



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

**DOE/EA-1684D**

DRAFT ENVIRONMENTAL ASSESSMENT  
FOR DOE FUNDING OF THE  
CONSTRUCTION AND OPERATION OF THE  
FACILITY FOR RARE ISOTOPE BEAMS  
MICHIGAN STATE UNIVERSITY,  
EAST LANSING, MICHIGAN

**U.S. Department of Energy  
Office of Science, Chicago Office**

**March 2010**

THIS PAGE INTENTIONALLY LEFT BLANK

## SUMMARY

The U.S. Department of Energy (DOE) proposes to fund the construction and operation of the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU). DOE would also oversee the pre-construction, construction, and pre-operations of the FRIB, and maintain significant involvement during operation. Under the Proposed Action, MSU would construct, operate, and ultimately decommission the FRIB.

The *Environmental Assessment for DOE Funding of the Construction and Operation of the Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan (FRIB EA)* addresses the potential environmental impacts of the Proposed Action and the No Action Alternative. The *FRIB EA* is prepared in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.) regulations of the President's Council on Environmental Quality (40 CFR 1500–1508) and DOE's NEPA implementing regulations (10 CFR 1021). Given that the impacts of operation of the proposed FRIB accelerator are similar in nature to other linear accelerators and the impacts from construction would be similar in nature to conventional excavation and construction projects, DOE believes an EA is an appropriate level of review at this time. It will assist in DOE's determination whether to prepare an environmental impact statement, if there are significant environmental impacts, or to issue a Finding of No Significant Impact (FONSI), if there are no significant environmental impacts.

### Summary of the Proposed Action

DOE published a “funding opportunity announcement” on May 20, 2008, seeking applications for the conceptual design and establishment of a particle acceleration facility—the FRIB that met the criteria described in the FOA for less than or equal to \$550 million over the next decade. In review of the applications, DOE considered the results of an independent merit review process, as well as an environmental critique. On December 11, 2008, MSU was selected to design and establish the FRIB. DOE's proposed action under NEPA is the design, construction, and operation of the FRIB.

DOE and MSU propose to construct and operate the FRIB on approximately 15 acres (6.07 hectares) on MSU's East Lansing, Michigan, campus. Its design is composed of buildings and/or building additions for a heavy ion/proton accelerator and ancillary laboratories, support facilities such as a larger liquid helium production building, and offices. Construction/operations would occur in the middle of campus, adjacent to the existing National Superconducting Cyclotron Laboratory (NSCL), which would ultimately be subsumed into the FRIB. The function and scope of operations of the FRIB would be similar to those of the NSCL, but the FRIB would have substantially more power. The existing NSCL research program relies on a 200 megaelectron volts per atomic mass unit (MeV/u) coupled cyclotron driver accelerator with 1 to 2 kilowatts of beam power. FRIB would be capable of a minimum energy of 200 MeV/u for all ions and up to 400 kilowatts beam power. A reaccelerator, with energy up to 12 MeV/u for uranium and up to 20 MeV/u for lighter ions, is also planned for the facility. The linear accelerator tunnel would be situated in an excavation up to 50 feet below grade. The ground where the FRIB would be located has been previously disturbed. The U.S. Nuclear Regulatory Commission (NRC) and the State of Michigan would both have regulatory jurisdiction over nuclear activities at the FRIB, and the State of Michigan would regulate other aspects of

1 construction and operation. MSU’s broad scope NRC license would be modified to cover  
2 oversight of all accelerator-related activities.

3 The FRIB would provide research opportunities for an international community of  
4 approximately 1,000 university and laboratory scientists, postdoctoral associates, and graduate  
5 students. The research conducted at the FRIB would involve experimentation with intense  
6 beams of rare isotopes—short-lived nuclei not normally found on Earth—that would enable  
7 researchers to address forefront scientific questions in nuclear structure and nuclear astrophysics.  
8 Operation would result in low levels of activation of air and groundwater, which MSU intends to  
9 manage according to NRC license requirements. Doses to workers and members of the public  
10 are anticipated to be less than one-tenth of the NRC radiation protection standards.

### 11 **No Action Alternative**

12 As required by Council on Environmental Quality regulations, the *FRIB EA* evaluates a No  
13 Action Alternative to serve as a basis for comparison with the action alternatives. Under the No  
14 Action Alternative, the FRIB would not be constructed and operated at MSU and the enhanced  
15 opportunities for scientific research would not be pursued.

### 16 **Purpose and Need**

17 The purpose of the Proposed Action—to design, construct, and operate the FRIB—is to support  
18 DOE’s mission to advance our basic understanding of science. The purpose of the Proposed  
19 Action is consistent with the outcome of DOE’s procurement process for the design,  
20 construction, and operation of an accelerator that produces rare isotope beams. DOE determined  
21 that the establishment of the FRIB is a high priority for the future of U.S. nuclear science  
22 research. The FRIB would establish a highly sophisticated research laboratory that would  
23 produce intense beams of rare isotopes. These beams enable scientists to study the nuclear  
24 reactions that power stars and generate the elements found on Earth; explore the structure of  
25 atomic nuclei, which form the core of all matter, and the forces that bind them together; test  
26 current theories about the fundamental nature of matter; and play a role in developing new  
27 nuclear medicines and other societal applications of rare isotopes.

### 28 **Affected Environment**

29 The proposed FRIB would be constructed and operated adjacent to, and eventually incorporate,  
30 the existing NSCL, which is located in the northeastern section of the MSU campus. The areas  
31 that would be utilized during construction are previously disturbed areas currently used for  
32 parking lots and support areas around the NSCL. During construction, an existing soil disposal  
33 area located south of the railroad tracks, east of Farm Lane, and north of East Mount Hope Road  
34 would be used for construction staging and soils disposal. This area is an open field within an  
35 area of undeveloped fields and has historically been used for these purposes. Both the FRIB  
36 construction site and the soils disposal site are highly disturbed and contain no water bodies or  
37 streams, historic resources, wetlands, floodplains, and no threatened or endangered species.

1 **Summary of Environmental Impacts**

2 The *FRIB EA* evaluates the potential environmental effects that could result from implementing  
3 the Proposed Action or the No Action Alternative. As it is still early in the design phase of the  
4 FRIB, the *FRIB EA* considers a range of potential design configurations or options for the FRIB  
5 that would provide a reasonable “bound” of the environmental impacts of construction,  
6 operation, and decommissioning of the FRIB. The configuration options under consideration by  
7 the conceptual and preliminary design teams would not be expected to substantially change the  
8 projected environmental impacts of construction, operation, or decommissioning of the FRIB.  
9 Therefore, the options discussed in more detail in the *FRIB EA* are those that might have  
10 somewhat different, but still small, environmental impacts. These options may not precisely  
11 reflect the final design, but impacts of the final design would be bounded by the configurations  
12 considered in the *FRIB EA*.

13 Potential impacts identified for the resources evaluated in the *FRIB EA* include the following:

- 14 • Land Use and Visual Resources – MSU would construct the proposed project on a  
15 previously disturbed site directly adjacent to the existing NSCL and use an existing  
16 nearby soils disposal area for storage and disposal of soils. Both activities are consistent  
17 with current MSU planning. During construction, use of Bogue Street and Shaw Lane  
18 would be disrupted. In addition, the Wharton Center surface parking area would be  
19 closed and demolished and used as a laydown area during the construction period.  
20 Shaw Lane between Bogue Street and Hagadorn Road would be closed to through-traffic  
21 for approximately 2 months if the linear option is selected.

22 No land use impacts from the operation of the FRIB are anticipated. No adverse visual  
23 impacts were identified. During decommissioning, underground structures would be  
24 decontaminated and buried in place and any aboveground structures removed or  
25 redeployed.

26 With the No Action Alternative, these impacts would not occur.

- 27 • Geology and Soils – The FRIB would be constructed using cut and fill construction  
28 techniques. Approximately 325,000 cubic yards (248,000 cubic meters) of soil would be  
29 excavated during the construction of the tunnel associated with the FRIB. Construction  
30 would not be expected to otherwise adversely impact the geology or soils of the area.  
31 Affected soils are stable and acceptable for standard construction requirements. Erosion  
32 prevention and sedimentation control measures would minimize the potential for adverse  
33 impacts. No impacts on geology and soils from the operation of the FRIB are  
34 anticipated. With decommissioning, underground structures would be buried in place.  
35 Fill material would be required to bury underground structures. The source and quantity  
36 of fill material would be determined at the time of demolition.

37 With the No Action Alternative, these impacts would not occur.

- 38 • Water Resource – Erosion and sedimentation controls during construction would limit  
39 potential impacts on surface water. During construction, moderate to heavy volumes of

1 groundwater would likely be encountered where excavations extend below the water  
2 table. A dewatering system could be used during construction to temporarily lower the  
3 water table below the level of the tunnels. The resulting groundwater would be filtered  
4 and discharged into the existing stormwater drainage system. After construction, the  
5 groundwater levels would be expected to return to normal with no long-term impacts or  
6 changes in groundwater flow or levels.

7 No impacts on wetlands or floodplains would occur from construction, operation, or  
8 decommissioning because none exist at the project site or soil disposal area.

9 Normal facility operations would not have adverse impacts on any surface water. During  
10 FRIB operation, neutrons produced from scattered beam particles that penetrate the thick  
11 concrete walls of the linac tunnels and that could activate groundwater would result in  
12 low levels of activation of any soil and groundwater adjacent to the FRIB tunnels, which  
13 MSU would manage according to NRC license requirements. These NRC license  
14 requirements would require that the concentrations of radionuclides in the groundwater  
15 be below NRC water effluents limits. The FRIB project design team has established a  
16 design and operations goal, which is more than a factor of 10 times better than the NRC  
17 requirements. The FRIB project design goal is to keep the average groundwater  
18 radionuclide concentrations in the region around the linac tunnel walls below EPA-  
19 established drinking water limits. Ensuring that the water adjacent to the FRIB tunnels  
20 would meet drinking water standards, which would normally be applied to water  
21 provided by a drinking water supplier after pumping and filtering, would provide a very  
22 high degree of protection of both the environment and the public.

23 With the No Action Alternative, these impacts of construction would not occur.

- 24 • Air Quality – Construction emissions would be short-term, sporadic, and localized.  
25 Fugitive dust would be controlled to minimize emissions. No adverse impacts would  
26 occur from construction emission. No continuous emissions of criteria air pollutants are  
27 expected to result from the Proposed Action during operations.

28 With the No Action Alternative, the construction impacts would not occur.

- 29 • Biological Resources – As the project site has been previously disturbed and has a high  
30 degree of development, impacts on protected flora and fauna are not expected. The  
31 existing soils disposal site has also been previously disturbed though similar soils  
32 disposal activities as those that would be required for the Proposed Action, so impacts on  
33 protected flora and fauna are not expected. No threatened or endangered species nor  
34 critical habitats exist at the project site or soil disposal area.

35 With the No Action Alternative, there would be no impacts on biological resources.

- 36 • Noise Impacts – Temporary and short-term noise would be generated during construction  
37 and have the potential, without mitigation, to adversely affect any sensitive nearby  
38 receptors. The nearest noise-sensitive receptors include dormitories to the north of  
39 Shaw Lane that are within about 140 feet (43 meters) of the proposed tunnel excavation

1 location and within 50 feet (15 meters) of the proposed front end building location. Other  
2 noise-sensitive facilities within 150 feet (46 meters) of the excavation would include the  
3 Wharton Center for Performing Arts, the plant biology laboratories, and the Biochemistry  
4 Building. The Biochemistry Building, which includes laboratories that contain vibration-  
5 sensitive experiments, is within about 50 feet (15 meters) of the tunnel excavation and the  
6 connector high bay and south high bay extensions. Pedestrians in the area near the  
7 construction site would be impacted by construction noise. Construction noise could be  
8 mitigated by employing standard construction noise mitigation, including use of quieted  
9 equipment, shielding of noisy equipment and activities, careful location of noisy  
10 equipment, proper maintenance of equipment, and administrative controls such as  
11 scheduling to avoid interfering with noise-sensitive activities. MSU would control the  
12 impact of construction activity on normal operation of the campus, especially on noise-  
13 and vibration-sensitive activities.

14 Workers would be expected to wear appropriate hearing protection during construction.

15 During operations, noise sources would be relatively minor and similar to ongoing NSCL  
16 activities.

17 During decommissioning, noise sources would be similar to those during construction,  
18 although the amount of earthmoving activity would be much less. Therefore, noise  
19 impacts from decommissioning are expected to be less.

20 With the No Action Alternative, operational noise impacts of the NSCL would remain  
21 and would be minor.

- 22 • Utilities – Existing non-power utilities supporting the NSCL have adequate capacity to  
23 support construction and operation of FRIB. Estimated power requirements for FRIB  
24 operations are about 18 megawatts which would be supplied by offsite commercial  
25 power. FRIB would use the existing 21-megawatt substation at the MSU Power Plant and  
26 require a new duct bank to deliver power to the FRIB.

27 With the No Action Alternative, these impacts would not occur.

- 28 • Cultural and Historical Resources – No intact cultural or historical resources are known  
29 to exist in potentially affected areas. All surface areas of the project site have been  
30 previously disturbed. Based on archaeological and architectural surveys previously  
31 conducted on the MSU campus in the vicinity of the NSCL, no impacts are expected on  
32 cultural or historical resources during FRIB construction, operations, or  
33 decommissioning, including excavation or equipment storage and rock/soils stockpiling  
34 in the proposed construction staging area.

35 With the No Action Alternative, no impacts would be expected.

- 36 • Health and Safety – Construction workers would be subject to typical hazards and  
37 occupational exposures faced at other industrial construction sites. Contractors would be  
38 expected to comply with existing health and safety requirements. MSU would apply its

1 existing occupational health and safety program to the new operations, and impacts on  
2 workers or the public would be low.

3 The FRIB would be designed and operated to ensure that no adverse impacts on the  
4 public would occur during operations from exposure to direct radiation in the vicinity of  
5 the FRIB tunnels, controlled airborne radiological releases from the FRIB stacks,  
6 ingestion of contaminated groundwater, or accidents. Existing radiation safety practices  
7 and experience at the NSCL and other particle accelerators are adequate to ensure that the  
8 radiological impacts of operation of the accelerator, including potential accidents, would  
9 be kept small and well within applicable NRC and EPA standards. MSU President Lou  
10 Anna Simon has committed to ensuring that the FRIB is designed, constructed, and  
11 operated in such a manner that it maintains the NSCL's excellent environmental and  
12 safety record by continuing the MSU ALARA program. The FRIB would be designed  
13 and operated following the same strategy of radiation safety management that has been  
14 successfully used at the NSCL. That strategy is to: 1) abide by all limits and license  
15 commitments, 2) maintain individual and collective doses at or below as low as  
16 reasonably achievable, and 3) manage the facility consistent with MSU and FRIB safety  
17 management practices (currently certified ISO and OHSAS programs). The strategy has  
18 been effective for the NSCL and would also be effective for the FRIB. For NSCL,  
19 incidents and near-misses since the institution of the current NSCL certified ISO 9001  
20 (Quality Management Systems), ISO 14001 (Environmental Management Systems), and  
21 OHSAS 18001 (Occupational Health and Safety Management Systems) programs have  
22 been localized and were not considered to pose significant hazards to personnel, the  
23 public, or the environment.

24 As part of the design process, a range of potential accident scenarios are being considered  
25 to ensure that the facility has adequate protections to minimize potential impacts.  
26 Accident conditions (including radiological) are being analyzed as part of the  
27 development of a conceptual design, which is ongoing for the FRIB. These analyses  
28 continually evolve as the design effort progresses to ensure all credible hazards are  
29 evaluated and appropriate controls are included in the design to safeguard the public,  
30 FRIB personnel, environment, and FRIB mission. For the FRIB, hazards that have been  
31 identified include electrical and chemical hazards, non-ionizing radiation (lasers), and  
32 waste handling, as well as ionizing radiation, oxygen-deficient atmosphere, and  
33 cryogenic hazards for the accelerator, target building, and support systems. The design  
34 and operational controls being included in the FRIB design are intended to provide a  
35 robust level of protection against these postulated events and provide protection for the  
36 public, FRIB workers, and environment. Based on the experience of other accelerator  
37 facilities, the evaluations presented in Chapter 5, Section 5.1.9, and Appendix C, and the  
38 MSU's commitment to certain design features and safety controls for the FRIB, it is  
39 expected that the health and safety impacts (risk) of foreseeable accidents can be  
40 managed at acceptably low levels through the facility design process and control of  
41 operations.

42 With the No Action Alternative, the health and safety impacts of NSCL operations would  
43 continue to be managed and would be low.

- 1       • Waste Management – Construction activities and operation of the facility would generate  
2 waste, possibly including hazardous waste. Waste would be characterized, stored, and  
3 disposed of in accordance with applicable regulations. Disposal would occur in existing  
4 facilities.

5           During operations, hazardous and radioactive waste streams would be similar to existing  
6 NSCL wastes and would be handled and disposed of using the existing MSU waste  
7 management program; no adverse impacts would occur. With the increased size and  
8 scope of operations, waste generation would increase but would be well within the  
9 existing capability and capacity of the MSU waste system.

10          With the No Action Alternative, the incremental waste generation associated with FRIB  
11 operation would not occur, and waste levels associated with the NSCL would remain the  
12 same.

- 13       • Transportation – No adverse impacts associated with the transport of construction  
14 materials are expected. Construction activities would cause an increase of approximately  
15 400 vehicles per day due to the shipment of construction materials and wastes, and the  
16 commuting of construction workers. The construction traffic would cause an increase of  
17 less than 4 percent in total traffic on the surrounding roads. Based on the estimated  
18 traffic volumes during construction, it is estimated that there would be fewer than  
19 2 construction-related accidents involving a motor vehicle, with no fatalities or injuries.  
20 Construction workers commuting to the site would experience approximately  
21 17 accidents, no fatalities, and 4 injuries over the duration of the construction period.

22          Road closures during FRIB construction would disrupt and divert traffic for periods of up  
23 to 2 years. Temporary closures of Bogue Street, Shaw Lane, and Wilson Road would  
24 also impact pedestrian and bicycle traffic. Temporary walkways would be established,  
25 with sufficient safety features such as fencing to direct pedestrian and bicycle traffic  
26 around the construction site.

27          With the No Action Alternative, the traffic disruptions associated with FRIB construction  
28 and incremental impacts associated with FRIB operation would not occur.

- 29       • Socioeconomics and Environmental Justice –Construction of the FRIB is expected to last  
30 from 2012 through 2016 and annual construction employment is expected to peak at  
31 175 employees. Total peak year earnings from both direct and indirect employment are  
32 estimated to be \$20.2 million. Total spending to build the facility is estimated to be  
33 \$548 million, of which \$348 million is assumed to be spent locally. Indirect economic  
34 output generated by that spending is estimated to be \$279 million, for a total economic  
35 impact of \$627 million during the construction phase. When the facility is fully  
36 operational it is estimated that it would require approximately 500 operations and support  
37 staff. When compared to employment at the existing NSCL, the FRIB would add  
38 approximately 160 new professional and technical service jobs. No high and adverse  
39 human health or environmental impacts are anticipated as a result of the construction or  
40 operation of the FRIB; consequently, there would be no disproportionately high and  
41 adverse effects on minority or low-income populations.

- 1           With the No Action Alternative, these impacts would not occur.
- 2           • Cumulative Impacts of the Proposed Action – No substantial cumulative impacts on the  
3 environment would be anticipated from implementing the Proposed Action. The  
4 cumulative impacts of construction of the FRIB and other construction projects at MSU  
5 during the FRIB construction timeframe would still be small. Operational impacts of the  
6 FRIB would be small and those impacts, collectively with other MSU operational  
7 impacts, would also be expected to be small.

# Table of Contents

1			
2	Chapter 1	Introduction .....	1-1
3	1.1	Background .....	1-1
4	1.1.1	Solicitation Process .....	1-1
5	1.1.2	Technology .....	1-2
6	1.2	Environmental Review Process .....	1-2
7	1.2.1	Public Involvement in Developing the Scope of this EA .....	1-3
8	1.2.2	Public Comments on the Scope of this EA .....	1-4
9	Chapter 2	Purpose and Need .....	2-1
10	Chapter 3	Description of the Proposed Action and Alternatives .....	3-1
11	3.1	Description of the Proposed Action .....	3-1
12	3.1.1	Accelerator Configuration Options .....	3-2
13	3.1.2	Major Linear Accelerator Components .....	3-6
14	3.1.3	Experimental Area and Research Infrastructure .....	3-11
15	3.1.4	Construction .....	3-16
16	3.1.5	Operations .....	3-20
17	3.1.6	Decommissioning FRIB .....	3-22
18	3.2	Description of the No Action Alternative .....	3-22
19	3.3	Alternatives Considered But Eliminated .....	3-23
20	Chapter 4	Affected Environment .....	4-1
21	4.1	Land Use .....	4-1
22	4.2	Geology and Soils .....	4-5
23	4.3	Water Resources .....	4-8
24	4.4	Climate and Air Quality .....	4-12
25	4.4.1	Climate .....	4-12
26	4.4.2	Greenhouse Gas .....	4-12
27	4.4.3	Air Quality .....	4-13
28	4.5	Biological Resources .....	4-14
29	4.6	Noise .....	4-15
30	4.7	Utilities .....	4-15
31	4.8	Cultural and Historical Resources .....	4-16
32	4.9	Human Health and Safety .....	4-16
33	4.9.1	Radiological Environment .....	4-16
34	4.9.2	Occupational Health and Safety .....	4-17
35	4.10	Waste Management .....	4-18
36	4.11	Transportation .....	4-20
37	4.12	Socioeconomics and Environmental Justice .....	4-23
38	Chapter 5	Environmental Consequences .....	5-1
39	5.1	Effects of the Proposed Action .....	5-1
40	5.1.1	Land Use and Visual .....	5-1
41	5.1.2	Geology and Soils .....	5-2
42	5.1.3	Water Resources .....	5-3
43	5.1.3.1	Surface Water .....	5-3
44	5.1.3.2	Groundwater .....	5-4
45	5.1.4	Climate and Air Quality .....	5-8
46	5.1.5	Biological Resources .....	5-10
47	5.1.6	Noise .....	5-10
48	5.1.7	Utilities .....	5-12

1	5.1.8	Cultural and Historical Resources .....	5-14
2	5.1.9	Human Health and Safety .....	5-14
3	5.1.9.1	Construction .....	5-14
4	5.1.9.2	Operations.....	5-16
5	5.1.9.3	Decommissioning Impacts .....	5-25
6	5.1.10	Waste Management.....	5-26
7	5.1.11	Transportation.....	5-29
8	5.1.11.1	Construction .....	5-30
9	5.1.11.2	Operations.....	5-33
10	5.1.12	Socioeconomics and Environmental Justice.....	5-35
11	5.2	Cumulative Impacts of the Proposed Action.....	5-37
12	5.3	No Action Alternative .....	5-37
13	Chapter 6	Agencies and Persons Consulted.....	6-1
14	6.1	Federal, State, and Local Agencies and Organizations .....	6-1
15	6.2	DOE Preparers and Reviewers.....	6-1
16	6.3	MSU Preparers and Reviewers .....	6-1
17	6.4	Science Application International Corporation Preparers and reviewers.....	6-2
18	Chapter 7	References .....	7-1
19	APPENDIX A	Notice of Intent.....	A-1
20	APPENDIX B	List of State and Federally Threatened and Endangered Species .....	B-1
21	APPENDIX C	Preliminary Assessment of FRIB Accident Hazards.....	C-1
22	APPENDIX D	Cultural Resource Study and Consultations .....	D-1
23	APPENDIX E	Environmental Synopsis .....	E-1
24			

## List of Figures

1		
2	Figure 3–1. Potential FRIB Configuration: Straight Linear Accelerator Configuration Option.....	3–4
3	Figure 3–2. Proposed FRIB Location – Straight Linear Accelerator Configuration Option .....	3–5
4	Figure 3–3. Proposed FRIB Location– Folded Linear Accelerator Configuration Option.....	3–5
5	Figure 3–4. Proposed FRIB Location– Double-folded Linear Accelerator Configuration Option.....	3–6
6	Figure 3–5. Conceptual Layout of a Proposed Ventilation System for the Target Facility .....	3–9
7	Figure 3–6. Block Diagram of the Facility for Rare Isotope Beams.....	3–12
8	Figure 3–7. Target Building and Installed Components .....	3–15
9	Figure 3–8. Existing National Superconducting Cyclotron Laboratory Experimental Areas with a	
10	Concept of the Change Necessary to Incorporate the Facility for Rare Isotope Beam ..	3–16
11	Figure 4–1. Project Location on Michigan State University Campus.....	4–2
12	Figure 4–2. Potential Michigan State University Building Development Opportunities.....	4–4
13	Figure 4–3. National Seismic Hazard Mapping–Michigan.....	4–7
14	Figure 4–4. The Upper Grand River Watershed in Ingham County, Michigan.....	4–8
15	Figure 4–5. Waterbodies Near the Project Site.....	4–9
16	Figure 4–6. Transportation Network In The Vicinity Of the Project Site.....	4–21

## List of Tables

17		
18	Table 3–1. Estimated Timeline for Construction and Operation .....	3–2
19	Table 3–2. Volatile Radioisotopes produced by the Uranium Ion Beam.....	3–10
20	Table 3–3. Approximate Building Characteristics.....	3–12
21	Table 3–4. Approximate Estimates of Construction Requirements .....	3–18
22	Table 3–5. Approximate Estimates of Construction Wastes .....	3–20
23	Table 4–1. Attainment Designations for Ingham County .....	4–13
24	Table 4–2. Comparison of Annual Average Doses Received by a U.S. Resident from All Sources.....	4–17
25	Table 4–3. Occupational Injury and Illness Rates, 2004 – 2008 .....	4–18
26	Table 4–4. On-Campus Traffic Accident Annual Rates .....	4–21
27	Table 4–5. Average Daily Traffic Count .....	4–22
28	Table 4–6. Economic Characteristics of Ingham County and the Lansing-East Lansing Metropolitan	
29	Statistical Area .....	4–24
30	Table 4–7. 2008 Minority Populations .....	4–25
31	Table 5–1. Groundwater Environmental Impact Limits and Project Design Goals.....	5–6
32	Table 5–2. Preliminary Modeling Results for Expected Mixed Beam Operations.....	5–7
33	Table 5–3. Estimated Construction Emissions .....	5–8
34	Table 5–4. Maximum Noise Levels at 50 Feet for Common Construction Equipment.....	5–10

1	Table 5–5. Noise Levels at Specific Distances from the Construction Site.....	5–11
2	Table 5–6. Annual Waste Generation from NSCL and FRIB Operations .....	5–28
3	Table 5–7. Frequency of Accidents and Related Consequences (per mile) <sup>a</sup> .....	5–30
4	Table 5–8. Number of Trips and Total Miles Traveled for Construction Activities .....	5–32
5	Table 5–9. Estimated Impacts of Traffic Accidents.....	5–33
6	Table 5–10. Personnel Traveling to and from the National Superconducting Cyclotron Laboratory	
7	(NSCL) .....	5–34
8	Table 5–11. Transportation Impacts During Operations.....	5–34
9		

## Common Metric/British System Equivalents

### Length

1 centimeter = 0.3937 inch

1 inch = 2.54 centimeters

1 centimeter = 0.0328 foot

1 foot = 30.48 centimeters

1 meter = 3.2808 feet

1 foot = 0.3048 meter

1 kilometer = 0.6214 mile

1 mile = 1.6093 kilometers

### Area

1 square centimeter = 0.1550 square inch

1 square inch = 6.4516 square centimeters

1 square meter = 10.7639 square feet

1 square foot = 0.09290 square meter

1 square kilometer = 0.3861 square mile

1 square mile = 2.5900 square kilometers

1 hectare = 2.4710 acres

1 acre = 43560 square feet = 0.4047 hectare

1 hectare = 10,000 square meters

1 square meter = .0001 hectare

### Volume

1 cubic centimeter = 0.0610 cubic inch

1 cubic inch = 16.3871 cubic centimeters

1 cubic meter = 35.3147 cubic feet

1 cubic foot = 0.0283 cubic meter

1 cubic meter = 1.308 cubic yards

1 cubic yard = 0.76455 cubic meter

1 liter = 1.0567 quarts

1 quart = 0.9463264 liter

1 liter = 0.2642 gallon

1 gallon = 3.7845 liters

### Weight

1 gram = 0.0353 ounce

1 ounce = 28.3495 grams

1 kilogram = 2.2046 pounds

1 pound = 0.4536 kilogram

1 metric ton = 1.1023 tons

1 ton = 0.9072 metric ton

### Energy

1 joule = 0.00094845 British thermal unit (BTU)

1 BTU = 1054.18 joule

1 joule =  $6.24 \times 10^{12}$  million electron volts (MeV)

1 MeV =  $1.602 \times 10^{-13}$  joule

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24

1 megawatt-year (MW-yr) = 1 kw-hr =  $1.14 \times 10^{-7}$  MW-yr =  $8.76 \times 10^6$  kilowatt-hours (kw-hrs)

**Power**

1 watt = 3.414 British thermal unit (BTU)/hr                      1 BTU/hr = 0.2929 watt

**Pressure**

1 newton/square meter (N/m<sup>2</sup>) =                                      1 psf = 48 N/m<sup>2</sup>  
0.0208 pound/square foot (psf)

**Force**

1 newton (N) = 0.2248 pound-force (lbf)                      1 lbf = 4.4478 N

**Radiation**

1 becquerel (Bq) =  $2.703 \times 10^{-11}$  curies (Ci)                      1 Ci =  $3.70 \times 10^{10}$  Bq

1 sievert (Sv) = 100 rem    1 rem = 0.01 Sv

1

## Scientific Notation Conversion Chart

Name	Symbol	Value Multiplied by:			
pico	p		0.000000000001	or $1 \times 10^{-12}$	or 1E-12
nano	n		0.000000001	or $1 \times 10^{-9}$	or 1E-09
micro	$\mu$		0.000001	or $1 \times 10^{-6}$	or 1E-06
milli	m		0.001	or $1 \times 10^{-3}$	or 1E-03
cento	c		0.01	or $1 \times 10^{-2}$	or 1E-02
deci	d		0.1	or $1 \times 10^{-1}$	or 1E-01
---		1		or $1 \times 10^0$	or 1E+00
deka	da	10		or $1 \times 10^1$	or 1E+01
hecto	h	100		or $1 \times 10^2$	or 1E+02
kilo	K	1,000		or $1 \times 10^3$	or 1E+03
mega	M	1,000,000		or $1 \times 10^6$	or 1E+06
giga	G	1,000,000,000		or $1 \times 10^9$	or 1E+09
tera	T	1,000,000,000,000		or $1 \times 10^{12}$	or 1E+12

2 The following symbols are occasionally used in conjunction with numerical expressions.

Symbol	Indicates the preceding value is:
<	less than
$\leq$	less than or equal to
>	greater than
$\geq$	greater than or equal to

3 In some cases, numerical values in this document have been rounded to an appropriate number of  
 4 significant digits to reflect the accuracy of data being presented. For example, the numbers  
 5 0.021, 21, 2100, and 2,100,000 all contain two significant digits. In some cases, where several  
 6 values are summed to obtain a total, the rounded total may not exactly equal the sum of its  
 7 rounded component values. Conversions from English to metric are rounded to maintain the  
 8 number of significant digits.

9

## Acronyms and Abbreviations

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31

### A

ac acre(s)  
ALARA as low as reasonably achievable

### B

BLS U.S. Bureau of Labor and Statistics  
BMP Best Management Practice

### C

°C degrees Celsius  
CAA Clean Air Act  
CBO Congressional Budget Office  
CEQ Council on Environmental Quality  
CERCLA Comprehensive Environmental Response, Compensation, and Liability Act  
CFC chlorofluorocarbon  
CFR Code of Federal Regulations  
cm centimeter(s)  
CO carbon monoxide  
CO<sub>2</sub> carbon dioxide

### D

DART days away (from work), restricted, transferred  
dBA decibels (A-weighted)  
DOE U.S. Department of Energy  
DOL U.S. Department of Labor  
DOT U.S. Department of Transportation

### E

EA Environmental Assessment  
EIS Environmental Impact Statement  
EO Executive Order  
EPA U.S. Environmental Protection Agency

### F

°F degrees Fahrenheit  
FEMA Federal Emergency Management Agency  
FHWA Federal Highway Administration  
FONSI Finding of No Significant Impact  
FR Federal Register  
FRIB Facility for Rare Isotope Beams  
*FRIB EA Environmental Assessment for DOE Funding of the Construction and Operation of the Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan*

ft feet  
ft<sup>2</sup> square feet  
ft<sup>3</sup> cubic feet  
ft/s feet per second  
FWS U.S. Fish and Wildlife Service  
FY fiscal year

### G

gal gallon(s)

*Acronyms and Abbreviations*

---

1	GDP	gross domestic product	33	MeV/u	megaelectron volts per atomic mass unit
2	GHG	Greenhouse Gases	34		
3	gpm	gallons per minute	35	MDEQ	Michigan Department of Environmental Quality (See also MDNRE)
4	gsf	gross square feet	36		
5	GVW	gross vehicle weight	37		
6		<b>H</b>	38	MDNR	Michigan Department of Natural Resources (now part of MDNRE)
7	ha	hectare(s)	39		
8	HDPE	High Density Polyethylene	40		
9	HPO	Historic Preservation Officer	41	MDNRE	Michigan Department of Natural Resources and Environment
10	hr	hour	42		
11	HVAC	heating, venting, and air conditioning	43		
12			44	MIOSHA	Michigan Department of Occupational Safety and Health Administration
13		<b>I</b>	45		
14	IAQ	Indoor Air Quality	46		
15	IBC	International Building Code	47	mi	mile(s)
16	in	inch(s)	48	mi <sup>2</sup>	square mile(s)
17	ISO	International Organization for Standardization	49	min	minute
18			50	ml	milliliter
19		<b>K</b>	51	MMI	Modified Mercalli Intensity
20	kg	kilogram(s)	52	MSA	Metropolitan Statistical Area
21	km	kilometer(s)	53	MSU	Michigan State University
22	km <sup>2</sup>	square kilometer(s)	54		<b>N</b>
23	kPa	kilopascal	55	N/A	not applicable
24	kV	kilovolt	56	NAAQS	National Ambient Air Quality Standards
25		<b>L</b>	57		
26	l	liter(s)	58	NDA	no data available
27	lb	pound(s)	59	NEPA	National Environmental Policy Act
28	lpm	liters per minute	60		
29		<b>M</b>	61	NHL	National Historic Landmark
30	m	meter(s)	62	NHPA	National Historic Preservation Act
31	m <sup>2</sup>	square meter(s)	63		
32	m <sup>3</sup>	cubic meter(s)	64	NO <sub>2</sub>	nitrogen dioxide
			65	NO <sub>x</sub>	oxides of nitrogen
			66	NOC	Notice of Coverage
			67	NOI	Notice of Intent
			68		

1	NPDES	National Pollution Discharge	36		<b>S</b>
2		Elimination System	37	s	second(s)
3	NRC	U.S. Nuclear Regulatory	38	SCE	secondary confinement exhaust
4		Commission	39	sf	square feet
5	NREPA	Natural Resources and	40	SHPO	State Historic Preservation
6		Environmental Protection Act	41		Office
7	NRHP	National Register of Historic	42	SNS	Spallation Neutron Source
8		Places	43	SO <sub>2</sub>	sulfur dioxide
9	NSAC	Nuclear Science Advisory	44	SVOC	semi-volatile organic compound
10		Committee	45	SWMP	Storm Water Management
11	NSCL	National Superconducting	46		Program
12		Cyclotron Laboratory	47	SWPPP	Storm Water Pollution
13	NSF	National Science Foundation	48		Prevention Plan
14		<b>O</b>			
15	O <sub>3</sub>	ozone	49		<b>T</b>
16	OHSAS	Occupational Health and Safety	50	tpy	tons per year
17		Assessment Series	51		<b>U</b>
18	ORCBS	Office of Radiation, Chemical,	52	UMRA	Unfunded Mandates Reform
19		and Biological Safety	53		Act
20	oz	ounce(s)	54	USACE	U.S. Army Corps of Engineers
21		<b>P</b>	55	USBC	U.S. Bureau of the Census
22	Pa	pascal(s)	56	U.S.C.	<i>United States Code</i>
23	Pb	lead	57		<b>V</b>
24	PCE	primary confinement exhaust	58	v	volts
25	PGA	peak ground acceleration	59	VMT	vehicle miles traveled
26	PM <sub>2.5</sub>	particulate matter less than	60	VOC	volatile organic compound
27		2.5 microns in diameter	61		<b>W</b>
28	PM <sub>10</sub>	particulate matter less than	62	WAN	Wide Area Network
29		10 microns in diameter	63		<b>Y</b>
30	ppm	parts per million	64	yd	yard(s)
31	psi	pounds per square inch	65	yd <sup>3</sup>	cubic yard(s)
32		<b>R</b>			
33	RCRA	Resource Conservation and			
34		Recovery Act			
35	RFQ	radio frequency quadrupole			

## Glossary

3 **accelerator:** Device used to increase the energy of particles, which then collide with other  
4 particles. Major types are linear accelerators and circular accelerators. The name refers to the  
5 path taken by the accelerated particle.

6 **affected environment:** A description of the existing environment that could be affected by the  
7 Proposed Action or its alternatives.

8 **ambient air:** The surrounding atmosphere, usually the outside air, as it exists around people,  
9 plants, and structures. (It is not the air in the immediate proximity of an emission source.)

10 **atom:** A particle of matter indivisible by chemical means. It is the fundamental building block  
11 of molecules. It consists of a positively charged nucleus and orbiting electrons. The number of  
12 electrons is the same as the number of protons in the nucleus.

13 **atomic number:**  $Z$ , the total number of protons found in a nucleus.

14 **attainment:** An area is designated as being in attainment by the U.S. Environmental Protection  
15 Agency if it meets the National Ambient Air Quality Standards (NAAQS) for a given criteria  
16 pollutant. Non-attainment areas are areas in which any one of the NAAQS have been exceeded,  
17 maintenance areas are areas previously designated non attainment and subsequently re-  
18 designated as attainment, and unclassifiable areas are areas that cannot be classified on the basis  
19 of available information as meeting or not meeting the NAAQS for any one criteria pollutant.

20 **background radiation:** Ionizing radiation present in the environment from cosmic rays and  
21 natural sources in the Earth; background radiation varies considerably with location.

22 **beta particle (beta radiation, beta ray):** An electron of either positive charge ( $e^+$  or  $\beta^+$ ) or  
23 negative charge ( $e^-$  or  $\beta^-$ ) emitted by an atomic nucleus or neutron in the process of a  
24 transformation. Beta particles are more penetrating than alpha particles but less than gamma  
25 rays or x-rays. Electron capture is a form of beta decay.

26 **criteria pollutants:** The Clean Air Act requires the U.S. Environmental Protection Agency to  
27 set air quality standards for common and widespread pollutants after preparing criteria  
28 documents summarizing scientific knowledge on their health effects. Currently, there are  
29 standards in effect for six criteria pollutants: sulfur dioxide ( $SO_2$ ), carbon monoxide (CO),  
30 particulate matter equal to or less than 10 microns in diameter ( $PM_{10}$ ), nitrogen dioxide ( $NO_2$ ),  
31 ozone ( $O_3$ ), and lead (Pb).

32 **cryogenic:** The branches of physics and engineering that involve the study of very low  
33 temperatures, how to produce them, and how materials behave at those temperatures. Cryogenic  
34 cooling of devices and material is usually achieved via the use of liquid nitrogen, liquid helium,  
35 or a cryocooler (which uses high pressure helium lines).

1 **cyclotron:** Circular accelerator in which the particle is bent in traveling through a magnetic field,  
2 and an oscillating potential difference causes the particles to gain energy.

3 **cultural resources:** The prehistoric and historic districts, sites, buildings, objects, or any other  
4 physical activity considered important to a culture, subculture, or a community for scientific,  
5 traditional, religious, or any other reason.

6 **cumulative impact:** The impact on the environment which results from the incremental impact  
7 of the action when added to other past, present, and reasonably foreseeable future actions  
8 regardless of what agency (Federal or non-Federal) or person undertakes other such actions.  
9 Cumulative impacts can result from individually minor but collectively significant actions taking  
10 place over a period of time.

11 **curie (Ci):** A measure of the radioactivity level of a substance (that is, the number of unstable  
12 nuclei that are undergoing transformation in the process of radioactivity decay); one curie equals  
13 the disintegration of  $3.7 \times 10^{10}$  (37 billion) nuclei per second and is equal to the radioactivity of  
14 one gram of radium-226.

15 **decay (radioactive):** The change of one radioactive nuclide into a different nuclide by the  
16 spontaneous emission of radiation such as alpha, beta, or gamma rays, or by electron capture.  
17 The end product is a less energetic, more stable nucleus. Each decay process has a definite half-  
18 life.

19 **decibel (dB):** A logarithmic measurement unit that describes a particular sound pressure level  
20 compared to a standard reference value. The threshold of human hearing is approximately 0 dB,  
21 and the threshold of discomfort or pain is around 120 dB. A-weighted decibels (dBA) refer to  
22 measured decibels whose frequencies have been adjusted to correspond to the highest sensitivity  
23 of human hearing, which is typically in the frequency range of 1,000 to 4,000 hertz.

24 **dose:** The amount of energy deposited in the body by ionizing radiation per unit body mass.

25 **electron volt:** A unit of energy equal to the kinetic energy (or energy of motion) an electron  
26 gains when being accelerated through a potential difference of 1 volt. Another unit of energy is  
27 the joule and 1 joule equals  $6.2415 \times 10^{18}$  electron volts. One joule is roughly the energy needed to  
28 lift 1 kilogram (2.2 pounds) on the surface of the earth by 0.1 meter (4 inches). Kiloelectron  
29 volt: One thousand electron volts. Megaelectron volt: One million electron volts.

30 **exposure to radiation:** The incidence of radiation from either external or internal sources on  
31 living or inanimate material by accident or intent.

32 **gamma ray:** A highly penetrating type of nuclear radiation, similar to x-radiation, except that it  
33 comes from within the nucleus of an atom, and, in general, has a shorter wavelength.

34 **General Conformity Rule:** The General Conformity Rule is applicable to non attainment or  
35 maintenance areas (see attainment) as designated by the U.S. Environmental Protection Agency  
36 (EPA), and ensures that Federal actions conform to each State Implementation Plan for air  
37 quality. These plans, approved by the EPA, are each State's individual plan to achieve the  
38 NAAQS as required by the Clean Air Act. The EPA is required to promulgate a Federal

1 Implementation Plan if a State defaults on its implementation plan. A conformity requirement  
2 determination for the action is made from influencing factors, including, but not limited to, non  
3 attainment or maintenance status of the area, types of emissions and emission levels resulting  
4 from the action, and local impacts on air quality.

5 **greenhouse gases:** Gases that trap heat in the atmosphere are often called greenhouse gases.  
6 Their presence leads to global warming. Some greenhouse are emitted to the atmosphere  
7 through natural processes. Other greenhouse gases are created and emitted solely through human  
8 activities. The principal greenhouse gases are: carbon dioxide, methane, nitrous oxide, water  
9 vapor, ozone, and fluorinated gases.

10 **half-life:** The time in which half the (large number of) atoms of a particular radioactive nuclide  
11 disintegrate. The half-life is a characteristic property of each radioactive isotope.

12 **hazardous air pollutants:** Air pollutants that are known to cause or may reasonably be  
13 anticipated to cause adverse effects to human health or adverse environmental effects. 188  
14 specific pollutants and chemical groups were initially identified as hazardous air pollutants, and  
15 the list has been modified over time.

16 **health effects:** Within the context of this Environmental Impact Statement, health effects are  
17 defined as the number of additional latent cancer fatalities due to a radioactive release (that is,  
18 the number of cancer fatalities resulting from this release that are in excess of those cancer  
19 fatalities which the general population would normally experience from other causes).

20 **heavy ion:** An ionized (i.e., positively or negatively charged) atom which is usually heavier than  
21 helium.

22 **isotope:** Any of two or more species of atoms of a chemical element with the same atomic  
23 number and nearly identical chemical behavior, but with different atomic mass (number of  
24 neutrons) or mass number and different physical properties.

25 **latent cancer fatalities:** Estimation of latent cancer fatalities assumes that 1) exposures to the  
26 radioactive material released to the environment occur over a 50-year period, and 2) the internal  
27 dose resulting from such exposure are 50-year committed doses, meaning that following  
28 inhalation or ingestion of the radioactive material, the resulting internal doses are based on  
29 tracking the material in the body for a 50-year period. The time period over which latent cancer  
30 fatalities occur is undefined, and could occur well after 50 years following the release.

31 **linear accelerator:** Particle accelerator laid out in a straight line. The Facility for Rare Isotope  
32 Beams would have a linear accelerator. An alternative considered is a folded linear accelerator.

33 **National Ambient Air Quality Standards (NAAQS):** Section 109 of the Clean Air Act  
34 requires the U.S. Environmental Protection Agency to set nationwide standards, the NAAQS, for  
35 widespread air pollutants. Currently, six pollutants are regulated by primary and secondary  
36 NAAQS (see criteria pollutants).

37 **nuclide:** Any species of atom that exists for a measurable length of time. A nuclide can be  
38 distinguished by its atomic mass, atomic number, and energy state.

1 **oxides of nitrogen (NO<sub>x</sub>):** Gases formed primarily by fuel combustion, which contribute to the  
2 formation of acid rain. Hydrocarbons and oxides of nitrogen combine in the presence of sunlight  
3 to form ozone, a major constituent of smog.

4 **proton:** One of the basic particles that makes up an atom. The proton is found in the nucleus  
5 and has a positive electrical charge equal to the negative charge of an electron and a mass similar  
6 to that of a neutron: a hydrogen nucleus.

7 **radiation:** The emitted particles (alpha, beta, neutrons) or photons (X-rays, gamma rays) from  
8 the nuclei of unstable (radioactive) atoms as a result of radioactive decay. Some elements are  
9 naturally radioactive; others are induced to become radioactive by bombardment in a nuclear  
10 reactor or other particle accelerator. The characteristics of naturally occurring radiation are  
11 indistinguishable from those of induced radiation.

12 **radiation dose:** The amount of energy from ionizing radiation deposited within tissues of the  
13 body; it is a time-integrated measure of potential damage to tissues from exposure to radiation  
14 and as such is related to health-based consequences.

15 **radioactive half-life:** The time required for one half of the atoms in a radioactive isotope to  
16 decay.

17 **radioactive waste:** Materials that are radioactive and for which there is no further use.

18 **radioactivity:** The spontaneous decay or disintegration of an unstable atomic nucleus  
19 accompanied by the emission of radiation.

20 **rem:** The unit dose representing the amount of ionizing radiation needed to produce the same  
21 biological effects as one roentgen of high-penetration X-rays (about 200,000 electron volts). The  
22 biological effects of 1 rem are presumed to be independent of the type of radiation.

23 **shielding:** A protective barrier, usually a dense material, that reduces the passage of radiation  
24 from radioactive materials to the surroundings by absorbing it.

25 **source:** A radioactive material that produces radiation for experimental or industrial use.

26 **source term:** The quantities of materials released during an accident to air or water pathways  
27 and the characteristics of the releases (for example, particle size distribution); used for  
28 determining accident consequences.

29 **stable:** Strictly speaking, a nuclide that is not radioactive. The definition is often relaxed to  
30 include very long-lived nuclides that are naturally occurring.

31 **superconductivity:** A property that occurs in certain materials at very low temperatures. When  
32 superconductive, a material has an electrical resistance of exactly zero and no interior magnetic  
33 field.

1 **target nuclide:** The initial nucleus in a nuclear reaction on which a projectile is incident. It is  
2 used in the context of a nuclear reaction where the projectile interacts with a target nucleus,  
3 producing a product nucleus and a projectile.

4 **x-ray:** Electromagnetic radiation with wavelengths between ultraviolet and gamma rays.

5

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK

1  
2

# CHAPTER 1

## INTRODUCTION

3 The U.S. Department of Energy (DOE) has prepared this *Environmental Assessment for DOE*  
4 *Funding of the Construction and Operation of the Facility for Rare Isotope Beams, Michigan*  
5 *State University, East Lansing, Michigan (FRIB EA)* to evaluate the potential environmental  
6 impacts associated with the construction and operation of the Facility for Rare Isotope Beams  
7 (FRIB) on approximately 15 acres (6 hectares) on the campus of Michigan State University  
8 (MSU) in East Lansing, Michigan. The FRIB’s design would be composed of buildings and/or  
9 building additions for a heavy ion/proton accelerator and ancillary laboratories, support facilities  
10 such as a larger liquid helium production building, and offices. Construction would occur on  
11 campus, adjacent to the existing National Superconducting Cyclotron Laboratory (NSCL), which  
12 would ultimately be subsumed into the FRIB.

13

### 1.1 BACKGROUND

14 The FRIB concept has undergone numerous studies and assessments within DOE and by  
15 independent parties such as the National Research Council of the National Academy of Sciences.  
16 These studies—in addition to the joint DOE and National Science Foundation 2007 Nuclear  
17 Science Advisory Committee Long Range Plan—concluded that such a facility is a vital part of  
18 the U.S. nuclear science portfolio, complements existing and planned international efforts, and  
19 would provide capabilities unmatched elsewhere. The FRIB concept was developed to meet the  
20 goals of the studies, analyses, and recommendations conducted since the 1996 Nuclear Science  
21 Advisory Committee Long Range Plan first recommended the development of a next-generation  
22 nuclear structure and astrophysics facility as a high priority.

23

#### 1.1.1 Solicitation Process

24 DOE published a “funding opportunity announcement” (FOA) on May 20, 2008, seeking  
25 applications for the conceptual design and establishment of a particle acceleration facility—the  
26 FRIB—as a National User Facility (DOE 2008a). The applications received were subject to a  
27 merit review process conducted by a panel of world-renowned experts from universities, national  
28 laboratories, and Federal agencies. The appraisal included rigorous evaluation of the proposals  
29 based on the merit review criteria described in the FOA, presentations by the applicants, and  
30 visits by the merit review panel to the applicants sites. As a result of the peer review, MSU’s  
31 application was chosen for the award. MSU also offered a direct cost share to the project. In  
32 addition, DOE performed an environmental critique in accordance with NEPA’s DOE  
33 procurement, financial assistance, and joint ventures regulations (10 CFR 1021.216). The  
34 environmental critique concluded (based on the information disclosed in the proposals as well as  
35 DOE accelerator experience) that “the physical, environmental impacts identified for both of the  
36 applications would be minor and localized, and could be successfully managed to further reduce  
37 them, and hence, little discrimination between the applications was possible on an environmental  
38 basis.”

1 On December 11, 2008, MSU was selected to design and construct the FRIB (DOE 2008b).  
2 Following selection of the MSU proposal, an environmental synopsis (i.e., summary) of the  
3 information in the environmental critique was filed with EPA. This synopsis is presented in  
4 Appendix E.

5 A Cooperative Agreement with DOE was signed on June 8, 2009, establishing terms and  
6 conditions for the work to be performed (MSU 2009a). The agreement specifies the joint  
7 commitment by DOE and MSU to fund the construction of the FRIB, and as it is a DOE National  
8 User Facility, DOE' substantial involvement in the design, construction, and operation.  
9 Operation of the FRIB would be addressed in subsequent cooperative agreements.

### 10 **1.1.2 Technology**

11 The purpose of an accelerator in basic research is to accelerate ions, protons, or electrons to high  
12 speed and collide these beams of energetic particles with a fixed target (or sometimes another  
13 counter-rotating beam). By studying the products of these collisions, scientists can gain a better  
14 understanding of the properties of the atomic nucleus and the forces that keep it together.

15 Currently, the NSCL operates two superconducting accelerators (cyclotrons), the K500 and the  
16 K1200. The K500 was the world's first cyclotron to use superconducting magnets and the  
17 K1200 is the highest energy continuous beam accelerator in the United States. Using these and  
18 other related devices, scientists are able to create rare isotopes and learn more about the origins  
19 of elements in the cosmos. Coupling these two cyclotrons, accelerating the beam from the first  
20 machine in the second one, results in making even rarer isotopes and affords scientists the  
21 capability to better understand atomic nuclei. For example, these beams are also used to study  
22 the effect of cosmic rays on electronic devices in satellites, and on humans during long space-  
23 flight missions to Mars.

24 The function and scope of operations of the FRIB would be similar to those of the NSCL, but the  
25 FRIB would have substantially more power. The existing NSCL research program relies on an  
26 up to 200 megaelectron volts per unit atomic mass (MeV/u) coupled cyclotron driver accelerator  
27 with 1 to 2 kilowatts of beam power. The FRIB would be capable of 200 MeV/u energy for all  
28 species and higher energies for lighter ions, up to 600 MeV/u for protons, with up to  
29 400 kilowatts of beam power. This is made possible by the use of Superconducting Radio  
30 Frequency cavities.

## 31 **1.2 ENVIRONMENTAL REVIEW PROCESS**

32 The National Environmental Policy Act (NEPA) requires Federal agencies to examine the  
33 impacts of their proposed actions before decisions are made. Pursuant to NEPA, as amended  
34 (42 U.S.C. 4321 et seq.), and in accordance with the Council on Environmental Quality's  
35 Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500–1508) and  
36 DOE's implementing regulations (10 CFR 1021), DOE prepared an environmental critique and  
37 environmental synopsis during the solicitation process, and now has prepared this draft  
38 environmental assessment (EA). The objectives of this EA are to inform the public and

1 decisionmakers by:

- 2 • Stating the underlying purpose and need for the DOE Proposed Action to design,  
3 construct, and operate the FRIB
- 4 • Describing the Proposed Action and identify the alternatives that satisfy the purpose and  
5 need for DOE action
- 6 • Describing the baseline environmental conditions at the alternative site location
- 7 • Analyzing the potential indirect, direct, and cumulative impacts on the existing  
8 environment from construction, operation, and decommissioning the FRIB and from the  
9 No Action Alternative
- 10 • Comparing the impacts from implementation of the construction, operation, and  
11 decommissioning of the FRIB with those of the No Action Alternative
- 12 • Enabling DOE to determine whether an environmental impact statement (EIS) is required  
13 to fully understand the potential significant impacts associated with the Proposed Action

#### 14 **1.2.1 Public Involvement in Developing the Scope of this EA**

15 Scoping is a process in which the public, regulators, and other interested parties provide  
16 comments directly to a Federal agency on the scope of a NEPA document. Although scoping is  
17 generally associated with an EIS, DOE felt this enhanced public involvement opportunity would  
18 increase its ability to understand and, more importantly, address any public interest regarding the  
19 FRIB. This process was initiated by publication of a Notice of Intent (NOI) in the *Federal*  
20 *Register*. The NOI for this *FRIB EA* (74 FR 55221) was published on October 27, 2009, and  
21 initiated a 45-day public scoping period ending on December 11, 2009. The NOI, as published,  
22 is provided in Appendix A.

23 On December 31, 2009, President Obama stated “Today, my Administration will recognize  
24 NEPA’s enactment by recommitting to environmental quality through open, accountable, and  
25 responsible decision making that involves the American public.” In keeping with the Obama  
26 Administration’s commitment to an open NEPA process, DOE hosted a public meeting on  
27 November 11, 2009, on the MSU campus in East Lansing. Approximately 35 people attended  
28 this meeting at which DOE provided information on the Proposed Action and the NEPA process.  
29 Preceding the scoping meeting, MSU hosted an educational open house, also attended by  
30 approximately 35 people, and provided tours of the NSCL. At both events, attendees had the  
31 opportunity to view informational materials and discuss issues directly with DOE and MSU  
32 officials and subject matter experts.

33 At the scoping meeting, DOE gave a presentation and invited attendees to provide comments.  
34 Oral comments were recorded by a court reporter; written comments were also accepted. In  
35 addition, the public was provided with other methods to submit comments: e-mail, mail, toll-free  
36 fax, and a project website.

1 Ongoing dialogue with the public will continue as this *FRIB EA* undergoes public review and  
2 comment. A 30-day comment period is planned, during which a public meeting will be held,  
3 followed by another 30-day comment period on the draft finding of no significant impact  
4 (FONSI). This latter comment period will occur only if DOE determines that a FONSI is  
5 warranted. If significant impacts are determined by DOE and a FONSI cannot be reached, DOE  
6 will prepare an EIS.

### 7 **1.2.2 Public Comments on the Scope of this EA**

8 DOE received 21 comment documents during the scoping period in addition to the oral  
9 comments made by 11 individuals at the public meeting. When the comment documents and  
10 transcript were analyzed they yielded 112 comments categorized under the following issues:  
11 alternatives, design/construction/operation/decommission, human health and safety,  
12 infrastructure, NEPA process, regulatory compliance, socioeconomics, and other. A report  
13 entitled *Facility for Rare Isotope Beams Environmental Assessment Scoping Report*  
14 (DOE 2009a) was prepared. Each comment category from the report is summarized in the  
15 following paragraphs and a response is provided for each summary.

16 **Alternatives:** The majority of the commenters expressed their strong support for the FRIB to be  
17 constructed and operated on the MSU campus. One commenter favored the folded linear  
18 accelerator because it would make better use of the space and minimize the footprint. Another  
19 commenter suggested an area off campus to alleviate potential safety and health issues.

20 **Response:** Chapter 3, Section 3.1.1, of this EA describes the alternative under consideration.  
21 MSU's proposal only identified one location for the proposed FRIB, which would take  
22 advantage of the existing NSCL and is located in a previously disturbed area. However, the EA  
23 explores different configurations intended to demonstrate the bounding conditions. Chapter 3,  
24 Section 3.3, discusses alternatives considered but eliminated from further study.

25 **Design/Construction/Operation/Decommission:** Commenters expressed their support for  
26 constructing and operating the FRIB on the MSU campus because of the university's strong track  
27 record in managing the NSCL and high standards for protecting and enhancing the environment,  
28 including actively promoting "green" practices on campus. By way of comparison, many  
29 commenters pointed out that MSU routinely handles major construction projects worth millions  
30 of dollars and has demonstrated over time its ability to supervise a large, complex project such as  
31 the FRIB and operate it in a safe and environmentally sensitive manner.

32 One commenter voiced concern in securing the construction site because of its close proximity to  
33 undergraduate dorms and another was concerned about the heavy equipment necessary for  
34 construction. One commenter pointed out that there may be a temptation to minimize wall  
35 thickness in order to save money during construction, which could potentially result in the  
36 transmission of hydrogen-3, also known as tritium, to groundwater outside the tunnel walls.  
37 Further, a concern was raised regarding staff not adequately trained to work in an unsecured  
38 facility that operated at orders of magnitude higher power than the NSCL. Another concern dealt  
39 with low-level radioactive waste resulting from the eventual decommissioning of the FRIB.

1 **Response:** Chapter 3, Sections 3.1.4 and 3.1.5, describe the construction and operations  
2 envisioned for the proposed FRIB. Appropriate administrative and engineered barriers would be  
3 employed during construction and operation to ensure that all applicable Federal, state, and local  
4 environment, health, and safety laws, regulations, and permit requirements are met, including  
5 adherence to MSU’s “Be Spartan Green” campaign and commitment to environmental  
6 stewardship. Security considerations will also be met. Decommissioning is addressed in Section  
7 3.1.6 and, if necessary, further NEPA review would be implemented at the time  
8 decommissioning commences.

9 **Human Health and Safety:** MSU President Lou Anna Simon has committed to ensuring that  
10 the FRIB is designed, constructed, and operated in such a manner that it maintains the NSCL’s  
11 excellent environmental and safety record by continuing the MSU ALARA program. The  
12 FRIB would be designed and operated following the same strategy of radiation safety  
13 management that has been successfully used at the NSCL. That strategy is to: 1) abide by all  
14 limits and license commitments, 2) maintain individual and collective doses as low as reasonably  
15 achievable, and 3) manage the facility consistent with MSU and FRIB safety management  
16 practices (currently certified Internal Organization for Standardization (ISO) and Occupational  
17 Health and Safety Assessment Series (OHSAS) programs). The strategy has been effective for  
18 the NSCL and would also be effective for the FRIB. For NSCL, incidents and near-misses since  
19 the institution of the current NSCL certified ISO 9001 (Quality Management Systems), ISO  
20 14001 (Environmental Management Systems) and OHSAS 18001 (Occupational Health and  
21 Safety Management Systems) programs have been localized and were not considered to pose  
22 significant hazards to personnel, the public, or the environment. Potential health and safety  
23 impacts are presented in Chapter 5, Section 5.1.9.

24 Accident conditions (including radiological) are initially analyzed as part of the development of  
25 a conceptual design, which is ongoing for the FRIB. These analyses continually evolve as the  
26 design effort progresses to ensure all credible hazards are evaluated and appropriate controls are  
27 included in the design to safeguard the public, FRIB personnel, environment, and FRIB mission.  
28 For the FRIB, hazards that have been identified include electrical and chemical hazards, non-  
29 -ionizing radiation (lasers), and waste handling, as well as ionizing radiation, oxygen--deficient  
30 atmosphere, and cryogenic hazards for the accelerator, target building, and support systems. The  
31 design and operational controls being included in the FRIB design are intended to provide a  
32 robust level of protection against these postulated events and provide protection for the public,  
33 FRIB workers, and environment. Based on the experience of other accelerator facilities, the  
34 evaluations presented in Chapter 5, Section 5.1.9, and Appendix C, and MSU’s commitment to  
35 environment, safety, and health related administrative limits for the FRIB, it is expected that the  
36 health and safety risk from foreseeable accidents can be managed at acceptably low levels  
37 through the facility design process and control of operations.

38 **Response:** The FRIB would be designed and constructed using modern technology and  
39 materials, and operated by trained staff to ensure protection of human health and the  
40 environment in accordance with all applicable Federal, state, and local laws, regulations, and  
41 permits. Potential health and safety impacts are presented in Chapter 5, Section 5.1.9.

42 **Infrastructure:** Several commenters pointed out that there was ample infrastructure available in  
43 the form of office space and plots to build homes to accommodate the expected ancillary

1 business and house the new employees and their families. One commenter was concerned about  
2 the associated noise, vibrations, and potential fluctuations in utilities, particularly water and  
3 electricity, during construction and operation of the FRIB and its effect on sensitive experiments  
4 conducted on campus.

5 **Response:** Chapter 5, Section 5.1.12, discusses the potential need for office and housing as it  
6 relates to the construction and operation of the FRIB. Chapter 4, Sections 4.6 and 4.7, describe  
7 the ambient noise situation and current infrastructure requirements to support the MSU campus;  
8 Chapter 5, Sections 5.1.6 and 5.1.7, the potential impacts regarding the FRIB. While construction  
9 would likely increase noise levels due to equipment and vehicles, routine and special mitigation  
10 measures would be employed to ensure the impacts are within acceptable limits. Likewise, any  
11 needed infrastructure improvements to ensure service reliability on campus would be identified  
12 in accordance with the final facility design.

13 **NEPA Process:** While one commenter reviewed available material and agreed with DOE's  
14 approach to preparing an EA because the impacts are expected to be small, another commenter  
15 wanted an EIS to be prepared. One commenter commended DOE for the detailed and thorough  
16 NEPA process it has undertaken regarding the FRIB project.

17 **Response:** Based on DOE's environmental critique and taking into consideration previous  
18 experience from the construction and operation of linear accelerators and the current conditions  
19 at the proposed site on MSU's campus, DOE believes the environmental impacts would be small  
20 and thus determined an EA is appropriate. However, because of the potential for public interest,  
21 DOE has decided to engage in more public outreach during this EA process, similar to what is  
22 normally performed during an EIS process. Early on, DOE implemented an open process for  
23 determining the scope of issues to be addressed, as well as identifying any significant issues  
24 related to the Proposed Action. This EA is being developed to ascertain whether construction or  
25 operation of the FRIB has the potential to significantly affect the environment. If the conclusion  
26 of this EA is that significant impacts are likely, an EIS will be prepared so those impacts can be  
27 fully delineated.

28 **Regulatory Compliance:** Several commenters made note of MSU routinely being recognized  
29 for its environmental stewardship and the NSCL's receiving ISO and OHSAS certifications of  
30 registration regarding environmental management, and health and safety management systems.  
31 It was also pointed out that organizations and activities at MSU abide by all state and university  
32 requirements to ensure that contractors, vendors, employees, and subcontractors comply with  
33 environmental regulations.

34 **Response:** As noted in Chapter 3, Section 3.1, the NSCL is regulated by the State of Michigan,  
35 U.S. Environmental Protection Agency, U.S. Department of Transportation, U.S. Department of  
36 Labor, and U.S. Nuclear Regulatory Commission. It also is registered under ISO 9001 (Quality  
37 Management Systems), ISO 14001 (Environmental Management Systems), and OHSAS 18001  
38 (Occupational Health and Safety Management Systems) and was recognized for its best-in-class  
39 safety record. Like the NSCL, the FRIB would also be regulated, certified, and registered by  
40 these agencies and organizations.

1 **Socioeconomics:** Many commenters enumerated the benefits of having the FRIB built and  
2 operated in their community, from bringing jobs that would stimulate the area’s economy and  
3 ensuring Michigan students are exposed to the most advanced nuclear research in the world, to  
4 the potential of transforming Michigan from the epicenter of the Rust Belt to a powerhouse of  
5 innovation, entrepreneurship, and vitality. Another commenter surmised that the FRIB would  
6 increase connectivity across a multitude of government and educational institutions and advance  
7 knowledge, transform lives, and allow important contributions to be made in areas that have yet  
8 to be discovered.

9 **Response:** Temporary jobs would be created during the construction phase and permanent jobs  
10 upon completion of the Proposed Action as discussed in Chapter 5, Section 5.1.12. Because  
11 many jobs at the FRIB would be highly specialized, it is expected that many of the new  
12 employees would relocate to the area from elsewhere in the country. In addition, both household  
13 spending by these new residents and the operations of the FRIB from the anticipated draw of up  
14 to 1,000 national and international users are expected to create job opportunities that would be  
15 filled by the local labor force. In addition to the users, 160 direct and 214 indirect jobs would be  
16 created. See Section 5.1.12.

17 **Other:** A commenter requested that a scoping summary report be posted to the project website.

18 **Response:** The *Facility for Rare Isotope Beams Environmental Assessment Scoping Report*  
19 (DOE 2009a) was posted on the FRIB project website at <http://www.frib.msu.edu/NEPA/>.

20

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK

1  
2

## CHAPTER 2 PURPOSE AND NEED

3 The purpose of the Proposed Action—design, construct, and operate the Facility for Rare Isotope  
4 Beams (FRIB)—is to support the U.S. Department of Energy’s (DOE’s) mission to advance our  
5 basic understanding of science. The purpose of the Proposed Action is consistent with the  
6 outcome of DOE’s procurement process for the design, construction, and operation of a particle  
7 acceleration facility.

8 The mission of the Office of Nuclear Physics in DOE’s Office of Science is to discover, explore,  
9 and understand all possible forms of nuclear matter. The Office of Nuclear Physics supports  
10 experimental and theoretical research; builds and operates world-class scientific user facilities  
11 such as particle accelerators; and develops advanced technologies to create, detect, and describe  
12 the different forms and complexities of nuclear matter that can exist in the universe, from its  
13 infancy to the present.

14 As noted in Chapter 1, Section 1.1, DOE determined that the establishment of the FRIB is a high  
15 priority for the future of U.S. nuclear science research. Future research will require driver beams  
16 one to two orders of magnitude more powerful than currently available, a greater variety of  
17 production techniques, more efficient and rapid delivery, and the ability to quickly stop and re-  
18 accelerate beams.

19 The development of the FRIB would establish a highly sophisticated research laboratory that  
20 would produce intense beams of rare isotopes. These beams would enable scientists to study the  
21 nuclear reactions that power stars and generate the elements found on Earth; explore the structure  
22 of the nuclei of atoms, which form the core of all matter, and the forces that bind them together;  
23 test current theories about the fundamental nature of matter; and play a role in developing new  
24 nuclear medicines and other societal applications of rare isotopes. Scientific research at the  
25 FRIB holds the promise to vastly expand our understanding of nuclear astrophysics and nuclear  
26 structure.

27

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK

1 **CHAPTER 3**  
2 **DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES**

3 The *Environmental Assessment for DOE Funding of the Construction and Operation of the*  
4 *Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan (FRIB EA)*  
5 evaluates two alternatives. These alternatives include the No Action Alternative and the  
6 Proposed Action—the design, construction, and operation of the Facility for Rare Isotope Beams  
7 (FRIB) adjacent to and ultimately encompassing the National Superconducting Cyclotron  
8 Laboratory (NSCL) on the Michigan State University (MSU) campus. The design for the FRIB  
9 is still in the conceptual design phase and a variety of technical and configuration options are still  
10 being considered. Thus, the final design and schedule as ultimately approved for construction  
11 may differ from those discussed in the EA.

12 As it is still early in the design phase of the FRIB, the description in this *FRIB EA* attempts to  
13 present a range of configurations that would provide a reasonable “bound” of the environmental  
14 impacts of constructing, operating, and decommissioning the FRIB. Hybrid configurations or  
15 entirely different configurations which may ultimately be selected would be expected to  
16 substantially reflect and bound the environmental impacts from the configuration options  
17 identified/analyzed in this EA. In the event the projected environmental impacts would exceed  
18 impacts identified, this EA would be modified to reflect that configuration and it would again be  
19 circulated for comment prior to any decision being made. In the event that the configuration  
20 design changes such that it is no longer bounded by the parameters in this EA, a new NEPA  
21 review will be performed to determine if the environmental impacts would be significant.

22 **3.1 DESCRIPTION OF THE PROPOSED ACTION**

23 The U.S. Department of Energy’s (DOE’s) role in the Proposed Action is funding and other  
24 substantial involvement in the construction and operation of the FRIB as a National User  
25 Facility. The “*funding opportunity announcement*” indicates: “the Department of Energy’s  
26 Office of Science recognizes that effective management of scientific facilities, programs, and  
27 projects is critical to the success of research and the achievement of project goals. It is essential  
28 that the FRIB have well-designed management plans for the establishment of the facility in order  
29 to successfully contribute to the Nuclear Physics program, the Office of Science, and the DOE  
30 mission. In common with other major Office of Science supported programs, the FRIB will be  
31 subject to regular and rigorous peer review of its scientific goals, project performance, and  
32 management structure, policies, and practices. MSU would manage the Facility.” DOE would  
33 have substantial involvement.

34 As described in more detail below, the FRIB project includes construction buildings and/or  
35 building additions for a heavy ion/proton accelerator and ancillary laboratories, support facilities,  
36 and offices. Construction would be adjacent to the existing NSCL, which would ultimately be  
37 incorporated into the FRIB.

38 DOE’s “*funding opportunity announcement*” for the FRIB established the following minimum  
39 parameters: “the minimum technical specifications of the FRIB are that the facility be based on  
40 a 200 MeV/u, 400 kW superconducting heavy-ion driver linac. The initial capabilities of the

1 FRIB should include fragmentation of fast heavy-ion beams combined with gas stopping and  
2 reacceleration. The technical scope should include necessary facilities and equipment for the  
3 establishment and operation of the FRIB, including driver linac and switchyard, target facilities,  
4 cryogenics facilities, gas stopper, fragment separator(s), radioactive ion beam (RIB) post  
5 accelerator, experimental areas and instrumentation that will allow the community of facility  
6 users to shed light on important scientific issues.” (DOE 2008a)

7 FRIB would provide research opportunities for an international community of approximately  
8 1,000 scientists, postdoctoral associates, and graduate students. The research conducted at the  
9 FRIB would involve experimentation with intense beams of rare isotopes—short-lived nuclei not  
10 normally found on Earth—that would enable researchers to address innovative scientific  
11 questions in nuclear structure and nuclear astrophysics. Operation may result in low levels of  
12 activation of air and groundwater, which MSU intends to manage according to U.S. Nuclear  
13 Regulatory Commission (NRC) license requirements and U.S. Environmental Protection Agency  
14 (EPA) regulations. Doses to workers and members of the public are anticipated to be less than  
15 one-tenth of NRC and EPA radiation protection standards. Physical hazards to workers will be  
16 regulated by the State of Michigan Occupational Safety and Health Administration (MIOSHA).

17 Table 3–1 identifies the estimated timeline for construction and operation of the FRIB. Dates are  
18 believed to be accurate within 2 years, however, depending on authorized budget profiles and  
19 Congressional allocations, they could change substantially more.

20 **Table 3–1. Estimated Timeline for Construction and Operation**

---

Design (all phases)	2009 through 2013
Construction (some overlap with design and preoperational testing)	2012 through 2016
Preoperational testing (if applicable)	2016 through 2019
Normal operation	2019 through 2049

---

21 **3.1.1 Accelerator Configuration Options**

22 The structures that would house the accelerator would be thick-walled, reinforced concrete  
23 structures. The linear accelerator (linac) would be located in a tunnel below ground. A trench  
24 up to 1,800 feet (550 meters) in length (varying between 30 and 75 feet [9 and 23 meters] below  
25 grade) would be excavated for the accelerator, necessitating the closure of Bogue Street between  
26 Wilson Road and Shaw Lane for up to 3 years and possible closure of portions of Shaw Lane for  
27 a number of months. More compact versions of the accelerator with shorter lengths are also  
28 considered as technical options. Regardless of configuration, the high-energy end of the  
29 accelerator and target facilities building would join with the existing NSCL building. The site

1 where the FRIB would be located has been previously disturbed from prior construction on the  
2 MSU campus. Like the NSCL, the FRIB would be licensed by NRC and registered with the  
3 State of Michigan Department of Community Health. The combination of below-grade  
4 construction and thick-walled concrete and steel would shield the environment from the  
5 accelerator.

6 Figure 3–1 illustrates the straight linear accelerator FRIB configuration option that could be built  
7 as part of the Proposed Action. Another comparable layout may ultimately be chosen to be  
8 constructed. However, the main structures in any layout are:

- 9 • A front-end building. A belowground facility would house the ion sources and support  
10 equipment at the low-energy end of the linac.
- 11 • Underground linac tunnels between the front end building and the switchyard
- 12 • Switchyard to connect the linac to the target facility
- 13 • Underground target facilities on the south side of the NSCL near Wilson Road
- 14 • A south high bay extension and connector high bay between the NSCL and the high bay  
15 extension
- 16 • An experimental area addition to the east end of the NSCL, similar to current  
17 experimental areas
- 18 • Research infrastructure including: fragment separator, gas stoppers, reaccelerator, and  
19 experimental areas.
- 20 • A new liquid helium production building (cryoplant), similar to the current cryoplant, but  
21 with a larger capacity to produce liquid helium
- 22 • Airborne confinement system for treating and otherwise managing potentially  
23 contaminated air, including elevated stacks
- 24 • Supporting infrastructure



1

2

3

**Figure 3–1. Potential FRIB Configuration: Straight Linear Accelerator Configuration Option**

4

5

6

These components are discussed in more detail in Section 3.1.2. The actual orientation and location of the various components may change slightly as part of the design process, as is discussed in section 3.1.1.

7

8

9

10

11

12

13

Three basic configuration options for the linac are being considered during this EA process. These configuration options include a straight-linear accelerator configuration option, a folded accelerator configuration option with a partial surface facility across Bogue Street from the NSCL, and a double-folded accelerator configuration option with a folded linac south of the NSCL. Even though the final design has not been selected, the analysis of these three configuration options bounds the impacts from numerous possible hybrid and other configurations.

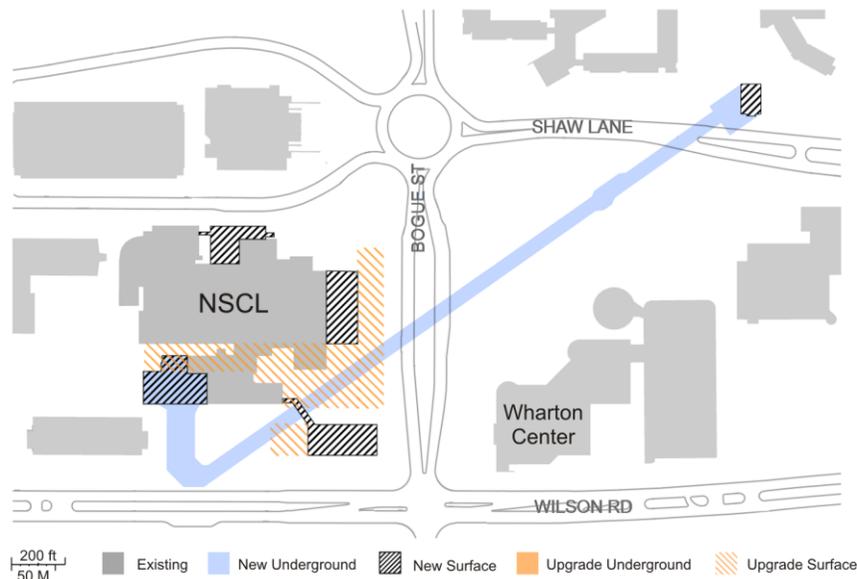
14

15

16

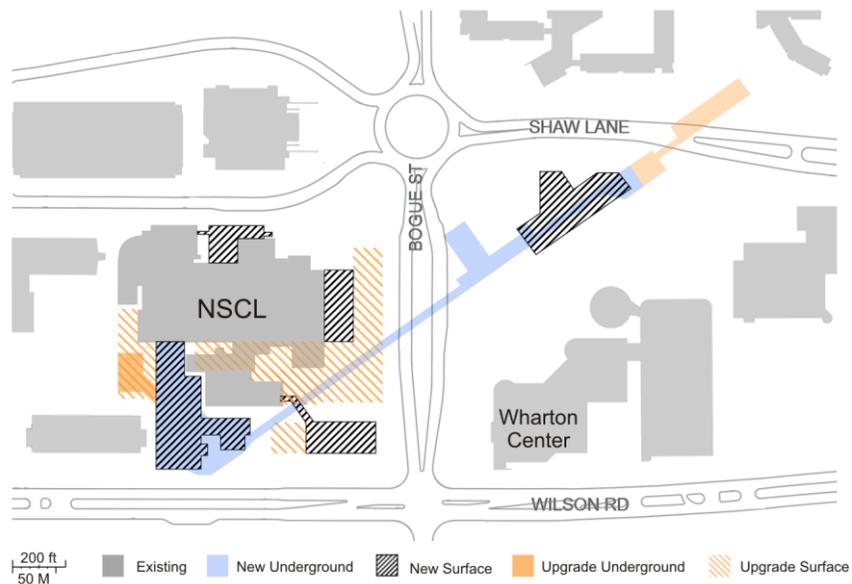
17

Under the straight-line configuration option, the low-energy end of the accelerator would be located in an existing grassy area across Shaw Lane near the McDonel Hall. An aboveground front-end building would connect to the underground tunnel at the low-energy end of the accelerator. This configuration option is illustrated in Figure 3–2.



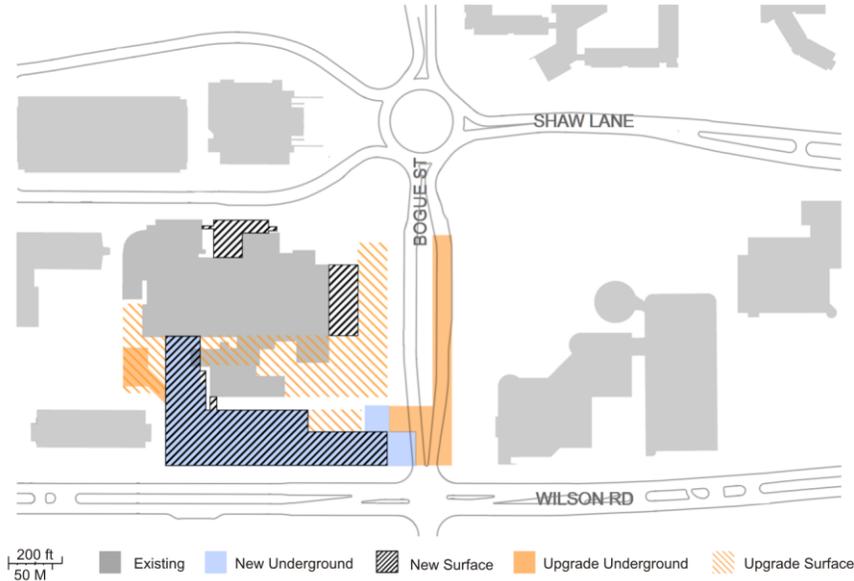
1  
2  
3  
**Figure 3–2. Proposed FRIB Location – Straight Linear Accelerator Configuration Option**

4 The folded linear accelerator configuration option would include a front-end building to be  
5 located on the southeast corner of Shaw Lane and Bogue Street in a future building site south of  
6 Shaw Lane. This configuration option is illustrated in Figure 3–3.



7  
8  
9  
**Figure 3–3. Proposed FRIB Location– Folded Linear Accelerator Configuration Option**

10 The double-folded linear accelerator configuration option would have a folded linac with the  
11 entire structure immediately south of the existing NSCL and north of Wilson Road. This  
12 configuration option is illustrated in Figure 3-4.



1  
2 **Figure 3–4. Proposed FRIB Location– Double-folded Linear**  
3 **Accelerator Configuration Option**

4 **3.1.2 Major Linear Accelerator Components**

5 As already stated in Section 3.1.1, the overall FRIB project would require construction of several  
6 structures to house the various components of the accelerator and supporting infrastructure.  
7 Because the design is still at the conceptual stage, the design details would likely change  
8 between the preliminary and final designs. The design details presented here should therefore  
9 only be considered conceptual. Important details such as beam power and beam energy are the  
10 same in all designs, as required by the project objectives. Details such as whether the linac is  
11 folded only change some details, such as tunnel length or front end building location, not  
12 whether they are needed. Where detailed numbers are presented, an attempt was made to present  
13 the “reasonable, bounding” estimate from the configuration options identified.

14 For the linear and both folded design configuration options, the key components could consist of  
15 the following facilities and systems.

16 **Front End Building**

17 The Front End Building will house the ion sources and the beginnings of the acceleration chain.  
18 Access to the concrete box-like linac tunnels from the Front End Building would be provided  
19 through access shafts constructed at the end of the linac tunnel farthest from the cyclotron  
20 building. This end structure may either be located north of Shaw Lane, with the linear  
21 configuration option, or constructed adjacent to the linac tunnel, with either of the folded over  
22 options.

23 **Accelerator Tunnel**

24 The Accelerator Tunnel houses the main accelerator components, including the linac. The tunnel  
25 could include construction of up to three underground enclosures (two linac enclosures and a

1 utility support enclosure). The tunnels could consist of enclosures for the linac and an enclosure  
2 for support conduits varying in length from approximately 500 feet up to approximately 1,700  
3 feet (150 meters to 520 meters) and could be constructed in a side-by-side or top-and-bottom  
4 configuration. In order to access the equipment at the NSCL building, one end of the parallel  
5 concrete box configuration would be located near the southwest corner of the existing cyclotron  
6 building. One box would house the FRIB linac, while the second box would house support  
7 equipment and provide access to the FRIB linac.

8 A second option includes construction of a single underground linac tunnel and an aboveground  
9 linac support building in lieu of an underground utility tunnel. This option would reduce the  
10 impacts of excavation for the facility.

### 11 **Target Building**

12 The Target Building houses the Beam Delivery System, the target and the fragment separator  
13 system (plus ancillary equipment). The target area shaft would be located near the southwest  
14 corner of the existing NSCL building, immediately west of the south high bay building. The  
15 target structure would be approximately 50 feet (15 meters) deep, up to approximately  
16 35,000 square feet (3,300 square meters) on the surface. The new target structure is expected to  
17 be located within approximately 20 feet (6 meters) of the existing biochemistry building. In  
18 addition, the target area would extend to the south where it would connect to the proposed  
19 conduits, within about 40 feet (12 meters) of Wilson Road. Key infrastructure including water,  
20 chilled water, sewer, steam tunnels, and electrical and telecommunications duct banks would be  
21 present.

### 22 **Cryoplant Expansion**

23 The Cryoplant Building house the liquid helium plant and ancillary equipment require to produce  
24 and maintain the cryogenic conditions necessary for the superconducting devices. In addition,  
25 current plans call for constructing a facility of about 4,000 square feet (370 square meters) on  
26 grade, with a possible second level for a utility support cryoplant expansion building. The  
27 cryoplant expansion building would be north of Wilson Road and west of Bogue Street for the  
28 linear and folded designs. For the double folded design, it would be part of the linac support  
29 structures north of Wilson Road. This facility would be constructed concurrently with the  
30 installation of the concrete box structures, and may be partially located over the box structures.

31 The FRIB superconducting elements require a refrigeration system (cryogenic plant) to cool  
32 down and maintain superconducting temperatures. The cryogenic plant would have a capacity of  
33 approximately 12.7 kilowatts (at 4.5 Kelvin) to ensure reliable operations. Additionally, the  
34 cryogenic plant cooling water capacity and building would be sized so that additional  
35 compressors could be added to increase capacity.

### 36 **Linac Airborne Confinement System**

37 The linac would be designed and operated in such a manner that any airborne radionuclides  
38 generated during both normal operations and accidents would be confined, controlled, and only  
39 released to the environment in a planned manner that would ensure that all regulatory  
40 considerations are met. In this manner, short-lived airborne radionuclides could be allowed to

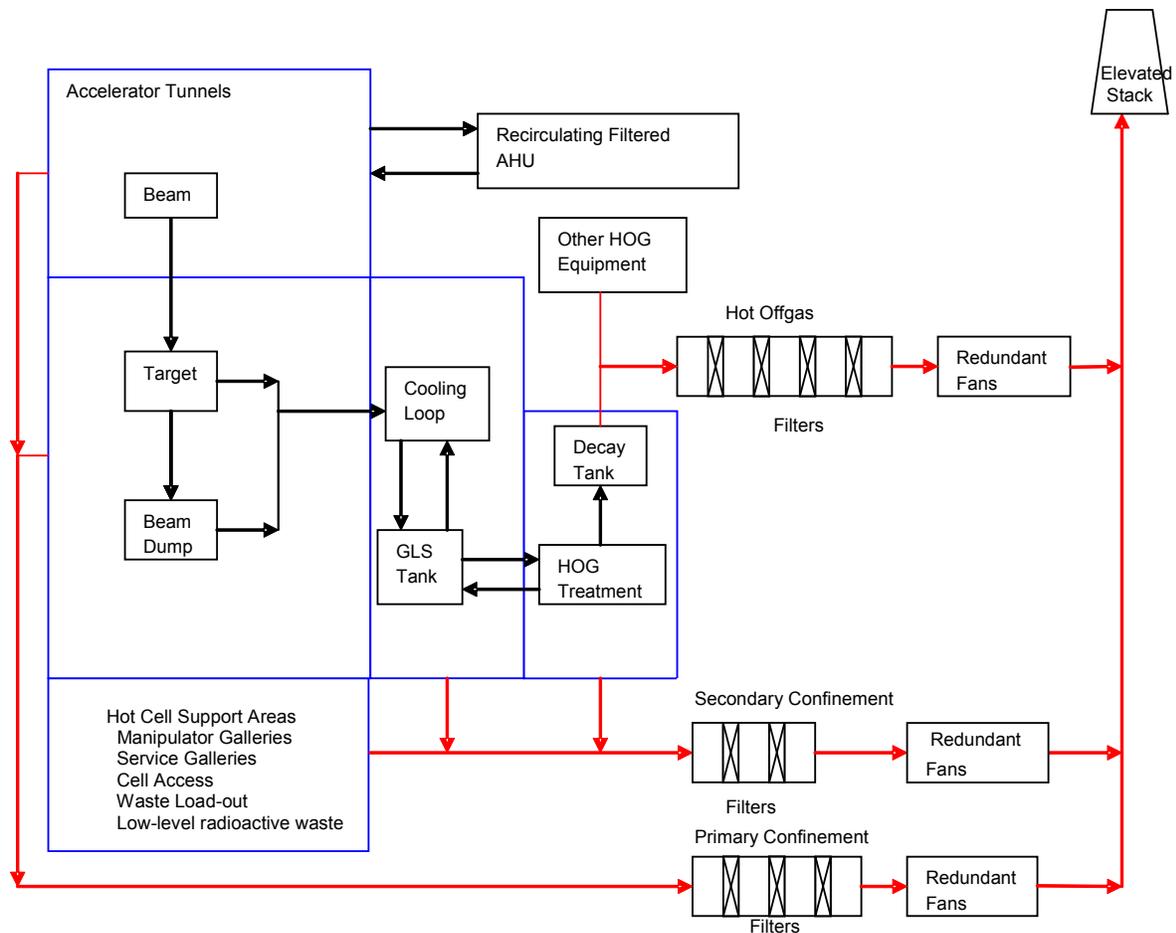
1 decay to harmless levels prior to release. MSU would design and install engineered barriers so  
2 that the FRIB would meet the as low as reasonably achievable (ALARA) goals. The systems for  
3 the two main areas, the linac and service area supporting the linac and the target area, would be  
4 treated separately.

5 Because the linac operation would activate the air in the tunnel, the facility would limit air  
6 exchanges between the linac tunnel and the surrounding environments. Additionally, the air in  
7 the tunnel would be circulated and filtered to remove significant radionuclides from the  
8 atmosphere. Before the tunnel air is exchanged or personnel enter the tunnel, a delay would be  
9 administratively provided to allow short-lived radionuclides to decay. Other than radioactive  
10 material, this process is used to manage other hazardous material such as ozone and nitrogen  
11 oxide that may be in the linac tunnel. These hazards are only applicable during and immediately  
12 following linac operation. During maintenance or other down times, without linac operation,  
13 these are not generated beyond negligible quantities.

14 The target would generate less air activation. Due to the much larger beam losses in the target  
15 area, this area contains local shielding that limits activation of the air. However, the potential for  
16 release of airborne radioactive material is higher in the target systems area than in the linac  
17 tunnel. A multi-confinement system approach for the target systems area currently in use at  
18 other accelerator facilities, or another approach, may be used to ensure emissions are within  
19 regulatory limits and MSU ALARA goals.

20 Ventilation requirements for the FRIB were estimated based on their counterparts at the NSCL  
21 and other accelerator facilities. A more-detailed source determination for the FRIB would be  
22 made to estimate the magnitude of potential releases and onsite and offsite doses from these  
23 releases before any final decision is made concerning the type of ventilation system required for  
24 the FRIB.

25 A conceptual design of the FRIB ventilation system for the target facility is presented in  
26 Figure 3–5. Airflow would be from areas with lower contamination risk into areas that have a  
27 higher contamination risk; therefore, three basic ventilation systems were assumed. These are  
28 primary confinement, secondary confinement, and hot offgas treatment. Concepts for these three  
29 systems are discussed below, along with their components, size requirements, and locations.



1  
2 **Figure 3–5. Conceptual Layout of a Proposed Ventilation System for the Target Facility**

3 The primary confinement exhaust (PCE) system for the Target Facility would consist of  
4 ventilation of primary confinement areas. Primary confinement areas are assumed to contain the  
5 maximum potential for contamination, for example, the target facility hot cell environment. The  
6 first component in the exhaust system would be a filter housing that would feed air to the PCE  
7 areas. The air would flow through the PCE area and exit through another bank of filters. For  
8 exhaust, air would flow from the filters through two redundant fans to an elevated stack located  
9 on a building roof. Care would be exercised to locate this exhaust point remotely from any  
10 building air intake structure. The primary filtration system (e.g., activated charcoal) will be  
11 identified during later design stages.

12 The secondary confinement exhaust (SCE) system would ventilate spaces containing equipment  
13 and systems. It would be maintained at a nominal negative pressure that would be adequate for  
14 confinement of facilities. Secondary confinement areas would be ventilated by a once-through  
15 ventilation system. Air would flow from the makeup air system into the SCE spaces, then to the  
16 filter trains co-located with the PCE filter trains, and then through redundant fans to the same  
17 elevated stack.

1 These PCE and SCE systems would principally interface with the cooling water loops. The  
2 water cooling loop that contains the most radioactivity is the one associated with a water-cooled  
3 beam dump considered for the FRIB. The anticipated dominant radioisotopes created in the  
4 water loops from a uranium primary beam are listed in Table 3–2. Depending on the primary  
5 beam used the set of isotopes created may be very different. It is anticipated that the purge gas  
6 would contain the first nine isotopes as well as hydrogen and moisture from the loop.

7 **Table 3–2. Volatile Radioisotopes produced by the Uranium Ion Beam**

<b>Isotope</b>	<b>Classification</b>	<b>Volatile</b>
Oxygen-14	Short-lived gas water spallation product	Yes
Oxygen-15	Short-lived gas water spallation product	Yes
Nitrogen-13	Short-lived gas water spallation product	Yes
Nitrogen-16	Short-lived gas water spallation product	Yes
Carbon-11	Short-lived gas water spallation product	Yes
Hydrogen-3 (tritium)	Liquid water spallation product	Yes
Xenon-133	Noble gas fission product	Yes
Iodine-131	Halogen fission product	Yes
Ruthenium-103	Volatile particulate fission product	Yes

8 Current design concepts for the hot offgas systems include an offgas treatment system to keep  
9 the volatile radionuclides confined within the system. Components that could be used include a  
10 copper oxide column to convert hydrogen in the offgas into water that is then fed back into the  
11 loop and a decay tank to allow short-lived radionuclides to decay prior to release. The effluents  
12 from the offgas treatment system, along with other hot-offgas-vented equipment such as vacuum  
13 pumps could be fed to a charcoal and HEPA filter train and from there to the elevated stack.

14 The FRIB would have one or more ventilation exhaust stacks. The current planned approach is  
15 to use a Strobic<sup>®</sup> style stack for airborne contaminants. The most likely locations for these  
16 stacks are the top of the cryogenic building and the target building/high bay. Specific locations  
17 would be defined based on the expected radiological isotopic releases. Noise would also be  
18 considered in placing the stacks. Stacks would be used for normal operation and for some  
19 accident conditions. For example, the required air exhaust would be different when operating the  
20 linac with personnel in the service tunnel and accessible portions of the experimental building  
21 than it would be when personnel are working in the linac.

## 22 **Supporting Infrastructure**

23 New 25-megawatt electrical lines would bring the power for the cryoplant and the radio  
24 frequency systems for the linac. An existing 14-megawatt gas turbine in the MSU Power Plant  
25 can provide 3 megawatts of power to the FRIB. The backup power generator would be sufficient

1 to keep the facility at 4 Kelvin for several hours or to warm it up in a controlled way. Water and  
2 sewer utilities adequate for the FRIB site would be provided as part of the MSU infrastructure.

3 Electrical distribution would be brought to the site from the campus utility plant and feed utility  
4 transformers, switchgear, and main distribution panels as required to meet the individual  
5 buildings' loads. Power would be supplied to the campus from either a commercial source or the  
6 existing MSU Power Plant. Subpanels would feed light fixtures, switches, receptacles, and  
7 equipment required to operate the buildings.

### 8 **3.1.3 Experimental Area and Research Infrastructure**

9 In addition to the accelerator components, the FRIB project includes facilities for the use of  
10 users, students, and staff, including office space, laboratories, and computers. Accommodations  
11 for short-term and long-term users would be made available.

12 The infrastructure required to accomplish the science goals of the FRIB is shown in Figures 3–1  
13 through 3–4. Existing NSCL offices, augmented by a new office wings contributed by MSU,  
14 would provide office space for staff and users. The current NSCL includes 189,390 square feet  
15 (17,594 square meters) of existing civil infrastructure.

16 Laboratory space would consist of about 164,000 square feet (15,000 square meters) of existing  
17 NSCL laboratory space, plus approximately 10,000 square feet (930 square meters) of space in  
18 the new experimental hall.

19 Assembly space for the linac components would be provided by an 11,000-square foot  
20 (1000-square meter) extension of the present south high bay. Class 100 (480-square foot  
21 [45-square meter]) and Class 10,000 (720-square foot [70-square meter]) clean rooms with  
22 high-pressure water rinse and chemical processing are available. Existing support space includes  
23 a full machine shop, detector laboratory, and target-making facility.

24 The present NSCL experimental and ancillary equipment would continue to be used once the  
25 FRIB linac becomes operational. The two cyclotrons would no longer be used to accelerate the  
26 primary stable ion beams, although there are plans for using the K1200 cyclotron as an  
27 accelerator for higher energy rare isotopes. The K500 could continue to be used to do accelerator  
28 physics experiments or may be decommissioned. Decommissioning would involve disposal or  
29 re-use of components.

30 Table 3–3 summarizes the approximate building characteristics of the existing NSCL and the  
31 new construction needed for the proposed FRIB.

1

**Table 3–3. Approximate Building Characteristics**

	Existing NSCL Facility/ Operations	FRIB Construction/and Operations <sup>a</sup>
Building area	189,390 square feet (17,595 square meters) including existing office space	Conceptual facility approximate size for both underground and above ground spaces: 200,000 gsf (19,000 square meters)
Circulation and immediate frontage roadway	1,600 linear feet (500 meters)	800 linear feet [restoration of roads disturbed by tunnel construction] 7,000 linear feet including temporary road for access to Wharton Center
Curb and gutter	6,000 linear feet (1800 meters)	
Stack or vent height(s)	The NSCL has a low stack for normal ventilation, but it is not designed as a contaminant discharge stack.	The FRIB would have a stack, but the location and height are not defined, but would likely be located on top of the high bay or the cryoplant building.

2

<sup>a</sup> Includes NSCL operations.

3

**Key:** FRIB=Facility for Rare Isotope Beams; NSCL=National Superconducting Cyclotron Laboratory.

4

**Source:** MSU 2010a

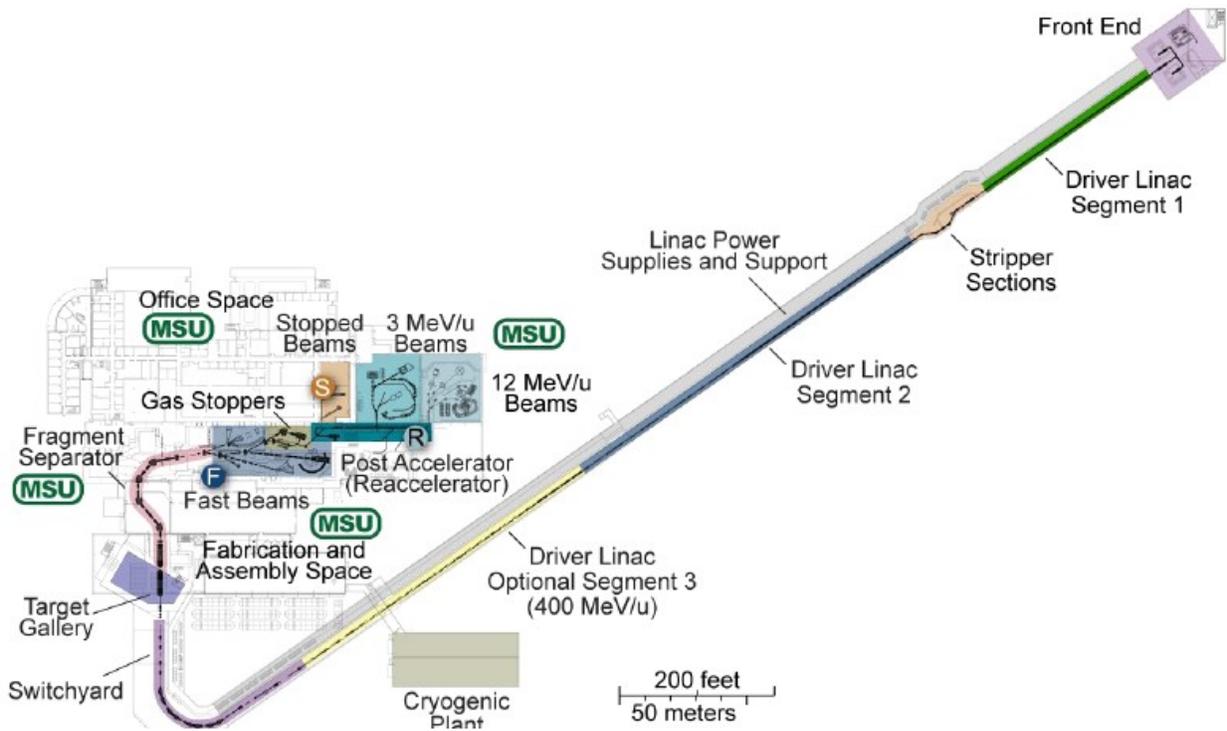
5

The possible facility layout is shown schematically in Figure 3–6. As part of the details outlined in the procurement MSU would share in the construction cost for the FRIB and make other, non-monetary contributions. Under the Proposed Action, MSU would furnish those portions of the FRIB labeled “MSU” in Figure 3–6. These portions are described in detail below.

6

7

8



9

10

**Figure 3–6. Block Diagram of the Facility for Rare Isotope Beams**

1    **Ion Source and Front End**

2    Electron cyclotron resonance ion sources developed in collaboration with Lawrence Berkley  
3    National Laboratory, and from the MSU Superconducting Source for Ions would produce the  
4    ions required for acceleration by removing multiple electrons to produce positive ions.

5    The ions would be transported in a low-energy beam transport system to a radio frequency  
6    quadrupole (RFQ) accelerator where the ions would be accelerated to about 2 percent of the  
7    speed of light. The medium-energy beam transport system would deliver the beam from the  
8    RFQ accelerator to Driver Linac Segment 1 at an energy level of 0.3 MeV/u, where the  
9    superconducting radio frequency cavities would take over the acceleration process.  
10    Superconducting technology would be used in the driver linac as it most efficiently achieves the  
11    100 percent duty factor operation needed to reach the required beam power. The driver linac  
12    (shown in segments in Figure 3–6) would meet intensity requirements by acceleration of  
13    multiple charge states, because the ion sources aren't capable of supplying the number of  
14    particles needed in a single charge state.

15    **Driver Linac and Stripper Sections**

16    Driver Linac Segment 1 would accelerate the beam to 17.5 MeV/u, or about 10 percent of the  
17    speed of light. At that point the ions need to have more electrons removed to provide more  
18    effective acceleration. Electrons would be removed in the stripper section when they pass  
19    through a thin layer of material. Following stripping in the stripping section, Driver Linac  
20    Segment 2 would accelerate up to five charge states to energies of at least 200 MeV/u for  
21    uranium with a beam power of 400 kilowatts. At this point the ions would be traveling at their  
22    full velocities of about half the speed of light. Driver Linac Segment 3 of the linac would  
23    initially have only focusing and diagnostic elements, with the possible addition of cryomodes  
24    to achieve 400 MeV.

25    The stripping system would be located between Driver Linac Segments 1 and 2 and would  
26    increase the downstream acceleration efficiency by increasing the charge state of the beam,  
27    because the energy gain is directly proportional to the number of electrons removed. It would  
28    consist of a stripper and an analysis section. Electrons would be removed from the beam ions by  
29    passing through a thin material such as a rotating-wheel carbon foil or other stripping method  
30    such as liquid metals, gas, or plasma. The material would be located at the object point of an  
31    achromatic and isochronous analyzing beam-line section used to remove unwanted charge states.  
32    The beam, consisting of many different ion charge states, would be focused so they all go  
33    through the stripper in the same place and same time. After the stripper, the different beams  
34    would be spread out for removal of unwanted charge states. Unwanted charge states would be  
35    removed by aperture slits at the dispersive midplane of the analyzing section; i.e., at the point  
36    where there is a physical separation between them so they can be caught on moveable plates. The  
37    compact design uses a second stripper to further increase the charge states. Local shielding and  
38    possibly remote handling systems would be used in this area to accommodate these controlled  
39    beam losses of about 20 percent of the beam power. The controlled beam losses would result  
40    from energy deposited in the stripper material and in the unwanted charge states. Simulations  
41    indicate that uncontrolled losses, losses due to particles straying from the central group, would be  
42    orders of magnitude less. The remaining analysis-system elements would bring up to five charge

1 states of uranium back to the linac axis in an achromatic and isochronous manner appropriate for  
2 acceleration in Driver Linac Segment 2. The beam would then be back in a tight group, ready for  
3 further acceleration.

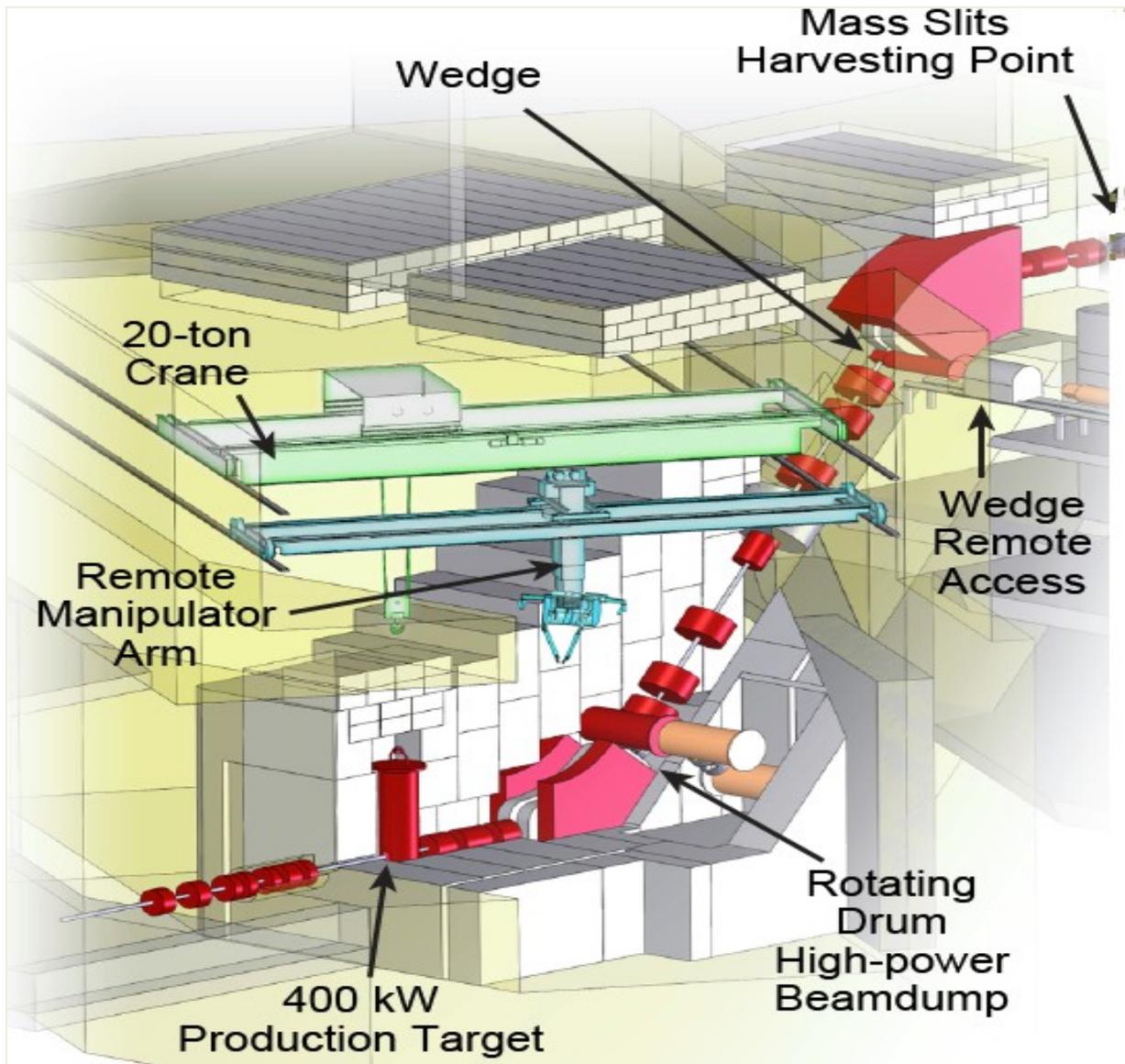
4 Space would be included in the linac design for extensive diagnostics. Beam-loss monitors  
5 would be placed along the linac to ensure that losses do not exceed 1 watt per meter. Non-  
6 intercepting beam probes, beam position monitors, would be placed between each cryomodule.  
7 At selected locations, longitudinal timing detectors would be included. For the entire length of  
8 the linac, a basic list of diagnostic elements and their locations would be established, and  
9 distances between components of the accelerating lattice would be chosen to accommodate the  
10 diagnostic elements. The many diagnostic elements would be used to assure the beam follows  
11 the prescribed path and does not end up in some place it's not supposed to be, like the vacuum  
12 tube wall.

### 13 **Beam Transport and Switchyard**

14 The beam transport system from the end of the linac to the production target (shown in  
15 Figure 3–6 as Segment 3 and the switchyard) would accommodate a beam energy of up to  
16 400 MeV/u for uranium of charge state  $79^+$  and correspondingly higher for lighter ions for a  
17 possible future upgrade. For reference purposes, the  $79^+$  charge state means there are only  
18 13 electrons remaining around the nucleus.

### 19 **Target Building**

20 The rare isotope beam production systems would consist of the high-power production target and  
21 a fragment pre-separator with its high-power beam dump. It is expected that remote handling  
22 capability would be required to assist target changes and frequent maintenance tasks. A possible  
23 conceptual design for the equipment in the target building is presented in Figure 3–7. Shielding  
24 would be designed such that radiation produced by the high-energy beam from the driver linac  
25 interacting with the production target and beam dump would be kept below ALARA goals for  
26 personnel and the public. Different production targets are likely to be required to be able to  
27 provide a wide range of rare isotopes for science with FRIB. In addition to a carbon-based solid  
28 target a liquid lithium target may also be used. To accommodate the latter the system would be  
29 designed such that in the case of accidental in-vacuum water leaks lithium water reactions do not  
30 occur or can be kept under control. Beam dumps may include water-cooled and gas-cooled  
31 dumps as well as liquid-metal-based dumps. Design of this system would be such that high-  
32 activity waste would be minimized. Remote handling of highly-activated components would  
33 ensure safe and efficient operation and minimum radiation exposure to personnel.

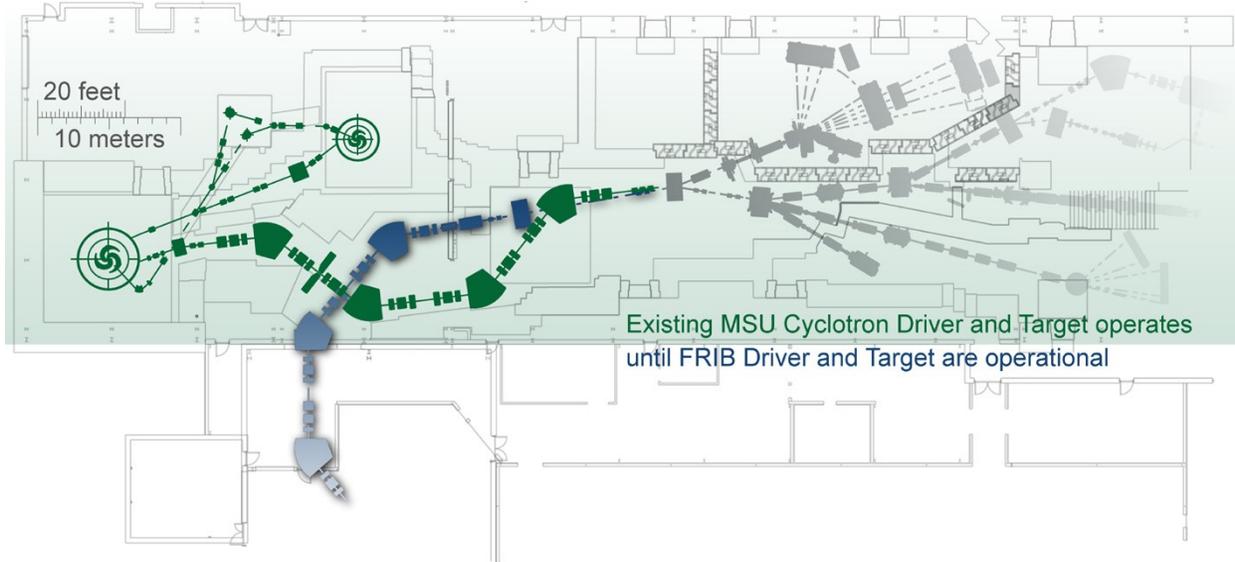


1  
2  
3  
4  
5  
6

Figure 3–7. Target Building and Installed Components

### Experimental Areas

Figure 3-8 illustrates both the existing NSCL cyclotron driver and experimental areas (in green) and how the FRIB fragment separator would be connected to the existing experimental area once operational.



1  
2 **Figure 3–8. Existing National Superconducting Cyclotron Laboratory Experimental Areas**  
3 **with a Concept of the Change Necessary to Incorporate the Facility for Rare Isotope Beam**

#### 4 **Other Technical Design Options and Configurations**

5 Many aspects of the FRIB design are still at the conceptual design stage. Therefore, some of  
6 technical features of the design may still change. For example, alternatives to the front end of  
7 the accelerator are still under consideration. Alternatives to the experimental areas being  
8 considered, including alternative geometries for the target facility, include shielding, remote  
9 handling systems, and other infrastructure appropriate for a particle fragmentation target capable  
10 of not only the baseline facility specifications, but also the upgraded 400-kilowatt beams from  
11 implementation of Segment 3 of the linac. Alternative concepts for the particle fragmentation  
12 separator layout are being considered, with safety performance being an important discriminator  
13 in the concept selection criteria. In addition, there is space sufficient to add additional targets in  
14 the future. The necessary space would either already be foreseen in the baseline target building  
15 or could be added as a separate target building at a later stage. A three-stage particle  
16 fragmentation separator layout with a horizontally oriented pre-separator is a technical option  
17 currently being studied. Different types of experimental equipment, based on input from the user  
18 community, may also be used.

#### 19 **3.1.4 Construction**

20 The description of potential construction activities in this *FRIB EA* attempts to "bound" the types  
21 of construction activities that might occur. Some details on construction methods that might be  
22 used would be decided by the construction contractor ultimately selected to build the proposed  
23 FRIB. The projected construction details presented in this section also attempt to "bound" the  
24 linac configurations under consideration. Most of the configuration options under consideration  
25 by the conceptual and preliminary design teams are not expected to substantially change the  
26 high-level details of the projected construction resources.

27 It is anticipated, with any of the configuration options, the aboveground structures would be  
28 conventional construction similar to the adjacent buildings on campus. This includes the

1 above-grade portion for the front end building, south high bay extension, cryoplant facility,  
2 connector high bay, experimental area addition, and the ventilation structures. Foundations  
3 would have spread footings; cast-in-place concrete walls and piers; concrete floor slabs; concrete  
4 masonry unit exterior walls with brick veneer to match the existing buildings; concrete masonry  
5 unit shaft walls; structural steel and steel framing; galvanized steel roofs, floors, and decks;  
6 single-ply roofing on rigid insulation; hollow metal doors and frames; drywall; and metal stud  
7 interior walls.

8 The plumbing systems would include minimal fixtures and toilet rooms throughout the new  
9 facilities. All estimates include emergency shower and eyewash equipment for the safety and  
10 protection of personnel in the facilities. Domestic water, where required, would connect to the  
11 existing campus water loop and provide point-of-use water heaters if needed. All structures that  
12 do not have a sloped roof would receive primary and secondary storm drainage systems.

13 The fire protection system in each building would consist of a connection to the site mains,  
14 backflow preventers, upright or sidewall heads, and all associated piping. A fully integrated fire  
15 alarm system that ties into the campus system would be provided at all buildings along with the  
16 extension of telephone and data conduits and cables throughout the buildings.

17 The heating, ventilation, and air conditioning system would consist of air handling units with  
18 steam heating and chilled water cooling. All buildings would be equipped with electric duct  
19 reheat coils and exhaust fans to meet the heating and ventilation loads. All grills, diffusers, and  
20 ductwork would be provided for a proper and complete air distribution system.

### 21 **Tunnel and Cryoplant Building**

22 The tunnel would be constructed in a conventional “open cut and cover” process with shoring to  
23 reduce the impact on adjacent structures as well as impacts of excavation. The tunnel would be  
24 cast-in-place concrete, encased in waterproofing and covered with compacted native materials.  
25 These native materials would be sorted on site or at the soil disposal area located south of the  
26 railroad tracks and north of East Mount Hope Road to create engineered fill. The proposed  
27 surface restoration would be similar to existing conditions.

28 Construction would require the use of approximately 15 acres (6 hectares) in the NSCL area,  
29 25 acres (10 hectares) at the soil disposal area, and an additional temporary laydown area.  
30 Excavated soils would be stockpiled either on the construction site or at the soil disposal area.  
31 The high water table would require well points placed strategically around the excavated areas to  
32 temporarily lower the water table. The groundwater would be filtered and discharged into the  
33 existing storm drainage system. Structural fill would be installed below the foundations along  
34 with a dewatering system. After the tunnel has the opportunity to cure, waterproofing material  
35 would be installed and the excavation would be backfilled and compacted.

36 The cryoplant building would be constructed concurrently with the tunnels. The new cryoplant  
37 building would be similar to the existing facility, only with a larger footprint. Construction  
38 would be typical of MSU utility and support buildings. Other aboveground facilities would be  
39 constructed as soon as a stable base can be provided. As the construction is completed,

1 landscaping would be restored, and the tunnels, target area, cryoplant building, and aboveground  
2 facilities would be turned over to MSU upon completion for installation of scientific equipment.

3 Site utilities, pedestrian lanes, and traffic lanes would be constructed or relocated to provide  
4 MSU faculty, staff, students, and visitors safe passage around the construction site and to provide  
5 for the continuous operation of the university. The utility relocations would be phased in order  
6 to minimize interruptions to existing facilities. A utility bridge over the proposed linac tunnel  
7 would be constructed. Earth retention systems would be installed to protect adjacent facilities  
8 and vegetation.

9 Table 3–4 summarizes the bounding parameters and characteristics of the construction of the  
10 FRIB.

11 **Table 3–4. Approximate Estimates of Construction Requirements**

<b>Material/Resource Requirements During Construction</b>	
<b>Surface water or groundwater (raw water)</b>	
Average usage	800 gallons per day (3,000 liters per day)
Peak usage	10,000 gallons per day (38,000 liters per day)
Total usage (gallons)	240,000 gallons (910,000 liters)
<b>Potable water</b>	
Average usage (gallons per day)	200 gallons per day (760 liters per day)
Peak usage (gallons per day)	800 gallons per day (3,000 liters per day)
Total usage (gallons)	240,000 gallons (910,000 liters)
<b>Electricity</b>	
Average usage per day	3,200 kilowatt-hours
Peak power usage	450 kilowatts
Total usage	960 megawatt-hours
Gasoline	27,500 gallons (104,000 liters)
Diesel fuel	161,000 gallons (609,000 liters)
Propane	12,000 gallons (45,000 liters)
Concrete	39,000 cubic yards (30,000 cubic meters)
Steel	6,100 metric tons
Crushed stone	3,000 cubic yards
Sand & Gravel	35,600 cubic yards (mostly excavated materials)

<b>Material/Resource Requirements During Construction</b>	
Asphalt	9,000 cubic yards
Lumber	12,000 board feet
	Concrete Cure and Seal – 3,500 gallons (13,000 liters)
Other materials	Concrete Admixtures – 9,500 gallons 6,000 (36,000 liters)
	Concrete Form Oil – 2,500 gallons (9,500 liters)

1 **Source:** MSU 2010a.

2 The construction would require excavation of approximately 325,000 cubic yards  
3 (248,000 cubic meters) of material. With the linear design configuration, the excavation would  
4 be generally 100 to 175 feet (30 to 55 meters) wide by 1,880 feet (570 meters) long. Tunnel  
5 construction is expected to require 24 months to complete.

6 The peak estimated workforce is 175 workers. Construction is estimated to require  
7 approximately 7,500 offsite truck trips for raw materials and supplies, 15,000 onsite truck trips  
8 for temporary storage and return of dirt removed during construction, 3,500 truck trips for  
9 nonhazardous waste disposal, and 10 rail trips for raw materials for facility construction.

10 During construction, bounding airborne emissions from construction-related activities include  
11 approximately 8,800 pounds (4,000 kilograms) per year of hydrocarbons, 66,000 pounds  
12 (30,000 kilograms) per year of carbon monoxide, 4,400 pounds (2,000 kilograms) per year of  
13 nitrogen oxides, and 1,260,000 pounds (570,000 kilograms) per year of carbon dioxide.  
14 Construction of the FRIB would be conducted using processes typical of MSU on-campus  
15 construction. Construction would be in compliance with all Federal, state, local, and university  
16 rules. Table 3–5 summarizes the bounding estimates of wastes that would be generated with  
17 construction of the proposed FRIB.

**Table 3–5. Approximate Estimates of Construction Wastes**

<b>Waste generated during construction</b>	
Solids (metric tons)	36 (All Michigan State University construction waste is recycled)
Liquids (metric tons)	12 (All MSU construction waste is recycled)
Waste Concrete	10 percent of total used in construction
Waste Steel	10 percent of total used in construction
Other	10 percent of total used in construction
<b>Nonhazardous liquids</b>	
Sanitary (cubic meters)	10,000 cubic meters
Other (cubic meters)	400,000 cubic meters for construction dewatering

Source: MSU 2010a.

### **3.1.5 Operations**

The function and scope of FRIB operations would be similar to those of the NSCL; however, the FRIB would have substantially more beam power. The existing NSCL research program relies on a 200 MeV/u coupled cyclotron driver accelerator with 1 to 2 kilowatts of beam power. The FRIB would be capable of a minimum of 200 MeV/u of energy for all ions and up to 400 kilowatts of beam power. A reaccelerator, with energy up to 12 MeV/u for uranium and up to 20 MeV/u for lighter ions, is also planned for the facility.

The NSCL has approximately 700 scientific users globally, 300 employees, and approximately \$20 million annually in National Science Foundation funding. The NSCL’s two coupled superconducting cyclotrons accelerate and fragment atomic nuclei for basic nuclear science experiments. Rare isotope beams are produced by primary beams with 1 to 2 kilowatts of power. The existing NSCL is, and proposed FRIB would be, regulated by the State of Michigan, EPA, U.S. Department of Transportation, U. S. Department of Labor, and NRC. In addition, the NSCL has an International Organization for Standardization (ISO) 9001-registered Quality Management System, an ISO 14001-registered Environmental Management System, an Occupational Health and Safety Assessment Series (OHSAS) 18001-registered Integrated Safety Management System, and a best-in-class safety record.

The NSCL would continue to operate approximately until the FRIB is completed as a National User Facility operated by MSU and funded by the National Science Foundation through a Cooperative Agreement. With the Proposed Action, the FRIB Project would establish the FRIB facility which would be a DOE Office of Science National User Facility operated by MSU funded through a Cooperative Agreement with DOE. Instead of two coupled cyclotrons as the basic particle accelerator currently being used at the NSCL, the FRIB would use a superconducting linac to accelerate and fragment atomic nuclei in basic nuclear science experiments. Rare isotope beams would continue to be made from primary beams, but the beam intensity could range up to 400 kilowatts of beam power. For some experiments, this would increase the intensity of the rare isotope beams by a factor of 400, greatly increasing the ability

1 to perform the scientific experiments and allowing for new experiments that could be done with  
2 the higher beam intensities. As with the NSCL, the FRIB would be regulated by the State of  
3 Michigan, EPA, the Department of Transportation, the Department of Labor, and NRC. It would  
4 have the same ISO and OHSAS registrations as the NSCL.

5 The principal difference between the existing NSCL and the proposed FRIB would be the linac  
6 as a new particle accelerator with which to perform the research. Many of the existing  
7 experimental facilities and areas would continue to be used. Under the current plans, research  
8 operations would continue at the NSCL while the construction activities supporting the FRIB are  
9 underway. Once construction is finished on the major facilities, installation and examination of  
10 the equipment would occur over several months. Operations at the NSCL would continue during  
11 most of this period. After installation of much of the equipment in the new facilities supporting  
12 the FRIB, a transition period would occur during which cyclotron operations at the NSCL would  
13 cease and transition to the linac operations would occur. The staffing levels of the fully  
14 operational FRIB would be higher than current NSCL levels. Preliminary estimates are that the  
15 facility operations staff would increase from 269 to 330, the daily number of visiting scientists  
16 would increase from 20 to 100, maintenance staff would increase from 30 to 40, and  
17 administrative support staff would increase from 22 to 30 (MSU 2010a).

18 The environment, safety, and health programs that are currently used at the NSCL and  
19 throughout the MSU campus would form the foundation for the FRIB programs. These include  
20 programs to protect the environment, minimize waste generation, prevent pollution, protect the  
21 FRIB workforce, and protect the MSU community.

22 The shielding design together with the radiation safety and security interlocks and search-and-  
23 evict procedures would ensure that no personnel or any members of the general public are  
24 exposed to any levels of radiation above the ALARA goals. Current regulatory limits require  
25 that NSCL workers receive exposures that are ALARA and less than 5000 millirem per year, and  
26 the general public receives less than 100 millirem per year or less than 2 millirem in any one  
27 hour. The design goal for anticipated exposure levels at FRIB conform to or are less than those  
28 permitted in the MSU NRC license and are consistent with the ALARA goals.

29 Radiological issues at the NSCL and the FRIB would fall under the MSU NRC broad scope  
30 license. As such the controls are typically implemented by NSCL staff with oversight by the  
31 independent MSU Office of Radiation, Chemical, and Biological Safety.

32 The FRIB would be managed in such a way as to maintain risks, exposures, and releases in  
33 compliance with applicable limits and ALARA goals.

34 The FRIB would follow the MSU ALARA program and be in accordance with limits for  
35 exposures, risks, and releases. As the design evolves, the FRIB safety needs would be compared  
36 with the NSCL practices and procedures to identify where changes are needed. Evaluation of  
37 and practices for control of any increased risks as compared to the current risks would be used to  
38 evolve the program.

39 Based on initial conservatively calculated activation products associated with FRIB operations,  
40 design allowances would be included to mitigate potential consequences for workers and the

1 public. For example, activities such as accelerator or target maintenance would be dependent on  
2 the details of the design built in to allow for removal of activated air to minimize potential  
3 exposure and abnormal impacts.

4 The FRIB would have a multi-tiered approach to radiological release confinement. Potential  
5 releases include gaseous releases from activated water, hydrogen-3 (also known as tritium) in the  
6 cryogenic helium, and activated air in the linac tunnel, among other possibilities. Releases of  
7 airborne contaminants could be expected from the linac tunnel and from cryogenic helium  
8 releases. Although releases of helium are not a normal operational condition, they are  
9 anticipated. Because the linac operation would activate the air in the tunnel, the facility would  
10 limit air exchanges between the linac tunnel and the surrounding environments. The FRIB  
11 would be designed to preclude uncontrolled releases of airborne radionuclides during normal  
12 operations and postulated accidents.

13 Applicable controls would be put in place to manage the isotope releases within the EPA's  
14 National Emissions Standards for Hazardous Air Pollutants (40 CFR Part 61) and limit the  
15 overall effective dose equivalent to less than 10 millirem per year. The conceptual design goal is  
16 to maintain the total dose limit to 1 millirem per year or less from the air pathway. These  
17 hazards would be only applicable during and immediately following linac operation. During  
18 maintenance or other times when the linac is not in operation, these would not be generated  
19 beyond negligible quantities.

### 20 **3.1.6 Decommissioning FRIB**

21 MSU expects the FRIB to be a long-term endeavor. The lifecycle of modern accelerators is  
22 approximately 30 years of operation. However, in the event that MSU decides not to continue the  
23 operation of the FRIB, either renovation or demolition of the facilities would be required. This  
24 could result in underground structures being decontaminated and buried in place and  
25 aboveground structures being removed or redeployed (MSU 2010a). Fill material would be  
26 required to fill in underground structures. The source of and quantity of fill material would be  
27 determined at the time of demolition. Environmental rules and regulations similar to  
28 construction of the FRIB would be applicable, including the National Environmental Policy Act  
29 (NEPA) if Federal agencies are involved with the process. All equipment within the structures  
30 would be expected to be removed and reused to the extent applicable. It is possible that some of  
31 the equipment would have become radioactive due to long-term irradiation and would be  
32 handled in accordance with MSU, NSCL, and FRIB standard practices and NRC regulations.

### 33 **3.2 DESCRIPTION OF THE NO ACTION ALTERNATIVE**

34 As required by the Council on Environmental Quality's implementing regulations  
35 (40 CFR 1502.14d), this *FRIB EA* considers a No Action Alternative to serve as a basis for  
36 comparison of the environmental impacts with the action alternatives. Under the No Action  
37 Alternative, the FRIB would not be constructed and operated at MSU and the scientific research  
38 proposed by DOE and others for the FRIB would be deferred or not performed. Operations at  
39 the NSCL would continue with funding from the National Science Foundation until NSCL  
40 becomes obsolete.

1     **3.3           ALTERNATIVES CONSIDERED BUT ELIMINATED**

2     Prior to the FRIB project, MSU had considered a south campus site for construction and  
3     operation of a rare isotope accelerator. That site, while technically possible, was rejected for a  
4     combination of technical, scientific, practical, and financial reasons (MSU 2006a).

5     As part of the procurement process, DOE considered only the NSCL site for which an  
6     application was received in response to the FRIB funding opportunity announcement (FOA).  
7     DOE published the FOA on May 20, 2008, seeking applications for the conceptual design, and  
8     establishment of a particle acceleration facility—the FRIB—as a National User Facility  
9     (DOE 2008a). The applications received were subject to a merit review process conducted by a  
10    panel of world-renowned experts from universities, national laboratories, and Federal agencies.  
11    The appraisal included rigorous evaluation of the proposals based on the merit review criteria  
12    described in the FOA, presentations by the applicants, and visits by the merit review panel to  
13    each applicant’s site. MSU’s application was chosen for award based upon the peer review  
14    results. MSU also offered a direct cost share to the project. In addition, DOE performed an  
15    environmental critique in accordance with NEPA’s DOE procurement, financial assistance, and  
16    joint ventures regulations (10 CFR 1021.216). The environmental critique concluded (based on  
17    the information disclosed in the proposals as well as on DOE accelerator experience) that “the  
18    physical, environmental impacts identified for both of the applications would be minor and  
19    localized, and could be successfully managed to further reduce them, and hence, little  
20    discrimination between the applications was possible on [an environmental] basis.”

21    On December 11, 2008, MSU was selected to design and construct the FRIB (DOE 2008b).  
22    Following selection of the MSU proposal, an environmental synopsis of the information in the  
23    environmental critique was filed with EPA. This synopsis is provided in Appendix E.

24    Based on this DOE selection process and environmental synopsis, no significant environmental  
25    impacts were expected from the design, construction, operation, and decommissioning of the  
26    FRIB at either the MSU NSCL or the other site. A decision, therefore, was made to prepare an  
27    EA for construction, operation, and decommissioning of the FRIB at MSU. Therefore, for  
28    purposes of this *FRIB EA*, the other site is not evaluated further.

29

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK

## CHAPTER 4 AFFECTED ENVIRONMENT

This chapter contains four types of information related to the Facility for Rare Isotope Beams (FRIB) project Area. This information includes:

- data on the status of important natural cultural, social, or economic resources and systems;
- data that characterize important environmental or social stress factors;
- a description of pertinent regulations, administrative standards, and development plans; and
- data on environmental and socioeconomic trends.

The information provides the context for interpreting the impacts from the construction and operation of the FRIB project, which are described in Chapter 5, Environmental Consequences. As such, it serves as a baseline against which any changes resulting from implementation of the Proposed Action can be identified and evaluated.

### 4.1 LAND USE

Michigan State University (MSU) was established in 1855 as the Agricultural College of the State of Michigan as a prototype for 69 land-grant institutions to be established under the Morrill Act of 1862. MSU was the first institution of higher learning in the United States to teach scientific agriculture (MSU 2009b).

MSU is located in East Lansing, Michigan, 3 miles (1.6 kilometers) east of Michigan's capitol, Lansing, Michigan. MSU is a 5,200-acre (2,100-hectare) campus including 2,100 acres (850 hectares) in existing or planned development and 553 buildings, 83 of which have instructional space. In addition, MSU owns 15,000 acres (6,000 hectares) throughout Michigan that are used for agricultural, animal, and forestry research (MSU 2009b).

The National Superconducting Cyclotron Laboratory (NSCL) is located in the southeastern section of the MSU campus. The NSCL is home to the Coupled Cyclotron Facility and receives strong funding support from MSU as well as from the National Science Foundation and the U.S. Department of Energy (DOE) (NSCL 2009).

The proposed facility would be constructed and operated adjacent to the existing NSCL in previously disturbed areas (see Figure 4-1 (project area indicated in red) or <http://maps.msu.edu/files/MSUcampus.pdf>). During construction, an existing soil disposal area located south of the railroad tracks, east of Farm Lane, and immediately north of East Mount Hope Road would be used (see Figure 4-1 (soil disposal area indicated in purple)). This 25-acre (10-hectare) site is an existing construction staging area within an area of undeveloped fields and has been used for numerous construction projects at MSU.

Draft Environmental Assessment for DOE Funding of the Construction and Operation of the Facility for Rare Isotope Beams, Michigan State University, East Lansing, Michigan

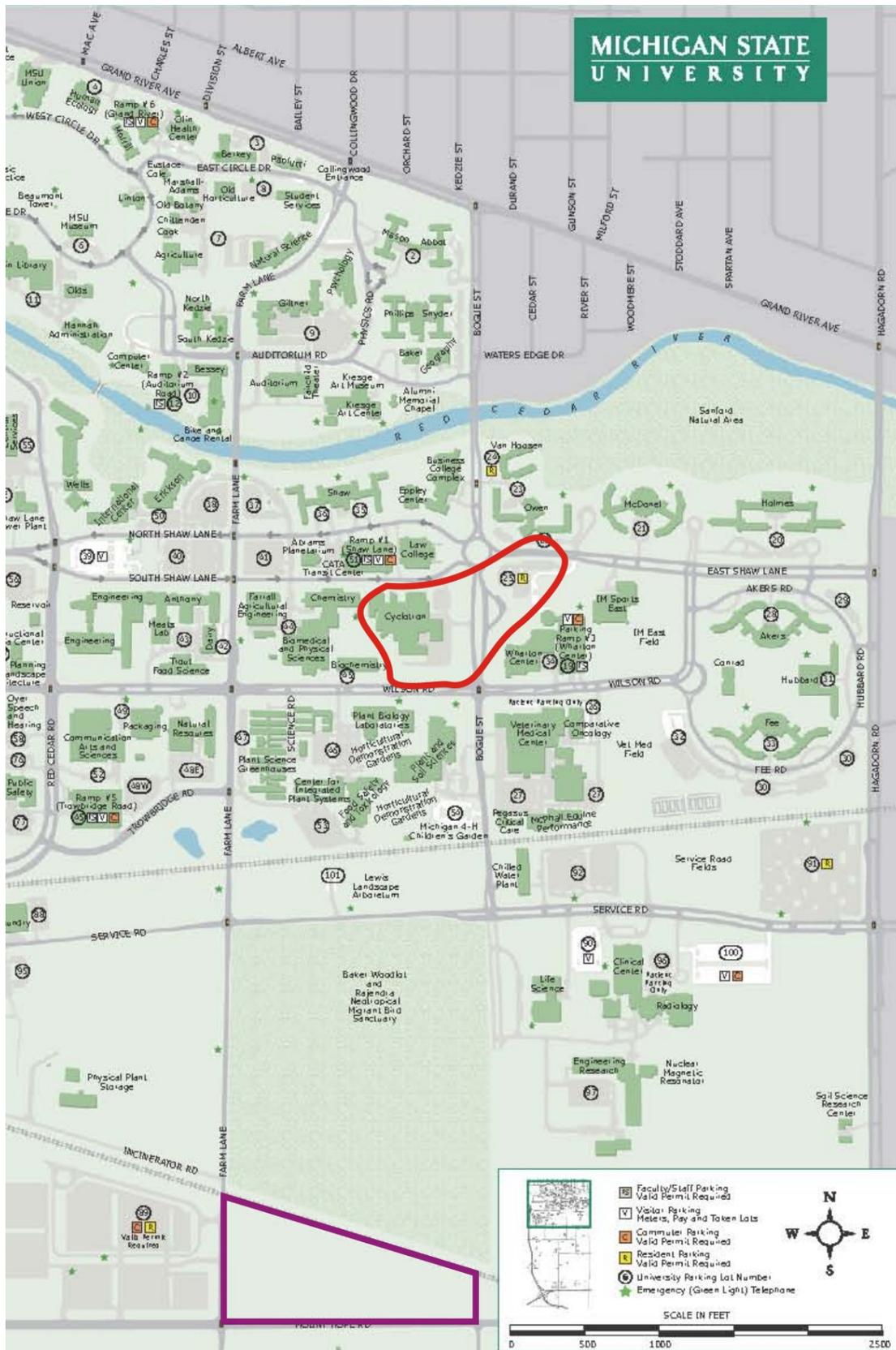


Figure 4-1. Project Location on Michigan State University Campus

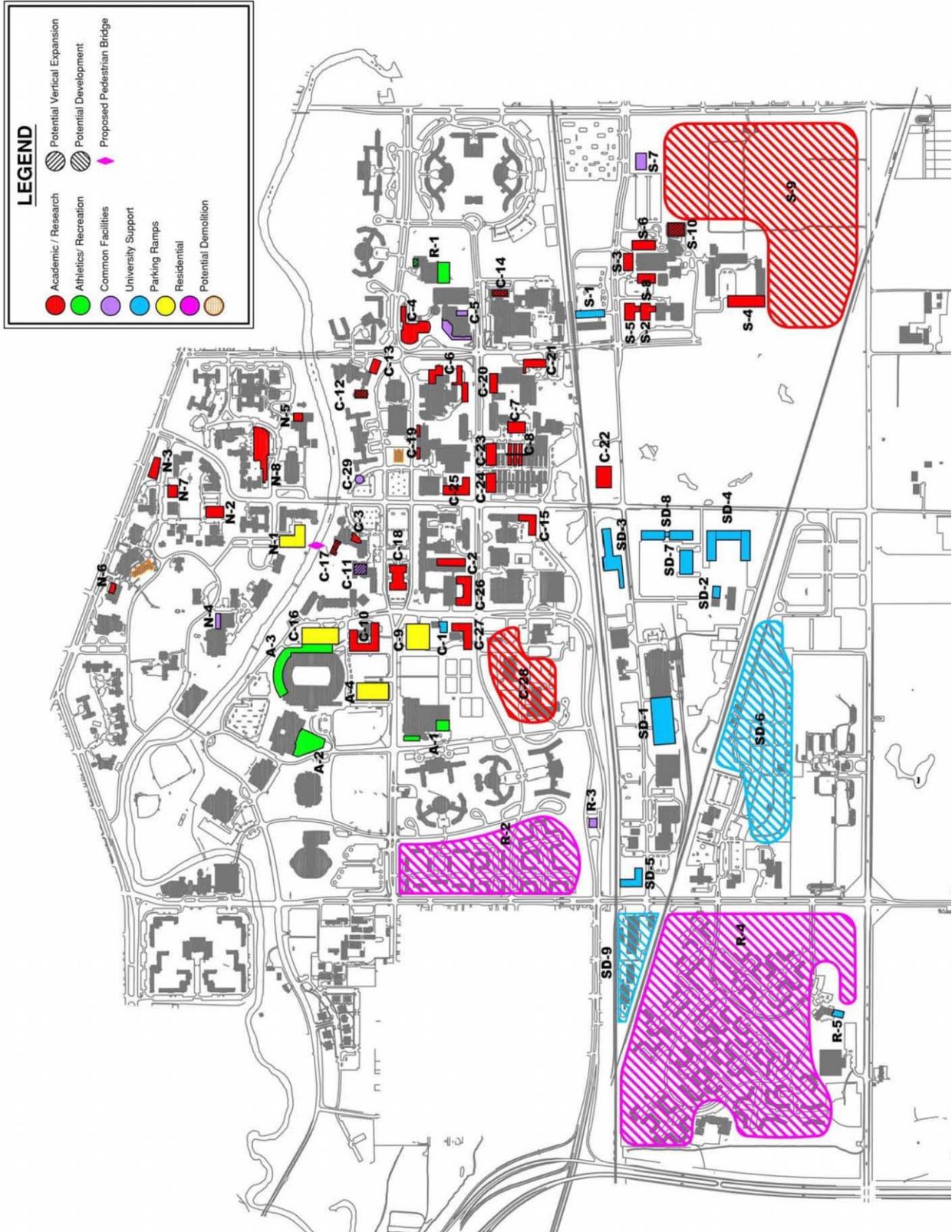
1  
2  
3

1 In December 2001, the MSU Board of Trustees adopted the Campus Master Plan (MSU 2007a).  
2 Since that time the university has built approximately 800,000 gross square feet  
3 (74,000 square meters) of new facilities with another 500,000 gross square feet  
4 (46,000 square meters) of facilities currently under construction. The Campus Master Plan has  
5 also resulted in numerous roadway reconstruction efforts that have positively redefined traffic  
6 patterns at the center of campus and significantly reduced injury accidents, as well as various  
7 enhancements to the open spaces on campus.

8 In 2007, the MSU offices of Campus Planning and Administration and Facilities Planning and  
9 Space Management completed a 5-year update of the Campus Master Plan (MSU 2007a). The  
10 purpose of the Campus Master Plan is to guide the long-term development of the MSU campus.  
11 The plan attempts to look forward 20 years with as much specificity as possible, while  
12 acknowledging that change will require flexibility to adapt within the context of the campus  
13 planning principles.

14 The plan serves as a decisionmaking tool, allowing planners and administrators to view each  
15 proposed change to the campus within the full context of all other expected changes, allowing  
16 future decisions to be made in a holistic manner. Figure 4–2 shows the building opportunity  
17 framework as outlined in the Campus Master Plan (MSU 2007a). The building opportunities  
18 planned for the project site include academic and research facilities (shown in red in Figure 4–2).

19 Continued use of the triangular 25-acre (10-hectare) soils disposal area south of the railroad  
20 tracks and immediately north of Mount Hope Road illustrated in Figure 4–1 is consistent with  
21 the Campus Master Plan.



1 Source: MSU 2007a  
 2 **Figure 4-2. Potential Michigan State University Building Development Opportunities**

1     **4.2           GEOLOGY AND SOILS**

2     A geotechnical report was completed for the project site in August 2009 (NTH 2009). The  
3     purpose of the study was to obtain preliminary geotechnical data along the proposed site  
4     alignment to advance current design concepts and provide additional information required for  
5     calculations associated with the FRIB. The site topography is generally sloped from north to  
6     south with minor grade changes for roadways, parking lots, and sidewalks. The ground surface  
7     elevation at the test boring locations ranges from approximately 849 to 868 feet (259 to  
8     265 meters) above mean sea level (NTH 2009).

9     Soil conditions at the site are variable, but generally consist of topsoil or fill deposits that are  
10    underlain by granular or cohesive materials of varying densities and consistencies (NTH 2009).

11           **Pavement and Surficial Topsoil** – The pavement thickness ranges from 0.4 to 0.5 feet  
12           (0.12 to 0.15 meters). The surficial soils between 0.5 and 1.5 feet (0.15 to 0.5 meters)  
13           consist of silty sand, clayey sand, or sandy clay.

14           **Fill Soil** – Granular or cohesive fill soils are encountered to depths ranging from  
15           approximately 1 to 16 feet (0.3 to 5 meters). The granular fill soils consist of very loose  
16           to medium compact gravel, sandy gravel, gravelly sand, sand, silty sand, or clayey sand.  
17           The cohesive fill soils consist of medium to hard sandy clay or silty clay.

18           **Natural Granular and Cohesive Soil** – The natural soil at the site is highly variable and  
19           consisted of interspersed granular and cohesive soil deposits. Stratified soil conditions  
20           are expected along the proposed FRIB tunnel alignment as well as the target area.  
21           Occasional cobbles and boulders were encountered within the test borings.

22    In general, the granular soils consist of very loose to very compact sandy gravel, gravelly sand,  
23    sand, silty sand, clayey sand, sandy silt, silt, and clayey silt. The cohesive soils consist of soft to  
24    very hard gravelly clay, sandy clay, silty clay, and clay (NTH 2009). These soils are  
25    characteristic of glacially influenced surface features.

26    Bedrock first occurs at depths ranging from 42 to 80 feet (13 to 24 meters). Bedrock is  
27    sedimentary and consists of limestone, sandstone, siltstone, or shale (NTH 2009).

28    The soil disposal area is a 25-acre (10-hectare) open field located east of Farm Lane, south of the  
29    railroad tracks, and immediately north of East Mount Hope Road. This soil disposal area is an  
30    existing construction staging area within an area of undeveloped fields and would be used during  
31    the construction of the proposed facility.

32    **Seismic Risk**

33    Magnitude and intensity measure different characteristics of earthquakes. Magnitude measures  
34    the energy released at the source of the earthquake. Magnitude is determined from measurements  
35    on seismographs. Intensity measures the strength of shaking produced by the earthquake at a  
36    certain location. Intensity is determined from effects on people, human structures, and the natural  
37    environment (USGS 2010a).

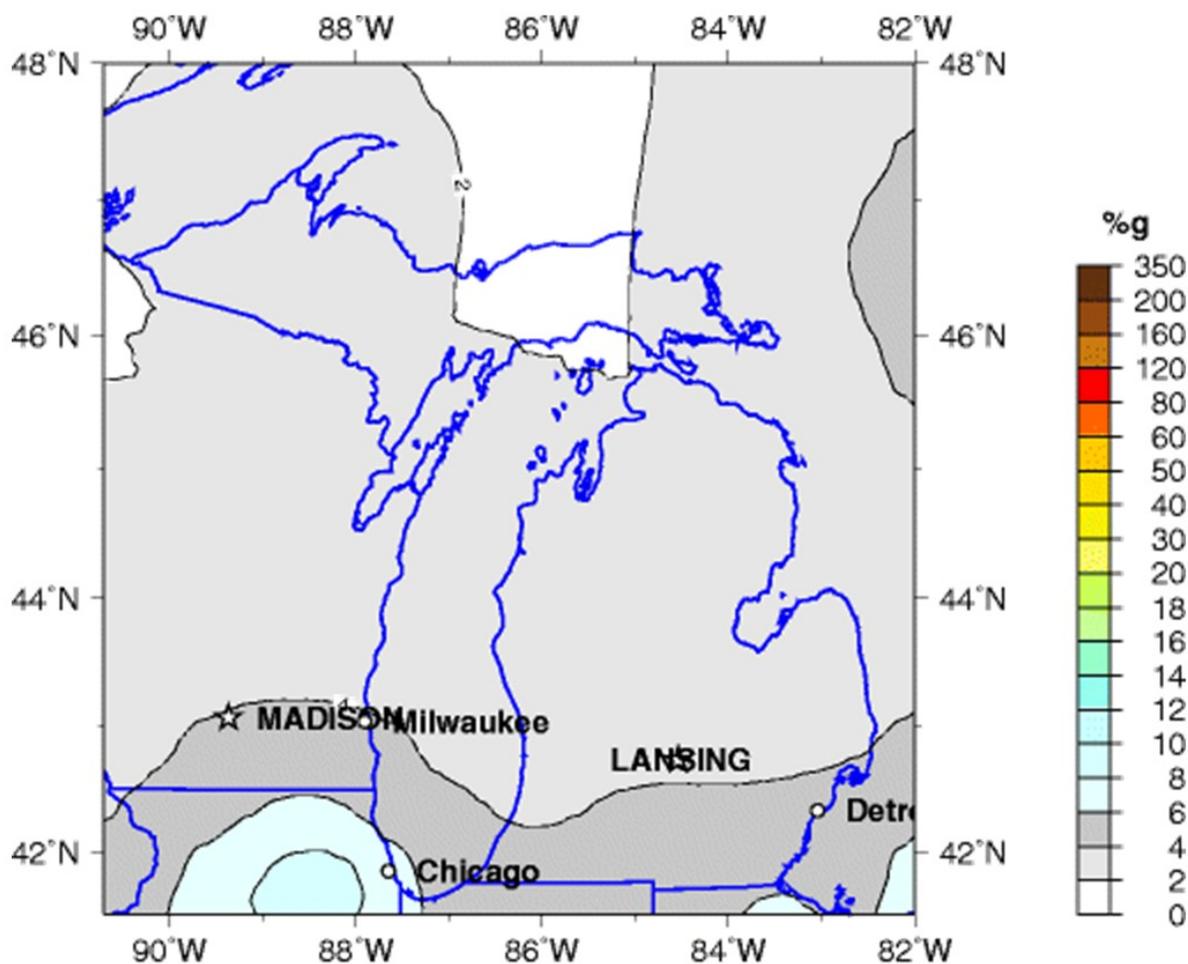
1 Michigan lies in a region of very low risk for earthquake occurrence. Shocks are characterized  
2 by intensities from I to VI on the Modified Mercalli Intensity (MMI) scale of observed  
3 earthquake effects. The nearest areas of substantial earthquake damage risk are located in the  
4 more seismically active regions that include southern Illinois, southwestern Indiana, and upstate  
5 New York. Earthquakes with epicenters in these areas may be felt in Michigan. Damage from  
6 earthquakes in Michigan has generally been limited to broken dishes, cracked plaster, and  
7 damaged chimneys, although two earthquakes with intensities of VIII on the MMI scale have  
8 been recorded (Bricker 1977; USGS 2010b). Intensity VIII effects are those with the potential to  
9 cause slight damage in specially designed structures but considerable damage in ordinary  
10 buildings.

11 The earliest record of earthquake tremors felt in Michigan were from a series of shocks centered  
12 near New Madrid, Missouri, in 1811 and 1812, associated with the area known now as the New  
13 Madrid seismic zone. As many as nine tremors from the New Madrid earthquake series were  
14 reportedly felt distinctly in Detroit (USGS 2010b). The New Madrid earthquake sequence of  
15 1811–1812 ranks as one of the largest in the United States since European settlement. The three  
16 largest shocks produced shaking as high as MMI X to XII (i.e., extreme to nearly total damage to  
17 man-made structures) at their epicenters, with estimated magnitudes ranging from 7.2 to 8.1.  
18 Estimate shaking across central Michigan was in the range of MMI V (USGS 2010c). Since the  
19 New Madrid earthquake sequence, earthquakes occurring within but mainly beyond the state  
20 have sporadically been felt in Michigan. Between 1872 and 1883, a number of moderate  
21 earthquakes were centered within Michigan. A minor earthquake was reported outside of Detroit  
22 on August 17, 1877. On February 4, 1883, an earthquake cracked windows and shook buildings  
23 in Kalamazoo, Michigan (MMI VI). This shock was felt in southern Michigan and northern  
24 Indiana. Cities as distant as Bloomington, Illinois, and St. Louis, Missouri, also reported feeling  
25 this earthquake (USGS 2010b).

26 More recently and most notably, the earthquake of August 9, 1947, damaged chimneys and  
27 cracked plaster over a large area of south-central Michigan and affected a total area of about  
28 50,000 square miles (130,000 square kilometers), including points north to Muskegon and  
29 Saginaw and parts of Illinois, Indiana, and Wisconsin. The cities of Athens, Bronson,  
30 Coldwater, Colon, Matteson Lake, Sherwood, and Union City in the south-central part of the  
31 state all experienced MMI VI effects. Reports of damage to chimneys and some instances of  
32 cracked or fallen plaster, broken windows, and merchandise thrown from store shelves were  
33 common in the epicentral area (USGS 2010b). This is the only earthquake listed in the National  
34 Geophysical Data Center Significant Earthquake Database as having occurred within about  
35 120 miles (200 kilometers) of MSU. This event was centered approximately 61 miles  
36 (98 kilometers) southwest of MSU and had a recorded magnitude of 4.7 (USGS 2010d).

37 Overall, in the central United States east of the Rocky Mountain Front, the distribution of  
38 historical earthquakes is a reasonable guide to seismic hazard (Crone and Wheeler 2000: 7, 183).  
39 Since 1973, a total of only seven earthquakes have been recorded within a 124-mile  
40 (200-kilometer) radius of MSU, with magnitudes ranging from 2.5 to 3.5. The closest was a  
41 magnitude 3.5 event (MMI V) located approximately 7 miles (12 kilometers) from MSU  
42 (USGS 2010e).

1 Probabilistic earthquake ground-motion data that include peak (horizontal) ground acceleration  
 2 (PGA) were specifically evaluated to provide a more quantitative assessment of seismic risk.  
 3 Estimates of probabilistic ground motion at a particular location consider earthquake-shaking at  
 4 all future possible earthquake magnitudes and at all possible distances from the location  
 5 (USGS 2010f). Earthquake-produced ground motion is expressed in units of percent “g” (force  
 6 of acceleration relative to that of Earth’s gravity). PGA is one parameter used by the U.S.  
 7 Geological Survey National Seismic Hazard Mapping Project. The U.S. Geological Survey  
 8 hazard maps have been adapted for use in the seismic design portions of the latest building codes  
 9 (USGS 2008a). The latest PGA data from the U.S. Geological Survey were used to assess the  
 10 site. The PGA values cited are based on a 2 percent probability of exceedance in 50 years. This  
 11 corresponds to an annual probability (chance) of occurrence of about 1 in 2,500. For MSU, the  
 12 calculated PGA is approximately 0.037 g (USGS 2008b) (see Figure 4-3). PGA values in the  
 13 range of 0 to 0.04 g indicate a very low seismic risk.



Source: USGS 2010g

Figure 4-3. National Seismic Hazard Mapping—Michigan

1 According to the NTH report, the site may be classified as Site Class D (reflecting a soft soil  
2 profile) in accordance with the definitions given in Section 1615.1.1 of the 2003 Michigan  
3 Building Code (NTH 2009). The 2003 Michigan Building Code adopts the 2003 International  
4 Building Code for seismic classifications (ICC and MDCIS 2004).

### 5 **4.3 WATER RESOURCES**

#### 6 **Surface Water**

7 MSU is located in Ingham County, Michigan, which crosses two major watersheds, the Upper  
8 Grand and the Huron. As shown in Figure 4-4, the portion of Ingham County, where the campus  
9 is located, is located in the Upper Grand River Watershed and lies within the Red Cedar River  
10 drainage basin (EPA 2009). The Upper Grand River Watershed is a 572,376-acre  
11 (231,640-hectares) watershed that traverses Hillsdale, Jackson, Eaton, Washtenaw, and Ingham  
12 Counties. The Upper Grand River Watershed contains the headwaters of one of the largest river  
13 basins in Michigan, with its outlet into Lake Michigan.

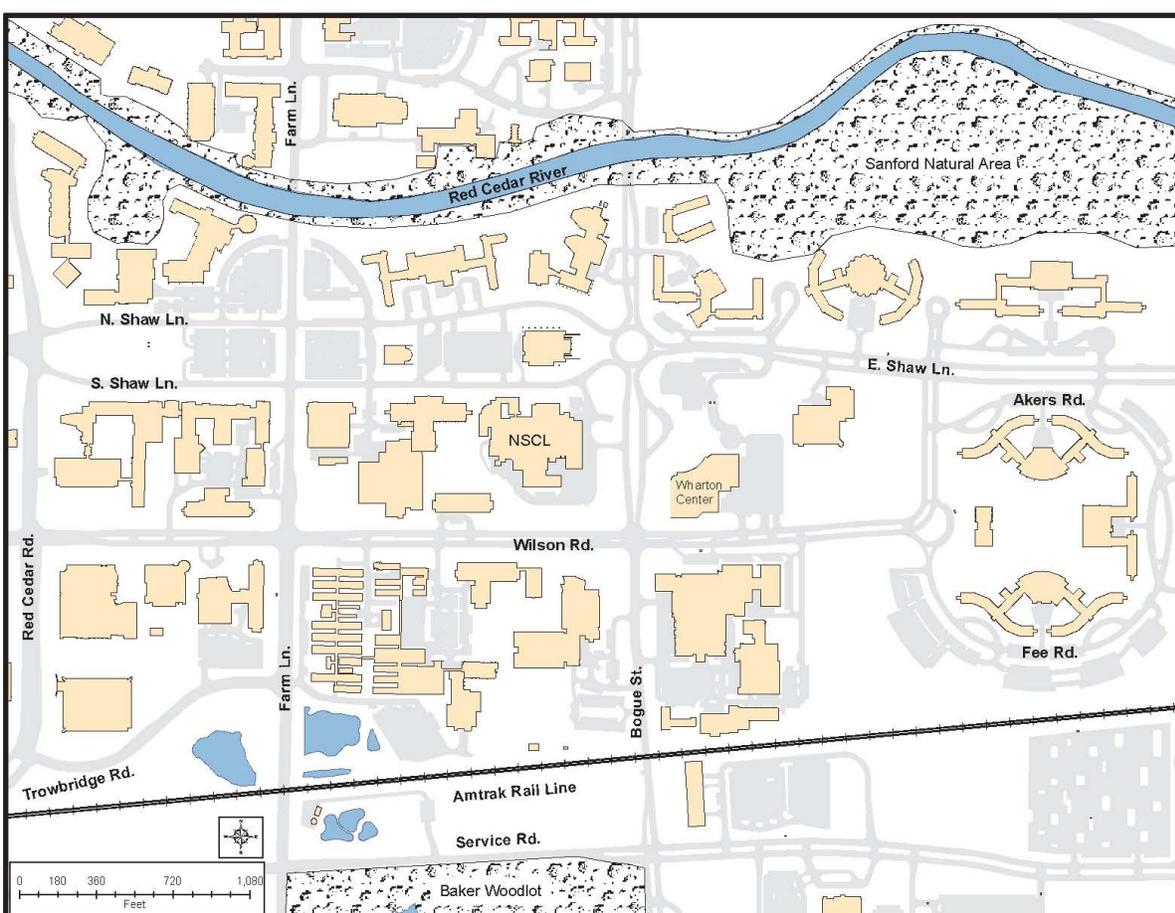


Source: EPA 2009

**Figure 4-4. The Upper Grand River Watershed in Ingham County, Michigan**

14  
15  
16

1 The project site is located in a well-developed area of MSU. As shown on Figure 4-5, the nearest  
 2 surface waters are the Red Cedar River to the north and two bodies of water to the southwest of  
 3 the project site on opposite sides of Farm Lane. The project site is approximately 1,000 feet  
 4 (300 meters) from the nearest point of the Red Cedar River, which discharges into Grand River  
 5 approximately 3 to 4 miles (5 to 6 kilometers) west of the site. There are no surface-water  
 6 bodies in immediate proximity to the construction laydown area for equipment staging and soils  
 7 storage. Directly north of the construction laydown area on Farm Lane, the two bodies of water  
 8 (north of Service Road) are approximately 2,250 feet (690 meters) from the closest part of the  
 9 laydown area. A larger body of water directly to the south of the U.S. Department of Agriculture  
 10 Regional Poultry Research Laboratory is approximately 2,500 feet (760 meters) from the closest  
 11 part of the construction laydown area.



12  
13

**Figure 4-5. Waterbodies Near the Project Site**

14 There are no floodplains on the proposed project site, or in the potential area of effect. The  
 15 floodplains in the area are upgradient from the proposed site, and therefore would not receive  
 16 stormwater from the construction area. These include the 100-year floodplain along the Red  
 17 Cedar River (FEMA 1980) north of the project site, and the 76-acre (30.8-hectare) native  
 18 floodplain (MSU 2010b) north of the project site (approximately 8,250 feet [2,515 meters] from  
 19 the site). Therefore, the Proposed Action would not require a floodplain assessment under DOE

1 regulations for implementing Executive Order 11988 (*Floodplain Management*)  
2 (10 CFR Part 1021), or a permit from the State of Michigan Floodplain Regulatory Authority,  
3 under Part 31, Water Resources Protection, of the Natural Resources and Environmental  
4 Protection Act (NREPA), 1994 Public Act 451, as amended (MDNRE 2010a). The Water  
5 Bureau within the Michigan Department of Natural Resources and Environment (MDNRE) has  
6 responsibility for processing National Pollution Discharge Elimination System (NPDES) permits  
7 under the authority of the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.), and  
8 NREPA Part 31, (1994 PA 451), as amended. [Note that until recently, MDNRE was two  
9 separate state agencies: Michigan Department of Natural Resources (MDNR) and the Michigan  
10 Department of Environmental Quality (MDEQ) and most of the regulations are still under the  
11 MDNR and MDEQ names.] The purpose of this permit is to control the discharge of pollutants  
12 into surface waters of the state to protect the environment. In addition to the NPDES permit,  
13 MDNRE's Certificate of Entry, Industrial Stormwater Guidance Document, identifies the  
14 process whereby MSU has received a Certificate of Coverage under the MDNRE Storm Water  
15 from Industrial Activities General Permit that regulates all stormwater discharges on campus  
16 (MDEQ 2010). The NSCL is covered under the Certificate of Coverage. Although stormwater  
17 from FRIB construction would be covered by MSU's existing Certificate of Coverage,  
18 construction of the FRIB would require a soil erosion and sedimentation plan approval from  
19 MDNRE. Currently, stormwater runoff from roof and ground surface drains flows to the MSU  
20 stormwater system. Discharges are authorized under the Certificate of Coverage issued by  
21 MDNRE.

22 MDNRE utilizes a Permit-by-Rule process to obtain Certificate of Coverage authorization to  
23 discharge. Construction activities of 5 acres (2.02 hectares) or more, with a point source  
24 discharge to the surface waters of the state, are required to submit a Notice of Coverage (NOC)  
25 to obtain coverage under the Permit-by-Rule process. Prior to submitting the NOC, the permittee  
26 must obtain coverage under NREPA, Part 91 (1994 PA 451), either by obtaining a Soil Erosion  
27 and Sedimentation Control (SESC) permit from the local SESC permitting agency or be  
28 designated an Authorized Public Agency by MDNRE pursuant to Part 91. The permittee must  
29 submit the NOC along with a site location map, copy of the SESC permit (if applicable), a copy  
30 of the SESC plan, and application fee to MDNRE at the address identified on the NOC.

31 One of the primary requirements of the Permit-by-Rule process is that all permitted sites must be  
32 inspected weekly, as well as within 24 hours of any rain or snowmelt event that results in a  
33 discharge from the site. The inspections must be conducted by a stormwater operator trained and  
34 certified by MDNRE and documented in an inspection report or log.

35 The issuance of a Certificate of Coverage does not authorize violations of any Federal, state, or  
36 local laws or regulations, nor does it obviate the necessity of obtaining such permits, including  
37 any other MDNRE permits, or approvals from other units of government as may be required by  
38 law (MDNRE 2010b).

### 39 **Groundwater**

40 The majority of the mid-Michigan area obtains its drinking water supply from the Saginaw  
41 Formation. This formation is an important aquifer that generally has very high water quality.  
42 The Saginaw Formation consists of mostly sandstone with interbedded shale, limestone, coal,

1 and gypsum. In most places, the thickness ranges from 100 to 200 feet (31 to 61 meters)  
2 (MSU 2010c).

3 The MSU Physical Plant Division supplies water to campus facilities. The MSU campus relies  
4 entirely on groundwater for its water supply needs. MSU has 17 Type I groundwater supply  
5 wells located on campus. All but one of the supply wells are located south of Mount Hope Road;  
6 the remaining well is located on the north campus, north of Mount Hope Road (MSU 2010c).  
7 Wells are completed at depths ranging from 285 to 435 feet (87 to 313 meters). On a daily  
8 average, MSU pumps approximately 4 million gallons (15 million liters) and has a maximum  
9 capacity of approximately 6.6 million gallons (25 million liters) (MSU 2010c). The water is  
10 delivered directly to facilities south of Mount Hope Road or to a central reservoir, where the  
11 water is treated prior to pumping to buildings north of Mount Hope Road. Before delivery to the  
12 main campus, the water is treated with fluoride, chlorine, and phosphate to provide potable water  
13 to users.

14 MSU monitors the quality of its water supply for a variety of potential contaminants in  
15 accordance with state and Federal regulations. The MSU Physical Plant Division prepares an  
16 annual Water Quality Report (MSU 2002) that provides key information about the quality of  
17 MSU's water supply. The Water Quality Report indicates that contaminants are either not  
18 detectable or are present in concentrations well below drinking water standards.

19 ground surface elevation at the various test boring locations ranges from approximately 849 to  
20 868 feet (259 to 265 meters) above mean sea level. Water-level observations were made at each  
21 of the test borings within the project site during and upon completion of drilling operations,  
22 except for within six test borings where drilling fluids were used or monitoring wells were  
23 installed and observations could only be made during drilling (NTH 2009). Additionally,  
24 groundwater could not be observed within two test borings due to soil collapsing within the test  
25 boring above the water table. Water was encountered at depths ranging from approximately 13.5  
26 to 34.2 feet (4 to 10.4 meters) below ground surface with elevations ranging from 827 to 839 feet  
27 (252 to 255 meters) above mean sea level. Groundwater was observed upon completion of  
28 drilling operations at depths ranging from 18 to 37.5 feet (5.5 to 11.4 meters) below ground  
29 surface with elevations ranging from 825.7 to 850 feet (252 to 259 meters) above mean sea level.  
30 (NTH 2009).

31 Fluctuations in groundwater levels are anticipated due to seasonal variations and following  
32 periods of prolonged precipitation or drought (NTH 2009). For example, relatively shallow  
33 groundwater may be encountered at the site, depending on the season of the year and recent  
34 precipitation. Additionally, groundwater-level observations made within fine-grained soils, such  
35 as those encountered at the project site, are not always indicative of long-term groundwater  
36 levels due to low hydraulic conductivity and the tendency of drilling operations to seal off  
37 natural paths of groundwater flow. Groundwater at the site has the potential to be affected by the  
38 level of the water in the nearby Red Cedar River (NTH 2009).

### 39 **Wetlands**

40 Michigan's wetland statute, NREPA, Part 303 (1994 PA 451), defines a wetland as "land  
41 characterized by the presence of water at a frequency and duration sufficient to support, and that

1 under normal circumstances does support, wetland vegetation or aquatic life, and is commonly  
2 referred to as a bog, swamp, or marsh” (1994 PA 451). The definition applies to public and  
3 private lands regardless of zoning or ownership.

4 Wetlands and soil area including wetland soils have been identified in an Ingham County Final  
5 Wetland Inventory (MDEQ 2006). These wetlands primarily exist along the Red Cedar River  
6 bank and in the Inland Lakes Research and Study Area; none are located in the area of effect for  
7 the project site or the soils disposal area. Accordingly, no wetland assessment is required to  
8 comply with Executive Order 11990 (*Protection of Wetlands*), and DOE regulations for  
9 implementing this Executive Order as set forth in *Compliance with Floodplain and Wetland*  
10 *Environmental Review Requirements* (10 CFR 1022).

## 11 **4.4 CLIMATE AND AIR QUALITY**

### 12 **4.4.1 Climate**

13 The climate of the East Lansing area is continental, characterized by larger temperature ranges  
14 and colder temperatures than similar latitudes near the Great Lakes. The area experiences some  
15 minimal lake effects (Michigan State Climatologist’s Office 2009a). Meteorological data are  
16 collected on the MSU campus in East Lansing and additional data are available from the  
17 meteorological station in Lansing. The long-term average wind direction is from the west  
18 (NCDC 1998). Average annual historical precipitation is 28.7 inches (72.9 centimeters).  
19 Precipitation is due to rain and thunderstorm activity in spring, summer, and fall, and snow in the  
20 winter. Average annual snowfall is 38.7 inches (98.3 centimeters). Severe weather events  
21 include hail, tornados, thunderstorms and high wind speeds, and snow and ice (NCDC 2010).  
22 The average monthly historical temperature is 47.4 degrees Fahrenheit (°F) (8.6 degrees Celsius  
23 [°C]), with a high average temperature of 70.7 °F (21.5 °C) in July and a low average  
24 temperature of 21.8 °F (-5.7 °C) in January (Michigan State Climatologist’s Office 2009b).

### 25 **4.4.2 Greenhouse Gas**

26 The “natural greenhouse effect” is the process by which part of terrestrial radiation is absorbed  
27 by gases in the atmosphere, warming the Earth’s surface and atmosphere. This greenhouse effect  
28 and the Earth’s radiation balance are affected largely by water vapor, carbon dioxide, and trace  
29 gases, which absorb infrared radiation and are referred to as greenhouse gases. Other greenhouse  
30 gases include nitrous oxide, halocarbons, and methane.

31 There is consensus among scientists, including those on the Intergovernmental Panel on Climate  
32 Change (IPCC), that increases in atmospheric concentrations of certain pollutants can produce  
33 changes in the Earth’s atmospheric energy balance and thereby influence global climate. These  
34 pollutants are commonly referred to as greenhouse gases, and this warming effect is referred to  
35 as global warming. Water vapor (1 percent of the atmosphere) is the most common and dominant  
36 greenhouse gas; only small amounts of water vapor are produced as the result of human  
37 activities. The principal greenhouse gases resulting from human activities are carbon dioxide,  
38 methane, nitrous oxide, and halocarbons. Halocarbons include chlorofluorocarbons;  
39 hydrofluorocarbons, which are replacing chlorofluorocarbons as refrigerants; and  
40 perfluorocarbons, which are a byproduct of aluminum smelting. Other gases of concern include

sulfur hexafluoride, which is widely used in insulation for electrical equipment. These gases are released in different quantities and have different potencies in their contributions to global warming (IPCC 2007; Justus and Fletcher 2006).

Sources of anthropogenic carbon dioxide include combustion of fossil fuels such as natural gas, oil, gasoline, and coal. It is estimated that carbon dioxide atmospheric levels have risen by more than 35 percent since the preindustrial period (since 1750) as a result of human activities. Emissions of other greenhouse gases have also risen. Annual global emissions of carbon dioxide are estimated to be 26.4 billion metric tons from fossil fuel use (IPCC 2007:3). Carbon dioxide is the most important anthropogenic greenhouse gas and is therefore of primary concern in this EA.

The IPCC concluded that warming of the earth's climate system is unequivocal, and that most of the observed increase in global average temperatures is very likely due to the observed increase in anthropogenic greenhouse gas concentrations. The IPCC reports potential impacts from warming of the climate system, including expansion of sea water volume; decreases in mountain glaciers and snow cover resulting in sea level rise; changes in arctic temperatures and ice; changes in precipitation, ocean salinity, and wind patterns; and changes in extreme weather (IPCC 2007:3-8).

#### 4.4.3 Air Quality

Ingham County is located in the South Central Michigan Intrastate Air Quality Control Region (40 CFR 81.196). Ingham County is designated as being located in an attainment area for all criteria pollutants (see Table 4–1). An attainment area is a specific geographic area considered to have air quality as good as or better than the national ambient air quality standards as defined in the Clean Air Act. The designation is made for each criteria pollutant.

**Table 4–1. Attainment Designations for Ingham County**

Criteria Pollutant	Designation
Sulfur Dioxide	Better than National Standards
Carbon Monoxide	Unclassifiable/attainment
Ozone (1-hour)	Unclassifiable/attainment
Ozone (8-hour)	Attainment
Particulate Matter with a diameter of 10 micrometers or less	Unclassifiable
Particulate Matter with a diameter of 2.5 micrometers or less	Unclassifiable/attainment
Nitrogen Dioxide	Cannot be classified or better than national standards

Source: 40 CFR 81.323.

Air pollutant emission sources at MSU include vehicles, generators, boilers, a power plant, and incinerators. There are no air pollutant emissions from operation of the NSCL (MSU 2010a). MSU has an air quality operating permit covering two waste incinerators and the MSU Power Plant.

1 The NSCL does not currently have airborne radiological emissions (MSU 2010a). There are no  
2 NSCL emissions identified in MSU’s air permit. Radioactive emissions do not reach regulatory  
3 levels. Hazardous air pollutants contained at MSU are specific to the MSU Power Plant.

#### 4 **4.5 BIOLOGICAL RESOURCES**

5 Biological resources include native or naturalized plants and animals and their habitats.  
6 Protected and sensitive biological resources include specific habitats and the plant and animal  
7 species listed as threatened or endangered by the U.S. Fish and Wildlife Service or the Michigan  
8 Department of Natural Resources and Environment or are otherwise protected under Federal or  
9 state law.

#### 10 **Existing Habitat**

11 The landscape on the MSU campus and its immediate vicinity consists of scattered undeveloped  
12 parcels located within a larger and more developed and urbanized area. Although most of the  
13 land has been developed for teaching and research facilities, three types of natural areas can be  
14 found on the MSU campus (MSU 2010d).

- 15 • Category 1 – Natural Area – managed at the highest level of protection and lowest level  
16 of usage
- 17 • Category 2 – High Quality Undeveloped Area – only limited impact allowed for teaching  
18 and research
- 19 • Category 3 – Undeveloped Area of Scientific Value – limited manipulation for research  
20 and demonstration may be allowed, subject to review and approval

21 The Category 1 areas located near the project site are the Sanford Natural Area, the Baker  
22 Woodlot and Rachana Rajendra Neotropical Migrant Bird Sanctuary, and the Red Cedar Natural  
23 Area. The Sanford Natural Area is a 34-acre (14-hectare) floodplain forest that is part of the  
24 676.57 acres (273.8 hectares) of forested land purchased in 1855 for the original Michigan  
25 Agricultural College campus. The closest portion of the Sanford Natural Area is located  
26 approximately 350 feet (100 meters) from the proposed site tunnel entrance on the north side of  
27 East Shaw Lane. The Baker Woodlot and Rachana Rajendra Neotropical Migrant Bird  
28 Sanctuary constitute a 78-acre (32-hectare) beech–maple forest. The Baker Woodlot and  
29 Rachana Rajendra Neotropical Migrant Bird Sanctuary are located approximately 1,700 feet  
30 (520 meters) from the project site. The Red Cedar Natural Area is a 76-acre (31-hectare) native  
31 floodplain forest split by Kalamazoo Street and is located approximately 7,000 feet  
32 (2100 meters) from the project site (MSU 2010b, 2010d, 2010e, 2010f).

33 Existing habitat at the project site is consistent with that of the surrounding area and includes a  
34 mix of industrial, urban, and natural habitat. Most of the site consists of large buildings, parking  
35 areas, and roads interspersed with mowed lawns. Most of the site is highly disturbed from past  
36 and present MSU activities and contains relatively small areas of natural vegetation. Vegetation  
37 primarily consists of planted grass lawns, shrubs, and trees that are mainly used for landscaping  
38 near buildings. Wildlife found within the immediate vicinity of the project site consists of  
39 species capable of living within a disturbed landscape and tolerant of human activity. Bird

1 species include the European starling, American robin, and house sparrow, while mammals  
2 include raccoon, gray squirrel, and small rodents.

3 The soil disposal area is an existing construction staging area within an area of undeveloped  
4 fields. The wildlife composition found at the disposal area is similar to that of the surrounding  
5 area; however, due to a lesser degree of development, greater species diversity is present. Bird  
6 species include the song sparrow, eastern bluebird, and mourning dove, while mammals found at  
7 the site include red fox, striped skunk, and the field mouse.

## 8 **Threatened and Endangered Species**

9 The Michigan Department of Natural Resources and Environment lists 55 species located in  
10 Ingham County. Of these 55 species, one species, the Indiana bat, is listed as a federally  
11 endangered species, while the eastern massasauga rattlesnake is listed as a species being  
12 considered for Federal status. See Appendix B for a complete listing, including scientific  
13 nomenclature. Due to the industrial and disturbed nature of the MSU campus, none of these  
14 species or suitable habitat is known to be present at the project site. Although the soil disposal  
15 area is located within a less developed setting, no listed species or suitable habitat is known to  
16 occur (MSUE 2009).

## 17 **4.6 NOISE**

18 Sources of noise at MSU in the area around the NSCL and the FRIB site include vehicular  
19 traffic, building equipment such as ventilation equipment, transformers, generators, a cryogenic  
20 plant, and water pumps. The primary noise areas in the NSCL, although soundproofed, are the  
21 compressor room in the cryogenic plant and a number of mechanical equipment rooms. Some of  
22 this equipment is indoors, which controls noise levels from these sources at noise-sensitive  
23 receptors nearby.

24 As the project site is in an area of campus that has undergone substantial construction in recent  
25 years, noise from building and road construction has been common in the general area around the  
26 project site. Recent construction in the project site vicinity has included the Wharton Center, the  
27 Biomedical and Physical Sciences building, building additions to the NSCL, and road  
28 construction. Each of these construction activities was conducted in such a manner to reduce  
29 noise impacts on the MSU staff and residents.

30 Noise-sensitive receptors near the project site include dormitories, classrooms, laboratories,  
31 offices, the performing arts center, and pedestrians (MSU 2010a).

## 32 **4.7 UTILITIES**

33 This section addresses the existing capacity and usage of utilities (i.e., electricity, fuel, and  
34 water) at the NSCL for use in current operations.

### 35 **Electricity**

36 While electricity is supplied to the NSCL by the MSU Power Plant, electricity for the FRIB  
37 would be supplied from the offsite commercial grid. Average rate of electric power use at the

1 NSCL is about 3.7 megawatts, with a peak usage rate of 4.1 megawatts, and a total usage of  
2 26,016 megawatt-hours per year (MSU 2010a). This is well within the MSU Power Plant  
3 capacity of 60 megawatts.

#### 4 **Fuel**

5 Diesel generator (for a backup generator) testing at the NSCL utilizes approximately 10 gallons  
6 (38 liters) per year of diesel fuel and No. 2 diesel fuel oil. Gasoline and natural gas are not  
7 currently used at the NSCL. Small quantities of propane are currently used at the NSCL to  
8 operate a fork lift. Industrial gases utilized at the NSCL consist of approximately 7.8 million  
9 pounds (3,500 metric tons) per year of nitrogen and approximately 10,000 pounds (4.7 metric  
10 tons) per year of helium (MSU 2010a).

#### 11 **Water**

12 The MSU Physical Plant Division provides water utilities to campus facilities. Potable water  
13 usage at the NSCL averages 370,000 gallons (1,400,000 liters) per day. The MSU potable water  
14 system currently pumps an average of 9,000 gallons (34,000 liters) per minute (MSU 2010a).  
15 Nonpotable water is not used for NSCL operations.

### 16 **4.8 CULTURAL AND HISTORICAL RESOURCES**

17 All surface areas in the vicinity of the NSCL area have been previously extensively disturbed.  
18 According to the MSU Campus Archaeology Program Director, no cultural or historical  
19 resources are likely to be found in these disturbed areas. Surveys, however, have identified one  
20 historical resource near the eastern portion of the Mount Hope Road soils storage/disposal area,  
21 i.e., an early 20<sup>th</sup> century historic farmstead (Goldstein 2010).

### 22 **4.9 HUMAN HEALTH AND SAFETY**

23 The existing human health and safety conditions in the vicinity of the NSCL provide a  
24 background against which the consequences of the Proposed Action and the No Action  
25 Alternative may be understood.

#### 26 **4.9.1 Radiological Environment**

27 According to the National Council on Radiation Protection and Measurements (NCRP 2009), the  
28 average annual ionizing radiation dose to a member of the general public in the United States is  
29 0.624 rem. Table 4–2 presents the various contributions to this total. These averages are  
30 considered to be generally applicable to the population of East Lansing and to the students and  
31 staff of MSU.

32 Estimates of human health impacts of ionizing radiation can be expressed in terms of the  
33 probability of a latent cancer fatality (LCF) for an individual or the number of LCFs in a  
34 population. For purposes of presenting such estimates in this environmental assessment, a dose-  
35 to-LCF factor of 0.0006 LCF per person-rem is used, consistent with the recommendation of the  
36 DOE Office of Environmental and Policy Guidance (DOE 2003).

**Table 4–2. Comparison of Annual Average Doses Received by a U.S. Resident from All Sources**

	Source	Dose (millirem per year) <sup>a</sup>	Percent of Total
<b>Ubiquitous background</b>	Radon and thoron	228	37
	Space	33	5
	Terrestrial	21	3
	Internal (body)	29	5
	<b>Subtotal</b>	<b>311</b>	<b>50</b>
<b>Medical</b>	Computed tomography	147	24
	Medical x-ray	76	12
	Nuclear medicine	77	12
	<b>Subtotal</b>	<b>300</b>	<b>48</b>
<b>Consumer</b>	Construction materials, smoking, air travel, mining, agriculture, fossil fuel combustion	13	2
<b>Other</b>	Occupational	0.5 <sup>b</sup>	0.1
	Nuclear fuel cycle	0.05 <sup>c</sup>	0.01
<b>Total</b>		<b>624</b>	<b>100</b>

<sup>a</sup> To convert millirem per year to millisieverts per year, divide by 100.

<sup>b</sup> Occupational dose is regulated separately from public dose and is provided here for informational purposes.

<sup>c</sup> Calculated using 153 person-sieverts per year from Table 6.1 of NCRP Report 160 using a 2006 U.S. population of 300 million.

**Source:** NCRP 2009.

## 4.9.2 Occupational Health and Safety

Over the 5-year period from 2004 to 2008, the total number of recordable injuries and illnesses at MSU averaged 1.4 per 200,000 labor hours, compared to an average of 2.0 for all Michigan colleges, universities, and professional schools. The average for all U.S. universities was 2.5 during the same time period. The NSCL rate of injury/illness cases involving days away from work, job restriction, or transfer (DART cases) during the same period was 0.2, compared to 0.6 for Michigan colleges, universities, and professional schools, and 1.0 for all U.S. universities. During that time, the NSCL experienced no fatalities. The NSCL record of occupational injury and illnesses is summarized in Table 4–3.

**Table 4–3. Occupational Injury and Illness Rates, 2004 – 2008**

	<b>Total Recordable Case Rate</b>	<b>DART<sup>a</sup> Case Rate</b>
National Superconducting Cyclotron Laboratory <sup>b</sup>	1.4	0.2
Michigan Universities <sup>c,d</sup>	2.0	0.6
U.S. Universities <sup>e</sup>	2.6	1.0

<sup>a</sup> Cases with days away from work, job restriction, or transfer (DART).

<sup>b</sup> Source: MSU 2010a.

<sup>c</sup> Source: BLS 2010a.

<sup>d</sup> Values are approximate. Data for “colleges, universities, and professional schools” were not explicitly stated in the 2005 published data.

<sup>e</sup> **Source:** BLS 2009.

During the period 2004 to 2008, an average of approximately 381 persons were monitored (i.e., assigned a personal radiation dosimeter) for occupational radiation exposure at the NSCL. The average annual recorded dose for these workers was about 13 millirem. The highest dose received by any worker in the reporting period from October 2008 through September 2009 was 388 millirem. These values are well below the U.S. Nuclear Regulatory Commission annual dose limit of 5,000 millirem and the NSCL “as low as reasonably achievable” administrative goal of 500 millirem.

#### **4.10 WASTE MANAGEMENT**

Waste management includes activities related to the transportation, treatment, storage, and/or disposal of wastes. Waste management activities may be a component of, but are not limited to, routine site operations, facility management, capital improvements, and/or ongoing remediation efforts. Waste minimization activities include various site-specific programs that support efforts to reduce the quantity and toxicity of site wastes, conserve resources and energy, reduce hazardous substance use, and prevent or minimize pollutant releases into the environment.

The Office of Radiation, Chemical, and Biological Safety (ORCBS) manages the following waste forms on the MSU campus: low-level radioactive waste, mixed low-level radioactive waste, hazardous waste, and nonhazardous waste. Current operation of the NSCL results in the generation of a variety of wastes. In general, hazardous wastes generated at MSU are managed in three separate groups: radioactive, chemical, and biohazardous wastes (although biohazardous wastes are not generated at the NSCL and are not foreseen to be generated at FRIB). Hazardous wastes generated at the NSCL are collected in specified waste containers, documented, and packaged according to MSU guidance on the safe handling and packaging of waste (MSU 2009c). All hazardous waste (including chemical waste) generated at the NSCL is delivered by licensed carriers to Resource Conservation and Recovery Act (RCRA) or Toxic Substances Control Act-permitted treatment, storage, and disposal facilities. Low-level radioactive waste and/or mixed low-level radioactive waste (e.g., flammable, corrosive, or toxic waste such as scintillation vials) generated at the NSCL is collected by MSU and delivered by licensed carriers to a licensed low-level radioactive waste disposal facility. No transuranic waste is generated from operations at the NSCL.

1 MSU holds an MDNRE, RCRA Part B Permit that allows MSU to manage hazardous waste at  
2 several designated container storage areas, tank storage units, and treatment units before the  
3 waste is shipped off site to RCRA-permitted treatment, storage, and disposal facilities. ORCBS  
4 provides hazardous waste pick-up and disposal services for all MSU facilities. Typically,  
5 individual facilities collect hazardous wastes in ORCBS-supplied containers, label the material  
6 properly, provide secondary packing if necessary, and submit an electronic pickup request form  
7 on the ORCBS website (MSU 2009c).

8 General refuse (i.e., nonhazardous solid waste) is discarded into dumpsters strategically located  
9 at MSU facilities. To avoid improper disposal of hazardous or chemical wastes (e.g., discarded  
10 commercial chemical products), established procedures guide MSU personnel as to which wastes  
11 can be placed in dumpsters. Work practices must be followed by all MSU laboratory staff in  
12 disposing and separating nonhazardous waste from hazardous waste (MSU 2009c). Wastes  
13 placed in dumpsters are collected by a commercial waste hauler and transported to the hauler's  
14 processing facility where recyclable materials are removed. The remaining waste is transported  
15 for disposal to an MDNRE-permitted sanitary landfill. All MSU construction and demolition  
16 waste is transported by commercial haulers to processing facilities where recyclable materials are  
17 removed.

18 The total volume of waste generated and disposed of at MSU is reduced by an active recycling  
19 program managed by the Office of Recycling and Waste Management. MSU has set clear goals  
20 to reduce its environmental footprint. By 2015, MSU will reduce waste by 30 percent  
21 (MSU 2010g). The “Be Spartan Green” campaign promotes environmental stewardship as a  
22 priority at MSU. Faculty, staff, and students are highly encouraged to eliminate waste through  
23 source reduction or material substitution, by reusing or recycling potential waste materials that  
24 cannot be minimized or eliminated, by reeducating through research on climate change, through  
25 environmental friendly “redesign” and green leadership in energy and environmental standards  
26 for new construction, and by rethinking purchasing habits and methods (MSU 2010g).

27 Wastewater is generated by a number of activities at MSU and consists of sanitary wastewater  
28 (from restrooms, kitchens, and sinks in certain buildings and laboratories), laboratory wastewater  
29 (from laboratory sinks and floor drains in most buildings), and stormwater runoff. Cooling water  
30 and cooling tower blowdown waters are discharged into the sanitary wastewater treatment  
31 system. The sanitary wastewater collection and treatment system collects wastewater from  
32 sanitation facilities, kitchens, office buildings, and other portions of the campus that do not  
33 contain radioactive or hazardous materials. Trace amounts of radioactivity may be found in sink  
34 water, shower water, and liquids from cleaning glassware in the NSCL facility laboratories.  
35 Liquid wastes from laboratories are discharged in accordance with procedures in the ORCBS  
36 Waste Disposal Guide (MSU 2009c).

37 Campus wastewater is collected and conveyed to the nearby City of East Lansing Waste Water  
38 Treatment Plant located just off campus on Trowbridge Road. Under the provisions of an  
39 existing agreement with the City of East Lansing, all sanitary wastewater and other industrial  
40 waste streams including cooling water and cooling tower blowdown water, coal pile runoff and  
41 other industrial wastes, including those containing trace amounts of radioactivity, are received  
42 and treated at the East Lansing Plant.

1 The volume of industrial wastewater discharged from current NSCL operations is approximately  
2 100 gallons (379 liters) per day.

### 3 **4.11 TRANSPORTATION**

4 The regional ground transportation network consists of several interstate highways, urban  
5 roadways surrounding and entering the MSU campus, and a campus road network. Interstate  
6 highways in the Lansing/East Lansing area include Interstate 69 and Interstate 96, which circle  
7 the Lansing/East Lansing urban area, and Interstate 496, an expressway that gives access to the  
8 Lansing/East Lansing urban areas from Interstates 69 and 96.

9 Figure 4–1 shows the road and rail network traversing the campus. Figure 4–5 shows the  
10 transportation network in the vicinity of the project site. All roads on campus are public roads  
11 (MSU 1996). The primary area of the campus is bounded by Grand River Avenue  
12 (State Route 43) to the north, Hagadorn Road to the east, Mount Hope Road to the south, and  
13 Harrison Road to the west. Within the campus are roadways and access roads, parking areas and  
14 garages, pedestrian and bicycle lanes, and footpaths. Two rail lines pass through the southern  
15 half of the campus.

16 The project site is bounded by South Shaw Lane (carrying eastbound traffic) to the north,  
17 Bogue Street to the east, and Wilson Road to the south. A traffic circle is located to the northeast  
18 of the project site at the intersection of North Shaw Lane, South Shaw Lane, East Shaw Lane,  
19 and Bogue Street. The portion of Bogue Street that passes in front of the project site has a grass  
20 median. All of these roads act as connectors to the urban area surrounding the campus.

21 The Wharton Center surface parking lot is located northeast of the project site and across  
22 Bogue Street on the south side of East Shaw Lane. The Shaw Lane parking deck is located  
23 across South Shaw Lane from the project site. The Wharton Center parking deck is located on  
24 the east side of the Wharton Center. The NSCL, adjacent to the project site, has 400 parking  
25 spaces available for use around the building (MSU 2010a).

26 A 25-acre (10-hectare) staging area located 1.2 miles (2 kilometers) south of the project site  
27 (Glasmacher and Koch 2009) is commonly used for storage or disposal of soil. The staging area  
28 is accessible from the project site area by traveling westbound on Wilson Road or North Shaw  
29 Lane to Farm Lane, and traveling south on Farm Lane past Mount Hope Road (see Figure 4–1  
30 for this route). The staging area is bordered by the railroad tracks, Farm Lane, and Mount Hope  
31 Road (MSU 2010a).

32 The Capital Area Transportation Authority uses Shaw Lane, Bogue Street, and Wilson Road as  
33 part of its bus routes (CATA 2010). Figure 4–6 shows Capital Area Transportation Authority  
34 bus stops on these roads that are closest to project site as well as the bicycle paths on campus.

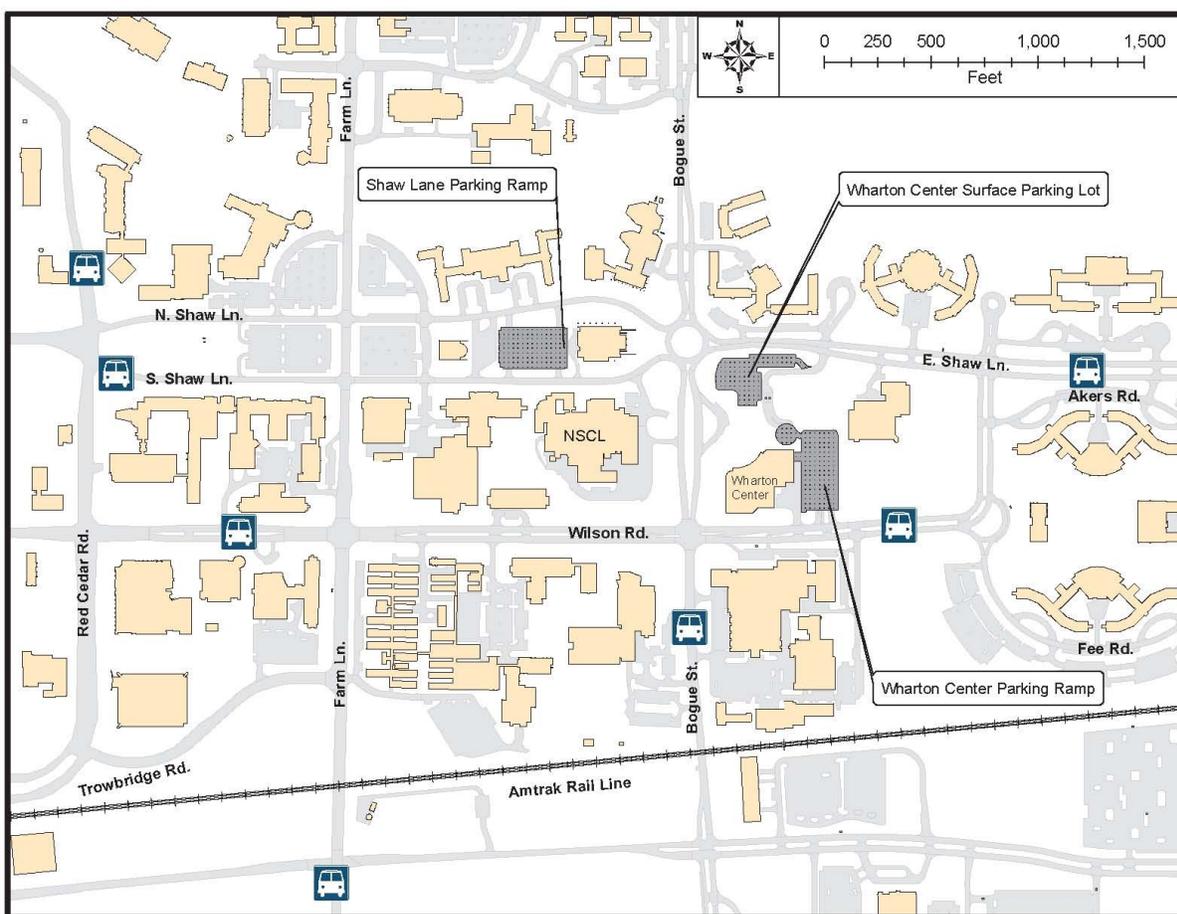


Figure 4-6. Transportation Network In The Vicinity Of the Project Site

Traffic accidents can occur on campus between vehicles or involve bicyclists and/or pedestrians. Table 4-4 shows the accident rates for these types of accidents for the years 2005-2009.

Table 4-4. On-Campus Traffic Accident Annual Rates

Year	Total - all accidents <sup>a</sup>			Vehicle - bicyclist accidents			Vehicle - pedestrian accidents		
	Number per year	Number of Injuries	Number of Fatalities	Number per year	Number of Injuries	Number of Fatalities	Number per year	Number of Injuries	Number of Fatalities
2005	326	49	0	19	13	0	5	5	0
2006	264	27	0	22	19	0	7	5	0
2007	214	23	0	11	9	0	5	7	0
2008	283	38	0	15	13	0	4 <sup>b</sup>	3 <sup>b</sup>	0
2009	206	32	0	15	10	0	10	8	0

<sup>a</sup> Includes 3 auto/bus collisions in 2007, 1 auto-bus collision in 2008, and 2 auto/bus collisions in 2009, with no resulting injuries.

<sup>b</sup> Includes 2 accidents only involving bicycles, resulting in 2 injuries.

Source: Fox 2010.

1 These accidents and resulting injuries reflect a certain level of construction that occurs on  
2 campus each year. No traffic fatalities have occurred on campus in at least 5 years, while an  
3 average of approximately 30 injuries occur each year.

4 Traffic studies have been performed by MSU. Table 4–5 shows the average daily traffic count  
5 for traffic corridors near the project site for 1997 and 2005 with the resulting percent change in  
6 traffic. Traffic has decreased in the area of campus where the project site is located with the  
7 largest decrease along Farm Lane. Traffic has decreased approximately 16 percent on Bogue  
8 Street in front of the project site with approximately 6,300 vehicles using this section of road  
9 each day. Traffic along Shaw Lane between Bogue Street and Hagadorn Road has decreased  
10 16 percent to 40 percent, depending on which side of Wilson Road the traffic counts were taken.

11 **Table 4–5. Average Daily Traffic Count**

Location (counts taken between the streets shown)	1997 ADT Volume	2005 ADT Volume	Change
<b>Bogue Street Corridor</b>			
Grand River Avenue – Dormitory Road	17,000	11,869	-30.2%
Dormitory Road – Waters Edge Drive	17,000	13,227	-22.2%
Waters Edge Drive – Business complex	17,000	13,928	-18.1%
Business complex – Shaw Lane	17,000	13,168	-22.5%
Shaw Lane – Wilson Road	7,500	6,274	-16.3%
Wilson Road – Railroad track	6,100	4,087	-33.0%
Railroad track – Service Road	6,100	4,064	-33.4%
<b>Farm Lane Corridor</b>			
Auditorium Road – Red Cedar River	19,700	10,088	-48.8%
Red Cedar River – North Shaw Lane	19,700	10,347	-47.5%
South Shaw Lane – Wilson Road	12,100	9,352	-22.7%
Wilson Road – Trowbridge Road	12,100	11,881	-1.8%
<b>Shaw/North Shaw/South Shaw Lane Corridor</b>			
Chestnut Drive – Red Cedar Road (Shaw)	14,500	9,505	-34.4%
Red Cedar Road – Farm Lane (South Shaw)	11,350	6,490	-42.8%
Red Cedar Road – Farm Lane (North Shaw)	11,350	7,922	-30.2
Planetarium Road – Bogue Street (South Shaw)	9,250	6,930	-25.1%
Farm Lane – Planetarium Road (North Shaw)	9,250	8,509	-8.0%
Planetarium Road – Bogue Street (North Shaw)	9,250	7,971	-13.8%
Bogue Street – Wilson Road (Shaw)	18,100	10,748	-40.6%
Bogue Street – Wilson Road (Shaw)	18,100	13,245	-26.8%
Wilson Road – Hagadorn Road (Shaw)	10,900	9,804	-10.1%
Wilson Road – Hagadorn Road (Shaw)	10,900	9,068	-16.8%

Location (counts taken between the streets shown)	1997 ADT Volume	2005 ADT Volume	Change
<b>Wilson Road Corridor</b>			
East Athletic Field	4,700	3,609	-23.2%
Wharton Center – small animal clinic	4,700	4,062	-13.6%
Bogue Street – Farm Lane	10,200	6,948	-31.9%
Bogue Street – Farm Lane	10,200	7,617	-25.3%
Farm Lane – Red Cedar Road	13,000	8,735	-32.8%
<b>Service Road Corridor</b>			
West of Hagadorn Road	11,400	9,596	-15.8%
Farm Lane – Bogue Street	12,900	10,680	-17.2%

1 **Key:** ADT=average daily traffic, NDA = no data available; TBD=to be determined.

2 **Source:** Fox 2010.

### 3 4.12 SOCIOECONOMICS AND ENVIRONMENTAL JUSTICE

4 MSU is located in the city of East Lansing in Ingham County, Michigan. East Lansing and  
5 Ingham County have 2008 populations of 45,931 and 277,528, respectively (DOC 2009a,  
6 2010a). Ingham County is part of the Lansing-East Lansing Metropolitan Statistical Area  
7 (MSA), which also includes Clinton and Eaton Counties. The 2008 population of the Lansing-  
8 East Lansing MSA was 454,035 (DOC 2009b). During the 2008–2009 school year, MSU had a  
9 total of 46,648 students, including 36,337 undergraduate students and 10,311 graduate and  
10 professional students. MSU employs approximately 5,052 faculty and academic staff and  
11 6,166 support staff (MSU 2009b).

12 Table 4–6 summarizes the total population, low-income population, labor force, employment,  
13 and unemployment rate in Ingham County and the Lansing-East Lansing MSA from 2001  
14 through 2008. The total populations of the county and MSA remained relatively stable over this  
15 time period, with the county population decreasing by approximately 1 percent and the MSA  
16 population increasing by approximately 1 percent. The percent of the population living below  
17 the poverty level in Ingham County and the Lansing-East Lansing MSA increased approximately  
18 4 and 5 percent, respectively. Both areas experienced increases in the unemployment rate over  
19 this time. The unemployment rate of these areas during 2008 was lower than the state average of  
20 8.4 percent, but higher than the national average of 5.8 percent (BLS 2010b, 2010c). Through  
21 2016, education and health care occupations are projected to have the strongest growth in the  
22 Lansing-East Lansing MSA (MDELEG 2010a).

**Table 4–6. Economic Characteristics of Ingham County and the Lansing-East Lansing Metropolitan Statistical Area**

Year	2001	2002	2003	2004	2005	2006	2007	2008
<b>Ingham County</b>								
<b>Population</b>	280,564	281,002	280,549	281,487	280,334	279,011	278,316	277,528
<b>Low-Income</b>	13.6%	13.5%	12.2%	14.8%	18.8%	20.4%	18.3%	18.3%
<b>Labor Force</b>	155,020	152,170	152,077	152,280	152,098	153,286	154,212	153,471
<b>Employment</b>	149,058	145,110	143,499	142,765	142,512	143,724	144,793	142,406
<b>Unemployment Rate</b>	3.8%	4.6%	5.6%	6.2%	6.3%	6.2%	6.1%	7.2%
<b>Lansing-East Lansing Metropolitan Statistical Area</b>								
<b>Population</b>	450,720	452,917	454,468	456,627	456,330	455,450	455,071	454,035
<b>Low-Income</b>	10.2%	10.5%	10.5%	13.1%	15.4%	14.7%	14.2%	14.4%
<b>Labor Force</b>	249,424	245,552	246,406	247,118	247,994	250,640	251,513	250,201
<b>Employment</b>	240,203	234,726	233,299	232,565	233,262	236,023	236,981	233,073
<b>Unemployment Rate</b>	3.7%	4.4%	5.3%	5.9%	5.9%	5.8%	5.8%	6.8%

Source: DOC 2009a, 2009;b;BLS 2010b.

Table 4–7 shows the distribution of minority populations in the city of East Lansing, Ingham County, and the surrounding Lansing-East Lansing MSA in 2008. Minority individuals are defined as members of the following population groups: Black or African American, American Indian or Alaska Native, Asian or Pacific Islander, Hispanic or Latino, some other race, and two or more races. The minority population percentage of East Lansing (20 percent) is slightly lower than the minority population percentages of Ingham County (24 percent), the State of Michigan (23 percent) and the United States (35 percent). The total minority population percentage of the Lansing-East Lansing MSA was slightly lower than that of the city of East Lansing.

The Isabella Indian Reservation is located approximately 70 miles (112.7 kilometers) north of East Lansing. In 2008 the total population of the reservation was 26,384 people, including a 13 percent minority population and an 18 percent low-income population. American Indian and Alaska Native was the largest minority group at this time, accounting for approximately 6 percent of the total reservation population (DOC 2010a).

Table 4–7. 2008 Minority Populations

Population	City of East Lansing		Ingham County		Lansing-East Lansing MSA	
		%		%		%
White, non-Hispanic	36,823	80%	212,153	76%	369,138	81%
White, Hispanic <sup>a</sup>	784	2%	9,038	3%	13,336	3%
Black or African American <sup>a</sup>	2,792	6%	26,949	10%	33,965	7%
American Indian and Alaska Native <sup>a</sup>	163	0%	822	0%	1,025	0%
Asian <sup>a</sup>	3,619	8%	12,248	4%	14,368	3%
Native Hawaiian and Other Pacific Islander <sup>a</sup>	73	0%	453	0%	787	0%
Some other race <sup>a</sup>	499	1%	4,443	2%	6,021	1%
Two or more races <sup>a</sup>	1,178	3%	11,422	4%	15,395	3%
<b>Total</b>	<b>45,931</b>	<b>100%</b>	<b>277,528</b>	<b>100%</b>	<b>454,035</b>	<b>100%</b>
<b>Total Hispanic<sup>b</sup></b>	<b>1,523</b>	<b>3%</b>	<b>16,647</b>	<b>6%</b>	<b>22,889</b>	<b>5%</b>
<b>Total Minority</b>	<b>9,108</b>	<b>20%</b>	<b>65,375</b>	<b>24%</b>	<b>84,897</b>	<b>19%</b>

<sup>a</sup> Includes Hispanic or Latino persons.

<sup>b</sup> Includes all persons designated as Hispanic or Latino, regardless of race.

**Key:** MSA=Metropolitan Statistical Area.

**Source:** DOC 2009a, 2010b.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK

1  
2

## CHAPTER 5 ENVIRONMENTAL CONSEQUENCES

3 This chapter describes the environmental consequences of the Proposed Action and the No  
4 Action Alternative, as well as the cumulative impacts of the Proposed Action when added to  
5 other past, present, and reasonably foreseeable future actions. The Proposed Action includes  
6 construction, operation, and decommissioning of the Facility for Rare Isotope Beams (FRIB) at  
7 the National Superconducting Cyclotron Laboratory (NSCL) at Michigan State University  
8 (MSU).

9

### 5.1 EFFECTS OF THE PROPOSED ACTION

10 The impacts presented in this section are expected to ‘bound’ the potential environmental  
11 impacts of any of the linac design configurations currently being considered and described in  
12 Chapter 3, Section 3.1. The impacts of the final design should be bounded by the configurations  
13 considered in this environmental assessment (EA). None of the configuration options, or hybrids  
14 thereof, under consideration by the conceptual and preliminary design teams are expected to  
15 substantially change the projected environmental impacts of construction, operation, or  
16 decommissioning of the FRIB. In the discussion that follows, impacts not ascribed to one  
17 configuration option can be assumed to apply to all three. When specific configuration options  
18 are mentioned, the intent is to document the bounding or a unique impact. As discussed in  
19 Chapter 3, if a new configuration is adopted that has impacts that fall outside of the bounds of  
20 this EA, a new National Environmental Policy Act (NEPA) analysis would be initiated to  
21 determine whether the impacts are significant.

22

#### 5.1.1 Land Use and Visual

23

##### Construction

24 MSU would construct the proposed project on a previously disturbed site directly adjacent to the  
25 existing NSCL. The existing soil disposal area located on East Mount Hope Avenue would be  
26 used during the construction of the proposed facility. Continued use of this site as a soils storage  
27 and disposal area is consistent with past and projected future use of this site. Construction of the  
28 proposed project would be consistent with the planned academic and research facilities outlined  
29 in the Campus Master Plan (MSU 2007a). During construction the site would be significantly  
30 disturbed, similar to other large construction projects that have been conducted on the campus.

31 During construction, use of Bogue Street and Shaw Lane could be disrupted under the straight  
32 and folded configuration options, Wilson Road could be disrupted under the double folded  
33 configuration option. Bogue Street between Shaw Lane and Wilson Road would be closed for  
34 approximately 2 years during construction of the proposed facility. In addition, the Wharton  
35 Center surface parking area would be closed and used as a laydown area during the construction  
36 period. Shaw Lane between Bogue Street and Hagadorn Road would be closed to through-traffic  
37 for approximately 2 months under the straight linear option (Glasmacher and Koch 2009). These  
38 road closures would impact vehicle traffic volume, bicycle and pedestrian traffic, parking  
39 availability, and use of city buses.

1    **Operation**

2    No land use impacts from the operation of the FRIB are anticipated. Newly constructed facilities  
3    would slightly change the current visual landscape but would be consistent with the appearance  
4    of the MSU campus and surrounding buildings. The experimental area addition, cryogenics  
5    facilities, and connector high bay and south high bay extension would be built adjacent to  
6    existing facilities and would have similar exterior finishes to the existing facilities. Under the  
7    straight linear option, the heavy ion linear accelerator (linac) front end building would be built  
8    near existing dormitories. It is planned that these buildings would be similar in style to existing  
9    buildings. These new structures would have a negligible effect on the visual characteristics of  
10   the campus.

11   **Decommissioning**

12   MSU expects the FRIB to be a long-term endeavor. Typically, modern accelerators have an  
13   operating life of 30 years. However, in the event that MSU decides not to continue the operation  
14   of the FRIB, either renovation or demolition of the facilities would be required. Transferable  
15   decontamination would be removed from underground structures and the structures assessed by  
16   MSU for potential future use. Final dispensation could include burying them in place and any  
17   aboveground structures removed or redeployed (MSU 2010a).

18   **5.1.2        Geology and Soils**

19   **Construction**

20   The FRIB would be constructed using cut and fill construction techniques. Under the straight  
21   option, approximately 325,000 cubic yards (250,000 cubic meters) of soil would be excavated  
22   during the construction of the tunnel associated with the FRIB (MSU 2010a). The tunnel would  
23   be constructed using a conventional “open cut and cover” process with earth retention systems to  
24   reduce the impact on adjacent structures and to reduce required excavation. Concrete,  
25   foundations, walls, floors and ceilings for the tunnels would be formed and placed during  
26   construction. The cryoplant building would be constructed concurrently with the tunnel. Other  
27   aboveground facilities would be constructed as soon as a stable base can be provided. The  
28   project site would be landscaped in a manner consistent with surrounding landscapes.

29   The high water table found at the site could require well points to be placed strategically around  
30   the excavated areas to temporarily lower the water table. The groundwater would be filtered and  
31   discharged into the existing storm drainage system. The tunnel would be cast-in-place concrete  
32   with appropriate waterproofing provided (e.g., encasing the tunnel in waterproofing or applying  
33   water proofing with the concrete) and it would be covered with either engineered fill or  
34   compacted native materials. These cover materials would be sorted on site or at the existing soil  
35   disposal area on East Mount Hope Road to create engineered fill (MSU 2010a).

36   The project site would be cleared and excavated during the construction of the FRIB. Earth  
37   retention systems would be installed to protect adjacent facilities and vegetation. Excavated soils  
38   would be stockpiled either on the construction site or at the existing soil disposal area. Structural  
39   fill would be installed below the foundations along with a dewatering system.

1 Based on visual observations, the existing topsoil at the site contains appreciable amounts of  
2 organic matter and is therefore susceptible to decomposition. Accordingly, the topsoil is not  
3 considered suitable for the support of building foundations, floor slabs, or pavements, nor for use  
4 as engineered fill material. This current fill material is generally variable in composition, has  
5 various amounts of organic or deleterious material, and was placed in an unknown fashion.  
6 Where fill material is encountered below planned foundation depths, the soil would need to be  
7 removed and replaced with clean, properly compacted, granular material (NTH 2009).

8 A finished floor elevation of 820 feet (250 meters) above sea level is proposed for the concrete  
9 box conduits and the accelerator facility located at the east end of the tunnel alignment. A  
10 finished floor elevation of 790 feet (241 meters) is proposed for the target gallery located near  
11 the NSCL. Based on the current plans, the finished floor of the concrete box conduits and the  
12 accelerator facility on the east end of the tunnel alignment would be approximately 30 to 50 feet  
13 (9 to 15 meters) below the ground surface. During site evaluation, rock was encountered at  
14 elevations of 784.5 to 792.5 feet (239 to 242 meters) above sea level; the target area would be  
15 founded at the elevation 790 feet (241 meters) above sea level. It is anticipated that the target  
16 area would be founded on bedrock consisting of sandstone, siltstone, or shale. The competent  
17 rock is adequate to support the proposed facility (NTH 2009).

18 Based on the existing geologic and soil conditions, there are no major impediments or hazards  
19 from construction activities associated with the FRIB. Grading, excavation, and site development  
20 activities could cause soil erosion and compaction. To minimize the potential for adverse  
21 impacts, best management practices, including appropriate erosion prevention and sediment  
22 control measures, would be implemented. The use of these measures would be in compliance  
23 with a construction-specific Storm Water Pollution Prevention Plan (SWPPP) and any required  
24 permits. There are no identified construction accident conditions that would have more than a  
25 temporary environmental impact (erosion) on the geology and soils of the proposed site.

## 26 **Operation**

27 No impacts on geology and soils from the operation of the FRIB are anticipated. Potential  
28 impacts associated with irradiation of groundwater and soil are discussed in Section 5.1.9.2.2.5.

## 29 **Decommissioning**

30 In the event that MSU decides not to continue the operation of the FRIB, either renovation or  
31 demolition of the facilities would be required. Transferable decontamination would be removed  
32 from underground structures and the structures assessed by MSU for potential future use. Final  
33 dispensation could include burying them in place and any aboveground structures removed or  
34 redeployed (MSU 2010a). Fill material would be required to bury underground structures. The  
35 source of and quantity of fill material would be determined at the time of demolition.

### 36 **5.1.3 Water Resources**

#### 37 **5.1.3.1 Surface Water**

38 In response to the 1987 amendments to the Clean Water Act, the U.S. Environmental Protection  
39 Agency developed Phase 1 of the National Pollutant Discharge Elimination System (NPDES)

1 Storm Water Program. The Phase 1 program addressed sources of stormwater runoff from  
2 various designated groups; one of those groups included construction activities that disturb 5 or  
3 more acres. In 2003 the Phase II NPDES stormwater requirements took effect, which lowered  
4 the size of disturbance to 1 acre (MDNRE 2010b). FRIB construction (e.g., clearing, grading,  
5 and excavation) would require a permit from the Michigan Department of Natural Resources and  
6 Environment (MDNRE) for the discharge of stormwater associated with construction activity.  
7 This National Pollutant Discharge Elimination System (NPDES) permit would require  
8 implementation of a SWPPP prior to initiating construction. The construction laydown area for  
9 equipment staging and stockpile area for excavated rock and soil, would also be managed under  
10 the SWPPP for this project. Proper containment and erosion controls would be provided to  
11 prevent transport of soil or sediment and machinery lubricants and other construction chemicals  
12 into surface waters during storm events. Hazardous materials used during construction (e.g., oil,  
13 gasoline, paint) would be stored within secondary containment to prevent spills or leaks from  
14 being carried by stormwater into surface waters.

15 There are no surface-water bodies in close proximity to the construction laydown area for  
16 equipment storage and soils stockpiling, nor to the proposed FRIB site (see Figure 4–1). The  
17 closest body of water to the project site is the Red Cedar River, located approximately 1,000 feet  
18 (305 meters) from the project site. Temporary, indirect surface-water quality impacts during  
19 construction could occur; impacts would be mitigated through the use of administrative controls  
20 (e.g., delineating work areas) and physical controls (e.g., best management practices to decrease  
21 erosion, sedimentation, and stormwater runoff). Best management practices, as applicable, would  
22 include erosion and sediment control structures, runoff interceptor trenches or swales, filter or  
23 silt berms/fences, sediment barriers or basins, rock-lined ditches/swales, slope shaping and  
24 retaining fences, surface-water runoff management, waste management systems, and stormwater  
25 drainage structures.

26 The Proposed Action would not involve activities within a 100-year or 500-year floodplain  
27 (FEMA 1980), nor does it involve any wetlands. No impacts on floodplains or wetlands would  
28 occur from implementation of the Proposed Action.

### 29 **5.1.3.2 Groundwater**

#### 30 **Construction**

31 One hundred percent secondary containment and sumps would be in place prior to  
32 commencement of construction to contain and remove any spill or release of material and to  
33 prevent contact with groundwater. Hazardous materials used during construction (e.g., oil,  
34 gasoline, paint) would be properly stored within secondary containment to prevent spills or leaks  
35 from releasing into groundwater.

36 As stated in Section 5.1.2, the high water table would require well points placed strategically  
37 around the excavated areas to temporarily lower the water table. After construction, the  
38 groundwater levels would be expected to return to normal with no long-term impacts or changes  
39 in groundwater flow or levels. The groundwater would be filtered and discharged into the  
40 existing stormwater drainage system (MSU 2010a).

1 During construction, moderate to heavy volumes of groundwater would likely be encountered  
2 where excavations extend below the groundwater table. Additionally, due to the proximity of the  
3 Red Cedar River, the encountered groundwater would have a readily available source of water  
4 for efficient recharge.

5 Based on anticipated depths of the required excavations and the soil characteristics at the project  
6 site, a dewatering system consisting of gravity wells could be used for dewatering the soil. In  
7 areas where the soil contains more silt, the use of eductor wells (appropriate for depths greater  
8 than about 30 feet [9 meters]) or well points (appropriate for depths less than about 30 feet  
9 [9 meters]) with a vacuum system may be necessary to dewater the soils (NTH 2009).

10 The spacing, diameter, and depth of the wells would depend on the excavation depth,  
11 groundwater levels, extent of granular soils, and the granular soil hydraulic conductivity  
12 value(s). The dewatering system would be designed by a qualified engineer, and reviewed and  
13 approved by the project engineer prior to commencement of work. The system would be  
14 designed and operated such that the groundwater level is lowered to at least 2 feet (0.61 meters)  
15 below excavation (NTH 2009).

16 Prior to construction, pump tests may be performed to obtain more data on the hydraulic  
17 conductivity of the aquifers impacting construction, and to allow for adequate design of the  
18 groundwater control measures for construction and for the permanent structure (NTH 2009).  
19 Designing a watertight structure and utilizing construction techniques that reduce the risk of  
20 future groundwater infiltration would be achieved by applying appropriate waterproofing (e.g.,  
21 encasing the tunnel in waterproofing or applying water proofing with the concrete) to the tunnel  
22 structure. The tunnel excavation would be backfilled and compacted (MSU 2010a).

## 23 **Operations**

24 The research conducted at the FRIB would involve experimentation with intense beams of rare  
25 isotopes. Neutrons that penetrates the thick concrete walls of the linac tunnels and are capable of  
26 activating groundwater would result in low levels of activation of any groundwater immediately  
27 adjacent to the FRIB tunnels, which MSU would manage according to NRC license  
28 requirements. These NRC license requirements would require that the concentrations of  
29 radionuclides in the groundwater be below NRC water effluents limits presented in Table 5–1.  
30 The FRIB project design team has established a design and operations goal which is over a factor  
31 of ten times lower than the NRC requirements reported in Appendix B to 10 CFR 20. The NRC  
32 requirements identify concentrations of contaminants that correspond to NRC established dose  
33 limits to workers (Subpart C) and members of the public (Subpart D), given certain conservative  
34 assumptions NRC has made about exposure. Moreover, the FRIB project design goal is to keep  
35 the average groundwater radionuclide concentrations in the region around the linac tunnel walls  
36 to below the level that corresponds to EPA established drinking water limits, shown in Table 5-  
37 1. Ensuring that the water adjacent to the FRIB tunnels would meet drinking water standards,  
38 which would normally only be applied to water provided by a drinking water supplier after  
39 pumping and filtering, would provide a very high degree of protection to both the environment  
40 and the public.

1 The FRIB approach to meeting the groundwater activation limits provides for an initial  
 2 conservative evaluation against the FRIB design goal and ultimate comparison against the water  
 3 effluent limits in 10 CFR 20 Appendix B. Table 5–1 provides FRIB applicable groundwater  
 4 regulatory limits and project design goals. All identified radionuclides will be evaluated for  
 5 compliance, but the two limiting radionuclides for compliance are <sup>3</sup>H and <sup>22</sup>Na.

6 **Table 5–1. Groundwater Environmental Impact Limits and Project Design Goals**

Target Receptor	Limits and Project Design Goals	
Groundwater <sup>a</sup> ( <i>in situ</i> ) NRC Water Effluent Limits	<sup>3</sup> H Effluent Limit (water) 1000 pCi/ml	<sup>22</sup> Na Effluent Limit (water) 6 pCi/ml
Groundwater <sup>b</sup> ( <i>in situ</i> ) Project Design Goal <sup>3</sup> Goal <sup>c</sup>	<sup>3</sup> H Drinking Water Standard <sup>b</sup> : 20 pCi/ml	<sup>22</sup> Na Drinking Water Standard <sup>b</sup> : 0.4 pCi/ml

7 <sup>a</sup> Standard refers to 10 CFR 20 (Nuclear Regulatory Commission) limits for radionuclides in effluents. Ingestion of these  
 8 concentrations continuously over the course of a year would produce a total effective dose equivalent of 50 mrem  
 9 (0.5 millisieverts). (Table 2 of Appendix B to 10CFR20)

10 <sup>b</sup> Standard refers to 40 CFR 141 (Environmental Protection Agency) limits for drinking water from community water systems.  
 11 (40 CFR 141.66 provides the limits) Generally this corresponds to an equivalent 4 mrem/yr to the whole body or any individual  
 12 organ for beta and photon radioactivity.

13 <sup>c</sup> Conservative project design goals are used to provide flexibility at the conceptual design stage in support of meeting regulatory  
 14 limits in the design for commissioning and operation of FRIB and accommodate future upgrades or changes in mission.

15 Potential groundwater activation was assessed using the MARS15 computer code  
 16 (FERMILAB 2009) for a range of particle beam types typical of (yet bounding) expected  
 17 operations and energies for an assumed 1 watt per meter (W/m) continuous beam loss from the  
 18 linac along the tunnel. A 1 W/m continuous loss is a conservative design basis beam loss for  
 19 groundwater activation based on experience at other linacs and is higher than would be expected  
 20 with the FRIB design. Localized losses which may exceed the 1 W/m will have localized  
 21 shielding applied to limit losses (e.g., stripper region). These assumptions maximize the  
 22 potential for activation of elements in the groundwater.

23 The initial evaluation against regulatory limits and design goals is based on the maximum  
 24 generation rate, and therefore the maximum equilibrium concentration, of radioactive material in  
 25 soil and water outside the tunnel. For the purpose of assessing compliance with the 10 CFR 20  
 26 effluent limits and the project design goals, the radionuclide concentration is being averaged over  
 27 the volume of soil within which 99.9 percent of the activation will occur (referred to as the  
 28 99.9 percent volume within this EA). Calculations indicate that the 99.9 percent volume extends  
 29 approximately 3 meters from the outside of the linac tunnel wall. The average radionuclide  
 30 concentrations in groundwater within that volume will meet the project design goals (i.e., be less  
 31 than the EPA drinking water standard) and be well below the applicable NRC effluent limits.

32 A preliminary evaluation of the potential for groundwater activation indicates that the baseline  
 33 design for the tunnel walls and use of soldier piles for shoring provides adequate shielding to  
 34 meet these goals (MSU 2010h). This conclusion is based on a conservative modeling approach  
 35 that assumes the water in the region to remain stagnant for 30 years so that calculated  
 36 radionuclide concentrations are at their maximum values. Any groundwater migration into this  
 37 region, such as from rainwater or snow melt, would reduce the concentrations and drive the

1 results further below the design goal. This current analysis has been conservatively performed to  
 2 assure that actual operation of FRIB is bounded by these results (MSU 2010h).

3 Detailed results for the initial evaluation of bounding mixed-beam operations with the baseline  
 4 FRIB tunnel wall design are presented in Table 5–2. The beam energies listed in the table are for  
 5 a proton beam at 400 kW. The assumed second beam <sup>18</sup>O, which was assumed to operate half  
 6 the time was assessed at the equivalent energy for that beam at the same beam power. These  
 7 results are an average of the 99.9 percent volume concentrations of <sup>3</sup>H and <sup>22</sup>Na at various  
 8 locations along the linac tunnel. The values presented are based on operating the linac with  
 9 mixed beam for the entire facility lifetime.

10 **Table 5–2. Preliminary Modeling Results for Expected Mixed Beam Operations**

	<sup>3</sup> H (pCi/ml)	<sup>22</sup> Na (pCi/ml)
NRC Water Effluent Limit (Appendix B of 10 CFR20)	1,000	6
EPA Drinking Water Limits (40 CFR 141.66)	20	0.4
<b>Mixed Beam Operation at:</b>		
200 MeV	1.5	0.05
611 MeV	6.1	0.20
1 GeV	10	0.32

11 **Source:** MSU 2010h

12 The preliminary, very conservative modeling results indicate that potential ground water  
 13 concentrations of <sup>3</sup>H and <sup>22</sup>Na in the 99.9 percent volume around the tunnels are far below the  
 14 NRC water effluent limits and even below EPA drinking water standards. The NRC regulation  
 15 defines the concentrations of radionuclides in water that would be permitted unrestricted release  
 16 to the environment. By applying the much lower FRIB project goal of meeting EPA drinking  
 17 water limits, there will be negligible impact on the environment from groundwater activation.

18 **Decommissioning**

19 Dismantling the FRIB would require implementation of stormwater runoff controls similar to  
 20 those used during construction. No impacts on surface water are expected from FRIB  
 21 decommissioning activities. Water quality impacts on groundwater during decommissioning are  
 22 expected to be less than operations impacts. With the cessation of operations, there would no  
 23 longer be low levels of groundwater activation. Liquids would be removed from the accelerator  
 24 and the tunnel would be in 100 percent volume secondary containment or the liquid would be  
 25 pumped through closed-loop systems to prevent releases to groundwater.

**5.1.4 Climate and Air Quality**

**Construction**

Construction of the Proposed Action, especially excavation of the linac tunnel, would involve a significant amount of earthmoving over a period of about 2 years. These activities would involve the use of excavation equipment, trucks, other heavy construction equipment, and stationary equipment that would emit various air pollutants. There would be emissions of particulate matter from equipment activity and wind-blown dust. In addition to these air pollutant sources there would be emissions from construction worker vehicles, emissions from architectural coatings, and various chemicals. Emissions from construction equipment have been estimated using U.S. Environmental Protection Agency air pollutant emission factors for diesel and gasoline engines (EPA 1996) and estimated fuel use. Emissions from trucks and employee vehicles have been estimated using the Mobile 6.2 mobile source emission factor model (EPA 2003) and estimated vehicle mileage. These estimated emissions from construction are summarized in Table 5–3. Emissions associated with construction of the proposed facility would be less than 68 tons (61 metric tons) per year of particulate matter with a diameter of 10 micrometers or less. These emissions would be limited to the construction period and no long-term impacts on air quality. In addition to the criteria pollutants listed and carbon dioxide, diesel equipment would emit small quantities of other toxic pollutants including aldehydes; benzene; toluene; xylenes; propylene; 1,3-butadiene; formaldehyde; acetaldehyde; acrolein; and various polycyclic aromatic hydrocarbons (EPA 2003).

**Table 5–3. Estimated Construction Emissions**

Pollutant	Construction Equipment (metric tons per year)	Dust from Construction Activity (metric tons per year)	Trucks (metric tons per year)	Employee Vehicles (metric tons per year)
<b>Carbon monoxide</b>	0.24	N/A	0.45	20
<b>Nitrogen dioxide</b>	0.1	N/A	1.7	1.9
<b>Volatile organic compounds</b>	0.18	N/A	0.09	1.2
<b>PM<sub>10</sub></b>	0.07	61.1	0.04	0.058
<b>PM<sub>2.5</sub></b>	0.07	9.2	0.04	0.04
<b>Sulfur dioxide</b>	<0.01	N/A	<0.01	<0.01
<b>Carbon dioxide</b>	40.	N/A	300	760

**Key:** N/A=not applicable, PM<sub>n</sub>=particulate matter with an aerodynamic diameter less than or equal to *n* microns.

Air pollutant emissions from construction activity would be mitigated by using standard dust control practices such as water sprays and surfactants, proper maintenance of equipment, use of low-sulfur fuels, minimization of disturbed soil area, area revegetation as soon as possible, administrative controls such as sequencing and scheduling, and other measures as required by

1 MDNRE and MSU. Other measures, if needed, could be taken to minimize emissions such as  
2 using electric equipment.

3 The use of construction equipment, trucks, and employee vehicles is expected to cause some  
4 increase in greenhouse gas emissions in the form of carbon dioxide. These are summarized in  
5 Table 5–3. To a lesser degree, mobile sources emit methane and nitrous oxide during fossil fuel  
6 combustion. These emissions can be decreased with less idling and improved maintenance of  
7 equipment. Carbon dioxide emissions and other greenhouse gases from electric generation  
8 resulting from increased electric use during construction have been estimated to be 685 metric  
9 tons per year total CO<sub>2</sub> equivalent. The EPA has released guidelines for the proposed reporting  
10 of greenhouse gases (74 FR 16447), but there are currently no laws or standards for greenhouse  
11 gas emissions. The Michigan Climate Action Council has recently published its Climate Action  
12 Plan which recommends policies and actions to achieve greenhouse gas reduction in Michigan  
13 (MDEQ 2009).

#### 14 **Operation**

15 No continuous emissions of criteria air pollutants are expected directly from the proposed facility  
16 during operations; however, the increased electricity requirements during operation of the FRIB  
17 (discussed in Section 5.1.7) will be more than 6 times the power consumed by the NSCL.  
18 Current plans are to use existing offsite, commercial power sources for FRIB operations. Testing  
19 of existing emergency generators would continue but would not increase as a result of FRIB  
20 operation. Emissions of radionuclides are discussed in Section 5.1.9. Periodic ventilation of the  
21 confined systems would include some emissions of nitrogen oxides and ozone. These emissions  
22 are expected to be negligible. Trace emissions of evaporated solvents, acids, and other  
23 chemicals would be released from fume hoods. These emissions would be associated with  
24 research and development activities, and would therefore be exempt from Federal and Michigan  
25 State permitting requirements (MSU 2010a).

26 The Clean Air Act, as amended, requires that Federal actions conform to the host state’s “state  
27 implementation plan.” The final rule, “Determining Conformity of General Federal Actions to  
28 State or Federal Implementation Plans,” requires a conformity determination for certain-sized  
29 projects in nonattainment areas. MSU is within an area currently designated as attainment for  
30 criteria air pollutants. Therefore, a conformity determination for this project is not necessary to  
31 meet the requirements of the final rule (40 CFR 51.850–51.860).

32 The generation of steam and electricity for operation of the FRIB facilities will cause some  
33 increase in greenhouse gas emissions in the form of carbon dioxide. Periodic testing of  
34 emergency generators is not expected to result in any increase in carbon dioxide emissions.  
35 Carbon dioxide emissions and other greenhouse gases from electric generation resulting from  
36 increased electric use during operation have been estimated to be 100,000 metric tons per year  
37 total CO<sub>2</sub> equivalent based on the estimated annual electric use and annual emission rates for  
38 greenhouse gases for electric generation in Michigan (EPA 2010). Incremental greenhouse gas  
39 emissions attributable to FRIB operation would be about 0.0014 percent of the total annual  
40 United States greenhouse gas emissions in 2005 (7.3 billion metric tons) (EPA 2007). Future  
41 greenhouse gas emissions reporting of carbon dioxide, methane, and nitrous oxide for large

1 fossil-fuel fired electric generating units and boilers may be necessary per EPA’s proposed rule  
2 (74 FR 16447). Currently there are no emission standards for greenhouse gas emissions.

### 3 **Decommissioning**

4 During decommissioning, construction-type activities would occur. There would be emissions  
5 from various pieces of equipment and from trucks moving material to fill the linac tunnels, if that  
6 decommissioning option is selected. It is expected that these activities would be more limited in  
7 emissions and duration than the original construction because the present decommissioning plans  
8 do not include a major excavation. In the event of a major excavation, impacts would be similar.

### 9 **5.1.5 Biological Resources**

10 As the project site has been previously disturbed and has a high degree of development, impacts  
11 on protected flora and fauna are not expected. Since neither threatened and endangered species  
12 nor critical habitat occur in the project area, formal consultations with the U.S. Fish and Wildlife  
13 Service and the MDNRE were not conducted.

### 14 **5.1.6 Noise**

#### 15 **Construction**

16 Noise impacts were analyzed by comparing the expected noise levels to a baseline level and its  
17 possible effects on people in the area. Construction noise was evaluated for typical construction  
18 equipment operating on a construction site. Typical construction equipment was assumed to be  
19 used (see Table 5-4).

20 **Table 5–4. Maximum Noise Levels at 50 Feet for**  
21 **Common Construction Equipment**

<b>Equipment Type</b>	<b>Maximum Noise Level (<math>L_{max}</math>) at 50 feet (dBA, slow)<sup>a</sup></b>
Compactor (ground)	80
Dozer	85
Dump Truck	84
Excavator	85
Generator	82
Grader	85
Pickup Truck	55
Warning Horn	85
Crane	85

22 **Key:** dBA = decibels A-weighted;  $L_{max}$  = maximum noise level.

23 <sup>a</sup> dBA, slow refers to a sound level meter sampling speed

24 **Source:** DOT 2006.

1 For purposes of analysis, it was assumed that the primary sources of noise during these activities  
 2 would be truck and vehicle traffic, heavy earthmoving equipment, and other construction  
 3 equipment or infrastructure powered by internal combustion engines used on site.

4 Construction equipment and construction worker vehicles would emit noise and result in an  
 5 increase in noise levels around the project site, along routes used to access the site, and near the  
 6 soil storage area. There may be some railroad activity associated with delivery of materials to  
 7 the campus. Changes in noise level would be temporary, although they could occur over several  
 8 years, and would be in accordance with MSU construction guidelines.

9 Using the Federal Highway Administration’s Roadway Construction Noise Model, construction  
 10 equipment was assumed for construction activities to produce noise levels at various distances  
 11 from the project site. Noise levels were evaluated for receptors at 100-foot increments. Noise  
 12 abatement measures were not considered in this analysis. Noise levels were calculated as an  
 13 equivalent noise level (average acoustic energy) over an 8-hour period ( $L_{eq(8)}$ ). The maximum  
 14 noise level ( $L_{max}$ ) shows the noise level of the loudest piece of equipment, which is generally the  
 15 largest contributor of the  $L_{eq(8)}$  noise level.

16 Potential noise sources would include variable pitch and volumes from vehicles and equipment  
 17 involved in clearing and grading the site, creating and/or placing engineered structures, and  
 18 conducting interior/exterior finish work. Table 5–5 shows the noise levels expected at distances  
 19 in 100-foot increments, as well as at the receptor sites, from the use of construction equipment.

20 **Table 5–5. Noise Levels at Specific Distances from**  
 21 **the Construction Site**

Distance from Construction Site (feet)	Maximum Noise Level <sup>a</sup> ( $L_{max}$ ) dBA	Equivalent Combined Noise Level ( $L_{eq}$ ) dBA
100	79.0	81.2
200	73.0	75.2
300	69.4	71.7
400	66.9	69.2
500	65.0	67.3
1,000	59	61.2
1,500	55.5	57.7
2,000	53	55.2

22 **Key:** dBA = decibels A-weighted;  $L_{max}$  = maximum noise level;  $L_{eq}$  = equivalent noise level.

23 <sup>a</sup> This is the noise level of the loudest piece of equipment; it is not a cumulative

24 Workers associated with construction activities would be expected to wear appropriate hearing  
 25 protection as required by the Michigan Occupational Safety and Health Administration  
 26 Department of Labor and Economic Growth (MIOSHA) standards-MIOSHA-STD-1405,

1 Part 680 and BSR-STD-1210, Part 380 (MIOSHA 2005, 2003). Sustained exposure to noise  
2 levels exceeding 80 decibels may result in hearing loss.

3 Under the straight configuration option, the nearest noise-sensitive receptors include dormitories  
4 north of Shaw Lane that are within about 140 feet (43 meters) of the proposed tunnel excavation  
5 location and within 50 feet (15 meters) of the proposed front end building location. Other noise-  
6 sensitive facilities within 150 feet (46 meters) of the excavation could include the Wharton  
7 Center for Performing Arts, the plant biology laboratories, and the Biochemistry Building.  
8 Under the double folded configuration, the Biochemistry Building, which includes laboratories  
9 that contain vibration-sensitive experiments, is within about 50 feet (15 meters) of the tunnel  
10 excavation and the connector high bay and south high bay extensions. Pedestrians in the area  
11 near the construction site would be impacted by construction noise. Construction noise could be  
12 mitigated by employing standard construction noise mitigation, including use of quieted  
13 equipment, shielding of noisy equipment and activities, careful location of noisy equipment,  
14 proper maintenance of equipment, and administrative controls such as scheduling to avoid  
15 interfering with noise-sensitive activities.

## 16 **Operation**

17 Noise sources associated with operation of the FRIB would include ventilations systems,  
18 possibly including one or more stacks; the cryogenics system compressors; and pumps. Some  
19 stacks and pressure relief valves would operate occasionally. During the design of these  
20 facilities, noise impacts on sensitive receptors from stacks and other sources would be  
21 considered. There would be some traffic noise from deliveries to the facility and from employee  
22 and researcher vehicles. It is expected that the number of truck trips from deliveries would be  
23 similar to existing trips for the NSCL (MSU 2010a).

## 24 **Decommissioning**

25 During decommissioning, noise sources would be similar to those during construction, although  
26 the amount of earthmoving activity would be much less. Therefore, noise impacts from  
27 decommissioning would be expected to be less.

## 28 **5.1.7 Utilities**

### 29 **Construction and Operation**

30 For the Proposed Action, connections would be made to existing utilities (e.g., power, potable  
31 water). Current utility easements would be maintained, to the extent practicable. If necessary,  
32 additional easements, or an extension to an existing easement, would be established for  
33 installation of required utilities.

### 34 **Electricity**

35 As indicated in Chapter 4, power for the proposed FRIB would be supplied by existing  
36 commercial power providers. As noted, the MSU Power Plant has a 60 megawatt capacity with  
37 current usage at 42 megawatts and is served by an existing substation that can bring  
38 commercially produced power off of the Michigan electric grid. MSU is proposing to use the

1 existing 21 MW substation at the power plant and a new duct bank to bring power to FRIB. An  
2 upgrade of the power plant is therefore not needed. Emergency power would be supplied by an  
3 uninterruptible power supply (MSU 2010a).

4 Electricity requirements for FRIB construction would be 3.2 megawatt-hours per day, with a  
5 peak usage of 0.45 megawatts, and a total usage of 960 megawatt-hours. A local, existing MSU  
6 power plant substation would be adequate for FRIB construction.

7 No environmental impacts are expected as a result of utility line extensions and power  
8 distribution improvements. Existing site utilities would be relocated prior to the tunnel  
9 excavation. The utility relocations (e.g., a utility bridge over the linac tunnel) would be phased  
10 in order to minimize interruptions to existing facilities. (MSU 2010a). Prior to construction,  
11 certain infrastructure that cannot be relocated (i.e., existing steam tunnels, large sewer, chilled  
12 water, electrical, and telecommunications duct banks located along Bogue Street and South Shaw  
13 Lane) would require proper design and planning to assure their protection (NTH 2009). Any  
14 earth-retention system design would incorporate the location of these utilities and provide a  
15 method to protect the utilities during FRIB construction (e.g., provide a method to support the  
16 utilities within the excavation inside the earth retention system). During the design phase of this  
17 action, each utility would be reviewed to determine its tolerance for movement, potential impacts  
18 of various support methods on the utilities, and the appropriate method to support each utility  
19 (NTH 2009).

20 Estimated power requirements for FRIB operations are about 18 megawatts (MSU 2010a). The  
21 recent electric energy usage at the NSCL has been equivalent to about 18,000 to 29,000  
22 megawatt-hours per year (MSU 2010a). Assuming continuous operating requirements for FRIB  
23 of about 18 megawatts, the annual FRIB electric energy usage would be about 158,000  
24 megawatt-hours, or an increase of about 129,000 to 140,000 megawatt-hours annually from  
25 current NSCL operations. This would increase the overall MSU annual electric energy usage of  
26 about 370,000 megawatt-hours (MSU 2010a) by about 35 to 38 percent.

## 27 **Fuel**

28 Fuel necessary for construction of the proposed facility would consist of propane, diesel fuel, and  
29 gasoline. Fuel consumption for construction is estimated to be 12,000 gallons (45,000 liters),  
30 161,000 gallons (610,000 liters), and 27,500 gallons (102,000 liters), respectively. (MSU 2010a).

31 FRIB operations fuel use is anticipated to be similar to the limited usage of fuels at the existing  
32 NSCL operations due to the fact that fuels will not be used for heating or other industrial  
33 purposes.

## 34 **Inert Gas**

35 Industrial gases estimated to be utilized during FRIB operations consist of approximately  
36 19 million pounds (8,600 metric tons) per year of nitrogen and approximately 33,000 pounds  
37 (15 metric tons) per year of helium (MSU 2010a).

1 **Water**

2 Nonpotable water usage for FRIB construction is estimated to average 800 gallons (3,000 liters)  
3 per day, with a peak usage of 10,000 gallons (38,000 liters) per day. The estimated total use of  
4 nonpotable water necessary for FRIB construction is 240,000 gallons (908,000 liters). The  
5 average potable water usage for FRIB construction is estimated to be 200 gallons (750 liters) per  
6 day, with a peak usage of 800 gallons (3,000 liters) per day. The estimated total use of potable  
7 water required for FRIB construction is 240,000 gallons (908,000 liters) (see Chapter 3,  
8 Table 3–1).

9 FRIB operations would not require the use of nonpotable water. Although the total amount of  
10 potable water required to support FRIB operations is undetermined at this time, it is anticipated  
11 that the MSU Physical Plant Division would have the ability/capacity to supply the necessary  
12 water needed.

13 The estimated volume of industrial wastewater discharge from FRIB operations is 300 gallons  
14 (1,100 liters) per day. Potable water usage for operations of the FRIB is undetermined at this  
15 stage of design; however, potable water usage is anticipated to be similar to current potable water  
16 usage for the NSCL’s operations.

17 **Decommissioning**

18 The utility requirements for FRIB decommissioning are anticipated to be less than those  
19 necessary to support operations. Decommissioning would likely require the same or less than  
20 the amount of utilities required during FRIB construction.

21 **5.1.8 Cultural and Historical Resources**

22 All surface areas of the project site have been previously disturbed. Based on archaeological and  
23 architectural surveys previously conducted on the MSU campus in the vicinity of the NSCL  
24 (Goldstein 2010), no impacts are expected on cultural or historical resources during FRIB  
25 construction, operations, or decommissioning, including excavation or equipment storage and  
26 rock/soils stockpiling in the proposed construction staging or soils disposal areas.

27 Hence DOE has made a determination pursuant to 36 CFR 800.4(d)(1) that no historic properties  
28 will be affected (see Appendix D). Supporting documentation (Goldstein 2010) included in  
29 Appendix D mentions a historic farmstead in the vicinity of the soils disposal area. However,  
30 this farmstead is outside of the FRIB undertaking’s area of potential effect. Consultation with the  
31 Michigan State Historic Preservation Officer is ongoing. A copy of this consultation is provided  
32 in Appendix D. If the Michigan State Historic Preservation Office responds to DOE’s  
33 determination, appropriate documentation will be included in the Final FRIB EA.

34 **5.1.9 Human Health and Safety**

35 **5.1.9.1 Construction**

36 Construction workers normally would not be working in any radiation areas associated with  
37 operation of the existing NSCL facility and would be expected to receive radiation doses no

1 more than is allowed to the general public under the ALARA program. When the final  
2 connection of the new target building is made to the existing experimental areas, some workers  
3 may require radiation worker training before they are allowed into existing NSCL areas. Most  
4 radiation exposure potential associated with the construction activities, such as use of  
5 radiography sources or other licensed radioactive material, would be managed by the  
6 contractor(s) in accordance with the applicable regulations and the terms of their license(s). The  
7 primary source of health and safety impacts from construction would be work-related accidents  
8 and illnesses typical of excavation and heavy construction activities. The Michigan average  
9 injury/illness incidence summaries for “Heavy and Civil Engineering Construction” for 2004–  
10 2008 (BLS 2010a) indicate an average rate of total recordable cases of 5.3 cases per 200,000  
11 labor hours. “Recordable cases” refers to occupational injuries and illnesses that are recordable  
12 under U.S. Occupational Safety and Health Administration regulations (29 CFR 1904). The  
13 FRIB project schedule shows construction proceeding from November 1, 2012, to September 30,  
14 2016 (47 months or 3.92 years), and a peak workforce of 175. Assuming each worker is on the  
15 job 2,000 hours per year, a bounding estimate of construction labor hours is 1.37 million. At a  
16 rate of 5.3 recordable cases per 200,000 labor hours, it is calculated that there would be 36  
17 recordable illness/injury cases during the 47-month construction period. The probability of a  
18 single construction worker fatality during that same period would be about 0.07.

19 As noted in Section 3.1, construction of the linac tunnel would involve excavating a trench up to  
20 1,800 feet (550 meters) long to a depth of between 30 and 75 feet (9 and 23 meters) across the  
21 campus, necessitating the closure of Bogue Street between Wilson Road and Shaw Lane for up  
22 to 3 years and possible closure of portions of Shaw Lane for a number of months. The hazards to  
23 students and passers-by from moving equipment and from the excavation itself may require  
24 mitigation. State of Michigan Occupational Safety and Health Administration (MIOSHA)  
25 regulations requiring the construction contractor to provide for appropriate shoring of  
26 excavations, maintain stable slopes within the excavations and on any soil stockpiles, and limit  
27 the possibility for unauthorized and inadvertent entry into hazardous areas would also provide  
28 protection for students and passers-by. By rerouting roads and sidewalks and installing physical  
29 barriers, warning signs, and informational postings directed at the campus population, MSU and  
30 the local public safety agencies could further reduce the potential for accidents or injuries  
31 resulting from construction traffic or inadvertent entry into the active construction area.

32 Vehicle accidents are a source of possible health and safety impacts from construction. The  
33 construction-related traffic on public roads on and near the MSU campus and the accident, injury  
34 and fatality rates are developed in Section 5.1.11. The total number of construction vehicle-  
35 miles is estimated to be 477,100. For this total mileage, fewer than 2 accidents could be  
36 anticipated and the probability of an injury in an accident would be 0.36, or about one chance in  
37 three. The probability of a fatality would be 0.005 or about five chances in one thousand. The  
38 miles driven by workers commuting to and from the project site would total about 5.3 million  
39 during the construction phase of the project. About 17 accidents and 4 injuries could be  
40 anticipated, and the probability of a single fatality in an accident would be about 0.05. Because  
41 transportation of excavated soil to the staging area accounts for less than one-tenth of the total  
42 construction vehicle miles, stockpiling excavated material at the construction site instead of  
43 transporting it to the staging area would not appreciably decrease the overall impacts.

1 The accident frequency statistics used in these estimates are for all types of motor vehicle  
2 accidents, including those involving pedestrians and cyclists. About one-tenth of the overall  
3 fatality rate per motor vehicle mile is due to pedestrian fatalities, and about one-fiftieth (0.02) of  
4 the overall rate is due to cyclist fatalities. Accordingly, the probability of a construction-related  
5 motor vehicle accident that results in pedestrian fatality would be about 0.006. The probability  
6 of a cyclist fatality resulting from a construction-related motor vehicle traffic accident would be  
7 about 0.001. This calculation makes use of average accident, injury and fatality rates and the  
8 results do not mean that a particular number of accidents, injuries, or fatalities would actually  
9 occur. They do, however, provide a means to compare vehicle accident risk with other types of  
10 health and safety impacts associated with the Proposed Action. Mitigation measures such as  
11 construction of new traffic or pedestrian lanes or closure of on-campus roads and rerouting of  
12 non-construction traffic during peak periods of activity could reduce construction vehicle  
13 accident rates below those indicated by the statistics. Similarly, measures that result in increased  
14 use of public transit or carpooling may reduce both the total number of vehicle miles associated  
15 with construction and the per-mile accident rates for commuting workers.

## 16 **5.1.9.2 Operations**

### 17 **5.1.9.2.1 Worker Impact from Normal Operations**

#### 18 **Occupational Health and Safety**

19 The occupational health and safety program at the NSCL is registered as Occupational Health  
20 and Safety Assessment Series 18001-compliant. The record of worker injuries and illnesses  
21 suggests that the program is effective. As noted in Section 4.9 of this EA, the NSCL rates of  
22 recordable and lost work-time injuries/illnesses are significantly lower than the averages for  
23 universities in the United States and for colleges, universities, and professional schools in  
24 Michigan. Completion of the FRIB would increase the number of NSCL staff from about 340 to  
25 about 500; however, the general nature of the operations and the adequacy of the existing  
26 Occupational Health and Safety program to manage workplace hazards should not change.  
27 Assuming that the average injury/illness rates shown in Chapter 4, Table 4-3 (1.4 recordable  
28 injury/illness cases and 0.2 lost work-time cases per 200,000 labor hours) remain unchanged, the  
29 addition of 160 full-time staff (320,000 person-hours per year) would be expected to result in an  
30 increase in the number of NSCL staff reportable injuries/illnesses from about 4.8 per year to  
31 about 7 per year. The average number of lost work-time injuries/illnesses per year among the  
32 NSCL staff would be expected to increase from 0.7 to 1.0.

#### 33 **Radiological Safety**

34 The stated strategy of radiation safety management at the NSCL is to: 1) abide by all limits and  
35 license commitments, 2) maintain individual and collective doses consistent with the MSU and  
36 FRIB as low as reasonably achievable (ALARA) program goals, and 3) manage the facility  
37 consistent with integrated safety management (ISM) practices through its certified ISO and  
38 OHSAS programs. Incidents and near-misses are investigated and subjected to causal analysis  
39 and corrective or preventative actions are developed, implemented and communicated to  
40 personnel. The strategy appears to be effective. Incidents and near-misses at NSCL since the  
41 institution of the current NSCL certified ISO 9001 (Quality Management Systems), ISO 14001

1 (Environmental Management Systems), and OHSAS 18001 (Occupational Health and Safety  
2 Management Systems) programs have been localized and were not considered to pose significant  
3 hazards to personnel, public or the environment. Since 1990, MSU has implemented and  
4 maintained an ALARA program, which has been implemented for NSCL operation and will be  
5 extended to the FRIB.

6 Construction workers would not normally be radiation workers and would be expected to receive  
7 radiation doses no more than is allowed to the general public under ALARA goals. When the  
8 final connection of the new target building is made to the existing experimental areas, some  
9 workers may require radiation worker training before they are allowed into existing NSCL areas.

10 For the October 2008 through September 2009 period, 443 personnel were monitored  
11 (i.e., assigned a personal radiation dosimeter). Of that number, 125 individuals received doses  
12 over 10 millirem/person/year. The highest dose recorded by any of these individual workers was  
13 388 millirem, well below the regulatory limit of 5,000 millirem per year and the ALARA  
14 (i.e., MSU administrative) goal of 500 millirem per year. These values are representative of the  
15 radiation safety record at the NSCL over the past 5 years. During that time no individual worker  
16 has exceeded the MSU ALARA goal.

17 The operation of the FRIB is expected to add about 160 technical staff positions (facility  
18 operations staff, visiting scientists, occupational safety and facility maintenance staff) to the  
19 existing NSCL complement. Many, if not all, of the new staff would be expected to be radiation  
20 workers and receive some radiation dose in the course of a year. The increased number and  
21 complexity of the operations associated with the FRIB may have the potential to increase the  
22 average worker doses. However, based on the evidence of past performance, the existing NSCL  
23 radiation safety management strategy should provide a suitable framework for developing  
24 specific controls needed to maintain individual and collective doses within the ALARA goals  
25 and well below regulatory limits.

26 Assuming that each of the approximate 600 FRIB radiation workers (443 current plus 160  
27 additional for the FRIB) receives an average annual dose of 13 millirem/person/year, the  
28 projected collective dose to the whole worker population would be about 7.8 person-rem per year  
29 (the collective sum of all individual doses for 600 workers). Based on a dose-to-LCF factor of  
30 0.0006 LCF per person-rem for both workers and the general public (DOE 2003), the probability  
31 of a single latent cancer fatality (LCF) resulting from radiation is estimated to be 0.0047. In  
32 other words, the probability that there would be 1 LCF among the 600 workers is about 0.0005  
33 or one-half of 1 percent per year. Over a 30-year facility operating life, the chance that there  
34 would be 1 LCF resulting from radiation among the worker population is about 0.14 or 14  
35 percent.

### 36 **5.1.9.2.2 Public Impact from Normal Operations**

#### 37 **5.1.9.2.2.1 Impacts from Traffic**

38 The estimated increase in local vehicle travel resulting from FRIB operations is presented in  
39 Table 5-6. Table 5-7 presents the projected accident and injury impacts of the increased traffic.  
40 Each year of operation of the FRIB is expected to result in approximately 2 additional traffic  
41 accidents in the surrounding region. Assuming accident, injury, and fatality rates remain

1 unchanged, about 65 additional traffic accidents are expected over the 30-year projected  
2 operational life of the facility. About 16 additional injuries are expected during that period and  
3 the probability of a fatality would be about 0.2 or 2 chances in 10.

#### 4 **5.1.9.2.2.2 Impacts from Direct Radiation**

5 U.S. Nuclear Regulatory Commission regulations and MSU Environmental Safety and Health  
6 (ESH) policies limit the total dose to individual members of the public to 100 millirem per year,  
7 with a limit of 2 millirem in any one hour from external (direct radiation) sources (10 CFR 20).  
8 MSU has committed to design goals for the FRIB of less than 10 millirem per year to the public  
9 with a maximum of 2 millirem in any one hour from external sources.

10 The direct radiation sources and potential dose impacts associated with operation of an  
11 accelerator facility can be estimated based on such factors as the properties of the particle beam,  
12 the physical configuration of the facility, the materials used in key components, and equipment  
13 performance characteristics. Documentation of these factors supports the ALARA program  
14 implementation and assures that the key elements of the program are maintained. Making  
15 estimates of the public dose impacts and refining the facility design to meet radiological safety  
16 goals is an integral part of the design effort. Several iterations of the process are expected as the  
17 design progresses from conceptual to final. The buried configuration of the linac tunnel should  
18 be a positive attribute in this regard because of the shielding provided by the natural shielding of  
19 the soil covering the tunnels. At other large accelerators, shielding, beam dumps, and accelerator  
20 controls have been successfully designed and implemented to keep direct radiation impacts on  
21 the public well below applicable standards and the radiological safety performance of those  
22 facilities is being considered in the FRIB design. After FRIB operations begin, operational  
23 controls would be implemented and surveillance would be required to ensure that the regulatory  
24 limits are met, and also to assess performance against the design goal.

#### 25 **5.1.9.2.2.3 Impacts from Release of Radioactive Material to the Atmosphere**

26 During the operation of the linac, radioactive material that could potentially be released to the  
27 atmosphere would be produced by two primary mechanisms: activation of air in the linac tunnel  
28 and target area by radiation produced by the beam interacting with matter, and activation of the  
29 water in the closed cooling loops for the target and beam stop. U.S. Environmental Protection  
30 Agency regulations (40 CFR 61) limit the annual dose to members of the public as a result of air  
31 emissions from a facility to 10 millirem. For the FRIB, MSU has committed to a design goal of  
32 10 percent of the regulatory limit (1 millirem per year) as a result of airborne emissions to the  
33 nearest receptor. Based on a dose-to-LCF factor of 0.0006 LCF per person-rem, consistent with  
34 the recommendation of the DOE Office of Environmental and Policy Guidance (DOE 2003), this  
35 translates to an annual LCF probability of  $6 \times 10^{-7}$  or 6 chances in 10 million.

36 **Linac tunnel air.** Operation of the linac would activate the air in the tunnel, producing  
37 radioactive isotopes of nitrogen, oxygen, hydrogen, carbon, and other elements. To achieve the  
38 design goal of limiting radiation exposures to the public and workers consistent with the ALARA  
39 program, the exchange of air between the linac tunnel and the surrounding environments would  
40 need to be controlled. The facility conceptual design calls for the air in the tunnel to be  
41 continuously circulated and filtered to reduce the quantity of radioactive material in the air.

1 When entry into the tunnel for maintenance is required, administrative controls would be used to  
2 delay the opening of the tunnel and the exchange of air with the outside environment until the  
3 short-lived (primarily gaseous) isotopes have decayed. The air would then be sampled to  
4 confirm that any release of radioactive or other hazardous material to the atmosphere is within  
5 acceptable limits. Because many of the radioactive isotopes that are expected to be produced in  
6 the tunnel have half-lives ranging from fractions of a second to a few hours, delaying the release  
7 of tunnel air for a period of hours following shutdown of the linac would make it possible to  
8 effectively manage the radioactive emissions. The design approach is that public radiation dose  
9 from release of the tunnel air to the environment immediately after shutdown of the linac several  
10 times per year would be at or below the regulatory limit, and that delaying the releases for even a  
11 few hours after shutdown would result in doses well below the design goal of 1 millirem per  
12 year.

13 **Target and Beam Dump Cooling Water.** The energy of the FRIB particle beam would be  
14 largely deposited in the targets and the beam dump, both of which require continuous cooling.  
15 The conceptual design accomplishes the heat removal function with closed cooling water loops.  
16 Activation of the cooling water by the beam would produce a number of different isotopes of  
17 nitrogen, oxygen, hydrogen, carbon, and other elements. In addition, hydrogen gas would be  
18 produced by radiolysis of the water. The use of closed cooling loops controls the release of  
19 volatile radioisotopes. To control the accumulation of hydrogen gas in the cooling water, a gas-  
20 liquid separator tank will be placed at a high point in the system. Gas that collects in the gas-  
21 liquid separator tank could be circulated through a closed system to convert the hydrogen gas to  
22 water while allowing the other gases and volatile radionuclides to accumulate in the gas phase  
23 until each reaches an equilibrium concentration dependent on its production rate and half-life or  
24 be processed via the FRIB offgas treatment system. The entire amount of mobile radioactivity  
25 created by the beam in the water would thereby be retained within the water loops and the offgas  
26 treatment system. To allow for periodic system maintenance, the conceptual design provides for  
27 the accumulated gases to be purged to a holding (decay) tank, where the radioactivity would be  
28 allowed to decrease before the contents are sampled, filtered, and released to the atmosphere.

29 At the conceptual design stage, the cooling water and offgas treatment systems are being  
30 configured to meet the regulatory limits on radioactive air emissions and to achieve the public  
31 dose design goal. The design features under consideration are straightforward and the  
32 technologies are mature.

#### 33 **5.1.9.2.2.4 Impacts from Release of Chemicals to the Atmosphere**

34 Scattered radiation from the linac beam losses create ozone and oxides of nitrogen in the tunnel  
35 air. Preliminary calculations and experience at other accelerator facilities indicate that the  
36 concentrations of both ozone and nitrogen oxides in the tunnel air at the time of shutdown would  
37 be below the applicable emergency exposure guidelines (DOE 2009b) at the time of shutdown.  
38 Both materials are chemically reactive and degrade fairly rapidly through interactions with other  
39 materials in the air. As discussed in Section 5.1.9.1.2.2, opening of the tunnel following  
40 operations would need to be delayed to allow decay of the short-lived radionuclides in the air,  
41 and the air concentrations of both ozone and oxides of nitrogen should drop well below  
42 applicable emissions limits in that time.

1 **5.1.9.2.2.5 Impacts from Irradiation of Groundwater**

2 Neutrons produced from scattered linac beam that penetrates the tunnel wall activate various  
3 elements in the surrounding soil and groundwater. Radioactive material thus produced might  
4 contribute to public dose from the FRIB operation, primarily by the groundwater consumption  
5 pathway, if steps were not taken during the design and operation of the FRIB to ensure that the  
6 concentrations in the groundwater adjacent to the tunnels were very small.

7 Activation of soil and groundwater has been observed in connection with the operation of other  
8 high-energy particle accelerators. The FRIB is being designed to incorporate lessons learned  
9 from past experience at other accelerators in order to minimize the amount of groundwater  
10 activation with FRIB operations.

11 Depending on the final design, the FRIB linac tunnel could be beneath the groundwater table  
12 over its entire length. In addition, rainwater and snowmelt may also be in the region close to the  
13 tunnel walls. Scattered radiation from the beam that penetrates the tunnel walls and structural  
14 materials would have the potential to activate both soil and water directly outside the tunnel  
15 walls. The water that may be outside the tunnel walls and subject to activation would not be  
16 readily available for consumption by the public. That water would have to migrate and would be  
17 diluted with time and distance. The nearest wells to the FRIB are on the south campus (over  
18 900 meters or 0.56 miles away) and used for agricultural purposes. The radioactive material  
19 concentrations in any water that ultimately migrated away from the tunnels would be highly  
20 diluted and well below concentrations at the FRIB, and therefore well below any regulatory  
21 standard.

22 **Design Goals to Ensure Minimal Impacts.** As indicated in Section 5.1.3.2, FRIB operations  
23 could result in low levels of activation of groundwater, which MSU would manage according to  
24 U.S. Nuclear Regulatory Commission license requirements. The FRIB project has established a  
25 design goal that would keep the average radioactive material concentrations in groundwater in  
26 the region around the linac tunnel walls (within about 10 feet (3 meters)) below the drinking  
27 water limits established by the EPA and therefore well below the NRC water effluent limits. The  
28 EPA limits apply to water provided by a drinking water supplier after pumping and filtering.  
29 Hence, ensuring that the water in the 99.9 percent volume adjacent to the FRIB tunnels would  
30 meet drinking water standards for radioactive materials provides a very high degree of protection  
31 of both the public and the environment. The FRIB design goals and regulatory limits are  
32 presented in Table 5–1. The FRIB goal of protecting the groundwater adjacent to the FRIB  
33 tunnels to EPA drinking water standards would ensure that the radioactive material  
34 concentrations in any water that ultimately migrated away from the tunnels to a point that it  
35 might be utilized as drinking water would be highly diluted and well below concentrations at the  
36 FRIB.

37 **Preliminary Results of Modeling.** Activation of groundwater outside the linac tunnel is being  
38 addressed at the conceptual design stage. A conservative, preliminary evaluation of the potential  
39 for groundwater activation has been performed as described in Section 5.1.3.2 and indicates that  
40 the baseline design for the tunnel walls and use of soldier piles for shoring provides adequate  
41 shielding to meet the FRIB project design goals (MSU 2010h). See Section 5.1.3.2 for more

1 details. Thus if the groundwater concentration in the vicinity of the FRIB tunnels can be  
2 maintained below EPA drinking water standards, the potential for human impacts are small.

3 To ensure that the FRIB impacts from irradiation of groundwater are managed over the long  
4 term, the FRIB will use the combination of good design, operational controls and surveillances  
5 during operation.

6 **Design.** The FRIB design process would reduce the potential for groundwater impacts by (1)  
7 reducing beam losses that would penetrate the linac and tunnel walls, and (2) ensuring that the  
8 tunnel wall design provides adequate shielding to reduce impacts on adjacent soils and  
9 groundwater.

10 Managing the routine beam losses (scattering) through design is important for several reasons.  
11 In addition to activating soil and water outside the tunnel, excessive beam loss may degrade both  
12 the operational capacity (useful beam energy) and activate equipment and materials inside the  
13 tunnel, thereby creating elevated radiation levels and doses to workers in the tunnel after  
14 shutdown. Therefore the entire linac system would be designed to minimize beam loss.

15 In addition, the tunnels walls would be designed to provide adequate shielding given the  
16 maximum beam loss from normal operations consistent with the design approach used at other  
17 linear accelerators

18 **Operational Controls.** The preliminary, conservative modeling approach assumes a continuous  
19 beam loss of 1 W/m over the entire length of the linac tunnel. It is also assumed that the  
20 groundwater adjacent to the tunnel remains stagnant for 30 years so that the calculated  
21 radionuclide concentrations in the water are at their maximum values. Diagnostic and protective  
22 features should reduce the average beam loss to less than the assumed value. The diagnostic and  
23 protective features would also limit temporary beam diversions to a few seconds or less and in  
24 the worst case would terminate the operation of the linac upon detection of abnormal conditions  
25 for which the control system could not correct. These features would be expected to limit the  
26 duration and intensity of any scattered or misdirected beam that might activate soil and  
27 groundwater outside the tunnel so that these abnormal operations have only a negligible  
28 contribute to soil activation.

29 **Surveillance.** Periodic measurements of radiation levels in the tunnel provide means to detect  
30 excessive beam scattering before the concentration of radioactive material in groundwater  
31 approaches a level of concern. Comparison of surveillance results with the radiation levels that  
32 are expected (based on the facility operating status and history) should highlight abnormal trends  
33 and cause them to be investigated. This would be corroborated with periodic groundwater  
34 samples.

### 35 **5.1.9.2.3 Impacts from Accidents**

36 In accordance with National Environmental Policy Act guidelines, an assessment of the  
37 environmental impacts of proposed actions should include consideration of the potential impacts  
38 of “reasonably foreseeable accidents” and intentional destructive acts (DOE 2002). The results  
39 of the accident impact analyses provide information to the decision process with regard to the

1 possible (as opposed to the expected) impacts from choosing a given alternative or course of  
2 action.

### 3 **5.1.9.2.3.1 Reasonably Foreseeable Accidents**

4 Accident conditions (including radiological) are initially postulated as part of the development of  
5 a conceptual design, which is ongoing for the FRIB. These analyses continually evolve as the  
6 design effort progresses to ensure all credible hazards are evaluated and appropriate controls are  
7 included in the design to safeguard the public, FRIB personnel, environment, and FRIB mission.  
8 For the FRIB, hazards that have been identified include electrical and chemical hazards, non-  
9 ionizing radiation (lasers), and waste handling, as well as ionizing radiation, oxygen-deficient  
10 atmosphere, and cryogenic hazards for the accelerator, target building, and support systems.  
11 Appendix C presents a summary of the results of the ongoing process of accident/hazard  
12 identification and evaluation and presents a listing of some of the more significant event types  
13 that are being addressed through the design process. Appendix C includes the range of accident  
14 conditions identified during the conceptual design effort and lists the possible causes or initiating  
15 events, the nature of the impacts, and the design features or operational controls that would  
16 prevent the accident or mitigate the consequences. The adequacy of the initial suite of potential  
17 controls for these postulated accident scenarios is best understood when assessed for the  
18 individual accident scenarios as presented in Appendix C. The listed controls demonstrate both  
19 that controls can be selected to assure that the hazard can be adequately controlled and that there  
20 is adequate defense in depth within the design to assure that the facility can operate safely.

21 At the conceptual design stage, the details of possible accident scenarios and their associated  
22 frequencies are often very uncertain and it is difficult or impossible to distinguish “reasonably  
23 foreseeable” scenarios from those that are purely hypothetical. For some accidents, the  
24 radiological source terms can be estimated at the conceptual design stage based on the  
25 experience of other accelerator facilities and the expected performance of FRIB systems. For  
26 others, the source terms are more difficult to estimate until the design progresses. At this early  
27 stage of design, conservative and/or bounding conditions and analysis for the more significant  
28 types of events have been performed. Six representative accident scenarios that are being used to  
29 guide the design evolution are summarized below.

- 30 • **Loss of beam control.** Although some very small beam losses are anticipated for normal  
31 FRIB linac operation, a conservative analysis was performed for a focused 400-kilowatt  
32 proton beam loss at a single location on the linac beam pipe. The concrete tunnel wall  
33 was assumed to be 20 inches (51 centimeters) thick with nominally 23 feet (7 meters) of  
34 soil serving as additional shielding. Although typical beam diagnostics and control  
35 systems would be expected to automatically shut down the beam within a fraction of a  
36 second, it was determined that shutting the beam down within approximately 13 seconds  
37 would prevent the direct radiation dose to the public at ground level from exceeding the  
38 normal operation regulatory limit of 2 millirem in any one hour. If the beam loss is over  
39 a larger area (which is more likely than its being focused at single location) the dose rate  
40 at the ground level receptor location would be even lower.
- 41 • **Release of air activation products from the linac tunnel.** Some activation of air within  
42 the FRIB linac tunnel and target regions occurs during operation, resulting primarily in

1 the production of short-lived radionuclides. Release of the activated air from the tunnel  
2 following shutdown of the accelerator would be controlled to allow most of the short-  
3 lived activity to decay before it is released. It was conservatively assumed that  
4 100 percent of the activated air in the tunnel would be inadvertently released to the  
5 atmosphere immediately after shutdown of the linac after a full year of operation with a  
6 proton beam. The results indicate that administrative and engineered controls  
7 (e.g., filtration) would be needed to reduce the level of radioactivity in the tunnel air such  
8 that this event would not result in a significant dose to an individual at the surface. This  
9 accident is considered unlikely and even partially effective controls and safety systems  
10 would serve to delay the release and reduce the dose.

- 11 • **Fires in the linac tunnel or target building.** The most conservative cases were  
12 associated with a fire in either the graphite or lithium target within the target building.  
13 Analysis of the resulting maximum (100 percent) release to the environment from either  
14 accident indicates the need for safety controls to maintain the frequency and potential  
15 consequences of the postulated event at low levels. As indicated in Appendix C, the  
16 controls in place for the beam operation (inert atmosphere, fire suppression system, and  
17 confinement system design) would either prevent the event entirely or appropriately  
18 reduce the consequences. The potential for a graphite target fire was postulated, but  
19 determined to be of such low likelihood that it was determined not to be credible. The  
20 lithium fire associated with a lithium-water reaction is presented below.
- 21 • **Lithium reaction with water.** Lithium, which has potential uses in the FRIB target and  
22 stripper, is assumed to react with cooling water as a result of a failure in either the water-  
23 filled beam dump or cooling water system within the vacuum confinement system. It  
24 was conservatively assumed that 100 percent of the activated target material (primarily  
25 beryllium) would become airborne in the target facility as a result of the reaction. Design  
26 and operational controls, such as the target facility configuration preventing water from  
27 directly impacting the lithium and primary and secondary confinement systems (each of  
28 which is filtered) would be expected to reduce the probability of this event or to  
29 appropriately mitigate the consequences if it were to occur. With safety controls in place,  
30 the resulting release to the environment would be very small.
- 31 • **Loss of helium inventory with maximum tritium concentration.** A conservative  
32 estimate of the tritium generated within the cryogenic helium in the linac tunnel was used  
33 to estimate the maximum tritium that could be released. If all the tritium and helium  
34 were released, the concentration in breathable air would be less than the regulatory limits  
35 for normal operations. As indicated in Appendix C, installed oxygen monitors and  
36 properly designed egress routes are needed to protect personnel in the linac tunnel or  
37 service areas from an oxygen deficient atmosphere hazard resulting from a postulated  
38 release of cryogenic helium.
- 39 • **Loss of confinement for the activated cooling water.** Small leaks are an anticipated  
40 event during FRIB operation. Accordingly, the systems would be designed to assure that  
41 leaks in heat exchangers cannot lead to a release directly to the environment. Activated  
42 cooling water loops would be within a controlled area (e.g., tunnel confinement) to  
43 provide positive control over any release of activated material. Secondly, a positive

1 means of control would be provided to assure that the cooling water cannot go directly to  
2 the environment through the cooling towers (e.g., by providing intermediate cooling  
3 loops or double-walled heat exchangers). Thus, although leaks of these systems are  
4 anticipated, they are easily managed within the facility to prevent impacts on the  
5 environment or the public. Protection for FRIB workers would be incorporated in the  
6 facility design to limit their potential exposure.

7 Although there is a non-negligible possibility for radiation exposure to workers, the FRIB design  
8 and operational teams plan to make full use of the successful approaches to personnel protection  
9 that have been worked out during the last 60 years of accelerator development in the United  
10 States and abroad. All of the postulated scenarios above have the potential to impact workers or  
11 the public through exposure to radiation above MSU administrative and regulatory thresholds for  
12 normal operations if they are not prevented or mitigated. Levels of potential exposure cannot be  
13 precisely quantified without a specific detailed design, but given the controls and mitigations  
14 discussed, while exposures might exceed MSU ALARA goals, they would be prevented or if  
15 they occurred would not be expected to exceed established EPA and NRC regulatory standards.  
16 Hence, considering the project approach to integrate safety and design and accounting for the  
17 anticipated administrative and engineered features in the facility, the maximum anticipated  
18 exposure to a worker would be less than 5 rem and a member of the public, 100 millirem total or  
19 2 millirem in any one hour. This corresponds respectively to a LCF probability of .003 or three  
20 chances in 1,000 and a LCF probability of  $1.2 \times 10^{-6}$  or 1.2 chances in 1 million.

21 Part of the evolving design process is to identify and analyze design basis accidents, as well as to  
22 develop the features and strategies to prevent or mitigate them to ensure that the consequences  
23 and risk are well understood and appropriately controlled. The design and operational controls  
24 included in the FRIB design are intended to provide a robust level of protection against these  
25 postulated events and provide protection for the public, FRIB workers, and the environment.  
26 Based on the experience of other accelerator facilities, the evaluations presented in Appendix C  
27 and MSU's commitment to certain design features and safety controls for the FRIB, it is  
28 expected that the health and safety risk from foreseeable accidents can be managed at acceptably  
29 low levels through the facility design process and control of operations.

#### 30 **5.1.9.2.3.2 Intentional Destructive Acts**

31 It is U.S. Department of Energy (DOE) policy that the environmental impacts of intentional  
32 destructive acts be considered in National Environmental Protection Act analyses (DOE 2006).  
33 DOE's *Recommendations for Analyzing Accidents under the National Environmental Policy Act*  
34 (DOE 2002) states that the consequences of an act of sabotage or terrorism could be addressed  
35 by comparison to those of a severe accident because the forces that could result in a release of  
36 radioactive or hazardous material would be similar to those considered in accident analyses. As  
37 discussed in Section 5.9.2.3.1, the radiological source terms for some postulated FRIB  
38 operational accident scenarios can be estimated at the conceptual design stage based on the  
39 experience of other accelerator facilities and the expected performance of FRIB system.  
40 Bounding source terms and conditions from these operational accident scenarios can be used to  
41 assess the potential impact of intentional destructive acts.

1 Because of its mission and design, the FRIB would not produce, use, or store large inventories of  
2 the types of materials that represent the primary sabotage/terrorist concern at DOE sites (i.e.,  
3 radioactive materials and toxic chemicals that can be readily dispersed into the environment).  
4 The production of radiation ceases when the accelerator is turned off and much of the radioactive  
5 material created by its operation disappears (decays) within seconds or minutes. In general, the  
6 accident source terms being used for design purposes would bound the possible source terms for  
7 intentional destructive acts because design analyses assume that each of the several factors  
8 contributing to the source term is somehow maximized. To produce a comparable source term, a  
9 successful act of terror or sabotage would require both the effective dispersal of the radioactive  
10 material (through fire or explosion) and the defeat or compromise of preventive or mitigative  
11 features (possibly several). Because the most highly radioactive materials produced within the  
12 FRIB (targets) are located deep underground and heavily shielded by concrete structures, an  
13 overt external attack would pose little threat of dispersal.

14 The list of FRIB accident types in Section 5.1.9.2.3.1 suggests some possible destructive act  
15 scenarios that might apply. The environmental impacts of any intentional destructive acts  
16 directed against the FRIB would be comparable to those of the reasonably foreseeable accidents.

### 17 **5.1.9.3 Decommissioning Impacts**

18 It is expected that decommissioning of the FRIB would involve the following general types of  
19 work activities:

- 20 1. Removal of materials and equipment items for reuse or recycling
- 21 2. Removal of targets and other transferable radioactive or hazardous materials for disposal  
22 as waste
- 23 3. MSU assessment of the area for potential alternate use and potentially sealing the  
24 underground structures and isolating (burying) them in place
- 25 4. Removal or redeployment/reuse of aboveground structures

26 At the end of the operational life of a complex facility the operations and maintenance staff is  
27 often redirected to carry out the initial phases of stabilization and decommissioning (items 1 and  
28 2 above). This practice takes advantage of the staff's existing work control processes and  
29 detailed knowledge of the facility and hazards. Because many of the actions to be taken in this  
30 phase of decommissioning (such as removal of components and packaging of waste) are similar  
31 to activities that would have been performed during the routine operation of the facility, it is  
32 reasonable to expect that accident/illness rates and occupational radiation exposures would be  
33 similar to those described in Section 5.1.9.2.1. Therefore, the net occupational health and safety  
34 impact of these initial stages of decommissioning should be comparable to those that would  
35 result from an additional 1 to 2 years of facility operation.

36 For work of the type suggested by items 3 and 4 above (isolation of underground structures and  
37 the removal/redeployment of aboveground structures), the work activities and resulting worker  
38 accident/illness rates should be more comparable to those for construction activities (assessed in  
39 Section 5.1.9.1) than those for facility operations. The number of labor hours needed to conduct

1 the isolation and removal/redeployment phase of decommissioning should be a small fraction of  
2 the initial construction effort and the occupational health and safety impacts would be  
3 proportionately lower. For industrial facilities, the labor requirement for decommissioning is  
4 typically estimated at less than 10 percent of that required for construction.

#### 5 **5.1.10 Waste Management**

##### 6 **Construction**

7 Construction of the FRIB would result in the generation of hazardous and nonhazardous waste.  
8 The estimated quantity of hazardous waste generated during construction is 79,000 pounds  
9 (36 metric tons) for hazardous waste solids and 3,600 gallons (13.7 cubic meters) for hazardous  
10 waste liquids. The estimated quantity of nonhazardous solids generated during construction is  
11 3,900 cubic yards (3,000 cubic meters) of concrete; 610 cubic yards (470 cubic meters) of steel;  
12 and 4,760 cubic yards (3,600 cubic meters) of miscellaneous nonhazardous solid wastes  
13 including crushed stone, asphalt, and sand and gravel (i.e., mostly excavated waste material.) In  
14 addition, 1,200 board feet (2.8 cubic meters) of lumber is estimated to be generated as  
15 nonhazardous solid waste during FRIB construction. Overall, construction wastes are expected  
16 to be generated in relatively small volumes (i.e., 10 percent of the total volume used during  
17 construction). Existing waste management capacities/processes at MSU easily absorb any  
18 temporary increases to waste volumes from FRIB construction activities. Nearly all MSU non-  
19 hazardous construction wastes would be recycled, consistent with the “Be Spartan Green”  
20 campaign to eliminate waste. It is concluded that FRIB non-hazardous construction wastes  
21 would have minimal impact on licensed waste disposal facilities.

22 Hazardous materials used during FRIB construction (e.g., oil, gasoline, paint) would be properly  
23 stored and secondary containment would be used to prevent spills or leaks. Waste material  
24 would be treated and disposed according to applicable regulatory compliance requirements.  
25 After collection in specified waste containers, proper documentation, and packaging, hazardous  
26 waste would be collected by a licensed waste hauler for treatment and disposal at a licensed  
27 facility, in accordance with the MSU Office of Radiation, Chemical, and Biological Safety  
28 (ORCBS) Waste Disposal Guide (MSU 2009c).

##### 29 **Operations**

30 The types of waste generated during FRIB operations can be estimated from those generated by  
31 current NSCL operations (Table 5–6). The quantities waste volumes would increase to allow for  
32 the increased operations of the FRIB. Similar to the NSCL, the types of waste would include  
33 low-level radioactive waste, mixed low-level radioactive waste, hazardous waste (nonradioactive  
34 waste), and nonhazardous wastes typically associated with the operation of any industrial or  
35 laboratory facility. It is expected that all of these waste types and volumes would be managed  
36 within the capacities of the existing MSU disposal processes and facilities.

37 The volume of industrial wastewater discharged from current NSCL operations is approximately  
38 100 gallons (380 liters) per day. The estimated volume of industrial wastewater discharge from  
39 FRIB operations is 300 gallons (1,100 liters) per day. Sanitary wastewater generation from the  
40 NSCL operations is approximately 12,000 gallons (45,000 liters) per day based on a conservative

1 use estimate of 35 gallons (130 liters) of water per person per day with 340 people at the facility.  
2 The estimated quantity of sanitary wastewater to be generated from FRIB operations is  
3 17,500 gallons (66,000 liters) per day using the same conservative estimate of 35 gallons  
4 (130 liters) of water per person per day with 500 people using the facility. The subsequent  
5 volume increase of sanitary wastewater during operations is approximately 47 percent.  
6 However, given the capacity of the MSU sanitary wastewater system with the ability to process  
7 wastewater from a student, faculty, and staff population of approximately 58,000 on campus  
8 (MSU 2009b), the volume of sanitary wastewater generated during FRIB operations is relatively  
9 small in comparison and the discharges would be well within the existing capacity of the MSU  
10 Physical Plant Division system.

1

**Table 5–6. Annual Waste Generation from NSCL and FRIB Operations**

<b>Waste Generation During Operations</b>	<b>Existing NSCL Facility Operations</b>	<b>New FRIB (with NSCL) Operations</b>
Hazardous/chemical solid waste	569 pounds (258 kilograms)	The quantities used would be scaled up conservatively 50 percent to support the increased use of these materials.
Hazardous/chemical liquid waste	1,500 gallons <sup>a</sup> (5680 liters) <ul style="list-style-type: none"> <li>• Sulfuric acid: 1,320 gallons (5000 liters)</li> <li>• Biocide: 75 gallons (280 liters)</li> <li>• Scale &amp; corrosion dispersant: 140 gallons (530 liters)</li> <li>• Additional small/negligible quantities of hazardous liquid waste (i.e., less than one drum) are processed annually and nominally one drum of solid waste (absorbent materials) to clean up spills are processed annually.</li> </ul>	The quantities used would be scaled up nominally by a factor of 4 to support the increased use of these materials for additional cooling towers.
Nonhazardous solids	Building waste: 250 cubic yards (190 cubic meters)	Solid wastes would increase with increased staffing. Disposal impact would be minimized with the increased capability of MSU's recycling program. See Chapter 4, Section 4.10, of this environmental assessment.
Sanitary wastewater	4,400,000 gallons (16,000,000 liters)	6,400,000 gallons (24,000,000 liters)
Industrial wastewater	36,000 gallons (140,000 liters)	110,000 gallons (420,000 liters)
Radiological Waste <sup>b</sup>	400 pounds (190 kilograms)	Radiological waste would be similar to NSCL waste, with the exception of some higher activity items.
<b>Class A Low-level Radioactive Waste</b>		
Non-Class A Low-level Radioactive Waste	<i>Low-specific activity and/or not otherwise specified for the last 3 years' worth of data</i>	

2  
3  
4  
5  
6

<sup>a</sup> Cooling tower wastewater treatment. NSCL uses two cooling towers.

<sup>b</sup> Only low-level radioactive waste would be generated, no transuranic or high-level radioactive waste would be generated.

**Key:** FRIB=Facility for Rare Isotope Beams; NSCL=National Superconducting Cyclotron Laboratory.

**Source:** MSU 2010a.

1 **Decommissioning**

2 The types of waste generated during decommissioning of the FRIB are estimated to be similar to  
3 the types generated during construction and could be handled by existing facilities. Underground  
4 structures would be buried in place and any aboveground structures removed or redeployed  
5 (MSU 2010a) consistent with best management practices in a manner protective of the  
6 environment.

7 **5.1.11 Transportation**

8 Transportation impacts are presented for the following aspects:

- 9 • Traffic volume
- 10 • On-Campus Infrastructure
- 11 • Traffic accidents
- 12 • Waste shipments during operations

13 Chapter 4, Table 4–2, presents the 2005 average daily traffic volume for campus streets in the  
14 vicinity of the project site. These data were analyzed to determine the impacts of closing the  
15 section of Bogue Street between Shaw Lane and Wilson Road, and the section of Shaw Lane  
16 between Bogue Street and Wilson Road. In addition, the number of vehicle trips associated with  
17 construction and operations of the proposed facility were compared to the 2005 average daily  
18 traffic volumes of nearby roads to determine the additional impact on the roads, taking into  
19 account road closures due to construction.

20 Traffic accidents are determined by using statistics collected by the Michigan State Police  
21 (MSP 2009). Statistics representing roadway accidents in Michigan were available for the  
22 following factors:

- 23 • Total number of miles driven
- 24 • Number of vehicle accidents
- 25 • Number of fatalities resulting from accidents
- 26 • Number of injuries resulting from accidents
- 27 • Number of bicyclists killed
- 28 • Number of pedestrians killed

29 For the purposes of this analysis, data from the years 2006 through 2008 were used to develop an  
30 average frequency per mile for each of the above factors to reflect the most current trends. These  
31 frequencies are shown in Table 5–7.

**Table 5–7. Frequency of Accidents and Related Consequences  
(per mile)<sup>a</sup>**

	<b>Vehicle Accidents</b>	<b>Fatalities</b>	<b>Injuries</b>	<b>Bicyclist Fatalities</b>	<b>Pedestrian Fatalities</b>
Average	$3.09 \times 10^{-06}$	$1.02 \times 10^{-08}$	$7.66 \times 10^{-07}$	$2.27 \times 10^{-10}$	$1.24 \times 10^{-09}$

<sup>a</sup> Represents a 3-year average of data from 2006 through 2008.

**Note:** These statewide statistics represent all motor vehicles (automobiles, trucks, and buses).

**Source:** MSP 2009.

These frequencies were used to calculate the projected number of motor vehicle accidents, fatalities, and injuries that would result from construction and operational activities; and to qualitatively determine the impacts on bicyclists and pedestrians. Assumptions were made as to how many miles would be driven. For example, an average one-way distance of 15 miles (24 kilometers) was used to determine impacts on employees commuting to the project site for work, whereas a one-way distance of 1 mile (1.6 kilometers) was used to estimate impacts associated with on-campus travel. The number of trips made for different activities were also estimated and multiplied by the number of miles per trip and the frequencies to quantitatively estimate the number of motor vehicle accidents, fatalities, and injuries.

ORCBS is responsible for ensuring radioactive materials and wastes are packaged and shipped in accordance with both U.S. Nuclear Regulatory Commission and U.S. Department of Transportation regulations. Transporting may involve walking or driving radioactive material across campus, or shipping off campus. All packages used to transport radioactive material must be strong, tight containers that would not leak under normal transportation conditions (such as dropping, jarring, or temperature extremes) (MSU 1996). In addition, ORCBS is responsible for collecting and shipping other regulated chemical and biological wastes (although neither NSCL nor the proposed FRIB generate biological wastes). Waste shipments usually contain wastes from several University departments to minimize the number of shipments made (MSU 2010a).

### **5.1.11.1 Construction**

Under the straight configuration option, Bogue Street between Shaw Lane and Wilson Road would be closed for approximately 2 years during construction of the proposed facility. In addition, the Wharton Center surface parking area would be closed and demolished and used as a laydown area during the construction period. Shaw Lane between Bogue Street and Hagadorn Road would be closed to through-traffic for approximately 2 months if the linear option is selected (Glasmacher and Koch 2009). These road closures would impact vehicle traffic volume, bicycle and pedestrian traffic, parking availability, and use of city buses.

### **Traffic Volume**

Based on Table 4–2 in Section 4.11, approximately 6,300 vehicles per day travel on Bogue Street between Shaw Lane and Wilson Road. If this section of road is closed for 2 years, southbound traffic on Bogue Street (north of Shaw Lane) would be diverted onto North Shaw Lane or Shaw Lane. In general, traffic using Bogue Street to access the campus from Grand River Avenue would decrease as people would access the campus from Grand River Avenue by using Hagadorn Road or Farm Lane. Northbound traffic on Bogue Street would be diverted onto

1 Wilson Road. Because the traffic currently using Bogue Street between Shaw Lane and Wilson  
2 Road would disperse among several roads, it is expected that the increased traffic on the other  
3 streets would remain below the 1997 average daily traffic volume for each of these streets. The  
4 impact of using Wilson Road for temporary equipment stationing is not anticipated to have a  
5 significant impact on traffic due to the planned occasional use of this road.

6 The 2-month closure of Shaw Lane between Bogue Street and Wilson Road would divert  
7 approximately 11,000 to 12,000 vehicles per day to other connecting roads. It is anticipated that  
8 this east-west bound traffic through the middle of campus would primarily divert to Wilson  
9 Road, which also travels east-west. The 2005 average daily traffic for Wilson Road ranges from  
10 approximately 4,000 vehicles near the east athletic field to approximately 7,000 vehicles west of  
11 Bogue Street. Diversion of traffic from Shaw Lane to Wilson Road would most likely cause  
12 traffic levels to exceed the 1997 average daily traffic on Wilson Road for the 2-month period.  
13 Shaw Lane is also a primary route for traffic traveling to football games at Spartan Stadium;  
14 therefore, the 2-month closure of a portion of Shaw Lane would not be planned to occur during  
15 football season.

16 Construction activities would cause an increase of approximately 400 vehicles per day due to the  
17 shipment of construction materials and wastes, and the commuting of construction workers. The  
18 construction traffic would cause less than a 4 percent increase in total traffic on the surrounding  
19 roads. This impact assumes each construction worker drives a car and travels to the construction  
20 site on campus, workers do not carpool or use the bus, nor do the workers park in other parts of  
21 campus.

22 Temporary closures of Bogue Street and Shaw Lane would also impact pedestrian and bicycle  
23 traffic. Temporary walkways would be established, with sufficient safety features such as  
24 fencing to direct pedestrian and bicycle traffic around the construction site.

## 25 **On-Campus Infrastructure**

26 There are currently 400 parking spaces associated with the NSCL. Construction of the FRIB  
27 would eliminate these parking spaces and the Wharton Center surface parking lot during the  
28 construction period. Other nearby parking space is available within a one-block distance from  
29 the NSCL in the Shaw Lane parking ramp and the Wharton Center parking ramp. Currently, the  
30 Shaw Lane parking ramp is typically used near 100 percent capacity during the week while the  
31 Wharton Center parking ramp is typically at approximately 70 percent capacity for faculty and  
32 staff and 60 percent capacity for visitors (Fox 2010); therefore, available parking in the Wharton  
33 Center should provide sufficient parking during daytime hours despite the loss of 400 parking  
34 spaces as a portion of the visitor spaces could be re-assigned to faculty and staff. In addition,  
35 NSCL personnel and construction workers could use the bus system or park in other lots on  
36 campus.

37 Large entertainment events that occur on campus can create temporary increases in traffic. The  
38 Wharton Center is a location where events occur that require a large number of parking spaces  
39 and can increase traffic around the NSCL. The closure of a segment of Bogue Street would  
40 impact the flow of traffic to these events; however, street signage would be used and campus  
41 police would be available for these events to direct traffic to and from the Wharton Center

1 parking deck using Hagadorn Road and Wilson Road. Closure of a segment of Shaw Lane for  
 2 2 months would be more problematic when managing Wharton Center event traffic because (1) a  
 3 large percentage of the daily number of vehicles that use Shaw Lane would be diverted to Wilson  
 4 Road, and (2) the entrance to the Wharton Center parking ramp from Shaw Lane would be  
 5 closed, leaving one entrance to the ramp off Wilson Road that could be used.

6 A bus stop is located on East Shaw Lane near Hagadorn Road. This bus stop is normally used by  
 7 city buses traveling along Shaw Lane. During the 2-month construction period when East Shaw  
 8 Lane would be closed, the bus stop on East Shaw Lane would be inaccessible. The buses that  
 9 use this bus stop could most likely be re-routed south on Farm Lane to Wilson Road, traveling  
 10 east-bound where passengers who would normally use the East Shaw Lane bus stop could  
 11 instead use the bus stop in front of the Wharton Center. Since it is only about a one-block  
 12 distance between the East Shaw Lane and Wharton Center bus stops, the additional walking  
 13 distance required by passengers who would normally use the East Shaw Lane bus stop would be  
 14 minimal.

15 **Traffic Accidents**

16 Table 5–8 shows the approximate number of shipments that would be made to support  
 17 construction activities, the assumed distance for each type of trip, and the total miles. Excavated  
 18 soil would either be shipped 1.2 miles (1.9 kilometers) to the soil disposal area located on East  
 19 Mount Hope Road (Glasmacher and Koch 2009), or stored at the construction site. For purposes  
 20 of analysis, it is assumed that the excavated soil would be transported to the staging area. For the  
 21 other activities in Table 5–6, the assumed one-way mileage is considered conservative.

22 **Table 5–8. Number of Trips and Total Miles**  
 23 **Traveled for Construction Activities**

Activity	Number of Trips <sup>a</sup>	Miles (one-way)	Total miles (two-way)
Excavated dirt from site	15,000	1.2 <sup>b</sup>	36,000
Truck trips for materials/supplies	7,500	20	300,000
Nonhazardous waste disposal	3,500	20	140,000
Hazardous waste shipments	11	50	1,100
<b>Total - construction miles</b>			<b>477,100</b>

25 <sup>a</sup> MSU 2010a.

26 <sup>b</sup> Glasmacher and Koch 2009.

27 Table 5–9 presents the estimated vehicle accident consequences using the frequency data in  
 28 Table 5–7. The estimates for determining worker commuting impacts are based on a peak  
 29 number of 175 workers commuting to the construction site for the total construction period,  
 30 driving a two-way average of 30 miles.

**Table 5–9. Estimated Impacts of Traffic Accidents**

<b>Activity</b>	<b>Number of Accidents</b>	<b>Number of Fatalities</b>	<b>Number of Injuries</b>
Excavated dirt from site	0.11	$3.66 \times 10^{-04}$	$2.76 \times 10^{-02}$
Truck trips for materials/supplies	0.93	$3.05 \times 10^{-03}$	$2.30 \times 10^{-01}$
Nonhazardous waste disposal	0.43	$1.42 \times 10^{-03}$	$1.07 \times 10^{-01}$
Hazardous waste shipments	0.0034	$1.12 \times 10^{-05}$	$8.42 \times 10^{-04}$
<b>Total - Construction Vehicles</b>	<b>1.47</b>	<b><math>4.9 \times 10^{-03}</math></b>	<b><math>3.7 \times 10^{-01}</math></b>
<b>Total - Worker Commute</b>	<b>16.5</b>	<b><math>5.44 \times 10^{-02}</math></b>	<b>4.09</b>

Based on Table 5–9, it is estimated that there could be fewer than 2 construction-related accidents involving a motor vehicle, with no fatalities or injuries. Construction workers commuting to the site could experience approximately 17 accidents, no fatalities, and 4 injuries over the duration of the construction period. These estimates are based on statewide statistics for both automobiles and trucks, and do not account for local factors such as traffic safety devices, police enforcement, and shared use of roads and parking areas with pedestrians and bicyclists.

#### 5.1.11.2 Operations

##### Traffic Volume

Based on information in Table 5–10, approximately 160 additional FRIB personnel and visiting scientists would travel to the FRIB compared to current operations. Assuming this increase in personnel increases local traffic by approximately 160 vehicles, the impact on nearby roads would be less than 1 or 2 percent, a negligible increase in traffic (see Table 4-5). It is anticipated that visiting scientists would stay in nearby hotels and would potentially carpool or use mass transit to visit the FRIB, lessening the impact further.

##### Traffic Accidents

Table 5–10 shows the approximate number of personnel who travel daily to work under current operations at the NSCL, the increase in number of personnel who would be expected to work at the FRIB, and the assumed distance for each type of trip. For conservatism, it is assumed that there would be one person per vehicle (the analysis does not account for use of carpooling, buses, or cycling). Operations staff are assumed to live within an average distance of 15 miles (24 kilometers) off campus. Visiting scientists are assumed to stay in a hotel within the Lansing/East Lansing area and travel by car to the FRIB. Trips made by facility maintenance staff and administrative support staff are assumed to be within the campus area.

**Table 5–10. Personnel Traveling to and from the National Superconducting Cyclotron Laboratory (NSCL)**

Personnel Type	NSCL Number of Personnel*	Number of Additional FRIB Personnel	Miles Per Trip (one-way)
Operations staff	268	62	15
Visiting scientists (per day)	20	80	5
Facility maintenance staff	30	10	1
Admin support staff	22	8	1
One daily trip for supplies	1	1	2
Total	341	161	24

\* MSU 2010a.

Table 5–11 shows the estimated number of additional accidents, fatalities, and injuries that would occur during FRIB operations as compared to the current NSCL operations. During FRIB operations, there would be an additional 2 traffic accidents that would not result in any injuries or fatalities as compared to current operations. Over a 30-year period, there would be an additional 65 traffic accidents with a total of 16 injuries but no fatalities.

**Table 5–11. Transportation Impacts During Operations**

Type of Transport	Current NSCL Operations			Proposed Action		
	Number of Accidents	Number of Fatalities	Number of Injuries	Number of Additional Accidents	Number of Additional Fatalities	Number of Additional Injuries
Regulated Waste Shipments	$1.05 \times 10^{-02}$	$3.46 \times 10^{-05}$	$2.60 \times 10^{-03}$	0	0	0
Daily trips for supplies	$3.21 \times 10^{-03}$	$1.06 \times 10^{-05}$	$7.96 \times 10^{-04}$	$3.21 \times 10^{-03}$	$1.06 \times 10^{-05}$	$7.96 \times 10^{-04}$
<b>Additional Personnel for the FRIB</b>						
Operations staff	6.45	$2.13 \times 10^{-02}$	1.60	1.49	$4.92 \times 10^{-03}$	$3.70 \times 10^{-01}$
Visiting scientists (per day)	$1.61 \times 10^{-01}$	$5.29 \times 10^{-04}$	$3.98 \times 10^{-02}$	$6.42 \times 10^{-01}$	$2.11 \times 10^{-03}$	$1.59 \times 10^{-01}$
Facility maintenance staff	$4.82 \times 10^{-02}$	$1.59 \times 10^{-04}$	$1.19 \times 10^{-02}$	$1.61 \times 10^{-02}$	$5.29 \times 10^{-05}$	$3.98 \times 10^{-03}$
Admin support staff	$3.53 \times 10^{-02}$	$1.16 \times 10^{-04}$	$8.76 \times 10^{-03}$	$1.28 \times 10^{-02}$	$4.23 \times 10^{-05}$	$3.19 \times 10^{-03}$
<b>Total (per year)</b>	<b>6.71</b>	<b><math>2.21 \times 10^{-02}</math></b>	<b>1.66</b>	<b>2.17</b>	<b><math>7.14 \times 10^{-03}</math></b>	<b><math>5.38 \times 10^{-01}</math></b>
<b>Total (30 years)</b>	<b><math>2.01 \times 10^{+02}</math></b>	<b><math>6.63 \times 10^{-01}</math></b>	<b><math>4.99 \times 10^{+01}</math></b>	<b><math>6.50 \times 10^{+01}</math></b>	<b><math>2.14 \times 10^{-01}</math></b>	<b><math>1.61 \times 10^{+01}</math></b>

**Key:** FRIB=Facility for Rare Isotope Beams; NSCL=National Superconducting Cyclotron Laboratory.

1 **Radioactive Waste**

2 In 2009, there were approximately 35 truck trips to the NSCL by qualified waste management  
3 staff to pick up regulated wastes (MSU 2010a). These trips were not necessarily trips taken to  
4 the NSCL only, and may be part of a route of pickups performed by qualified waste management  
5 staff. The number of these trips should remain approximately the same during FRIB operations  
6 (MSU 2010a); therefore, there are no increased nonradiological risks associated with transport of  
7 radioactive, chemical, or biological wastes from FRIB with no additional traffic accidents or  
8 resulting fatalities or injuries occurring.

9 The radiological composition of radioactive waste that would be generated by FRIB operations  
10 would be comparable to radioactive waste generated by NSCL operations, with the exception of  
11 some higher activity radiological waste. The disposal of these higher activity items would be  
12 handled on a case-by-case basis and sent to a licensed facility for disposal (MSU 2010a). As  
13 there would be no additional trips to transport radioactive waste for disposal above what is  
14 currently conducted, and the radiological waste would be packaged as required by U.S.  
15 Department of Transportation regulations, the additional radiological risks to the driver and the  
16 public would be negligible. No transuranic waste would be generated from operations at the  
17 FRIB.

18 **On-Campus Infrastructure**

19 Under the folded configuration option, once construction is complete, there would be  
20 approximately 300 parking spaces available at the FRIB, which is 100 fewer parking spaces than  
21 what is currently available (MSU 2010a). It is expected that the loss of these spaces would be  
22 offset by available parking space in the Wharton Center parking ramp. Use of the bus stop on  
23 South Shaw Lane would resume.

24 The update to the Campus Master Plan recognizes the need for future improvements to reduce  
25 traffic within the center of campus and provide additional parking. The need for future  
26 improvements to the mass transit system and establishment of a coordinated bicycle system are  
27 also identified in the plan as a means to reduce on-campus automobile use (MSU 2006b).

28 **5.1.12. Socioeconomics and Environmental Justice**

29 This section describes the impacts on employment and the local economy from construction and  
30 operation of the proposed facility. This section also addresses environmental justice.

31 **Construction**

32 Construction of the FRIB is expected to last from 2012 through 2016. Annual construction  
33 employment is expected to peak at 175 employees (MSU 2010a). This equates to approximately  
34 3.4 percent of construction industry employment in the Lansing-East Lansing Metropolitan  
35 Statistical Area (MSA). Construction occupations in the MSA are projected to increase  
36 5.5 percent by 2016 (MDELEG 2010a; BLS 2010d). The majority of new employees would  
37 likely be supplied by the local labor force. The direct construction employment is estimated to  
38 generate indirect employment of 145 jobs in the local area, for a total impact of 320 jobs. The

1 average worker in the construction industry earned \$49,036 in wages and an estimated \$21,317  
2 in benefits (MDELEG 2010b; BLS 2010d). It is estimated that total earnings of construction  
3 workers would be \$12.3 million during the peak year of construction. Earnings of indirect  
4 workers are estimated using the average annual wage for all industries in the Lansing-East  
5 Lansing MSA of \$37,856 and estimated benefits of \$16,457. Earnings of indirect workers are  
6 estimated to be \$7.9 million during the peak year. Total peak year earnings from both direct and  
7 indirect employment are estimated to be \$20.2 million. Total spending to build the facility is  
8 estimated to be \$548 million, of which \$348 million is assumed to be spent locally (AEG 2008).  
9 Indirect economic output generated by that spending is estimated to be \$279 million, for a total  
10 economic impact of \$627 million during the construction phase. The value added to the local  
11 economy from construction spending in terms of final goods and services directly comparable to  
12 gross domestic product (GDP) is estimated to be \$64 million annually. This equates to  
13 approximately 0.4 percent of the Lansing-East Lansing MSA's 2008 GDP, and 11.2 percent of  
14 the MSA's 2008 output in the construction industry (BEA 2009).

## 15 **Operations**

16 When the facility is fully operational it is estimated that it would require approximately  
17 500 operations and support staff. When compared to employment at the existing NSCL, the  
18 FRIB would add approximately 160 new jobs. This equates to approximately 2 percent of  
19 employment in the "professional and technical services" industry of the Lansing-East Lansing  
20 MSA. Due to the specialized nature of the facility, it is assumed that new operations  
21 employment would be supplied by an in-migration of workers from other areas. The new jobs at  
22 the FRIB would generate indirect employment of approximately 214 jobs throughout the MSA.  
23 The average worker in the professional and technical services industry earned \$54,236 in wages  
24 and an estimated \$23,577 in benefits (AEG 2008; MDELEG 2010b; BLS 2010d). It is estimated  
25 that the annual earnings of operations employees would be \$12.5 million. Earnings of indirect  
26 workers are calculated in the same manner as described above under construction. The annual  
27 earnings of indirect workers are estimated to be \$11.6 million, for a total earnings impact of  
28 approximately \$24 million annually. The annual operating budget of \$50 million (AEG 2008) is  
29 estimated to generate an indirect economic output of approximately \$40 million for a total  
30 impact of \$90 million in economic output. The value added from FRIB operations to the local  
31 economy in terms of final goods and services directly comparable to GDP is estimated to be  
32 \$56 million. This equates to approximately 0.3 percent of the Lansing-East Lansing MSA's  
33 2008 GDP.

## 34 **Environmental Justice**

35 Chapter 4, Section 4.12 describes the population demographics for the city of East Lansing,  
36 Ingham County, and the Lansing-East Lansing MSA. The impact assessments presented in the  
37 various resource areas throughout this EA have not identified any high and adverse impacts on  
38 the general public resulting from the Proposed Action. Because there are no high and adverse  
39 impacts on the general public, there would be no disproportionately high and adverse impact on  
40 minority or low-income populations, regardless of whether these populations are distributed  
41 homogeneously across the general population or clustered in certain census blocks.

1 **5.2. CUMULATIVE IMPACTS OF THE PROPOSED ACTION**

2 Cumulative impacts are those that may result from the incremental impacts of an action  
3 considered additively with the impacts of other past, present, and reasonably foreseeable future  
4 actions. Cumulative impacts are considered regardless of the agency or person undertaking the  
5 other actions (40 CFR 1508.7; CEQ 1997) and can result from the combined or synergistic  
6 effects of actions that are minor when considered individually over a period of time.

7 No past, present, or reasonably foreseeable future actions that are considered pertinent to the  
8 analysis of cumulative impacts for the Proposed Action have been identified at this time. The  
9 cumulative contribution of impacts that the conveyance and subsequent development of the  
10 property would make on the various environmental resources is expected to be minor.

11 **Construction**

12 The construction of the FRIB would take place in the developed area of the MSU campus.  
13 Construction of a NSCL upgrade of 206,500 gross square feet (19,180 square meters) to include  
14 construction of the FRIB is included in the Campus Master Plan. Construction of new facilities  
15 and renovation are common on this campus; it is estimated that the campus has added an average  
16 of approximately 200,000 gross square feet (18,600 square meters) every fiscal year since the  
17 issuance of the current Campus Master Plan in 2001 (MSU 2007a). The proposed facility would  
18 be consistent with current and expected development on the MSU campus. Construction of the  
19 addition to the Physical Science Building near the project site is scheduled to be completed in  
20 2011. Construction of the FRIB would not begin until 2013. No concurrent construction  
21 projects are anticipated to occur near the project site during the construction of the FRIB, thus no  
22 cumulative impacts from concurrent construction activities would occur.

23 **Operation**

24 The FRIB linac would replace the operation of the NSCL cyclotrons. The linac would be  
25 incorporated into the existing facilities over a period of approximately 6 months, during which  
26 neither the cyclotrons nor the linac would be operational. Thus, there would be no period during  
27 which both would be operational, and no cumulative impacts resulting from concurrent operation  
28 of the two facilities.

29 **5.3. NO ACTION ALTERNATIVE**

30 As described in Chapter 3, Section 3.2, under the No Action Alternative, the linac accelerator  
31 and its support facilities would not be constructed, and therefore, there would be no increase in  
32 construction-related emissions, waste generation, stormwater runoff, accidents, or traffic. The  
33 current NSCL operations would continue. As the types of research presently conducted at the  
34 facility would continue at the current level, the operations impacts of the No Action Alternative  
35 would be those described in Chapter 4, as the affected environment is the existing operations of  
36 the NSCL.

37 No alternative uses of the site have been identified for the campus area near the NSCL, and  
38 therefore, there are no reasonably foreseeable changes in impacts if the FRIB project does not go  
39 forward.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK

1 **CHAPTER 6**  
2 **AGENCIES AND PERSONS CONSULTED**

3 **6.1. FEDERAL, STATE, AND LOCAL AGENCIES AND ORGANIZATIONS**

4 Michigan State Historic Preservation Office

5 Michigan Department of Natural Resources and Environment, Waste and Hazardous Materials  
6 Division

7 Southeast Michigan Council of Governments

8 City of East Lansing

9 **6.2. DOE PREPARERS AND REVIEWERS**

10 Peter Siebach  
11 NEPA Compliance Officer

12  
13 Ron Lutha  
14 Federal Project Director

15  
16 Vicki Prouty  
17 Counsel

18  
19 Michelle McKown  
20 Counsel

21  
22 Brian Quirke  
23 Communications

24  
25 Bob Wunderlich  
26 Project Advisor

27 **6.3. MSU PREPARERS AND REVIEWERS**

28 Kevin Eisenbeis  
29 Director MSU EHS, MSU Document Manager

30  
31 Dr. Thomas Glasmacher  
32 FRIB Project Manager

33  
34 Peter Grivins  
35 FRIB Deputy ES&H Manager

36  
37 Bob Lowrie  
38 FRIB ES&H Manager

1  
2 Alex Parsons  
3 FRIB Communications Manager  
4  
5 Dr. Reg Ronningen  
6 NSCL Radiation Safety Officer  
7  
8 Dr. Al Zeller  
9 Head, NSCL Research Facilities Department  
10

11 **6.4. SCIENCE APPLICATION INTERNATIONAL CORPORATION**  
12 **PREPARERS AND REVIEWERS**

13  
14 Karen Bull  
15 Lead Author: Cultural Resources, Utilities, Waste, and Water Quality  
16  
17 Milton Gorden  
18 Lead Author: Transportation  
19  
20 Aaron Greene  
21 Lead Author: Biological Resources  
22  
23 James Jamison  
24 Lead Author: Human Health and Safety  
25  
26 Dr. Douglas Outlaw  
27 EA Project Manager; Lead Author: Front Matter, Chapters 1 – Introduction and Background,  
28 2 – Purpose and Need for Agency Action, and 3 – Description of Proposed Action and  
29 Alternatives  
30  
31 Sean Schatzel  
32 Lead Author: Socioeconomics and Environmental Justice  
33  
34 Dr. Ellen Taylor  
35 Lead Author: Chapter 5 - Environmental Consequences, Cumulative Impacts  
36  
37 Audra Upchurch  
38 Lead Author: Chapter 4 - Affected Environment, Geology and Soils, and Land Use  
39  
40 Robert Werth  
41 Lead Author: Air Quality, Noise, and Visual  
42  
43

- 1 **Document Production Team**
- 2
- 3 Hana Binder
- 4 Editor
- 5
- 6 Kimball Duvall
- 7 Document Production
- 8
- 9 Sharon Pietzyk
- 10 Public Outreach, Comment Response
- 11

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11

THIS PAGE INTENTIONALLY LEFT BLANK



- 1 DOC (U.S. Department of Commerce), 2009b, *Table 1, Annual Estimates of the Population of*  
2 *Metropolitan and Micropolitan Statistical Areas: April 1 2000 to July 1 2008*, Bureau of the  
3 Census, accessed through  
4 <http://www.census.gov/popest/metro/tables/2008/CBSA-EST2008-01.xls>, March 19.
- 5 DOC (U.S. Department of Commerce), 2010a, *Detailed tables from the 2006-2008 American*  
6 *Community Survey 3-Year Estimates*, Bureau of the Census, accessed through  
7 [http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=ACS&\\_submenuId=data](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_submenuId=data)  
8 [sets\\_1&\\_lang=en&\\_ts=](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_submenuId=data), January 21.
- 9 DOC (U.S. Department of Commerce), 2010b, *Detailed tables from the 2008 American*  
10 *Community Survey 1-Year Estimates*, Bureau of the Census, accessed through  
11 [http://factfinder.census.gov/servlet/DatasetMainPageServlet?\\_program=ACS&\\_submenuId=data](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_submenuId=data)  
12 [sets\\_1&\\_lang=en&\\_ts=](http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=ACS&_submenuId=data), January 21.
- 13 DOE (U.S. Department of Energy), 2002, *Recommendations for Analyzing Accidents Under the*  
14 *National Environmental Policy Act*, U.S. Department of Energy Environment, Safety and Health,  
15 Office of NEPA Policy and Compliance, July.
- 16 DOE (U.S. Department of Energy), 2003, *Estimating Radiation Risk from Total Effective Dose*  
17 *Equivalent (TEDE) – ISCORS Technical Report No. 1*, DOE/EH-412/0015/0802, Rev. 1, Office  
18 of Environmental Policy and Guidance, Washington, D.C., January.
- 19 DOE (U.S. Department of Energy), 2006, Memorandum from the Office of NEPA Policy and  
20 Compliance, Need to Consider Intentional Destructive Acts in NEPA Documents, December 1.
- 21 DOE (U.S. Department of Energy), 2008a, *Financial Assistance Funding Opportunity*  
22 *Announcement, Facility for Rare Isotope Beams*, Funding Opportunity Number: DE-PS02-  
23 08ER41535, Office of Nuclear Physics, May 20.
- 24 DOE (U.S. Department of Energy), 2008b, “U.S. Department of Energy Selects Michigan State  
25 University to Design and Establish Facility for Rare Isotope Beams”, accessed through  
26 <http://www.energy.gov/news/6794.htm>, December 11.
- 27 DOE (U.S. Department of Energy), 2009a, *Facility for Rare Isotope Beams Environmental*  
28 *Assessment Scoping Report*, Office of Science, Chicago, Illinois, December.
- 29 DOE (U.S. Department of Energy), 2009b, *Protective Action Criteria (PAC) with AEGLs,*  
30 *ERPGs and TEELS: Rev. 25 for Chemicals of Concern*, Subcommittee on Consequence  
31 Assessment and Protective Actions (SCAPA), accessed through  
32 [http://www.hss.energy.gov/HealthSafety/WSHP/chem\\_safety/teel.html](http://www.hss.energy.gov/HealthSafety/WSHP/chem_safety/teel.html), August.
- 33 DOT (U.S. Department of Transportation), 2006, *FHWA Highway Construction Noise*  
34 *Handbook*, Federal Highway Administration, accessed through  
35 <http://www.fhwa.dot.gov/Environment/noise/handbook/index.htm>, August.
- 36 EPA (U.S. Environmental Protection Agency), 1996, *Compilation of Air Pollutant Emission*  
37 *Factors, Section 3.3, “Gasoline and Diesel Industrial Engines,” AP-42*, October.

- 1 EPA (U.S. Environmental Protection Agency), 2003, *User's Guide to MOBILE6.1 and*  
2 *MOBILE6.2 Mobile Source Emission Factor Model*, EPA420-R-03-010, Office of  
3 Transportation and Air Quality, Assessment and Standards Division, August.
- 4 EPA (U.S. Environmental Protection Agency), 2007, *Inventory of U.S. Greenhouse Gas*  
5 *Emissions and Sinks, 1990-2005*, Washington, DC, April 15.
- 6 EPA (U.S. Environmental Protection Agency), 2009, *Surf Your Watershed, Ingham County*,  
7 accessed through [http://cfpub.epa.gov/surf/county.cfm?fips\\_code=26065](http://cfpub.epa.gov/surf/county.cfm?fips_code=26065), October 13.
- 8 EPA (U.S. Environmental Protection Agency), 2010, eGRID2007 Version 1.1 Year 2005 GHG  
9 Annual Output Emission Rates, accessed at <http://cfpub.epa.gov/egridweb/ghg.cfm>, March 2.
- 10 FEMA (Federal Emergency Management Agency), 1980, *Flood Insurance Rate Map (FIRM),*  
11 *City of East Lansing, Michigan, Ingham County*, August 1.
- 12 FERMILAB (Fermi National Accelerator Laboratory), 2009. MARS Code System, accessed  
13 through <http://www-ap.fnal.gov/MARS/>, December 8.
- 14 Fox, S., 2010, Michigan State University, Office of the Traffic Engineer, East Lansing,  
15 Michigan, personal communication (email) to M. Gorden, Science Applications International  
16 Corporation, Germantown, Maryland, "Data Requested from MSU for FRIB project (1st email),"  
17 January 27.
- 18 Glasmacher, T., and G. Koch, 2009, *Facility for Rare Isotope Beams Update*, Michigan State  
19 University, August.
- 20 Goldstein, L, 2010, Michigan State University, Department of Anthropology, East Lansing,  
21 Michigan, personal communication (letter) to Whom It May Concern, "Potential archeological  
22 resources in planned F-RIB project area," February 25.
- 23 ICC and MDCIS (International Code Council and Michigan Department of Consumer and  
24 Industry Services), 2004, *2003 Michigan State Code*.
- 25 IPCC (Intergovernmental Panel on Climate Change), 2007, *A Report of Working Group I of the*  
26 *Intergovernmental Panel on Climate Change, Summary for Policymakers*.
- 27 Justus, J.R., and S.R. Fletcher, 2006, "CRS Issue Brief for Congress: Global Climate Change,"  
28 accessed through <http://www.ncseonline.org/nle/crsreports/06apr/IB89005.pdf>, May 12.
- 29 MDELEG (Michigan Department of Energy, Labor, and Economic Growth), 2010a, *Michigan*  
30 *Labor Market Information, Occupational Projections( Long Term)*, accessed through  
31 <http://www.milmi.org/cgi/dataanalysis/occPrjReport.asp>, January 20.
- 32 MDELEG (Michigan Department of Energy, Labor, and Economic Growth), 2010b, *Quarterly*  
33 *Census of Employees and Wages, Lansing-East Lansing Metropolitan Statistical Area, 1st*  
34 *Quarter 2009*, accessed through <http://www.milmi.org/cgi/dataanalysis/?PAGEID=94>,  
35 January 29.

- 1 MDEQ (Michigan Department of Environmental Quality), 2006, *Ingham County Final Wetland*  
2 *Inventory*, Land and Water Management Division, December 15.
- 3 MDEQ (Michigan Department of Environmental Quality), 2009, *Michigan Climate Action Plan*,  
4 Michigan Climate Action Council, March.
- 5 MDEQ (Michigan Department of Environmental Quality), 2010, *Certificate of Entry Industrial*  
6 *Storm Water Program Guidance Document 2 of 4*, "National Pollutant Discharge Elimination  
7 System (NPDES) Storm Water from Industrial Activities General Permit," accessed through  
8 [http://www.michigan.gov/deq/0,1607,7-135-3313\\_3682\\_3712---,00.html](http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3712---,00.html) on February 18
- 9 MDNRE (Michigan Department of Natural Resources and Environmental), 2010a, *Floodplains,*  
10 *Flood Hazard Management*, accessed through [http://www.michigan.gov/deq/0,1607,7-135-](http://www.michigan.gov/deq/0,1607,7-135-3313_3684_3725-11255--,00.html)  
11 [3313\\_3684\\_3725-11255--,00.html](http://www.michigan.gov/deq/0,1607,7-135-3313_3684_3725-11255--,00.html), February 22.
- 12 MDNRE (Michigan Department of Natural Resources and Environmental), 2010b, *Construction*  
13 *Site Program*, accessed through [http://www.michigan.gov/deq/0,1607,7-135-3313\\_3682\\_3716-](http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-23997--,00.html)  
14 [23997--,00.html](http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-23997--,00.html), February 22.
- 15 Michigan State Climatologist's Office, 2009a, *Climate of the East Lansing Area*, accessed  
16 through <http://climate.geo.msu.edu/Stations/2395/NARRAT.txt>, June 15.
- 17 Michigan State Climatologist's Office, 2009b, *Precipitation and Temperature Summaries for the*  
18 *East Lansing Area for the 30 Year Period 1951-1980*, accessed through  
19 <http://climate.geo.msu.edu/stations/2395>, June 15.
- 20 MIOSHA (Michigan Occupational Safety and Health Administration), 2003, *Part 380,*  
21 *Occupational Noise Exposure*, BSR-STD-1210, Department of Consumer and Industry Services,  
22 Director's Office, Occupational Health Standards, April.
- 23 MIOSHA (Michigan Occupational Safety and Health Administration), 2005, Department of  
24 Labor and Economic Growth, Director's Office, Occupational Health Standards, *Part 680. Noise*  
25 *Exposure for Construction*, MIOSHA-STD-1405, Department of Labor and Economic Growth,  
26 Director's Office, Occupational Health Standards, June.
- 27 MSP (Michigan State Police), 2009, *2008 Michigan Crash Facts Statewide*, Criminal Justice  
28 Information Center-Traffic Crash Statistics and Office of Highway Safety Planning-Traffic  
29 Safety Programs.
- 30 MSU (Michigan State University), 1996, *Radiation Safety Manual*, Office of Radiation,  
31 Chemical and Biological Safety, East Lansing, Michigan, July 1.
- 32 MSU (Michigan State University), 2002, *Michigan State University Water Quality Report for*  
33 *2001*, Physical Plant Division, Power and Water Department, East Lansing, Michigan, June.
- 34 MSU (Michigan State University), 2006a, *Isotope Science Facility at Michigan State University,*  
35 *Upgrade of the NSCL Rare Isotope Research Capabilities*, MSUCL-1345, November.

- 1 MSU (Michigan State University), 2006b, *Campus Master Plan Update: Preliminary*  
2 *Framework Review – Campus Public Forum*, November.
- 3 MSU (Michigan State University), 2007a, *Michigan State University, Campus Master Plan*  
4 *Update 2007, Executive Summary*, East Lansing, Michigan, January.
- 5 MSU (Michigan State University), 2007b, *MSU Detailed Campus Map*, accessed through  
6 <http://maps.msu.edu/files/MSUcampus.pdf>, August.
- 7 MSU (Michigan State University), 2009a, "MSU, U.S. Department of Energy sign agreement  
8 for FRIB", accessed through <http://news.msu.edu/story/6426/>, June 8.
- 9 MSU (Michigan State University), 2009b, *MSU Facts*, accessed through  
10 <http://www.msu.edu/thisismsu/facts.html>, October 13.
- 11 MSU (Michigan State University), 2009c, *Michigan State University Waste Disposal Guide,*  
12 *How to Properly Dispose of Waste Materials Generated at Michigan State University,*  
13 Environmental Health & Safety/Office of Radiation, Chemical & Biological Safety, East  
14 Lansing, Michigan, April.
- 15 MSU (Michigan State University), 2009d, *Cyclotron Electrical Use Reduction Report,*  
16 December 22.
- 17 MSU (Michigan State University), 2010a, *Data Call Response*, East Lansing, Michigan.
- 18 MSU (Michigan State University), 2010b, *Red Cedar Natural Area*, accessed through:  
19 [http://www.cpa.msu.edu/nat\\_area/redcdr.htm](http://www.cpa.msu.edu/nat_area/redcdr.htm), January 15.
- 20 MSU (Michigan State University), 2010c, *Environmental Compliance, Programs and*  
21 *Guidelines, Wellhead Protection*, Office of Radiological, Chemical, and Biological Safety,  
22 accessed through  
23 [http://www.orcbs.msu.edu/enviro/programs\\_guidelines/wellhead/wh\\_09backgroundinfo.htm](http://www.orcbs.msu.edu/enviro/programs_guidelines/wellhead/wh_09backgroundinfo.htm),  
24 January 15.
- 25 MSU (Michigan State University), 2010d, *Michigan State University Campus Natural Areas,*  
26 accessed through: [http://www.cpa.msu.edu/nat\\_area/namap.htm](http://www.cpa.msu.edu/nat_area/namap.htm), January 15.
- 27 MSU (Michigan State University), 2010e, *Baker Woodlot and Rachana Rajendra Neotropical*  
28 *Migrant Bird Sanctuary*, accessed through [http://www.cpa.msu.edu/nat\\_area/baker.htm](http://www.cpa.msu.edu/nat_area/baker.htm),  
29 January 15.
- 30 MSU (Michigan State University), 2010f, *Sanford Natural Area*, accessed through  
31 [http://www.cpa.msu.edu/nat\\_area/sanford.htm](http://www.cpa.msu.edu/nat_area/sanford.htm) on January 15.
- 32 MSU (Michigan State University), 2010g, *Be Spartan Green, Environmental Stewardship on the*  
33 *Campus of MSU, Reuse/Recycle*, accessed through  
34 <http://www.bespartangreen.msu.edu/reuse/index.html>, January 17.

- 1 MSU (Michigan State University), 2010h, *Groundwater Activation Evaluation*, draft,  
2 February 3.
- 3 MSUE (Michigan State University Extension), 2009, *Michigan Natural Features Inventory*,  
4 *Ingram County*, accessed through  
5 [http://web4.msue.msu.edu/mnfi/data/cnty\\_dat.cfm?county=Ingham](http://web4.msue.msu.edu/mnfi/data/cnty_dat.cfm?county=Ingham), December 17.
- 6 NCDC (National Climatic Data Center), 1998, *Climatic Wind Data for the United States*,  
7 accessed through <http://www.ncdc.noaa.gov/oa/mpp/wind1996.pdf>, November.
- 8 NCDC (National Climatic Data Center), 2010, *NCDC Storm Events for Michigan - Ingham*  
9 *County*, accessed through <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>,  
10 January 19.
- 11 NCRP (National Council on Radiation Protection and Measurements), 2009, *Ionizing Radiation*  
12 *Exposure of the Population of the United States*, NCRP Report No. 160, Bethesda, Maryland,  
13 March 3.
- 14 NSCL (National Superconducting Cyclotron Laboratory), 2009, *Graduate Education at NSCL*  
15 *and MSU*, accessed through <http://www.nscl.msu.edu/edu/graduate>, October 13.
- 16 NTH (NTH Consultants, Ltd.), 2009, *Geotechnical Investigation, Proposed Facility for Rare*  
17 *Isotope Beams, East Lansing, Michigan*, Lansing, Michigan, August 6.
- 18 Rogers, R., 2010, Michigan State University Extension, personal communication (email) to A.  
19 Greene, Science Applications International Corporation, Germantown, Maryland, "Re: Question  
20 about Weed Shiner Status," February 25.
- 21 USGS (U.S. Geological Survey), 2008a, *2008 United States National Seismic Hazard Maps*, ,  
22 *Fact Sheet 2008–3018*, April.
- 23 USGS (U.S. Geological Survey), 2008b, *National Seismic Hazard Maps - 2008*, accessed  
24 through <http://gldims.cr.usgs.gov/nshmp2008/viewer.htm>, April 23.
- 25 USGS (U.S. Geological Survey), 2010a, *Magnitude/Intensity Comparison*, Earthquake Hazards  
26 Program, National Earthquake Information Center, accessed through  
27 [http://earthquake.usgs.gov/learn/topics/mag\\_vs\\_int.php](http://earthquake.usgs.gov/learn/topics/mag_vs_int.php), February 18.
- 28 USGS (U.S. Geologic Survey), 2010b, *Michigan Earthquake History*, accessed through  
29 <http://earthquake.usgs.gov/earthquakes/states/michigan/history.php>, January 18.
- 30 USGS (U.S. Geological Survey), 2010c, *Missouri Earthquake History, Historic Earthquakes*,  
31 Earthquake Hazards Program, accessed through  
32 <http://earthquake.usgs.gov/regional/states/missouri/history/php> and  
33 [http://earthquake.usgs.gov/regional/states/events/1811-1812.php#february\\_7](http://earthquake.usgs.gov/regional/states/events/1811-1812.php#february_7), January 29.
- 34 USGS (U.S. Geological Survey), 2010d, Earthquake Search, Circular Area, NEIC: Earthquake  
35 Search Results, Search Parameters NGDC Significant Earthquake Database, Significant U.S.

1 Earthquakes (1568 - 1989), Latitude 42.72984 N, Longitude -84.4810 W, Radius 200 km,  
2 Earthquake Hazards Program, National Earthquake Information Center, accessed through  
3 [http://neic.usgs.gov/neis/epic/epic\\_circ.html](http://neic.usgs.gov/neis/epic/epic_circ.html), January 29.

4 USGS (U.S. Geological Survey), 2010e, Earthquake Search, Circular Area, NEIC: Earthquake  
5 Search Results, Search Parameters: USGS/NEIC (PDE) 1973 – Present Data Base, Latitude  
6 42.72984 N, Longitude -84.4810 W, Radius 200 km, Earthquake Hazards Program, National  
7 Earthquake Information Center, accessed through [http://neic.usgs.gov/neis/epic/epic\\_circ.html](http://neic.usgs.gov/neis/epic/epic_circ.html),  
8 January 29.

9 USGS (U.S. Geological Survey), 2010f, *FAQs — What is probabilistic ground motion?, A*  
10 *Simple Description of Seismic Hazard Maps*, Earthquake Hazards Program, accessed through  
11 <http://earthquake.usgs.gov/learn/faq/?faqID=207>, January 29.

12 USGS (U.S. Geologic Survey), 2010g, *Michigan Seismic Hazard Map*, accessed through  
13 <http://earthquake.usgs.gov/earthquakes/states/michigan/hazards.php>, January 18.

#### 14 **Code of Federal Regulations**

15 10 CFR 20, U.S. Nuclear Regulatory Commission, “Standards for Protection Against Radiation.”

16 10 CFR 1021, U.S. Department of Energy, “National Environmental Policy Act Implementing  
17 Procedures.”

18 10 CFR 1021.216, “National Environmental Policy Act Implementing Procedures, DOE  
19 Decisionmaking: Procurement, financial assistance, and joint ventures.”

20 10 CFR 1022, U.S. Department of Energy, “Compliance with Floodplain and Wetland  
21 Environmental Review Requirements.”

22 29 CFR 1904, Occupational Safety and Health Administration, U.S. Department of Labor,  
23 “Recording and Reporting Occupational Injuries and Illnesses.”

24 40 CFR 51.850–51.860, “Requirements for Preparation, Adoption, and Submittal of  
25 Implementation Plans.”

26 40 CFR 61, U.S. Environmental Protection Agency, “National Emission Standards for  
27 Hazardous Air Pollutants.”

28 40 CFR 81.196, “Designation of Areas for Air Quality Planning Purposes, Designation of Air  
29 Quality Control Regions – South Central Michigan Intrastate Air Quality Control Region.”

30 40 CFR 81.323, “Designation of Areas for Air Quality Planning Purposes, Attainment Status  
31 Designations – Michigan.”

32 40 CFR 141, U.S. Environmental Protection Agency, “National Primary Drinking Water  
33 Regulations.”

1 40 CFR 1500–1508, Council on Environmental Quality, “Regulations for Implementing the  
2 Procedural Provisions of the National Environmental Policy Act.”

3 40 CFR 1508.7, Council on Environmental Quality, “Terminology and Index: Cumulative  
4 Impact.”

5 **Federal Register**

6 74 FR 16447, U.S. Environmental Protection Agency, 2009, “Mandatory Reporting of  
7 Greenhouse Gases; Proposed Rule,” April 10.

8 74 FR 55221, U.S. Department of Energy, 2009, “Notice of Intent to Prepare an Environmental  
9 Assessment, To Open a Public Scoping Period, and To Conduct a Public Scoping Meeting,”  
10 October 27.

11 **United States Code**

12 33 U.S.C. 1251 et seq., Clean Water Act of 1972.

13 42 U.S.C. 4321 et seq., National Environmental Policy Act of 1969, as amended.

14 **Michigan Compiled Laws**

15 1994 PA 451, Natural Resources and Environmental Protection Act.

16

1

2

3

4

**APPENDIX A  
NOTICE OF INTENT**

Access at: <http://www.gpoaccess.gov/nara/index.html>.

John Q. Easton,  
Director, Institute of Education Sciences.  
[FR Doc. E9-25838 Filed 10-26-09; 8:45 am]  
BILLING CODE 4000-01-P

**DEPARTMENT OF ENERGY**

**Notice of Intent To Prepare an Environmental Assessment, To Open a Public Scoping Period, and To Conduct a Public Scoping Meeting**

**AGENCY:** Office of Science, Department of Energy.

**ACTION:** Notice of Intent to Prepare an Environmental Assessment, to open a public scoping period, and to conduct a public scoping meeting for the funding of the construction and operation of the Facility for Rare Isotope Beams at Michigan State University, East Lansing, Michigan.

**SUMMARY:** The Department of Energy (DOE) announces its intent to prepare an Environmental Assessment (EA) pursuant to the National Environmental Policy Act (NEPA) and to hold a public scoping meeting on the proposed Federal action to fund the construction and operation of the Facility for Rare Isotope Beams (FRIB) on the campus of Michigan State University (MSU) in East Lansing, Michigan. FRIB's design is composed of buildings and/or building additions for a heavy ion/proton accelerator, ancillary laboratories, and support facilities. Construction/operation would occur adjacent to the existing National Superconducting Cyclotron Laboratory (NSCL), which would ultimately be subsumed into FRIB. The EA will identify and assess potential environmental impacts from the Proposed Action and a range of reasonable alternatives so DOE can determine whether to prepare an environmental impact statement (EIS) or issue a finding of no significant impact (FONSI). DOE is also opening a 45-day scoping period to allow the public the opportunity to voice any concerns it might have and to make recommendations about the analytical approach and alternatives. During the scoping period, a public meeting will be held. If at any point during the preparation of the EA DOE determines that it is necessary to prepare an EIS, this scoping process will serve as the scoping process that would normally follow a Notice of Intent to prepare an EIS.

**DATES:** The public scoping period starts with the publication of this Notice in

the **Federal Register** and will continue until December 11, 2009. DOE will consider all comments received or postmarked by that date in defining the scope of the EA. Comments received or postmarked after that date will be considered to the extent practicable.

DOE invites public comment on the scope of this EA during a public scoping meeting from 6:30 p.m. to 10 p.m. on November 11, 2009 in room 1400 of the Biomedical and Physical Sciences Building (BPS) on the campus of Michigan State University, in East Lansing, Michigan. The scoping meeting will be preceded by an educational open house to be held from 4 p.m. to 6 p.m. at the NSCL, which is adjacent to BPS.

**ADDRESSES:** Written comments or suggestions on the scope of the EA may be submitted by mail to: FRIB Comments, U.S. Department of Energy, Office of Science, Chicago Office (STS), 9800 South Cass Avenue, Argonne, Illinois 60439; by toll free fax to 1-888-676-3672; by e-mail to [frib.comments@ch.doe.gov](mailto:frib.comments@ch.doe.gov); or through the EA Web site at <http://www.frib.msu.edu/NEPA/>.

The Pre-approval Draft EA is expected to be completed in the Spring of 2010. Advance requests for copies can also be made at this time via the methods above. In making your request, please specify whether you would like a paper copy, a compact disc, or notification of its availability on the Internet.

**FOR FURTHER INFORMATION CONTACT:** For further information on the proposed project, contact Mr. James Hawkins, FRIB Program Manager, U.S. Department of Energy, SC-26.2/ Germantown Building, 1000 Independence Avenue, SW., Washington, DC 20585-1290, by telephone at 301-903-3613, or via e-mail at [James.Hawkins@science.doe.gov](mailto:James.Hawkins@science.doe.gov); or Dr. Thomas Glasmacher, FRIB Project Manager, Facility for Rare Isotope Beams, Michigan State University, East Lansing, MI 48824-1321, by telephone at 517-908-7750, or via e-mail at [glasmacher@frib.msu.edu](mailto:glasmacher@frib.msu.edu). The FRIB project is described in detail at the FRIB Web site, <http://www.frib.msu.edu/>.

For general information concerning DOE's NEPA process, contact: Peter Siebach, NEPA Compliance Officer, U.S. Department of Energy, Office of Science-Chicago Office (STS), 9800 South Cass Avenue, Argonne, Illinois 60439, by telephone at 603-252-2007, or via e-mail at [Peter.Siebach@ch.doe.gov](mailto:Peter.Siebach@ch.doe.gov). This Notice of Intent and general information on the DOE NEPA process are available at <http://www.gc.energy.gov/NEPA/>.

**SUPPLEMENTARY INFORMATION:**

**Background**

DOE published a "funding opportunity announcement" on May 20, 2008 seeking applications for the design and establishment of a particle acceleration facility—the FRIB—as a National User Facility. The FRIB would take about a decade to design and build and would cost an estimated \$550 million, including cost sharing from MSU. MSU would also make other, non-monetary contributions. The research conducted at FRIB would involve experimentation with intense beams of rare isotopes—short-lived nuclei not normally found on earth—that will enable researchers to address pressing questions in nuclear structure and nuclear astrophysics. Two applications were received. The results of an independent merit review process, as well as an environmental critique, i.e., a comparison of environmental information provided in the applications, were considered by DOE and on December 11, 2008, MSU was selected to design and establish the FRIB. A cooperative agreement with DOE was signed on June 8, 2009, establishing terms and conditions for the work to be performed and ensuring DOE's substantial ongoing involvement in the project.

**Purpose and Need for Action**

DOE has a mission to advance our basic understanding of science. Scientific research at a FRIB holds the promise to vastly expand our understanding of nuclear astrophysics and nuclear structure. DOE determined that the establishment of the FRIB is a high priority for the future of U.S. nuclear science research. The FRIB establishes a highly sophisticated research laboratory that would produce intense beams of rare isotopes. These beams enable scientists to study the nuclear reactions that power stars and generate the elements found on earth; explore the structure of the nuclei of atoms, which form the core of all matter and the forces that bind them together; test current theories about the fundamental nature of matter; and play a role in developing new nuclear medicines and other societal applications of rare isotopes.

The FRIB concept has undergone numerous studies and assessments within DOE and by independent parties such as the National Research Council of the National Academy of Sciences. These studies—in addition to the joint DOE/National Science Foundation (NSF) Nuclear Science Advisory Committee (NSAC) 2007 Long Range Plan—concluded that such a facility is

a vital part of the U.S. nuclear science portfolio, complements existing and planned international efforts, and will provide capabilities unmatched elsewhere.

#### Proposed Action and Alternatives

DOE and MSU propose to construct and operate the FRIB on approximately 10 acres on its East Lansing, Michigan campus. Its design is composed of buildings and/or building additions for a heavy ion/proton accelerator and ancillary laboratories, support facilities such as a cryomodule, and offices. Construction/operations would occur on campus, adjacent to the existing NSCL, which would ultimately be subsumed into FRIB. The function and scope of operations of FRIB would be similar to NSCL, but FRIB would have substantially more power. The existing NSCL research program relies on a 200 MeV/u coupled cyclotron driver accelerator with 1–2 kW beam power. FRIB would be capable of 200 MeV/u energy for all species, higher energies for lighter ions up to 600 MeV/u for protons with up to 400 kW beam power. A 12 MeV/u reaccelerator is also planned for the facility. Upgrade is possible, but not currently planned.

Most of the structures that would house the accelerator would be thick-walled, reinforced concrete structures. The heavy ion linear accelerator (linac) would be located in a tunnel below grade. A trench (varying between 30 and 75 feet below grade up to 1,800 feet long) would be excavated for the accelerator, necessitating that Bogue Street be closed between Wilson Road and East Shaw Lane two years and portions of East Shaw Lane possibly to be closed for a number of months. The high energy end of the accelerator would join with the existing NSCL building.

The ground where FRIB would be located has been previously disturbed. Like the NSCL, the FRIB would be licensed by the Nuclear Regulatory Commission (NRC). Operation would result in low levels of activation of air and groundwater, which MSU would manage in accordance with NRC license requirements and Environmental Protection Agency regulations. Radiation doses to workers and members of the public from operation of the FRIB would be limited to well below NRC radiation protection standards.

As required by NEPA, the EA will evaluate a No Action alternative to serve as a basis for comparison with the action alternatives. Under the No Action alternative, a FRIB would not be constructed and operated at MSU,

although other use of the site could not be ruled out.

#### Preliminary Identification of Environmental Issues

In the EA, DOE will examine public health and safety effects and environmental impacts from the construction and operation of the proposed FRIB at MSU. This notice is to inform the public of the proposed project and to solicit comments and suggestions for consideration in the preparation of the EA. To help the public frame its comments, this notice contains a preliminary list of potential environmental issues that DOE has tentatively identified for analysis. It is not intended to be comprehensive, nor to imply any predetermination of impacts. These issues include:

1. Impacts from construction accidents;
2. Impacts to both workers and the public from potential exposure to radiation and other hazards under routine operations and credible accident scenarios including natural disasters (e.g., floods, hurricanes, tornadoes, and seismic events);
3. Transportation related impacts;
4. Impacts on surface and groundwater and on water use and quality;
5. Impacts on air and soil;
6. Socioeconomic impacts;
7. Disproportionately high and adverse impacts on minority and low income populations;
8. Impacts on land-use plans, policies and controls, and visual resources;
9. Pollution prevention and waste management practices and activities;
10. Unavoidable adverse impacts and irreversible and irretrievable commitments of resources;
11. Cumulative environmental effects of past, present, and reasonably foreseeable future actions;
12. Status of compliance with all applicable Federal, state and local statutes and regulations, international agreements, and required Federal and State environmental permits, consultations, and notifications; and
13. Impacts of intentional destructive acts, including sabotage and terrorism.

Since the proposed site is adjacent to a currently operating accelerator facility and would involve digging and construction in previously disturbed areas now occupied primarily by parking lots and roads, impacts in several areas are expected to be minor. These impact areas will therefore not be evaluated in detail:

- Impacts on protected, threatened, endangered, or sensitive species of animals or plants, or their critical habitats;

- Impacts on cultural or historic resources; and
- Impacts on floodplains and wetlands.

#### Scoping Process

DOE invites Federal agencies, State, local and Tribal governments, the general public and international community to participate in the scoping process both to refine the environmental issues to be analyzed and to identify the reasonable range of alternatives. Both oral and written comments will be considered and given equal weight by DOE. The public scoping period starts with the publication of this Notice in the *Federal Register* and will continue until December 11, 2009. DOE will consider all comments received or postmarked by then in defining the scope of the EA. Comments received or postmarked after that date will be considered to the extent practicable.

The scoping meeting will be held at the location, date, and times indicated above under the DATES section. It will provide interested parties the opportunity to ask questions about the project and comment on the EA scope. A facilitator will establish procedures needed to ensure that everyone who wishes to speak has the opportunity to do so. Should any speaker desire to provide further information that cannot be presented within the designated time, such additional information may be submitted in writing by the date listed in the DATES section. Both oral and written comments will be considered and given equal weight by DOE.

The scoping meeting will be preceded by an educational open house, to be held at the location, date, and times indicated above under the DATES section. During the open house, members of the public can register to provide oral comments at the scoping meeting, provide written comments, view FRIB informational materials, engage project staff, and tour the existing NSCL.

The Pre-approval Draft EA is planned to be issued for state and public review by the Spring of 2010. Persons submitting comments during the scoping process will receive a copy. Others who would like to receive a copy of the draft EA when it is issued should notify DOE per the ADDRESSES section above.

If at any time during preparation of the EA DOE determines that potentially significant environmental impacts might occur with the implementation of the Proposed Action and that an EIS would be needed, DOE will issue a Notice of Intent to prepare an EIS in the *Federal*

**Register.** In that case, this scoping process will serve as the scoping process that normally would follow a Notice of Intent to prepare an EIS. Accordingly, DOE will consider any comments on the scope of the EA received during this scoping process in preparing such an EIS.

Issued in Washington, DC on October 20, 2009.

Jehanne Gillo,  
Director, Facilities and Project Management  
Division, Office of Nuclear Physics.

[FR Doc. E9-25847 Filed 10-26-09; 8:45 am]

BILLING CODE 6450-01-P

#### DEPARTMENT OF ENERGY

##### Environmental Management Site-Specific Advisory Board, Northern New Mexico

**AGENCY:** Department of Energy.  
**ACTION:** Notice of open meeting.

**SUMMARY:** This notice announces a meeting of the Environmental Management Site-Specific Advisory Board (EM SSAB), Northern New Mexico. The Federal Advisory Committee Act (Pub. L. 92-463, 86 Stat. 770) requires that public notice of this meeting be announced in the **Federal Register**.

**DATES:** Wednesday, November 18, 2009, 1 p.m.–8 p.m.

**ADDRESSES:** Holiday Inn Santa Fe, 4048 Cerillos Road, Santa Fe, New Mexico.

**FOR FURTHER INFORMATION CONTACT:** Menice Santistevan, Northern New Mexico Citizens' Advisory Board (NNMCAB), 1660 Old Pecos Trail, Suite B, Santa Fe, NM 87505. Phone (505) 995-0393; Fax (505) 989-1752 or e-mail: [msantistevan@doeal.gov](mailto:msantistevan@doeal.gov).

##### SUPPLEMENTARY INFORMATION:

**Purpose of the Board:** The purpose of the Board is to make recommendations to DOE in the areas of environmental restoration, waste management, and related activities.

##### Tentative Agenda

- 1 p.m. Call to Order by Co-Deputy Designated Federal Officers, Ed Worth and Lee Bishop.  
Establishment of a Quorum, Lorelei Novak:
- Roll Call;
  - Excused Absences.
- Welcome and Introductions, Ralph Phelps.  
Approval of Agenda.  
Approval of September 30, 2009 Meeting Minutes.
- 1:15 p.m. Old Business:
- Written reports;

- Other items.
- 1:30 p.m. New Business.  
1:45 p.m. Co-Deputy Designated Federal Officers' Report, Ed Worth and Lee Bishop.  
2:15 p.m. NNMCAB Annual Evaluation Report, Pam Henline.  
2:45 p.m. Break.  
3 p.m. Matters From Board Members.  
3:30 p.m. Presentation on Los Alamos National Laboratory Groundwater Monitoring System (Existing and New Wells), Danny Katzman.  
5 p.m. Dinner Break.  
6 p.m. Public Comment Period.  
6:15 p.m. Consideration and Action on Recommendation(s).  
7:00 p.m. End of Year Report, Michael Graham.  
7:45 p.m. Meeting Feedback.  
8 p.m. Adjourn, Ed Worth and Lee Bishop.

**Public Participation:** The EM SSAB, Northern New Mexico, welcomes the attendance of the public at its advisory committee meetings and will make every effort to accommodate persons with physical disabilities or special needs. If you require special accommodations due to a disability, please contact Menice Santistevan at least seven days in advance of the meeting at the telephone number listed above. Written statements may be filed with the Board either before or after the meeting. Individuals who wish to make oral statements pertaining to agenda items should contact Menice Santistevan at the address or telephone number listed above. Requests must be received five days prior to the meeting and reasonable provision will be made to include the presentation in the agenda. The Deputy Designated Federal Officer is empowered to conduct the meeting in a fashion that will facilitate the orderly conduct of business. Individuals wishing to make public comment will be provided a maximum of five minutes to present their comments.

**Minutes:** Minutes will be available by writing or calling Menice Santistevan at the address or phone number listed above. Minutes and other Board documents are on the Internet at: <http://www.nnmcab.org/>.

Issued at Washington, DC on October 20, 2009.

Rachel Samuel,  
Deputy Committee Management Officer.  
[FR Doc. E9-25842 Filed 10-26-09; 8:45 am]  
BILLING CODE 6450-01-P

#### DEPARTMENT OF ENERGY

##### Environmental Management Site-Specific Advisory Board, Oak Ridge Reservation

**AGENCY:** Department of Energy.  
**ACTION:** Notice of open meeting.

**SUMMARY:** This notice announces a meeting of the Environmental Management Site-Specific Advisory Board (EM SSAB), Oak Ridge Reservation. The Federal Advisory Committee Act (Pub. L. 92-463, 86 Stat. 770) requires that public notice of this meeting be announced in the **Federal Register**.

**DATES:** Wednesday, November 18, 2009, 6 p.m.

**ADDRESSES:** DOE Information Center, 475 Oak Ridge Turnpike, Oak Ridge, Tennessee.

**FOR FURTHER INFORMATION CONTACT:** Patricia J. Halsey, Federal Coordinator, Department of Energy Oak Ridge Operations Office, P.O. Box 2001, EM-90, Oak Ridge, TN 37831. Phone (865) 576-4025; Fax (865) 576-2347 or e-mail: [halseypj@oro.doe.gov](mailto:halseypj@oro.doe.gov) or check the Web site at <http://www.oakridge.doe.gov/em/ssab>.

##### SUPPLEMENTARY INFORMATION:

**Purpose of the Board:** The purpose of the Board is to make recommendations to DOE in the areas of environmental restoration, waste management, and related activities.

**Tentative Agenda:** The main meeting presentation will be on Mercury Remediation Strategy and Activities.

**Public Participation:** The EM SSAB, Oak Ridge, welcomes the attendance of the public at its advisory committee meetings and will make every effort to accommodate persons with physical disabilities or special needs. If you require special accommodations due to a disability, please contact Pat Halsey at least seven days in advance of the meeting at the phone number listed above. Written statements may be filed with the Board either before or after the meeting. Individuals who wish to make oral statements pertaining to the agenda item should contact Pat Halsey at the address or telephone number listed above. Requests must be received five days prior to the meeting and reasonable provision will be made to include the presentation in the agenda. The Deputy Designated Federal Officer is empowered to conduct the meeting in a fashion that will facilitate the orderly conduct of business. Individuals wishing to make public comment will be provided a maximum of five minutes to present their comments.

1  
2  
3

**APPENDIX B**  
**LIST OF STATE AND FEDERALLY THREATENED AND ENDANGERED SPECIES**

<b>Scientific Name</b>	<b>Common Name</b>	<b>Federal Status</b>	<b>State Status</b>
<i>Acris crepitans blanchardi</i>	Blanchard's cricket frog	–	T
<i>Alasmidonta marginata</i>	Elktoe	–	SC
<i>Alasmidonta viridis</i>	Slippershell	–	T
<i>Ammodramus henslowii</i>	Henslow's sparrow	–	E
<i>Ammodramus savannarum</i>	Grasshopper sparrow	–	SC
<i>Angelica venenosa</i>	Hairy angelica	–	SC
<i>Arabis perstellata</i>	Rock cress	–	T
<i>Asclepias purpurascens</i>	Purple milkweed	–	T
<i>Astragalus neglectus</i>	Cooper's milk vetch	–	SC
<i>Baptisia lactea</i>	White or prairie false indigo	–	SC
<i>Betula populifolia</i>	Gray birch	–	SC
<i>Carex crus-corvi</i>	Raven's-foot sedge	–	E
<i>Carex davisii</i>	Davis's sedge	–	SC
<i>Carex lupuliformis</i>	False hop sedge	–	T
<i>Carex trichocarpa</i>	Hairy-fruited sedge	–	SC
<i>Carex typhina</i>	Cattail sedge	–	T
<i>Castanea dentata</i>	American chestnut	–	E
<i>Clemmys guttata</i>	Spotted turtle	–	T
<i>Clemmys insculpta</i>	Wood turtle	–	SC
<i>Cryptotis parva</i>	Least shrew	–	T
<i>Cypripedium candidum</i>	White lady slipper	–	T
<i>Diarrhena obovata</i>	Beak grass	–	T
<i>Emys blandingii</i>	Blanding's turtle	–	SC
<i>Falco peregrinus</i>	Peregrine falcon	–	E
<i>Galearis spectabilis</i>	Showy orchis	–	T
<i>Gomphus lineatifrons</i>	Splendid clubtail	–	SC
Great Blue Heron Rookery	Great Blue Heron Rookery	–	
<i>Hemicarpha micrantha</i>	Dwarf-bulrush	–	SC
<i>Hemileuca maia</i>	Barrens buckmoth	–	SC
<i>Hybanthus concolor</i>	Green violet	–	SC
<i>Hydrastis canadensis</i>	Goldenseal	–	T
<i>Linum virginianum</i>	Virginia flax	–	T
<i>Lycopus virginicus</i>	Virginia water-horehound	–	T
<i>Microtus pinetorum</i>	Woodland vole	–	SC
<i>Morus rubra</i>	Red mulberry	–	T
<i>Myotis sodalis</i>	Indiana bat	LE	E
<i>Notropis anogenus</i>	Pugnose shiner	–	E

Scientific Name	Common Name	Federal Status	State Status
Notropis texanus	Weed shiner	–	X
Oecanthus laricis	Tamarack tree cricket	–	SC
Panax quinquefolius	Ginseng	–	T
Papaipema speciosissima	Regal fern borer	–	SC
Pleurobema sintoxia	Round pigtoe	–	SC
Poa paludigena	Bog bluegrass	–	T
Rallus elegans	King rail	–	E
Scirpus clintonii	Clinton's bulrush	–	SC
Scirpus torreyi	Torrey's bulrush	–	SC
Scleria triglomerata	Tall nut rush	–	SC
Scutellaria parvula	Small skullcap	–	T
Silphium perfoliatum	Cup plant	–	T
Sistrurus catenatus catenatus	Eastern massasauga	C	SC
Spiza americana	Dickcissel	–	SC
Terrapene carolina carolina	Eastern box turtle	–	SC
Tradescantia virginiana	Virginia spiderwort	–	SC
Venustaconcha ellipsiformis	Ellipse	–	SC
Villosa iris	Rainbow	–	SC

**Key:** E=Endangered; C=Species being considered for federal status; SC=Special concern; T=Threatened; LE=Listed Endangered; X= species is considered extirpated from the state (Rogers 2010)

**Source:** MSUE 2009.

#### References:

MSUE (Michigan State University Extension), 2009, *Michigan Natural Features Inventory, Ingham County*, accessed through [http://web4.msue.msu.edu/mnfi/data/cnty\\_dat.cfm?county=Ingham](http://web4.msue.msu.edu/mnfi/data/cnty_dat.cfm?county=Ingham), December 17.

Rogers, R., 2010, Michigan State University Extension, personal communication (email) to A. Greene, Science Applications International Corporation, Germantown, Maryland, “Re: Question about Weed Shiner Status,” February 25.

## APPENDIX C

### PRELIMINARY ASSESSMENT OF FRIB ACCIDENT HAZARDS

The event summaries provided in this section are a summary of the results of the ongoing process of accident/hazard identification and evaluation and represent some (not all) of the more significant event types that are being addressed through the design process. These scenarios are provided to demonstrate that credible controls are available to prevent or mitigate the postulated accident scenarios identified for operation of the Facility for Rare Isotope Beams (FRIB). As the design and safety basis evolves, so do the control strategy and specific controls identified for each of the hazards and postulated events where the potential exists for a significant exposure to FRIB workers or the public. This selection process is integral to the preliminary design process.

**Preliminary Assessment of Accident Hazards at the Facility for Rare Isotope Beams**

Event/Hazard	Possible Cause or Initiating Condition	Possible Prevention or Mitigation Measures
<p><b>Tunnel Air Loss of Confinement</b> – Air in the linac tunnel becomes activated during operation. Unmitigated, the activated air could be above 10 CFR Part 20<sup>a</sup> limits for release to the environment.</p>	<ul style="list-style-type: none"> <li>• Operator error -- entering the tunnel before short-lived radionuclides adequately decay</li> <li>• Ventilation system failure allowing air to be exhausted to the environment</li> <li>• External events that cause loss of confinement of the tunnel entry/exit locations</li> <li>• Failure of the isolation system between the linac tunnel and the utility service area.</li> </ul>	<ul style="list-style-type: none"> <li>• Closed loop air handling system during linac operation limiting air exchange with the environment</li> <li>• Tunnel air handling system would include appropriate filtering and conditioning of the air to reduce activated materials. This could include humidity control, which would limit tritium activity and filtration (e.g., a combination of industrial, HEPA, and activated charcoal filters) to remove material.</li> <li>• Delay of 4 hours after beam trip before personnel reentry or starting air exchange between the linac tunnel and the environment. If industrial hygiene monitoring determines that the air quality meets defined parameters, then reentry could be permitted at an earlier time.</li> <li>• Pressure in the linac tunnel would be monitored and maintained at a pressure lower than the environment or the utility services area.</li> <li>• Ventilation system damper design (“fail as is” and monitoring of damper position) and interlock with administrative controls to verify position prior to operation.</li> <li>• Robust linac tunnel design and entry points provide a passive barrier between the activated air in the tunnel and either the service area or public environment.</li> </ul>
<p><b>Target Facility Air Loss of Confinement</b> – Air in the Target Facility becomes activated during operation. Unmitigated, the activated air could be above 10 CFR Part 20 limits for release to the environment.</p>	<ul style="list-style-type: none"> <li>• Operator error -- entering the confinement before short lived radionuclides adequately decay</li> <li>• Ventilation system failure allowing air to be exhausted to the environment</li> <li>• External events that cause loss of confinement of the Target Facility entry/exit locations</li> <li>• Failure of the isolation system between the Target Facility confinement and the personnel access areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Closed loop air handling system during operation limiting air exchange with the environment</li> <li>• Target Facility air handling system would include appropriate filtering and conditioning of the air to reduce activated materials. This could include humidity control which would limit tritium activity and filtration (e.g., a combination of industrial, HEPA, and activated charcoal filters) to remove material.</li> <li>• Delay after beam trip before personnel reentry or starting air exchange between the Target Facility confinement and the environment. Industrial hygiene monitoring determines air quality meets defined parameters before reentry.</li> </ul>

**Preliminary Assessment of Accident Hazards at the Facility for Rare Isotope Beams**

Event/Hazard	Possible Cause or Initiating Condition	Possible Prevention or Mitigation Measures
		<ul style="list-style-type: none"> <li>• Pressure in the Target Facility confinement would be monitored and maintained at a pressure lower than the environment or the personnel access areas.</li> </ul>
<p><b>Coolant water leak</b> - Failure of the cooling water system allows activated cooling water to spill in the utility service area or cooling tower area with potential exposure to workers.</p>	<ul style="list-style-type: none"> <li>• Piping or component failure, including seal or packing failure.</li> <li>• Heat exchanger tube failure</li> <li>• Human error during maintenance or operations</li> <li>• Impact from equipment (e.g., lifting or moving heavy equipment).</li> </ul>	<ul style="list-style-type: none"> <li>• Water activation control via resin beds, tritium getter, etc. as needed to limit (mitigate) the potential release consequences from a spill.</li> <li>• Heat exchanger design (potentially double-walled heat exchanger design)</li> <li>• Monitoring and removal and disposal of highly activated water system components as necessary.</li> <li>• Including an intermediate loop between the primary cooling loop and the cooling tower.</li> </ul>
<p><b>Failure of the cryogenic system</b> causing an ODH (oxygen deficient hazard) for workers or the public.</p>	<ul style="list-style-type: none"> <li>• Mechanical failure</li> <li>• Human error during maintenance</li> <li>• Loss of cooling/insulation for the cryogenic system</li> </ul>	<p>Linac tunnel:</p> <ul style="list-style-type: none"> <li>• Oxygen detection and alarms along the tunnel when personnel are in the tunnel</li> <li>• Egress locations in the tunnel designed to limit lighter than air gases from entering the egress area and thus limits the potential for ODH issues in the stairs used for egress.</li> <li>• Additional ventilation for the tunnel for the region of the tunnel where oxygen monitoring detects a potential ODH concern. This would pull fresh air toward the break and preferentially exhaust the leaking helium.</li> <li>• Cryogenic system design requires multiple barriers to leakage, limiting the potential for direct leakage to the environment.</li> <li>• Cryogenic system pressure relief devices to remove helium from the line and prevent rupture or other failures of the helium into the tunnel.</li> </ul> <p>Target Building:</p> <ul style="list-style-type: none"> <li>• Oxygen detection and alarm in the facility when personnel are in the area.</li> <li>• Additional ventilation for the room or region of the facility where oxygen monitoring detects a potential ODH concern. This would pull fresh air toward the break and preferentially exhaust the leaking helium.</li> <li>• Cryogenic system design requires multiple barriers to</li> </ul>

**Preliminary Assessment of Accident Hazards at the Facility for Rare Isotope Beams**

Event/Hazard	Possible Cause or Initiating Condition	Possible Prevention or Mitigation Measures
		leakage, limiting the potential for direct leakage to the environment. <ul style="list-style-type: none"> <li>• Cryogenic system pressure relief devices to remove helium from the line and prevent rupture or other failures of the helium into the facility.</li> </ul> Cryoplant: <ul style="list-style-type: none"> <li>• Oxygen detection and alarm within all regions of the facility.</li> <li>• Egress locations in the plant are designed to limit lighter than air gases from entering the egress area and thus limits the potential for ODH issues in the egress site.</li> <li>• Additional ventilation for the room where oxygen monitoring detects a potential ODH concern. This would pull fresh air toward the break and preferentially exhaust the leaking helium.</li> <li>• Cryogenic system design requires multiple barriers to leakage, limiting the potential for direct leakage to the environment.</li> <li>• Cryogenic system pressure relief devices to remove helium from the line and prevent rupture or other failures of the helium into the facility.</li> </ul>
<b>Failure of the cryogenic system</b> causing a release of the tritium resulting in exposure to workers or the public.	<ul style="list-style-type: none"> <li>• Mechanical failure</li> <li>• Human error during maintenance</li> <li>• Loss of cooling/insulation for the cryogenic system</li> </ul>	<ul style="list-style-type: none"> <li>• Activation of the helium within the linac tunnel and the target facility results in low to negligible levels of tritium in the cryogenic system. A release of the cryogenic helium that, when mixed with air to get a 5 percent oxygen concentration, would be well below radiological exposure limits. The major concern is ODH and not radiological exposure.</li> <li>• The same mitigating features as for ODH hazards are also applicable for this event.</li> </ul>
<b>Failure of the activated cooling water lines</b> leading to a release directly to the environment.	<ul style="list-style-type: none"> <li>• Mechanical failure</li> <li>• Human error during maintenance</li> </ul>	<ul style="list-style-type: none"> <li>• Activated cooling water loops include either a double-walled heat exchanger or an intermediate loop preventing activated water from leaving the controlled (primary or secondary) confinement within the facility.</li> <li>• Cooling lines that exit the confinement system are monitored for activation.</li> </ul>

**Preliminary Assessment of Accident Hazards at the Facility for Rare Isotope Beams**

Event/Hazard	Possible Cause or Initiating Condition	Possible Prevention or Mitigation Measures
		<ul style="list-style-type: none"> <li>• Pressure differences are maintained to assure that activated water would not leak to a system that could fail with a release directly to the public environment.</li> <li>• Cooling water activation and contamination would be monitored and the water cleaned or disposed of as needed.</li> <li>• Filter systems to remove radioactivity from the water would be included in primary cooling loops.</li> </ul>
<p><b>Direct exposure to workers or the public</b> from loss of beam control (direction) leading to beam impacting beam pipe wall.</p>	<ul style="list-style-type: none"> <li>• Loss of control for magnet (cryogenic or warm)</li> <li>• Mechanical failure</li> <li>• Human error during maintenance or beam tuning</li> <li>• Change in beam rigidity due to a magnet malfunction.</li> </ul>	<ul style="list-style-type: none"> <li>• Machine Protection System detecting beam losses and tripping the beam when radiation levels in the tunnel, target facilities, or the fragment pre-separator exceed expected conditions.</li> <li>• Personnel Protection System detecting beam losses and tripping the beam to limit potential exposure to a member of the public to less than 2 millirem in any 1 hour or exposure to a worker above MSU ALARA goals.</li> <li>• In known high-loss areas (e.g., stripper region), local shielding would be provided to mitigate the potential consequences from these regions.</li> </ul>
<p><b>Lithium Target release</b> due to lithium/water reaction resulting from a loss of confinement for the water-cooled beam dump.</p>	<ul style="list-style-type: none"> <li>• Mechanical failure of water-cooled beam dump allows water to leak into the common vacuum system with lithium target (if this concept is chosen)</li> <li>• Leaks in cooling lines for shielding and other components that lead to system overpressure leading to confinement breach</li> </ul>	<ul style="list-style-type: none"> <li>• Minimize lithium quantity in the target module.</li> <li>• Layout of water filled beam dump and cooling lines prevents liquid water direct contact with the lithium target.</li> <li>• Target module design with shutters that close on fault detection and isolate the lithium target from the remainder of the system.</li> <li>• System inert atmosphere provided on system failure. The lithium target is isolated by shutters from the remainder of the system and the internals flooded with inert gas (expected to be argon) to limit/prevent lithium/water reaction.</li> </ul>
<p><b>Graphite Target Fire</b> – During and for a very short time after beam operation on the graphite target, the material is hot enough that if it were to come in contact with air it would</p>	<ul style="list-style-type: none"> <li>• Confinement system boundary failure.</li> </ul>	<ul style="list-style-type: none"> <li>• Robust vacuum system designed as confinement for the target material.</li> <li>• Inherent design of the target cooling system which cools the target within a few revolutions reducing the frequency of a fire.</li> </ul>

**Preliminary Assessment of Accident Hazards at the Facility for Rare Isotope Beams**

Event/Hazard	Possible Cause or Initiating Condition	Possible Prevention or Mitigation Measures
result in a fire.		<ul style="list-style-type: none"> <li>•</li> <li>• Venting of vacuum system with inert gas before target removal</li> <li>• Target Facility confinement system with filtered HVAC preventing material from being released to the environment.</li> </ul>
<p><b>Water Beam Dump System Failure</b>                      – A failure in the water beam dump system would release activated water within the Target Building.</p>	<ul style="list-style-type: none"> <li>• Mechanical failure of the water dump outer boundary.</li> <li>• Change in beam rigidity due to improper controls on beam operations, with increased beam energy leading to failure of the beam dump confinement.</li> <li>• Beam dump rotation inappropriate for operation. A dump that is operating a reduced rotation rate would lead to premature failure of the water beam dump walls</li> <li>• Failure of the rotational seal causing leaks or affecting system rotation.</li> <li>• Loss of water flow leads to steam buildup and system failure.</li> </ul>	<ul style="list-style-type: none"> <li>• Vacuum system would be designed such that water from an in-vacuum leak can be locally contained in easily removed</li> <li>• Area is managed as a contaminated area limiting the impact of leaks in this region.</li> <li>• Water cooling loop for the beam dump include water contamination control which limits the impact of a system failure.</li> <li>• The floor design in this area includes a floor sump to capture any leakage.</li> <li>• Vacuum system is monitored and can be automatically isolated as needed.</li> <li>• Water cooling system monitoring would verify water dump cooling is adequate for the beam operation.</li> </ul>

**Key** ALARA=as low as reasonably achievable; HEPA= high-efficiency particulate air; HVAC=heating, ventilation, and air conditioning; MSU=Michigan State University; ODH=oxygen-deficient hazard; tritium=hydrogen-3.

<sup>a</sup> 10 CFR 20, U.S. Nuclear Regulatory Commission, “Standards for Protection Against Radiation.”

1  
2  
3  
4

**APPENDIX D**  
**CULTURAL RESOURCE STUDY AND CONSULTATIONS**

MICHIGAN STATE  
UNIVERSITY

DATE: February 25, 2010  
TO: Whom It May Concern  
FROM: Lynne Goldstein, Ph.D., RPA  
Professor of Anthropology  
Director, Campus Archaeology Program  
RE: Potential archaeological resources in planned F-RIB project area

The MSU Campus Archaeology Program has completed a preliminary review of the area included within the proposed F-RIB project area. Although there is a possibility that some historic and prehistoric resources may be affected by the excavation and construction of the accelerator and adjacent spaces, it is our view that this possibility is unlikely in all but one area.

The Campus Archaeology Program has conducted a number of archaeological assessments across MSU's campus. The F-RIB project area, near Bogue Street, and bounded on the north and south by Shaw Lane and Wilson Road, has already been extensively modified by buildings, roads, and utility installations. Historical maps, archives, and aerial photographs do not indicate the presence of historical structures in this area prior to campus expansion during the 1950s and 60s. Although a number of the extant structures in this area were built in the early 1960s (such as Owen and McDonel Hall), the F-RIB project as currently proposed will not affect these buildings or their surrounding areas.



**DEPARTMENT OF ANTHROPOLOGY**

College of Social Science

Michigan State University  
354 Baker Hall  
East Lansing, MI  
48824-1118  
517/353-2950  
FAX: 517/432-2363

Web: anthropology.msu.edu

The project area is within 1200 feet of the Red Cedar River, but the extensive modification to the landscape by the University all but negates the possibility of prehistoric sites being present. Nonetheless, an MSU Campus Archaeologist must monitor the excavation and construction for the F-RIB project in order to mitigate any potential disturbances to culturally sensitive materials. Further, the excavations for this project will go deeper than any survey method or technique that archaeologists commonly use. Close monitoring of the excavations will be especially important for this reason, since we will be able to examine profiles and horizons that we do not ordinarily have the opportunity to see. The F-RIB construction team understands this, and has indicated their willingness to allow access to the site so that we can monitor the area during excavations.

Our area of concern is not related directly to the project area itself, but to where the excavation materials will be deposited along Mt. Hope Road. This space, known as Lot-89, is bounded by Mt. Hope, Farm Lane, and the C & O Railroad. Its most recent use has been as an unpaved parking lot. Historical documentation indicates the presence of an early 20th century farmstead in the eastern portion of the lot. In the near future, this lot is slated to become a paved parking lot. We recommend that Campus Archaeology be provided resources to mitigate this site, as it will be directly impacted by activities of the F-RIB project.

We have attached a map indicating the location of the F-RIB project area and the location of Lot-89 and the early 20<sup>th</sup> century farmstead.



**Department of Energy**

Office of Science  
Chicago Office  
9800 South Cass Avenue  
Argonne, Illinois 60439

March 1, 2010

Environmental Review Coordinator  
State Historic Preservation Office  
Michigan Historical Center  
P.O. Box 30740  
702 W. Kalamazoo St.  
Lansing, MI 48909-8240

Dear Sir or Madam:

**SUBJECT: SECTION 106 CONSULTATION FOR FACILITY FOR RARE ISOTOPE BEAMS (FRIB), MICHIGAN STATE UNIVERSITY (MSU), EAST LANSING, MICHIGAN**

The U.S. Department of Energy (DOE) and MSU are partnering on the construction and operation of the FRIB on the MSU campus. The purpose of this letter is to provide a determination to your office to satisfy the consultation requirements of Section 106 of the National Historic Preservation Act (16 U.S.C. § 470f), as amended (NHPA).

FRIB will enable physicists to study the nuclear reactions that power stars and that have generated the elements found on Earth; explore the structure of the nuclei of atoms, which form the core of all matter and the forces that bind them together; test current theories about the fundamental nature of matter; and play a role in developing new nuclear medicines and other societal applications of rare isotopes. The total project cost is estimated to be approximately \$550M. Because of the Federal contribution, it qualifies as a "Federal undertaking" under NHPA and is therefore subject to the requirements of the Advisory Council on Historic Preservation regulations for Protection of Historic Properties (36 CFR Part 800).

DOE has worked with MSU to complete the enclosed Application for Section 106 Review. Based on the Application and associated supporting information, DOE has determined, pursuant to 36 CFR § 800.4(d)(1), that no historic properties will be affected.



Printed on Recycled Paper

Environmental Review Coordinator

-2-

March 1, 2010

I note that a historic farmstead was identified by MSU's Campus Archaeology Program during their internal review (see enclosed memorandum from Dr. Lynne Goldstein). However, DOE and MSU have no plans to engage in the "type of activity that has the potential to cause effects on historic properties" (36 CFR § 800.3(a)) in the vicinity of the farmstead. Moreover, while the farmstead site would be adjacent to the area designated for FRIB related soils storage and disposal, the site would be outside of the storage/disposal area and would be protected to ensure it is left undisturbed. Please also note that while MSU is considering constructing a paved parking lot which would have the potential to impact the farmstead, it is entirely unrelated to the Federal undertaking or the FRIB Project in general.

Please feel free to contact me via telephone at 630-252-2007, or by e-mail at [peter.siebach@ch.doe.gov](mailto:peter.siebach@ch.doe.gov). Alternatively, you can contact our Federal Project Director, Mr. Ronald Lutha via telephone at 630-252-8173 or via e-mail at [ronald.lutha@ch.doe.gov](mailto:ronald.lutha@ch.doe.gov).

Sincerely,



Peter R. Siebach, Acting Director  
Program Support Services

Enclosures:

1. Application for Section 106 Review (including supporting documentation)
2. Memorandum from L. Goldstein, Ph.D., Director, Campus Archaeology Program

cc: T. Glasmacher, MSU, w/o encls.  
K. Eisenbeis, MSU, w/o encls.

1 **APPENDIX E**  
2 **ENVIRONMENTAL SYNOPSIS**

3 Prior to award, DOE underwent a competitive procurement process and selected MSU based on the merits  
4 of its application. Part of that process was the preparation of an "environmental critique," which is a  
5 comparative analysis of environmental issues pertinent to the decision (10 CFR, Section 1021 .216). A  
6 publicly available summary, which DOE refers to as an "environmental synopsis" is also enclosed.

## **ENVIRONMENTAL SYNOPSIS: FACILITY FOR RARE ISOTOPE BEAMS**

### **PURPOSE**

Department of Energy (DOE) National Environmental Policy Act (NEPA) regulations found at Title 10 Code of Federal Regulations, Section 1021.216 establish environmental review requirements for DOE competitive procurements. The requirements include preparation of an “environmental critique” of proposals in the competitive range to include:

- A brief discussion of the purpose of the procurement and each offer, including any site, system, or process variations among the offers having environmental implications;
- A discussion of the salient characteristics of each offeror's proposed site, system, or process as well as alternative sites, systems, or processes;
- A brief comparative evaluation of the potential environmental impacts of the offers, which will address direct and indirect effects, short-term and long-term effects, proposed mitigation measures, adverse effects that cannot be avoided, areas where important environmental information is incomplete and unavailable, unresolved environmental issues and practicable mitigating measures not included in the offeror's proposal; and
- To the extent known for each offer, a list of Federal, Tribal, state, and local government permits, licenses, and approvals, if any, that must be obtained.

The intent is to help the selection official in decision-making. The “environmental synopsis” is a publicly available summary of the environmental critique.

### **BACKGROUND**

DOE published a “funding opportunity announcement” on May 20, 2008 seeking applications for the design, construction, and operation of a particle acceleration facility - the Facility for Rare Isotope Beams (FRIB). The research conducted at FRIB would involve experimentation with intense beams of rare isotopes—short-lived nuclei not normally found on earth—that will enable researchers to address pressing questions in nuclear structure and nuclear astrophysics. Two applications were received. The results of an independent merit review process, as well as the environmental critique, were considered by DOE and on December 11, 2008, Michigan State University (MSU) was selected to design and establish the FRIB.

### **SITE SUMMARY/SALIENT CHARACTERISTICS OF APPLICATIONS**

#### Michigan State University

Michigan State University (MSU) proposed to construct and operate the FRIB on 10.5 acres on its East Lansing, Michigan campus. Its design is composed of buildings and/or building additions for a heavy ion/proton accelerator and ancillary laboratories, support facilities such as a cryomodule, and offices. Construction/operations would occur in the middle of campus,

**Environmental Synopsis -- Facility For Rare Isotope Beams**

adjacent to the existing National Superconducting Cyclotron Laboratory (NSCL), which would ultimately be subsumed into FRIB. The function and scope of operations of FRIB would be similar to NSCL, but FRIB would have substantially more power. The existing NSCL research program relies on a 200 MeV/u coupled cyclotron driver accelerator with 1-2 kW beam power. FRIB would be capable of 200 MeV/u energy and up to 400 kW beam power. A 12 MeV/u reaccelerator is also planned for the facility. Upgrade is possible, but limited space is available. The linac tunnel would be situated in an excavation up to 50 ft below grade. The ground where FRIB would be located has been previously disturbed. The Nuclear Regulatory Agency would have regulatory jurisdiction over the FRIB. MSU's broad scope license would be modified to cover oversight of all accelerator related activities.

**Application B**

Construction and operation were proposed to occur at an existing National Laboratory operated by a contractor for the Department of Energy. The proposed design included construction of buildings and/or building additions for a heavy ion/proton accelerator and ancillary laboratories, technical support facilities such as a cryomodule, and offices. Construction/operations were proposed to occur at the fringes of the developed part of the Laboratory, within and adjacent to complementary operations, e.g., a small heavy ion linac. The FRIB was proposed to use a 200 MeV/u heavy ion and 600 MeV/u proton linac driver with up to 400 kW beam power. Existing infrastructure was proposed to be modified and redeployed as a reaccelerator. Space was available for substantial upgrade within the 40 acres to be set aside for FRIB. The FRIB linac tunnel was proposed to be situated at or near grade, covered by an earthen berm. The site where FRIB (including the linac, target area, laboratories, and offices) was proposed to be located had been previously disturbed. It was intended that oversight occur per DOE Orders.

**COMPARATIVE EVALUATION**

The following table provides a comparison of the Environmental Critique criteria discussed above:

	<b>Environmental Critique Criteria</b>			
	<b>1 Applicant's awareness of project-related requirements</b>	<b>2 Potential environmental impacts of the proposed work</b>	<b>3 Proposed mitigation measures</b>	<b>4 Adverse effects that cannot be avoided</b>
<b>Offeror Michigan State University</b>	Acceptable	Acceptable	Acceptable	Acceptable
<b>"Application B"</b>	Acceptable	Acceptable	Acceptable	Acceptable

Other possible adjectival ratings were "marginal" and "unacceptable/unknown".

Both applications had the potential to activate air and water in close proximity to the beam line; however, levels of activation would be low, and historically (at other existing accelerators) these

**Environmental Synopsis -- Facility For Rare Isotope Beams**

have been routinely and safely controlled well below applicable safety standards. In both cases, potential radiation exposure to workers and the public were estimated to be well below standards. It was noted that the greater potential for public interest at MSU, as a result of proximity to students and the public, could be largely addressed through enhanced public participation, identical or similar to what is performed during an Environmental Impact Statement process.

**CONCLUSION**

It was determined that all of the physical, environmental impacts identified for both of the applications would be minor and localized, and could be successfully managed to further reduce them, and hence, little discrimination between the applications was possible on this basis.

**Prepared by:**



**Peter R. Siebach, NEPA Compliance Officer  
U.S. Department of Energy  
Office of Science -- Chicago Office**

7/23/2009

**Date**