SO BUILDHGT S10C        5.49     5.49     5.49     5.49     5.49     5.49
SO BUILDWID S10C       20.80    18.96    16.55    84.36    69.20    68.80
SO BUILDWID S10C       83.87    96.40   106.00   112.38   115.34   114.80
SO BUILDWID S10C       23.55    22.94    22.95    22.38    22.53    22.00
SO BUILDWID S10C       20.80    18.96    16.55    84.36    69.20    68.80
SO BUILDWID S10C       83.87    96.40   106.00   112.38   115.34   114.80
SO BUILDWID S10C       23.55    22.94    22.95    22.38    22.53    22.00

SO SRCGROUP   CT CT1
SO SRCGROUP   CO2 S1C-S10C
SO FINISHED


RE STARTING
RE ELEVUNIT FEET
RE DISCCART  744522.  3982825.  1120.  36.0
RE FINISHED


ME STARTING
*** all windspeeds <.7 m/sec set equal zero (calm)
ME INPUTFIL  ORNA8.ASC
ME ANEMHGHT    9.100 METERS
ME SURFDATA  13891  1991           ORTN
ME UAIRDATA  13897  1991           NATN
ME WINDCATS    1.54     3.09     5.14     8.23    10.80
ME FINISHED


OU STARTING
OU MAXTABLE ALLAVE 50
OU MAXIFILE 1 CT  .1 WB12CT.SUM
OU MAXIFILE 1 CO2 .1 WB12CO2.SUM
OU FINISHED

 *** Message Summary For ISC3 Model Setup ***

 --------- Summary of Total Messages --------

A Total of           0 Fatal Error Message(s)
A Total of           1 Warning Message(s)
A Total of           0 Informational Message(s)


   ******** FATAL ERROR MESSAGES ********
              ***   NONE  ***
```

```
   ********   WARNING MESSAGES   ********
CO W205     9 FLAGDF:No Option Parameter Setting.  Forced by Default to ZFLAG=0.

***********************************
*** SETUP Finishes Successfully ***
***********************************
```

```
 *** ISCST3 - VERSION 97363 ***    *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET            ***        06/15/98
                                   ***                                                                ***        19:41:09
                                                                                                                 PAGE   1
**MODELOPTs: CONC                            RURAL  ELEV   FLGPOL DFAULT

                                              ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Intermediate Terrain Processing is Selected

**Model Is Setup For Calculation of Average CONCentration Values.

  --  SCAVENGING/DEPOSITION LOGIC --
**Model Uses NO DRY DEPLETION.  DDPLETE =  F
**Model Uses NO WET DEPLETION.  WDPLETE =  F
**NO WET SCAVENGING Data Provided.
**Model Does NOT Use GRIDDED TERRAIN Data for Depletion Calculations

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
           1. Final Plume Rise.
           2. Stack-tip Downwash.
           3. Buoyancy-induced Dispersion.
           4. Use Calms Processing Routine.
           5. Not Use Missing Data Processing Routine.
           6. Default Wind Profile Exponents.
           7. Default Vertical Potential Temperature Gradients.
           8. "Upper Bound" Values for Supersquat Buildings.
           9. No Exponential Decay for RURAL Mode

**Model Accepts Receptors on ELEV Terrain.

**Model Accepts FLAGPOLE Receptor Heights.

**Model Calculates  1 Short Term Average(s) of:   1-HR

**This Run Includes:    11 Source(s);       2 Source Group(s); and       1 Receptor(s)

**The Model Assumes A Pollutant Type of:  OTHER

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
         Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)
         Model Outputs External File(s) of Threshold Violations (MAXIFILE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values:  c for Calm Hours
                                                                m for Missing Hours
                                                                b for Both Calm and Missing Hours
```

```
**Misc. Inputs:  Anem. Hgt. (m) =     9.10 ;    Decay Coef. =   0.0000     ;    Rot. Angle =     0.0
                 Emission Units = GRAMS/SEC                                 ;  Emission Rate Unit Factor =   0.10000E+07
                 Output Units   = MICROGRAMS/M**3

**Input Runstream File: wb12.inp                                        ;  **Output Print File: wb12.out
**Detailed Error/Message File:    ERRORS.OUT
```

```
*** ISCST3 - VERSION 97363 ***     *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET          ***        06/15/98
                                   ***                                                              ***        19:41:09
                                                                                                               PAGE   2
**MODELOPTs: CONC                           RURAL  ELEV   FLGPOL DFAULT
```

*** POINT SOURCE DATA ***

SOURCE ID	NUMBER PART. CATS.	EMISSION RATE (GRAMS/SEC)	X (METERS)	Y (METERS)	BASE ELEV. (METERS)	STACK HEIGHT (METERS)	STACK TEMP. (DEG.K)	STACK EXIT VEL. (M/SEC)	STACK DIAMETER (METERS)	BUILDING EXISTS	EMISSION RATE SCALAR VARY BY
CT1	0	0.22015E+05	743267.0	3981595.0	317.0	7.52	304.80	9.80	4.88	YES	
S1C	0	0.55230E+02	742933.0	3981537.0	316.8	13.56	480.00	7.18	0.41	YES	
S2C	0	0.43150E+02	743170.0	3981701.0	321.3	9.14	480.00	7.18	0.30	YES	
S3C	0	0.55230E+02	743471.0	3981795.0	331.6	8.53	480.00	7.18	0.41	YES	
S4C	0	0.28290E+02	743552.0	3981865.0	317.3	14.93	480.00	7.18	0.25	YES	
S5C	0	0.10273E+03	743645.0	3981965.0	316.5	20.42	480.00	7.18	0.41	YES	
S6C	0	0.37420E+02	743239.0	3981635.0	320.0	7.92	480.00	7.18	0.30	YES	
S7C	0	0.19660E+02	743347.0	3981717.0	320.0	11.58	480.00	7.18	0.20	YES	
S8C	0	0.10273E+03	743567.0	3982073.0	316.5	20.42	480.00	7.18	0.41	YES	
S9C	0	0.55230E+02	743339.0	3981977.0	331.6	8.53	480.00	7.18	0.41	YES	
S10C	0	0.28290E+02	743447.0	3982027.0	317.3	14.93	480.00	7.18	0.25	YES	

```
*** ISCST3 - VERSION 97363 ***    *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET               ***     06/15/98
                                  ***                                                                    ***     19:41:09
                                                                                                                 PAGE   3
**MODELOPTs: CONC                     RURAL  ELEV   FLGPOL DFAULT

                                      *** SOURCE IDs DEFINING SOURCE GROUPS ***

GROUP ID                                         SOURCE IDs

CT        CT1     ,

CO2       S1C     , S2C     , S3C     , S4C     , S5C     , S6C     , S7C     , S8C     , S9C     , S10C    ,
```

```
*** ISCST3 - VERSION 97363 ***     *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET                ***        06/15/98
                                   ***                                                                    ***        19:41:09
                                                                                                                     PAGE   4
**MODELOPTs: CONC                         RURAL  ELEV   FLGPOL DFAULT

                                          *** DIRECTION SPECIFIC BUILDING DIMENSIONS ***


SOURCE ID: CT1
 IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK
   1   7.5,   79.0, 0      2   7.5,   67.6, 0      3   7.5,   54.2, 0      4   7.5,   39.1, 0      5   7.5,   22.9, 0      6   7.5,   20.4, 0
   7   7.5,   36.2, 0      8   7.5,   50.9, 0      9   7.5,   64.0, 0     10   7.5,   75.2, 0     11   7.5,   84.1, 0     12   7.5,   90.4, 0
  13   7.5,   94.0, 0     14   7.5,   96.8, 0     15   7.5,   98.2, 0     16   7.5,   97.7, 0     17   7.5,   94.3, 0     18   7.5,   88.0, 0
  19   7.5,   79.0, 0     20   7.5,   67.6, 0     21   7.5,   54.2, 0     22   7.5,   39.1, 0     23   7.5,   22.9, 0     24   7.5,   20.4, 0
  25   7.5,   36.2, 0     26   7.5,   50.9, 0     27   7.5,   64.0, 0     28   7.5,   75.2, 0     29   7.5,   84.1, 0     30   7.5,   90.4, 0
  31   7.5,   94.0, 0     32   7.5,   96.8, 0     33   7.5,   98.2, 0     34   7.5,   97.7, 0     35   7.5,   94.3, 0     36   7.5,   88.0, 0


SOURCE ID: S1C
 IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK
   1  10.5,   39.6, 0      2  10.5,   37.9, 0      3  10.5,   35.1, 0      4  10.5,   31.3, 0      5  10.5,   26.5, 0      6  10.5,   26.5, 0
   7  10.5,   28.5, 0      8  10.5,   29.7, 0      9  10.5,   30.0, 0     10  10.5,   31.7, 0     11  10.5,   33.4, 0     12  10.5,   34.1, 0
  13  10.5,   33.8, 0     14  10.5,   32.4, 0     15  10.5,   34.1, 0     16  10.5,   37.3, 0     17  10.5,   39.2, 0     18  10.5,   40.0, 0
  19  10.5,   39.6, 0     20  10.5,   37.9, 0     21  10.5,   35.1, 0     22  10.5,   31.3, 0     23  10.5,   26.5, 0     24  10.5,   26.5, 0
  25  10.5,   28.5, 0     26  10.5,   29.7, 0     27  10.5,   30.0, 0     28  10.5,   31.7, 0     29  10.5,   33.4, 0     30  10.5,   34.1, 0
  31  10.5,   33.8, 0     32  10.5,   32.4, 0     33  10.5,   34.1, 0     34  10.5,   37.3, 0     35  10.5,   39.2, 0     36  10.5,   40.0, 0


SOURCE ID: S2C
 IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK
   1   6.1,  394.4, 0      2   6.1,  329.8, 0      3   6.1,  255.1, 0      4   6.1,  172.7, 0      5   6.1,   85.1, 0      6   6.1,   70.8, 0
   7   6.1,  159.2, 0      8   6.1,  242.8, 0      9   6.1,  319.0, 0     10   6.1,  385.5, 0     11   6.1,  440.3, 0     12   6.1,  481.8, 0
  13   6.1,  508.5, 0     14   6.1,  519.9, 0     15   6.1,  519.1, 0     16   6.1,  510.3, 0     17   6.1,  486.0, 0     18   6.1,  447.0, 0
  19   6.1,  394.4, 0     20   6.1,  329.8, 0     21   6.1,  255.1, 0     22   6.1,  172.7, 0     23   6.1,   85.1, 0     24   6.1,   70.8, 0
  25   6.1,  159.2, 0     26   6.1,  242.8, 0     27   6.1,  319.0, 0     28   6.1,  385.5, 0     29   6.1,  440.3, 0     30   6.1,  481.8, 0
  31   6.1,  508.5, 0     32   6.1,  519.9, 0     33   6.1,  519.1, 0     34   6.1,  510.3, 0     35   6.1,  486.0, 0     36   6.1,  447.0, 0


SOURCE ID: S3C
 IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK  IFV    BH      BW  WAK
   1   5.5,   33.2, 0      2   5.5,   32.4, 0      3   5.5,   30.6, 0      4   5.5,   27.8, 0      5   5.5,   26.3, 0      6   5.5,   29.3, 0
   7   5.5,   32.2, 0      8   5.5,   34.1, 0      9   5.5,   35.0, 0     10   5.5,   34.8, 0     11   5.5,   33.6, 0     12   5.5,   31.3, 0
  13   5.5,   28.1, 0     14   5.5,   24.2, 0     15   5.5,   26.6, 0     16   5.5,   29.6, 0     17   5.5,   31.8, 0     18   5.5,   33.0, 0
  19   5.5,   33.2, 0     20   5.5,   32.4, 0     21   5.5,   30.6, 0     22   5.5,   27.8, 0     23   5.5,   26.3, 0     24   5.5,   29.3, 0
  25   5.5,   32.2, 0     26   5.5,   34.1, 0     27   5.5,   35.0, 0     28   5.5,   34.8, 0     29   5.5,   33.6, 0     30   5.5,   31.3, 0
  31   5.5,   28.1, 0     32   5.5,   24.2, 0     33   5.5,   26.6, 0     34   5.5,   29.6, 0     35   5.5,   31.8, 0     36   5.5,   33.0, 0
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*** ISCST3 - VERSION 97363 ***   *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET ***   ***   06/15/98
***   19:41:09
PAGE 5

**MODELOPTs: CONC   RURAL ELEV FLGPOL DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: S4C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	17.4,	115.7,	0	2	17.4,	109.9,	0	3	17.4,	100.7,	0	4	5.5,	14.4,	0	5	5.5,	10.9,	0	6	5.5,	10.7,	0
7	17.4,	84.0,	0	8	5.5,	18.1,	0	9	5.5,	21.0,	0	10	5.5,	23.3,	0	11	5.5,	24.9,	0	12	5.5,	25.7,	0
13	5.5,	25.7,	0	14	5.5,	25.0,	0	15	5.5,	23.5,	0	16	5.5,	23.3,	0	17	5.5,	23.5,	0	18	17.4,	118.0,	0
19	17.4,	115.7,	0	20	17.4,	109.9,	0	21	17.4,	100.7,	0	22	17.4,	88.5,	0	23	17.4,	73.6,	0	24	17.4,	67.4,	0
25	17.4,	84.0,	0	26	5.5,	18.1,	0	27	5.5,	21.0,	0	28	5.5,	23.3,	0	29	5.5,	24.9,	0	30	5.5,	25.7,	0
31	5.5,	25.7,	0	32	5.5,	25.0,	0	33	5.5,	23.5,	0	34	5.5,	23.3,	0	35	5.5,	23.5,	0	36	17.4,	118.0,	0

SOURCE ID: S5C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	17.4,	115.7,	0	2	17.4,	109.9,	0	3	17.4,	100.7,	0	4	17.4,	88.5,	0	5	17.4,	73.6,	0	6	17.4,	67.4,	0
7	17.4,	84.0,	0	8	17.4,	98.0,	0	9	17.4,	109.0,	0	10	17.4,	116.7,	0	11	17.4,	120.9,	0	12	17.4,	121.4,	0
13	17.4,	118.2,	0	14	17.4,	111.4,	0	15	17.4,	104.8,	0	16	17.4,	111.9,	0	17	17.4,	116.7,	0	18	17.4,	118.0,	0
19	17.4,	115.7,	0	20	17.4,	109.9,	0	21	17.4,	100.7,	0	22	17.4,	88.5,	0	23	17.4,	73.6,	0	24	17.4,	67.4,	0
25	17.4,	84.0,	0	26	17.4,	98.0,	0	27	17.4,	109.0,	0	28	17.4,	116.7,	0	29	17.4,	120.9,	0	30	17.4,	121.4,	0
31	17.4,	118.2,	0	32	17.4,	111.4,	0	33	17.4,	104.8,	0	34	17.4,	111.9,	0	35	17.4,	116.7,	0	36	17.4,	118.0,	0

SOURCE ID: S6C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	4.9,	47.2,	0	2	4.9,	42.9,	0	3	4.9,	37.3,	0	4	4.9,	30.6,	0	5	4.9,	22.9,	0	6	4.9,	23.1,	0
7	4.9,	31.1,	0	8	4.9,	38.1,	0	9	4.9,	44.0,	0	10	4.9,	48.5,	0	11	4.9,	51.6,	0	12	4.9,	53.1,	0
13	4.9,	53.0,	0	14	4.9,	51.3,	0	15	4.9,	49.3,	0	16	4.9,	51.1,	0	17	4.9,	51.3,	0	18	4.9,	50.0,	0
19	4.9,	47.2,	0	20	4.9,	42.9,	0	21	4.9,	37.3,	0	22	4.9,	30.6,	0	23	4.9,	22.9,	0	24	4.9,	23.1,	0
25	4.9,	31.1,	0	26	4.9,	38.1,	0	27	4.9,	44.0,	0	28	4.9,	48.5,	0	29	4.9,	51.6,	0	30	4.9,	53.1,	0
31	4.9,	53.0,	0	32	4.9,	51.3,	0	33	4.9,	49.3,	0	34	4.9,	51.1,	0	35	4.9,	51.3,	0	36	4.9,	50.0,	0

SOURCE ID: S7C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	8.5,	51.2,	0	2	8.5,	54.8,	0	3	8.5,	56.8,	0	4	8.5,	57.1,	0	5	8.5,	55.6,	0	6	8.5,	55.5,	0
7	8.5,	58.9,	0	8	8.5,	61.4,	0	9	8.5,	62.0,	0	10	8.5,	60.7,	0	11	8.5,	57.6,	0	12	8.5,	52.7,	0
13	8.5,	46.3,	0	14	8.5,	41.4,	0	15	8.5,	44.1,	0	16	8.5,	45.5,	0	17	8.5,	45.4,	0	18	8.5,	46.0,	0
19	8.5,	51.2,	0	20	8.5,	54.8,	0	21	8.5,	56.8,	0	22	8.5,	57.1,	0	23	8.5,	55.6,	0	24	8.5,	55.5,	0
25	8.5,	58.9,	0	26	8.5,	61.4,	0	27	8.5,	62.0,	0	28	8.5,	60.7,	0	29	8.5,	57.6,	0	30	8.5,	52.7,	0
31	8.5,	46.3,	0	32	8.5,	41.4,	0	33	8.5,	44.1,	0	34	8.5,	45.5,	0	35	8.5,	45.4,	0	36	8.5,	46.0,	0

*** ISCST3 - VERSION 97363 *** *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET *** 06/15/98
*** *** 19:41:09
PAGE 6

**MODELOPTs: CONC RURAL ELEV FLGPOL DFAULT

*** DIRECTION SPECIFIC BUILDING DIMENSIONS ***

SOURCE ID: S8C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	17.4,	113.0,	0	2	17.4,	106.6,	0	3	17.4,	97.0,	0	4	17.4,	84.4,	0	5	17.4,	69.2,	0	6	17.4,	68.8,	0
7	17.4,	83.9,	0	8	17.4,	96.4,	0	9	17.4,	106.0,	0	10	17.4,	112.4,	0	11	17.4,	115.3,	0	12	17.4,	114.8,	0
13	17.4,	110.8,	0	14	17.4,	103.4,	0	15	17.4,	104.0,	0	16	17.4,	111.4,	0	17	17.4,	115.5,	0	18	17.4,	116.0,	0
19	17.4,	113.0,	0	20	17.4,	106.6,	0	21	17.4,	97.0,	0	22	17.4,	84.4,	0	23	17.4,	69.2,	0	24	17.4,	68.8,	0
25	17.4,	83.9,	0	26	17.4,	96.4,	0	27	17.4,	106.0,	0	28	17.4,	112.4,	0	29	17.4,	115.3,	0	30	17.4,	114.8,	0
31	17.4,	110.8,	0	32	17.4,	103.4,	0	33	17.4,	104.0,	0	34	17.4,	111.4,	0	35	17.4,	115.5,	0	36	17.4,	116.0,	0

SOURCE ID: S9C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	5.5,	34.3,	0	2	5.5,	33.7,	0	3	5.5,	31.9,	0	4	5.5,	29.3,	0	5	5.5,	25.7,	0	6	5.5,	26.3,	0
7	5.5,	30.1,	0	8	5.5,	33.1,	0	9	5.5,	35.0,	0	10	5.5,	35.9,	0	11	5.5,	35.6,	0	12	5.5,	34.3,	0
13	5.5,	31.9,	0	14	5.5,	28.6,	0	15	5.5,	26.9,	0	16	5.5,	30.2,	0	17	5.5,	32.6,	0	18	5.5,	34.0,	0
19	5.5,	34.3,	0	20	5.5,	33.7,	0	21	5.5,	31.9,	0	22	5.5,	29.3,	0	23	5.5,	25.7,	0	24	5.5,	26.3,	0
25	5.5,	30.1,	0	26	5.5,	33.1,	0	27	5.5,	35.0,	0	28	5.5,	35.9,	0	29	5.5,	35.6,	0	30	5.5,	34.3,	0
31	5.5,	31.9,	0	32	5.5,	28.6,	0	33	5.5,	26.9,	0	34	5.5,	30.2,	0	35	5.5,	32.6,	0	36	5.5,	34.0,	0

SOURCE ID: S10C

IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK	IFV	BH	BW	WAK
1	5.5,	20.8,	0	2	5.5,	19.0,	0	3	5.5,	16.5,	0	4	17.4,	84.4,	0	5	17.4,	69.2,	0	6	17.4,	68.8,	0
7	17.4,	83.9,	0	8	17.4,	96.4,	0	9	17.4,	106.0,	0	10	17.4,	112.4,	0	11	17.4,	115.3,	0	12	17.4,	114.8,	0
13	5.5,	23.5,	0	14	5.5,	22.9,	0	15	5.5,	22.9,	0	16	5.5,	22.4,	0	17	5.5,	22.5,	0	18	5.5,	22.0,	0
19	5.5,	20.8,	0	20	5.5,	19.0,	0	21	5.5,	16.5,	0	22	17.4,	84.4,	0	23	17.4,	69.2,	0	24	17.4,	68.8,	0
25	17.4,	83.9,	0	26	17.4,	96.4,	0	27	17.4,	106.0,	0	28	17.4,	112.4,	0	29	17.4,	115.3,	0	30	17.4,	114.8,	0
31	5.5,	23.5,	0	32	5.5,	22.9,	0	33	5.5,	22.9,	0	34	5.5,	22.4,	0	35	5.5,	22.5,	0	36	5.5,	22.0,	0

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*** ISCST3 - VERSION 97363 ***    *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET            ***        06/15/98
                                  ***                                                                ***        19:41:09
                                                                                                                PAGE   7
**MODELOPTs: CONC                          RURAL  ELEV   FLGPOL DFAULT

                                              *** DISCRETE CARTESIAN RECEPTORS ***
                                                (X-COORD, Y-COORD, ZELEV, ZFLAG)
                                                            (METERS)

   ( 744522.0, 3982825.0,     341.4,      36.0);
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*** ISCST3 - VERSION 97363 ***    *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET            ***        06/15/98
                                  ***                                                                 ***        19:41:09
                                                                                                                 PAGE   8
**MODELOPTs: CONC                         RURAL  ELEV   FLGPOL DFAULT

                              *** METEOROLOGICAL DAYS SELECTED FOR PROCESSING ***
                                                 (1=YES; 0=NO)

      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1 1 1 1 1
      1 1 1 1 1 1 1 1 1 1   1 1 1 1 1 1

        NOTE:  METEOROLOGICAL DATA ACTUALLY PROCESSED WILL ALSO DEPEND ON WHAT IS INCLUDED IN THE DATA FILE.


                        *** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
                                                   (METERS/SEC)

                                    1.54,    3.09,    5.14,    8.23,   10.80,


                                        *** WIND PROFILE EXPONENTS ***
```

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

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*** ISCST3 - VERSION 97363 ***     *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET              ***         06/15/98
                                   ***                                                                  ***         19:41:09
                                                                                                                    PAGE   9
**MODELOPTs: CONC                             RURAL  ELEV   FLGPOL DFAULT

                    *** THE FIRST  24 HOURS OF METEOROLOGICAL DATA ***

     FILE: ORNA8.ASC                                   FORMAT: (4I2,2F9.4,F6.1,I2,2F7.1,f9.4,f10.1,f8.4,i4,f7.2)
     SURFACE STATION NO.:  13891                       UPPER AIR STATION NO.:  13897
                   NAME: ORTN                                            NAME: NATN
                   YEAR:    1991                                         YEAR:   1991
```

YR	MN	DY	HR	FLOW VECTOR	SPEED (M/S)	TEMP (K)	STAB CLASS	MIXING HEIGHT (M) RURAL	MIXING HEIGHT (M) URBAN	USTAR (M/S)	M-O LENGTH (M)	Z-0 (M)	IPCODE	PRATE (mm/HR)
91	1	1	1	32.0	1.82	303.1	2	2125.8	2161.9	0.0000	0.0	0.0000	0	0.00
91	1	1	2	52.1	2.30	303.2	3	2196.4	2223.4	0.0000	0.0	0.0000	0	0.00
91	1	1	3	97.4	3.72	302.8	2	2266.9	2284.9	0.0000	0.0	0.0000	0	0.00
91	1	1	4	119.5	3.90	300.0	3	2337.4	2346.5	0.0000	0.0	0.0000	0	0.00
91	1	1	5	104.3	3.39	298.1	3	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	6	122.6	2.57	297.3	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	7	108.5	2.71	297.2	3	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	8	120.6	2.76	297.4	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	9	134.4	2.15	298.5	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	10	99.4	1.20	300.6	1	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	11	106.0	1.38	301.9	2	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	12	113.0	1.24	302.7	2	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	13	98.5	1.38	303.1	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	14	120.9	1.13	303.6	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	15	123.5	0.00	304.4	3	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	16	9.2	0.78	304.0	1	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	17	11.2	0.98	302.5	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	18	312.1	0.78	302.1	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	19	250.0	0.00	301.9	3	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	20	144.0	1.88	301.4	3	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	21	128.3	4.62	299.7	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	22	114.9	5.02	298.3	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	23	88.2	7.96	296.5	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00
91	1	1	24	81.5	5.35	293.9	4	2408.0	2408.0	0.0000	0.0	0.0000	0	0.00

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*** NOTES:  STABILITY CLASS 1=A, 2=B, 3=C, 4=D, 5=E AND 6=F.
            FLOW VECTOR IS DIRECTION TOWARD WHICH WIND IS BLOWING.
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*** ISCST3 - VERSION 97363 *** *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET *** 06/15/98
*** *** 19:41:09
PAGE 10

**MODELOPTs: CONC RURAL ELEV FLGPOL DFAULT

*** THE MAXIMUM 50 1-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: CT ***
INCLUDING SOURCE(S): CT1 ,

** CONC OF OTHER IN MICROGRAMS/M**3 **

RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR) OF TYPE		RANK	CONC	(YYMMDDHH) AT	RECEPTOR (XR,YR) OF TYPE	
1.	1040519.44000	(91052301) AT (	744522.00, 3982825.00)	DC	26.	408944.15600	(91103013) AT (	744522.00, 3982825.00)	DC
2.	860371.37500	(91071318) AT (	744522.00, 3982825.00)	DC	27.	407653.59400	(91041610) AT (	744522.00, 3982825.00)	DC
3.	852523.31300	(91021122) AT (	744522.00, 3982825.00)	DC	28.	407477.68800	(91071319) AT (	744522.00, 3982825.00)	DC
4.	730122.50000	(91062409) AT (	744522.00, 3982825.00)	DC	29.	406411.00000	(91053015) AT (	744522.00, 3982825.00)	DC
5.	715342.68800	(91032316) AT (	744522.00, 3982825.00)	DC	30.	406308.28100	(91012307) AT (	744522.00, 3982825.00)	DC
6.	661015.50000	(91122008) AT (	744522.00, 3982825.00)	DC	31.	403909.93800	(91011924) AT (	744522.00, 3982825.00)	DC
7.	588806.12500	(91122006) AT (	744522.00, 3982825.00)	DC	32.	401106.93800	(91051419) AT (	744522.00, 3982825.00)	DC
8.	566632.50000	(91031924) AT (	744522.00, 3982825.00)	DC	33.	398889.31300	(91051006) AT (	744522.00, 3982825.00)	DC
9.	528942.06300	(91090713) AT (	744522.00, 3982825.00)	DC	34.	390928.28100	(91082716) AT (	744522.00, 3982825.00)	DC
10.	522100.75000	(91031210) AT (	744522.00, 3982825.00)	DC	35.	387549.31300	(91051422) AT (	744522.00, 3982825.00)	DC
11.	505200.96900	(91050223) AT (	744522.00, 3982825.00)	DC	36.	384416.31300	(91120224) AT (	744522.00, 3982825.00)	DC
12.	495518.90600	(91081406) AT (	744522.00, 3982825.00)	DC	37.	376056.21900	(91030411) AT (	744522.00, 3982825.00)	DC
13.	484229.78100	(91051024) AT (	744522.00, 3982825.00)	DC	38.	374980.28100	(91100124) AT (	744522.00, 3982825.00)	DC
14.	484089.75000	(91051012) AT (	744522.00, 3982825.00)	DC	39.	374238.78100	(91041723) AT (	744522.00, 3982825.00)	DC
15.	458267.34400	(91091508) AT (	744522.00, 3982825.00)	DC	40.	370532.78100	(91100202) AT (	744522.00, 3982825.00)	DC
16.	452520.68800	(91101006) AT (	744522.00, 3982825.00)	DC	41.	368265.96900	(91051414) AT (	744522.00, 3982825.00)	DC
17.	451771.87500	(91042012) AT (	744522.00, 3982825.00)	DC	42.	367364.46900	(91122813) AT (	744522.00, 3982825.00)	DC
18.	447626.53100	(91110306) AT (	744522.00, 3982825.00)	DC	43.	359781.78100	(91110402) AT (	744522.00, 3982825.00)	DC
19.	436331.84400	(91070504) AT (	744522.00, 3982825.00)	DC	44.	352743.71900	(91021209) AT (	744522.00, 3982825.00)	DC
20.	434912.84400	(91013015) AT (	744522.00, 3982825.00)	DC	45.	351305.65600	(91011914) AT (	744522.00, 3982825.00)	DC
21.	431920.71900	(91082706) AT (	744522.00, 3982825.00)	DC	46.	349772.53100	(91032315) AT (	744522.00, 3982825.00)	DC
22.	414508.93800	(91012304) AT (	744522.00, 3982825.00)	DC	47.	344577.96900	(91122005) AT (	744522.00, 3982825.00)	DC
23.	413562.81300	(91050716) AT (	744522.00, 3982825.00)	DC	48.	343476.03100	(91122814) AT (	744522.00, 3982825.00)	DC
24.	411230.18800	(91081509) AT (	744522.00, 3982825.00)	DC	49.	337569.43800	(91052401) AT (	744522.00, 3982825.00)	DC
25.	410081.40600	(91042020) AT (	744522.00, 3982825.00)	DC	50.	334396.34400	(91101824) AT (	744522.00, 3982825.00)	DC

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

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*** ISCST3 - VERSION 97363 ***     *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET                ***        06/15/98
                                   ***                                                                    ***        19:41:09
                                                                                                                     PAGE  11
**MODELOPTs: CONC                             RURAL   ELEV    FLGPOL DFAULT

                                  *** THE MAXIMUM   50   1-HR AVERAGE CONCENTRATION   VALUES FOR SOURCE GROUP:  CO2       ***
                                      INCLUDING SOURCE(S):    S1C      , S2C      , S3C      , S4C      , S5C      , S6C      , S7C      ,
         S8C      , S9C      , S10C     ,

                                            ** CONC OF OTHER    IN MICROGRAMS/M**3                            **
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RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)	OF TYPE	RANK	CONC	(YYMMDDHH)	AT	RECEPTOR (XR,YR)	OF TYPE
1.	23410.70120	(91071812)	AT	(744522.00, 3982825.00)	DC	26.	17071.55470	(91062409)	AT	(744522.00, 3982825.00)	DC
2.	21986.40040	(91032316)	AT	(744522.00, 3982825.00)	DC	27.	16991.44140	(91032418)	AT	(744522.00, 3982825.00)	DC
3.	21535.64450	(91120224)	AT	(744522.00, 3982825.00)	DC	28.	16965.68750	(91020413)	AT	(744522.00, 3982825.00)	DC
4.	20892.60940	(91081509)	AT	(744522.00, 3982825.00)	DC	29.	16848.01560	(91082716)	AT	(744522.00, 3982825.00)	DC
5.	20041.11330	(91051421)	AT	(744522.00, 3982825.00)	DC	30.	16829.27340	(91112409)	AT	(744522.00, 3982825.00)	DC
6.	20030.30660	(91040123)	AT	(744522.00, 3982825.00)	DC	31.	16754.21090	(91082516)	AT	(744522.00, 3982825.00)	DC
7.	19808.75980	(91020822)	AT	(744522.00, 3982825.00)	DC	32.	16634.74020	(91100218)	AT	(744522.00, 3982825.00)	DC
8.	19677.09960	(91011924)	AT	(744522.00, 3982825.00)	DC	33.	16623.85740	(91012001)	AT	(744522.00, 3982825.00)	DC
9.	19644.17970	(91010308)	AT	(744522.00, 3982825.00)	DC	34.	16616.91020	(91123123)	AT	(744522.00, 3982825.00)	DC
10.	19468.10550	(91082621)	AT	(744522.00, 3982825.00)	DC	35.	16578.47850	(91071318)	AT	(744522.00, 3982825.00)	DC
11.	19457.75000	(91090713)	AT	(744522.00, 3982825.00)	DC	36.	16355.34860	(91110402)	AT	(744522.00, 3982825.00)	DC
12.	19398.85160	(91071507)	AT	(744522.00, 3982825.00)	DC	37.	16330.78220	(91100423)	AT	(744522.00, 3982825.00)	DC
13.	18869.52930	(91071319)	AT	(744522.00, 3982825.00)	DC	38.	16329.21580	(91050711)	AT	(744522.00, 3982825.00)	DC
14.	18642.33980	(91032315)	AT	(744522.00, 3982825.00)	DC	39.	16133.59860	(91120405)	AT	(744522.00, 3982825.00)	DC
15.	18337.98050	(91103013)	AT	(744522.00, 3982825.00)	DC	40.	16127.61620	(91031210)	AT	(744522.00, 3982825.00)	DC
16.	18333.78710	(91050716)	AT	(744522.00, 3982825.00)	DC	41.	15932.03130	(91091421)	AT	(744522.00, 3982825.00)	DC
17.	18156.91020	(91100422)	AT	(744522.00, 3982825.00)	DC	42.	15881.87790	(91112318)	AT	(744522.00, 3982825.00)	DC
18.	17871.23240	(91030411)	AT	(744522.00, 3982825.00)	DC	43.	15826.50290	(91122009)	AT	(744522.00, 3982825.00)	DC
19.	17843.57420	(91040321)	AT	(744522.00, 3982825.00)	DC	44.	15798.71290	(91062103)	AT	(744522.00, 3982825.00)	DC
20.	17636.11520	(91052301)	AT	(744522.00, 3982825.00)	DC	45.	15557.46880	(91112315)	AT	(744522.00, 3982825.00)	DC
21.	17512.26170	(91091619)	AT	(744522.00, 3982825.00)	DC	46.	15491.74800	(91031905)	AT	(744522.00, 3982825.00)	DC
22.	17505.71290	(91091610)	AT	(744522.00, 3982825.00)	DC	47.	15443.38180	(91041616)	AT	(744522.00, 3982825.00)	DC
23.	17472.12110	(91100420)	AT	(744522.00, 3982825.00)	DC	48.	15405.26950	(91031924)	AT	(744522.00, 3982825.00)	DC
24.	17386.54490	(91110307)	AT	(744522.00, 3982825.00)	DC	49.	15323.43360	(91051419)	AT	(744522.00, 3982825.00)	DC
25.	17223.24020	(91121006)	AT	(744522.00, 3982825.00)	DC	50.	14943.97560	(91101006)	AT	(744522.00, 3982825.00)	DC

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*** RECEPTOR TYPES:  GC = GRIDCART
                     GP = GRIDPOLR
                     DC = DISCCART
                     DP = DISCPOLR
                     BD = BOUNDARY
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 *** ISCST3 - VERSION 97363 ***     *** CT & 10 STACKS @ MON. TOWER*4MW*1991 JUL-SEP WB MET                    ***        06/15/98
                                    ***                                                                        ***        19:41:09
                                                                                                                          PAGE  12
**MODELOPTs: CONC                           RURAL  ELEV    FLGPOL DFAULT


*** Message Summary : ISCST3 Model Execution ***

 --------- Summary of Total Messages --------

A Total of           0 Fatal Error Message(s)
A Total of           1 Warning Message(s)
A Total of         666 Informational Message(s)

A Total of         666 Calm Hours Identified


   ******** FATAL ERROR MESSAGES ********
              ***  NONE  ***


   ********   WARNING MESSAGES   ********
CO W205     9 FLAGDF:No Option Parameter Setting.  Forced by Default to ZFLAG=0.

   ************************************
   *** ISCST3 Finishes Successfully ***
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