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NUREG-2209

# Environmental Impact Statement for Construction Permit for the Northwest Medical Isotopes Radioisotope Production Facility

Draft Report for Comment

Office of Nuclear Reactor Regulation

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## Draft Report for Comment

Manuscript Completed: October 2016
Date Published: October 2016

Office of Nuclear Reactor Regulation

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**Responsible Agency:** U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation.

**Title:** *Environmental Impact Statement for the Construction Permit for the Northwest Medical Isotopes, LLC (NWMI) Medical Radioisotope Production Facility, Draft Report for Comment*

The proposed Northwest Medical Isotopes, LLC (NWMI), facility would be located in Columbia, Missouri.

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# ABSTRACT


The U.S Nuclear Regulatory Commission (NRC) has prepared this environmental impact statement (EIS) in response to an application submitted by Northwest Medical Isotopes, LLC (NWMI), for a construction permit for the NWMI medical radioisotope production facility. The EIS includes the analysis that evaluates the environmental impacts of the proposed action and considers the following alternatives to the proposed action: (1) the no-action alternative (i.e., the construction permit is denied), (2) one alternative site, and (3) two alternative technologies.

After weighing the environmental, economic, technical, and other benefits against environmental and other costs, and considering reasonable alternatives, the NRC staff's preliminary recommendation, unless safety issues mandate otherwise, is to issue a construction permit to NWMI. The NRC staff based its recommendation on the following factors:

- the NRC staff's review of the NWMI Environmental Report;
- the NRC staff's consultation with Federal, State, and local agencies and Tribal officials;
- the NRC staff's independent environmental review; and
- the NRC staff's consideration of public comments received.

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# EXECUTIVE SUMMARY

## BACKGROUND

By letter dated November 7, 2014, Northwest Medical Isotopes, LLC (NWMI) submitted Part 1 of a two-part application to the U.S. Nuclear Regulatory Commission (NRC) for a construction permit under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 that would allow construction of the NWMI medical radioisotope production facility (NWMI facility) in Columbia, Missouri. By letter dated February 5, 2015, NWMI withdrew and resubmitted this portion of its construction permit application to include a discussion of connected actions in their environmental report (ER) in response to a letter from the NRC (NWMI 2015a, 2015b). To issue a permit, the NRC is required to consider the environmental impacts of the proposed action under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq., herein referred to as NEPA). The NRC's environmental protection regulations that implement NEPA in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51 describe several types of actions that would require an environmental impact statement (EIS). The regulation at 10 CFR 51.20 does not specifically identify construction permits and operating licenses for production and utilization facilities as an action that would require an EIS. However, for the NWMI environmental review, the NRC staff determined that an EIS was appropriate to assess the environmental impacts of the proposed action.

Upon acceptance of Part 1 of NWMI's application, the NRC staff began the environmental review process described in 10 CFR Part 51 by publishing a Notice of Intent in the *Federal Register* (80 FR 72115) to prepare an EIS and to conduct scoping activities. In preparation of this EIS, the NRC staff performed the following:

- conducted a public scoping meeting on December 8, 2015, in Columbia, Missouri;
- conducted a site audit at the proposed NWMI site and an alternative site in September 2015;
- reviewed NWMI's ER;
- consulted with Federal, State, and local agencies, as well as Tribal officials;
- conducted a review of the guidance in *Final Interim Staff Guidance Augmenting NUREG-1537, Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Format and Content," for Licensing Radioisotope Production Facilities and Aqueous Homogeneous Reactors;* and *Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors: Standard Review Plan and Acceptance Criteria"*; and
- considered public comments received during the EIS scoping process.

## PROPOSED ACTION

The proposed Federal action is for the NRC to decide whether to issue a construction permit under 10 CFR Part 50 that would allow construction of the NWMI medical radioisotope production facility. If the NRC were to issue a construction permit, NWMI could build the proposed facility at the 7.4-acre (3-hectare) Discovery Ridge site, in Boone County, Columbia, Missouri. The NWMI process would involve fabricating low-enriched uranium (LEU) targets, shipping targets to university research reactors, irradiating LEU targets at university research reactors, returning targets to NWMI, LEU target dissolution, and molybdenum-99 (Mo-99) recovery and purification.

The issuance of a construction permit is a separate licensing action from the issuance of an operating license. Before NWMI can operate the proposed production facility, NWMI must (1) submit an application for an operating license and a license to receive and possess special nuclear material for its processes, pursuant to the NRC requirements, (2) must substantially complete construction in accordance with an NRC-issued construction permit, and (3) obtain an NRC operating license. If NWMI were to submit an application for an operating license, the NRC staff would prepare a supplement to this EIS in accordance with 10 CFR 51.95(b).

## PURPOSE AND NEED FOR ACTION

The purpose and need of this proposed Federal action is to provide a medical radioisotope production option that could help meet the need for a domestic source of Mo-99. The determination of need and the decision to produce radioisotopes are at the discretion of applicants or other medical radioisotope production decisionmakers. This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954, as amended, or findings in the environmental analysis under NEPA that would lead the NRC to reject a construction permit application, the agency does not have a role in the planning decisions as to whether a particular radioisotope production facility should be constructed and operated.

## ENVIRONMENTAL IMPACTS OF CONSTRUCTION, OPERATIONS, AND DECOMMISSIONING

This EIS evaluates the potential environmental impacts of the proposed action. The environmental impacts from the proposed action are designated as SMALL, MODERATE, or LARGE. The following definitions of these three significance levels, as presented in the final interim staff guidance to NUREG–1537, apply:

> **SMALL:** Environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. In assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the agency's regulations are considered SMALL.
>
> **MODERATE:** Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> **LARGE:** Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Table ES–1 summarizes the NRC staff's findings on the level of impacts on environmental resources from the construction, operations, and decommissioning of the NWMI facility.

**Table ES–1. Summary of NRC Conclusions on the Environmental Impacts of Construction, Operations, and Decommissioning of the Proposed NWMI Facility**

| **Resource Area** | **Impacts** |
|---|---|
| Land Use and Visual Resources | SMALL |
| Air Quality and Noise | SMALL |
| Geologic Environment | SMALL |
| Water Resources | SMALL |
| Ecological Resources | SMALL[(a)] |
| Historic and Cultural Resources | No historic properties affected |
| Socioeconomic Impacts | SMALL |
| Human Health | SMALL |
| Waste Management | SMALL |
| Transportation | SMALL |
| Accidents | SMALL |
| Environmental Justice | See note below[(b)] |
| **Cumulative Impacts** (Including Regional Growth and Climate Change) | |
| Land Use and Visual Resources | SMALL |
| Air Quality and Noise | SMALL to MODERATE |
| Geologic Environment | SMALL |
| Water Resources | SMALL |
| Ecological Resources | MODERATE |
| Historic and Cultural Resources | No historic properties affected |
| Socioeconomics Impacts | SMALL |
| Human Health | SMALL |
| Waste Management | SMALL |
| Transportation | SMALL |
| Environmental Justice | See note below[(b)] |

[(a)] The NRC determined that the proposed action would result in no effect to species and habitats protected under the Endangered Species Act of 1973, as amended or to essential fish habitat designated under the Magnuson–Stevens Fishery Conservation and Management Act, as amended.

[(b)] There would be no disproportionately high and adverse impacts to minority and low-income populations and subsistence consumption from the proposed action and from cumulative impacts.

## ALTERNATIVES

The NRC staff considered the environmental impacts associated with the following alternatives to constructing the NWMI facility at the Discovery Ridge site:

- the no-action alternative;
- construction, operations, and decommissioning of the NWMI facility at the University of Missouri Research Reactor site (alternative site);

- construction, operations, and decommissioning of a linear accelerator-based facility at the Discovery Ridge site (Alternative technology No.1); and
- construction, operations, and decommissioning of a subcritical fission-based facility at the Discovery Ridge site (Alternative technology No.2).

The NRC staff evaluated each alternative using the same resource areas that were used in evaluating impacts from the proposed action. The NRC staff determined that the no-action alternative would result in SMALL impacts to all resource areas. However, the no-action alternative does not fulfill the purpose and need of the project. The environmentally preferred alternatives are the construction, operations, and decommissioning of the NWMI facility at the Discovery Ridge site (proposed action), the linear accelerator-based facility at the Discovery Ridge site (Alternative Technology No. 1), and the subcritical fission-based facility at the Discovery Ridge site (Alternative Technology No. 2). The direct and indirect impacts associated with the proposed action and the two alternative technologies would be SMALL for all resource areas. The NRC staff determined that the construction, operations, and decommissioning of building the NWMI facility at the alternative site would likely result in greater impacts than the proposed action.

## PRELIMINARY RECOMMENDATION

After weighing the environmental, economic, technical, and other benefits against environmental and other costs, and considering reasonable alternatives, the NRC staff's preliminary recommendation, unless safety issues mandate otherwise, is the issuance of a construction permit to NWMI. The NRC staff based its preliminary recommendation on the following factors:

- NWMI's ER;
- the NRC staff's consultation with Federal, State, and local agencies, as well as Tribal officials;
- the NRC staff's independent environmental review; and
- the NRC staff's consideration of public comments received during the scoping process.

# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| C | degree(s) Celsius |
| F | degree(s) Fahrenheit |
| ac | acre(s) |
| ACHP | Advisory Council on Historic Preservation |
| ADAMS | Agencywide Documents Access and Management System |
| AIHA | American Industrial Hygiene Association |
| ALOHA | Areal Locations of Hazardous Atmospheres |
| AEGL | Acute Exposure Guideline Level |
| ALARA | as low as is reasonably achievable |
| APE | area of potential effect |
| AQCR | air quality control region |
| bgs | below ground surface |
| BIA | U.S. Bureau of Indian Affairs |
| BLS | U.S. Bureau of Labor Statistics |
| BMP | best management practice |
| B.P. | before present |
| CAA | Clean Air Act |
| Ci | curie |
| CEQ | Council on Environmental Quality |
| CFR | *Code of Federal Regulations* |
| cfs | cubic feet per second |
| $CH_4$ | methane |
| cm | centimeter |
| CO | carbon monoxide |
| $CO_2$ | carbon dioxide |
| $CO_{2eq}$ | carbon dioxide equivalent |
| CRMP | cultural resource management plan |
| CWA | Clean Water Act |
| dB | decibel(s) |
| dBA | decibels on the A-weighted scale |
| DBA | design-basis accident |
| DOE | U.S. Department of Energy |
| DOL | U.S. Department of Labor |

| | |
|---|---|
| DOT | U.S. Department of Transportation |
| EA | environmental assessment |
| ECHO | Enforcement and Compliance History Online |
| EIA | Energy Information Administration |
| EIS | environmental impact statement |
| EO | Executive Order |
| EPA | U.S. Environmental Protection Agency |
| ER | Environmental Report |
| ERPG | Emergency Response Planning Guideline |
| ESA | Endangered Species Act |
| FEMA | U.S. Federal Emergency Management Agency |
| FHWA | U.S. Federal Highway Administration |
| FR | *Federal Register* |
| ft | foot (feet) |
| $ft^2$ | square foot (feet) |
| FWS | U.S. Fish and Wildlife Service |
| gal | gallon(s) |
| GHG | greenhouse gas |
| gpd | gallons per day |
| gpm | gallons per minute |
| GTCC | greater than Class C |
| GWP | global warming potential |
| ha | hectare(s) |
| HAP | hazardous air pollutant |
| HEPA | high-efficiency particulate air |
| HEU | highly enriched uranium |
| $HNO_3$ | Nitric Acid |
| hp | horsepower |
| hr | hour(s) |
| IAEA | International Atomic Energy Agency |
| in. | inch |
| kg | kilogram(s) |
| km | kilometer(s) |
| kph | kilometer(s) per hour |
| $km^2$ | square kilometer(s) |

| | |
|---|---|
| L | liter(s) |
| $L_{DN}$ | day-night sound intensity level |
| LEU | low enriched uranium |
| Lpd | liter(s) per day |
| m | meter(s) |
| $m^2$ | square meter(s) |
| $m^3$ | cubic meter(s) |
| $m^3$/day | cubic meter(s) per day |
| $m^3$/min | cubic meter(s) per minute |
| $mi^3$/s | cubic mile(s) per second |
| mg/L | milligram(s) per liter |
| $mg/m^3$ | milligram(s) per cubic meter |
| mgd | million gallon(s) per day |
| m/s | meter(s) per second |
| MAR | material at risk |
| MBTA | Migratory Bird Treaty Act |
| mgd | million gallons per day |
| MHA | maximum hypothetical accident |
| mi | mile |
| min | minute |
| mph | mile(s) per hour |
| $mi^2$ | square mile(s) |
| µg | microgram |
| µm | microns |
| $\mu g/m^3$ | microgram per cubic meter |
| MDNR | Missouri Department of Natural Resources |
| MMI | Modified Mercalli Intensity |
| MOI | maximum offsite individual |
| mrem | milliroentgen equivalent man |
| MSL | mean sea level |
| mSv | millisievert |
| MT | metric ton(s) |
| MU | University of Missouri |
| MURR | University of Missouri Research Reactor |
| NAAQS | National Ambient Air Quality Standards |

| | |
|---|---|
| NaOH | Sodium Hydroxide |
| NCDC | National Climatic Data Center |
| NCES | National Center for Education Statistics |
| NEA | Nuclear Energy Agency |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NNSA | National Nuclear Security Administration |
| $NO_2$ | nitrogen dioxide |
| $NO_x$ | nitrogen oxide |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | U.S. National Park Service |
| NRC | U.S. Nuclear Regulatory Commission |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| NUREG | NRC technical report designation (Nuclear Regulatory Commission) |
| NWMI | Northwest Medical Isotopes, LLC |
| OSHA | Occupational Safety and Health Administration |
| OSTR | Oregon State TRIGA Reactor |
| PAC | protective action criterion/criteria |
| Pb | Lead |
| PGA | peak ground acceleration |
| PM | particulate matter |
| ppb | parts per billion |
| ppm | parts per million |
| PSAR | preliminary safety analysis report |
| PSD | prevention of significant deterioration |
| RCA | radiation-controlled area |
| RCRA | Resource Conservation and Recovery Act |
| ROI | region of influence |
| RM | river mile |
| RPF | radioisotope production facility |
| SER | safety evaluation report |
| SHPO | State Historic Preservation Office |

| | |
|---|---|
| SIL | significant impact level |
| SNM | Society of Nuclear Medicine and Molecular Imaging |
| $SO_2$ | sulfur dioxide |
| SPCC | Spill Prevention, Control, and Countermeasure |
| SSC | species of special concern |
| TDS | total dissolved solids |
| TEDE | total effective dose equivalent |
| TEEL | Temporary Emergency Exposure Limit |
| TIF | Tax Increment Finance |
| TMDL | total maximum daily load |
| TNM | traffic noise model |
| TPY | tons per year |
| TSV | target solution vessel |
| μg | microgram(s) |
| μm | micron(s) |
| U.S. | United States |
| U.S.C. | *United States Code* |
| USCB | U.S. Census Bureau |
| USDA | U.S. Department of Agriculture |
| USDOI | U.S. Department of Interior |
| USGCRP | U.S. Global Change Research Program |
| USGS | U.S. Geological Service |
| VOC | volatile organic compound(s) |
| WWTP | Wastewater Treatment Plant |
| $yd^3$ | cubic yard(s) |
| Y-12 | Y-12 National Security Complex |

# 1.0 INTRODUCTION

By letter dated November 7, 2014, Northwest Medical Isotopes, LLC (NWMI) submitted Part 1 of a two-part application to the U.S. Nuclear Regulatory Commission (NRC) for a construction permit under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, "Domestic Licensing of Production and Utilization Facilities," that would allow construction of the NWMI medical radioisotope production facility (NWMI facility) in Columbia, Missouri. The NWMI facility is a production facility as defined in 10 CFR 50.2. By letter dated February 5, 2015, NWMI withdrew and resubmitted Part 1 of its construction permit application to include a discussion of connected actions in its Environmental Report in response to a letter from the NRC (NWMI 2015a, 2015b). The Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) authorizes the NRC to issue construction permits and operating licenses for production and utilization facilities. To issue a construction permit, the NRC is required to consider the environmental impacts of the proposed action under the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.). The NRC's environmental protection regulations that implement NEPA in 10 CFR Part 51 describe several types of actions that would require an environmental impact statement (EIS). Construction permits and operating licenses for a medical isotope production facility are not specifically identified in 10 CFR 51.20 as an action that would require an EIS. Such activities may require an environmental assessment (EA) or an EIS, depending on their potential for significant impacts that may affect the quality of the human environment (NRC 2012).

An EA is used to determine whether the impacts from the proposed action may be significant and whether a finding of no significant impact can be made. If, based on the EA, the NRC concludes that the proposed action could result in significant impacts to the human environment, the agency would prepare an EIS. In some cases, the NRC may decide to prepare an EIS without first preparing an EA if there is the potential for significant impacts to the human environment or the proposed action involves a matter that the Commission, in the exercise of its discretion, has determined should be covered by an EIS. For the NWMI environmental review, the NRC staff determined that pursuant to 10 CFR 51.20(a)(2), the proposed action should be covered by an EIS as a matter of discretion. The NRC staff made this determination because (1) of the potential that an EA might not support a finding of no significant impact and (2) operation of the proposed NWMI facility, a connected action to the issuance of a construction permit, will include target fabrication and scrap recovery, processes similar to the processes that fuel fabrication facilities use and 10 CFR 51.20(b)(7) requires an EIS for a license that authorizes possession and use of special nuclear material (SNM) for processing and fuel fabrication and for scrap recovery.

## 1.1 Background

Nuclear medicine practitioners frequently use a variety of radioisotopes to diagnose and treat illnesses in patients. Molybdenum-99 (Mo-99) is the radioisotope currently in highest demand (NRC 2012) for medical use. Mo-99 decays with a 66-hour half-life to technetium-99m, which in turn decays with a 6-hour half-life to technetium-99. Technetium-99m is the most commonly used medical radioisotope in the world. It is used in about 20 to 25 million medical diagnostic procedures annually, or about 80 percent of all diagnostic nuclear medicine procedures (IAEA 2013a). Uses for technetium-99m include the following (National Research Council 2009):

- bone scans,
- lung perfusion imaging,

- kidney scans and functional imaging,
- liver scans,
- cardiac perfusion imaging,
- brain perfusion imaging,
- gall bladder function imaging,
- blood pool imaging, and
- thyroid and salivary gland imaging.

Mo-99 is commonly produced through the neutron activation of naturally occurring molybdenum or as a by-product of uranium-235 fission. No U.S. domestic producers of Mo-99 exist. A majority of the U.S. supply of Mo-99 is produced at the High Flux Reactor in Petten, Netherlands. The only other international producers are located in South Africa, Australia, Belgium, Poland, Czech Republic, and France. Serious domestic and international shortages over the last decade resulted from planned and unplanned maintenance shutdowns at these facilities (National Research Council 2009). In addition to issues of production reliability, global demand for the radioisotope is increasing, proliferation of highly enriched uranium, and transporting the radioisotope across international borders is becoming more difficult (National Research Council 2009).

## 1.2 Proposed Federal Action

The proposed Federal action is for the NRC to decide whether to issue a construction permit under 10 CFR Part 50 that would allow construction of the NWMI facility, a medical radioisotope production facility (Chapter 2 provides a description of the facility and isotope production process). If the NRC were to issue a construction permit, NWMI could build the proposed facility on a 3.0-hectare (ha) (7.4-acre (ac)) site, Lot 15 of the Discovery Ridge Research Park, in Boone County, Columbia, Missouri. The issuance of a construction permit is a separate licensing action from the issuance of an operating license. Before NWMI can operate the proposed production facility, NWMI must (1) submit an application for an operating license and a license to receive and possess special nuclear material for its processes, pursuant to the NRC requirements, (2) substantially complete construction in accordance with an NRC issued construction permit, and (3) obtain an NRC operating license. If NWMI were to submit an application for an operating license, the NRC staff would prepare a supplement to this EIS in accordance with 10 CFR 51.95(b).

## 1.3 Purpose and Need for the Proposed Federal Action

A curie (Ci) is a unit of measurement describing the radioactive disintegration rate of a substance; 1 Ci is $3.700 \times 10^{10}$ disintegrations per second (Institute of Medicine (IOM) 1995).

The term "6-day Ci" comes from producers to determine the number of curies present in a shipment 6 days after it leaves the production facility (National Research Council 2009).

The purpose of and need for this proposed Federal action is to provide a medical radioisotope production option that could help meet the need for a domestic source of Mo-99. For the past 2 decades, the United States has relied on imported medical radioisotopes, such as Mo-99, iodine-131, and xenon-133. Mo-99, for example, is used to perform about 50,000 medical procedures daily in the United States. Global shortages of medical radioisotopes in the last decade have highlighted the need for prompt action to ensure a reliable domestic supply. Demand in the United States for Mo-99 is approximately 5,000 6-day curies (Ci) ($2 \times 10^{14}$ 6-day becquerels (Bq)) per week. This demand is expected to increase about 0.5 percent per year (OECD 2014). In recent years, U.S. policy as established by the American Medical Isotopes Production Act (42 U.S.C. 2065 et seq.) is to ensure a reliable supply of medical radioisotopes while minimizing the use of highly enriched uranium for civilian purposes through, among other things, supporting commercial projects that produce medical radioisotopes domestically without the use of highly enriched uranium (AMIPA 2012; NNSA 2011; White House 2012).

The proposed action for the NRC is to decide whether to issue a construction permit, which would allow NWMI to construct a facility that uses low-enriched uranium to produce Mo-99. NWMI could not operate its facility until it applies for and is issued an operating license. The NRC would review that application and separately decide whether to issue an operating license. If the facility is licensed to operate, NWMI expects to produce up to 2,500 6-day Ci ($9.3 \times 10^{13}$ 6-day Bq) of Mo-99 per week (NWMI 2015a, 2015c).

## 1.4 U.S. Nuclear Regulatory Commission Environmental Review

The NRC's process to review applications for construction permits consists of two separate, parallel reviews. The safety review evaluates the applicant's ability to meet the NRC regulatory safety requirements. The NRC staff documents the findings of the safety review in a Safety Evaluation Report. The environmental review, governed by the requirements in 10 CFR Part 51, evaluates the environmental impacts of, and alternatives to, the proposed action. This draft EIS presents the results of this evaluation. The NRC considers the findings in both the EIS and the Safety Evaluation Report in its decision to grant or deny the issuance of a construction permit.

To guide its assessment of the environmental impacts of the proposed action or alternative actions, the NRC established a standard of significance for impacts using the Council on Environmental Quality (CEQ) terminology for "significantly" (40 CFR 1508.27). Because the significance and severity of an impact can vary with the setting of the proposed action, both "context" and "intensity," as defined in CEQ regulation 40 CFR 1508.27, were considered (see text box). Based on this, the NRC established three levels of significance for potential impacts: SMALL, MODERATE, and LARGE, as defined below.

**SMALL**: Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.

**MODERATE**: Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.

**LARGE**: Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

Significance indicates the importance of likely environmental impacts and is determined by considering two variables: context and intensity.

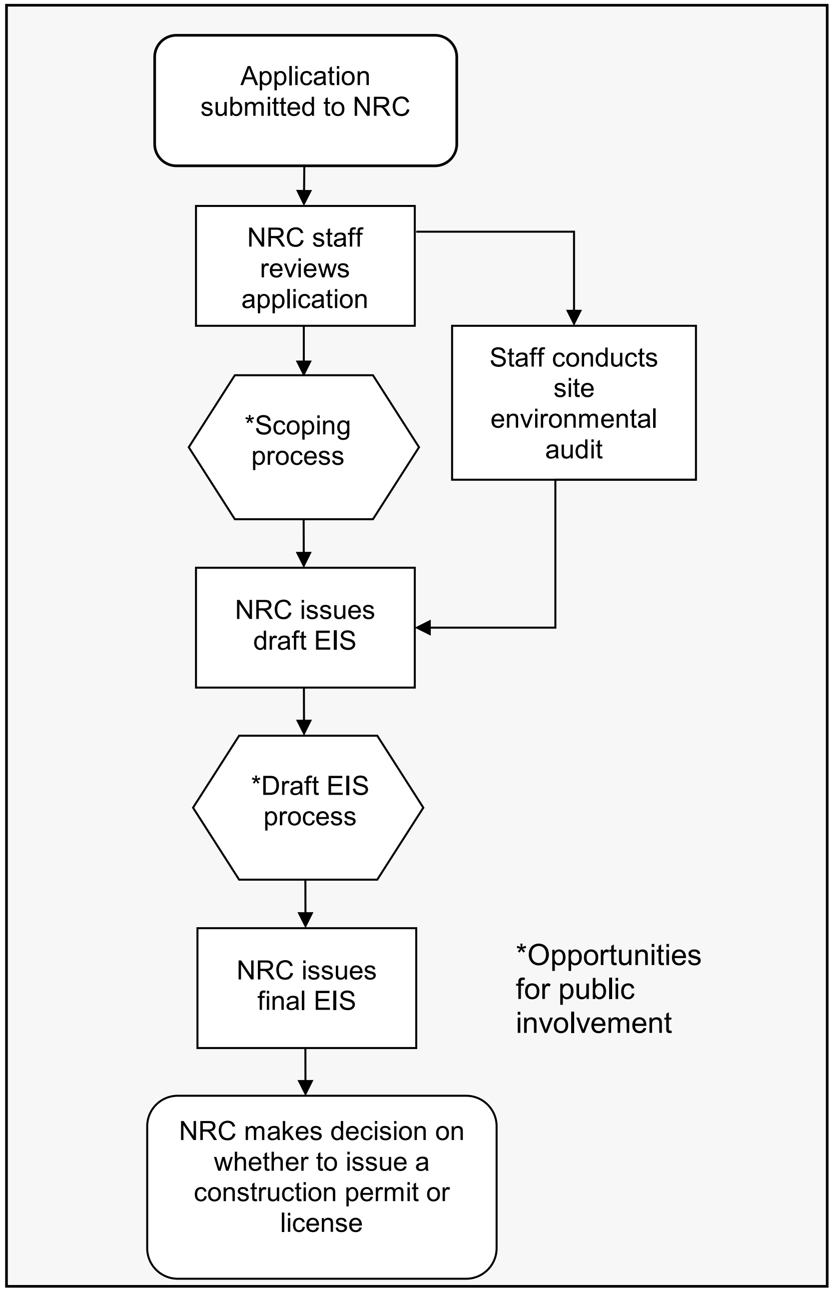
Context is the geographic, biophysical, and social context in which the effects will occur.

Intensity refers to the severity of the impact, in whatever context it occurs.

On November 7, 2014, NWMI submitted its ER with Part 1 of its application for a construction permit. By letter dated February 5, 2015, NWMI withdrew and resubmitted Part 1 of its construction permit application to include a discussion of connected actions in its ER in response to a letter from the NRC (NRC 2015a; NWMI 2015b). After reviewing Part 1 of the application for sufficiency, on June 8, 2015, the NRC staff published a Notice of Acceptance for Docketing in the *Federal Register* (80 FR 32418). On November 18, 2015, the NRC staff published a *Federal Register* notice (80 FR 72115) of its intent to prepare an EIS and conduct a scoping process. This notice began the 45-day scoping period. On December 8, 2015, the NRC held a public scoping meeting in Columbia, Missouri. The NRC's report entitled, "Summary of the Public Scoping Meeting Conducted Related to the Review of the Proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility," presents the comments received during the scoping process (NRC 2016a). In September 2015, the NRC staff conducted a site audit at the proposed and alternative NWMI facility sites to verify information in NWMI's Environmental Report. During the site audit, the NRC staff met with NWMI personnel; reviewed specific documentation; and toured the proposed site, the alternative site, and the University of Missouri Research Reactor, one of the reactors where NWMI plans to have its targets irradiated (NRC 2015b).

Figure 1–1 shows the major milestones in the public review of an EIS. After the site audit and the scoping period, the NRC staff compiles its findings in a draft EIS. The draft EIS is available for public comment for 45 days. During this time, the NRC staff hosts a public meeting and collects public comments. Based on the information gathered, the NRC staff will amend the draft EIS as necessary and then publish a final EIS.

**Figure 1–1. Environmental Review Process**



## 1.5 Scope of the EIS

> **Actions are connected if they:**
>
> - Automatically trigger other actions that may require environmental impact statements.
> - Cannot or will not proceed unless other actions are taken previously or simultaneously.
> - Are interdependent parts of a larger action and depend on the larger action for their justification.

As described in Section 1.2 of the EIS, the proposed Federal action is for the NRC to decide whether to issue a construction permit under 10 CFR Part 50 that would allow construction of the NWMI facility. CEQ regulations implementing NEPA state that the NEPA analysis should also include connected actions (40 CFR 1508.25). In determining the scope of its environmental review for the proposed action, the NRC staff, consistent with 10 CFR 51.14(b), will discuss connected actions to the proposed action (see how actions are connected in text box) in implementing Section 102(2) of NEPA.

> **Scope of the EIS**
>
> - Construction, operations, and decommissioning of the proposed NWMI facility.
> - Transportation and irradiation of LEU targets at research reactors.

The NRC staff has determined that it is appropriate to evaluate the potential impacts from operations and decommissioning given that such activities are connected to construction and cannot proceed unless other actions (e.g., issuance of a construction permit) are taken previously. In order to operate and produce radioisotopes in the proposed NWMI facility, NWMI proposes to fabricate low-enriched uranium (LEU) targets under 10 CFR Part 70, "Domestic Licensing of Special Nuclear Material." This EIS will also evaluate the potential environmental impacts from operation of the proposed NWMI facility that will consist of both the 10 CFR Parts 50 and 70 activities. Operation of NWMI's proposed facility will depend on LEU targets being transferred to and from, and irradiated in, one or more research reactors that are authorized, by an operating license amendment, to irradiate the NWMI LEU targets. The NRC staff will conduct a separate safety review and environmental review of each operating license amendment application submitted by these research reactors. However, because Mo-99 production cannot occur until research reactors are licensed to irradiate NWMI's LEU targets and the environmental impacts from LEU target irradiation at research reactors has not been previously assessed, the NRC staff concluded that LEU irradiation at research reactors is an interdependent part of the proposed NWMI facility operation. The NRC staff also determined that transportation of LEU targets and irradiation of LEU targets at research reactors are actions connected to operation of the proposed NWMI facility. Therefore, the NRC will assess the environmental impacts associated with transporting and irradiating LEU targets at the identified research reactors in this EIS.

## 1.6 Preconstruction Activities

In a final rule dated October 9, 2007 (72 FR 57416), the Commission limited the definition of "construction" to those activities that fall within its regulatory authority in 10 CFR 51.4. Many of the activities required to build a radioisotope production facility are not part of the NRC action to license the proposed NWMI facility because they do not have a reasonable nexus to radiological health and safety and/or common defense and security; therefore, they are not within the NRC's authority to regulate. Activities associated with building the proposed NWMI facility that are not within the purview of the NRC action are grouped under the term "preconstruction." Preconstruction activities include clearing and grading, excavating, building of service facilities (e.g., paved roads, parking lots), erection of support buildings, and other associated activities. These preconstruction activities may take place before the application for a construction permit is submitted, during the staff's review of a construction permit application, or after a construction permit is granted. Consequently, the NRC evaluates preconstruction impacts as cumulative impacts and not as direct impacts resulting from the NRC's Federal action. Although preconstruction activities are outside the NRC's regulatory authority, many are within the regulatory authority of local, State, or other Federal agencies.

Preconstruction activities could occur whether or not the construction permit is granted. However, because preconstruction is related to the building of the proposed NWMI facility, Chapter 4 of the EIS presents a single combined impact level to increase the readability of the document. When the combined preconstruction and NRC-authorized construction activity impact category level is SMALL for any resource area (e.g., land use, water resources), no further breakdown of impacts between preconstruction and NRC-authorized construction will be provided. When the combined preconstruction and NRC-authorized construction activity impact category level is greater than SMALL for any resource area, the impact from solely NRC-authorized construction activities will be discussed separately. This is consistent with NRC Staff Guidance (NRC 2011, 2013a) and the NRC's analysis of similar licensing actions. See *Environmental Impact Statement for the Construction Permit for the SHINE Medical Radioisotope Production Facility EIS* (NRC 2015c, 2015d). Section 4.14, "Cumulative Impacts," of the EIS incorporates the impacts from "preconstruction" to satisfy NRC's regulatory requirements in 10 CFR 51.71(d). In addition, throughout the EIS, construction refers to preconstruction activities and NRC-authorized construction.

## 1.7 Consultation and Correspondence

The Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.), and the National Historic Preservation Act of 1966 (54 U.S.C. 300101 et seq.) require Federal agencies to consult with applicable State and Federal agencies and groups before taking actions that may affect endangered species, fisheries, and historic and archaeological resources. The NRC staff contacted Federal, State, regional, local, and Tribal agencies with environmental expertise in the areas that the proposed project could potentially affect. Agencies contacted during the formal consultation processes and the NWMI environmental review process included the following:

- Advisory Council on Historic Preservation,
- Boone County Government Center,
- Mid-Missouri Regional Planning Commission,
- Absentee-Shawnee Tribe of Indians of Oklahoma,
- Caddo Nation of Oklahoma,
- Cherokee Nation,
- Cheyenne and Arapaho Tribes,
- The Chickasaw Nation,
- The Choctaw Nation of Oklahoma,
- Citizen Potawatomi Nation,
- Delaware Nation,

- Eastern Shawnee Tribe of Oklahoma,
- Iowa Tribe of Kansas and Nebraska,
- Iowa Tribe of Oklahoma,
- Miami Tribe of Oklahoma,
- Missouri Department of Conservation,
- Missouri Department of Health and Senior Services,
- Missouri Department of Natural Resources,
- Missouri Department of Public Safety,
- Missouri Department of Transportation,
- The Muscogee (Creek) Nation,
- Omaha Tribe of Nebraska,
- The Osage Nation,
- Otoe-Missouria Tribe of Indians, Oklahoma,
- Pawnee Nation of Oklahoma,
- Peoria Tribe of Indians of Oklahoma,
- Ponca Tribe of Indians of Oklahoma,
- Ponca Tribe of Nebraska,
- Prairie Band Potawatomi Nation,
- The Quapaw Tribe of Indians,
- Sac and Fox Nation of Missouri in Kansas and Nebraska,
- Sac and Fox Nation, Oklahoma,
- Sac and Fox Tribe of the Mississippi in Iowa,
- Shawnee Tribe,
- United Keetoowah Band of Cherokee Indians of Oklahoma,
- Winnebago Tribe of Nebraska,
- Wyandotte Nation,
- Kaw Nation, Oklahoma,
- Yankton Sioux Tribe of South Dakota,
- U.S. Fish and Wildlife Service, and
- U.S. Department of Energy.

Chapter 9 provides a list of those who received a copy of this EIS.  Appendix C contains a chronological list of all correspondence sent and received during the environmental review.

## 1.8 Status of Compliance

NWMI is responsible for complying with applicable NRC regulations and other Federal, State, and local requirements. Appendix B to this EIS includes a list of the permits and licenses that Federal, State, and local authorities must issue to NWMI before construction or operation of the proposed facility.

# 2.0 PROPOSED FEDERAL ACTION

## 2.1 Site Location and Layout

Northwest Medical Isotopes, LLC (NWMI) would construct and operate the proposed NWMI medical radioisotope production facility (NWMI facility) in Columbia, Missouri, within the University of Missouri Discovery Ridge Research Park. Discovery Ridge Research Park has been established as a research, development, and office park pursuant to Section 172.273 of Chapter 172 of the Missouri Revised Statutes. The proposed Discovery Ridge site, Lot 15 of the Discovery Ridge Research Park, encompasses 3.0 hectares (ha) (7.4 acres (ac)) of land (Figure 2–1) that is owned by the University of Missouri. The proposed Discovery Ridge site is bordered by U.S Highway 63 to the south, a mixture of cultivated crops and pasture to the north and east, and a research and laboratory facility to the northwest (Figure 2–1, Figure 2–2, and Figure 2–3) (NWMI 2015a). Access to the proposed Discovery Ridge site is from Discovery Drive and Discovery Parkway. The NWMI facility would comprise four main buildings (Figure 2–3):

(1) Radioisotope Production Facility (RPF) Building,

(2) Waste Management Building,

(3) Diesel Generator Building, and

(4) Administration Building.

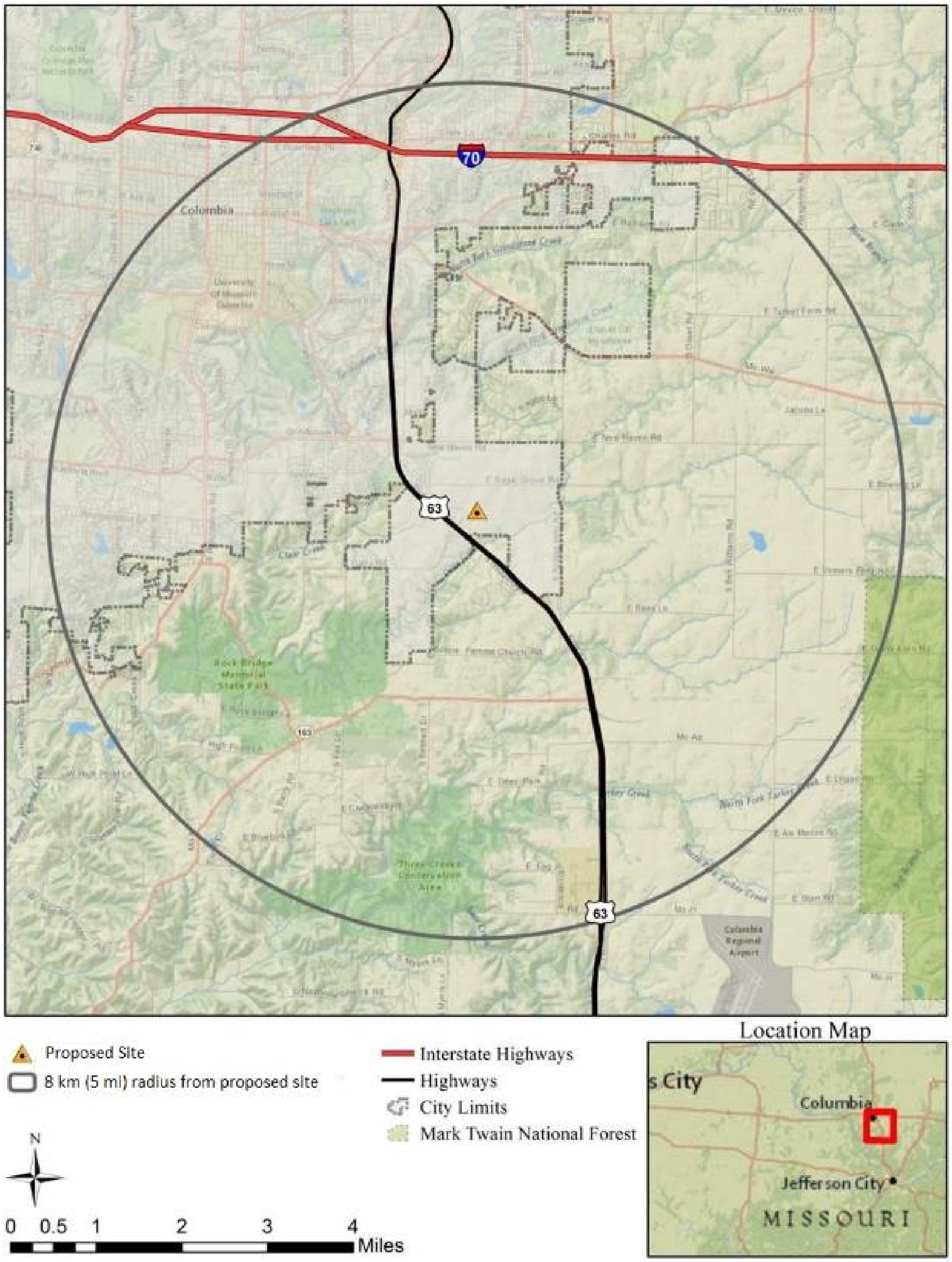
These four main buildings would collectively cover approximately 71,150 square feet ($ft^2$) (6,610 square meters ($m^2$)) (NWMI 2016b). The largest of the proposed buildings would be the RPF Building, which would extend 106.7 m (350 ft) in length and 56.4 m (185 ft) in width and would have an estimated height of 19.8 m (65 ft) above grade (NWMI 2015a). The tallest exhaust vent stack would be higher, extending 22.9 m (75 ft) above grade (NWMI 2015a).

Other features associated with the proposed NWMI facility include support structures, such as storage tanks and fuel tanks, and engineered features, such as parking lots, fences, a paved entrance road, and berms. The proposed NWMI facility would occupy a rectangular area that would result in a total estimated footprint of approximately 210,000 $ft^2$ (19,383 $m^2$).

**Figure 2–1. Discovery Ridge Research Park and Proposed NWMI Site (Discovery Ridge)**

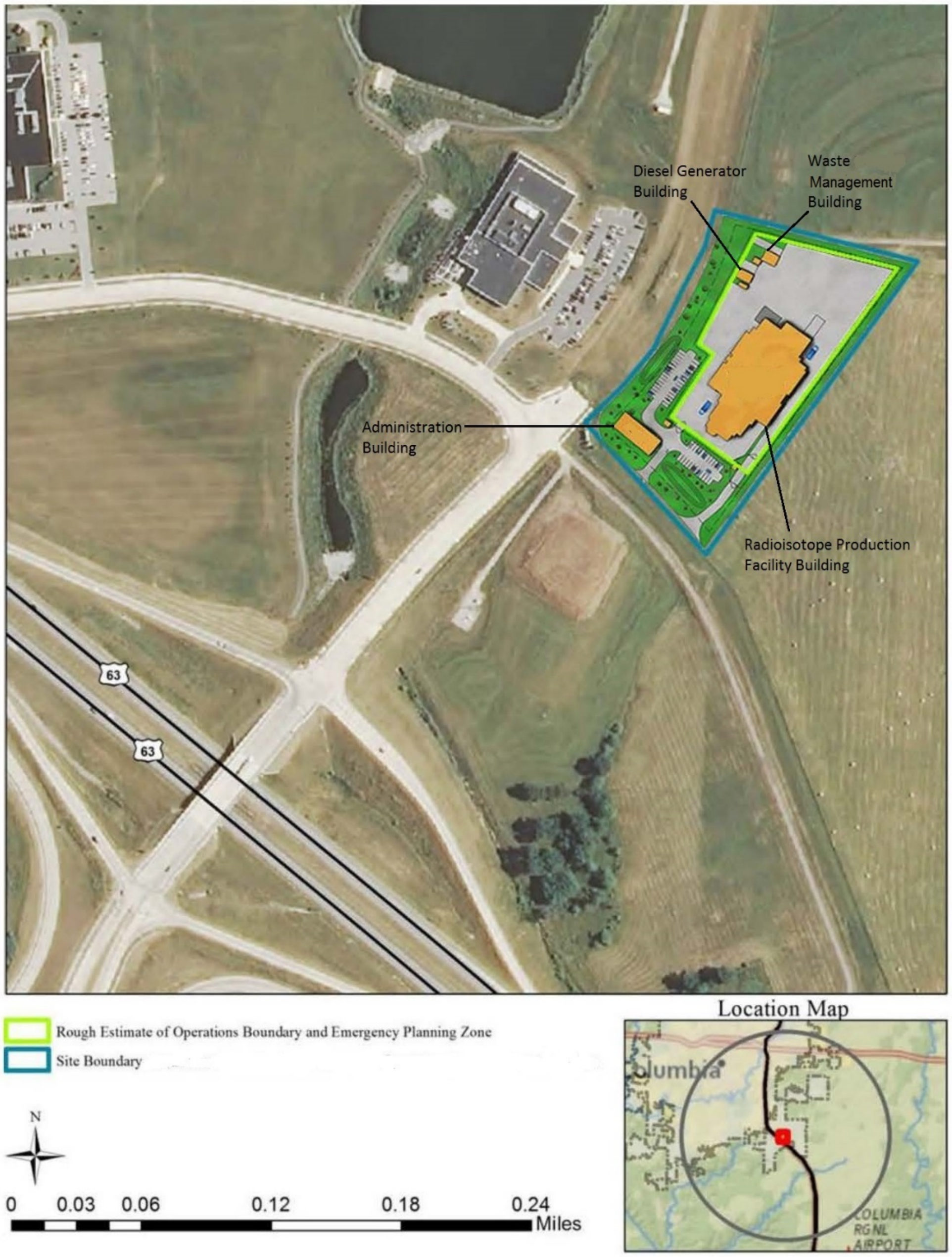

Source: Modified from NWMI 2015a

**Figure 2–2. Proposed NWMI Site (Discovery Ridge) and Surrounding Area Within 5-mi (8-km) Radius**




Source: Modified from NWMI 2015a

**Figure 2–3. Proposed NWMI Facility Site Boundary and Site Layout**




Source: Modified from NWMI 2015a

## 2.2 Construction Activities

The construction period for the proposed NWMI facility would extend for 17 months and would require a peak construction workforce of 82 workers (NWMI 2015a, 2015c).

Construction activities would include earthmoving (clearing, grading) excavation, pile driving, facility build-out, installation of parking areas, and delivery of construction-related materials and components. Materials needed to construct the NWMI facility would include concrete, structural steel, miscellaneous steel, steel liner, asphalt, stone granular material, roofing materials, and precast concrete (NWMI 2015a). Table 2–1 presents the estimated amounts needed for each of these materials.

**Table 2–1. Estimated Construction Materials Requirements**

| Material | Amount |
|---|---|
| Concrete | 4,260 $yd^3$(3,257 $m^3$) |
| Structural Steel | (400 t) (363 MT) |
| Miscellaneous Steel | 50 t (45 MT) |
| Steel Liner | 140 t (127 MT) |
| Asphalt | 320 $yd^3$ (245 $m^3$) |
| Stone Granular Material | 1,700 $yd^3$ |
| Roofing | 50,000 $ft^2$ (4,645 $m^2$) |
| Precast Concrete | 480 t (435 MT) |

[a] $yd^3$ = cubic yard(s), $m^3$ = cubic meter(s), and MT = metric ton(s).

Source: NWMI 2015a

NWMI estimates that the proposed facility would require, on average, approximately 20 truck deliveries and 1 offsite waste shipment each month during construction (NWMI 2015a). Rather than operating an onsite batch plant, ready-mix concrete supplied by commercial vendors would be delivered to the site (NWMI 2015c). The maximum depth of excavation would be 7.0 m (23 ft) below grade to account for potential overexcavation (NWMI 2015a, 2015c). NWMI estimates that approximately 6,881 $m^3$ (9,000 $yd^3$) would be excavated (earthwork) to support construction activities and that construction equipment necessary to support these activities would consume 28,000 liters (L) (7,395 gallons (gal)) of diesel fuel (NWMI 2015a).

Overall, construction activities would disturb the entire 3.0 ha (7.4 ac) of the proposed Discovery Ridge site. Of this total, NWMI projects that approximately 2 ha (5 ac) will be permanently affected (i.e., occupied by buildings, paved areas, etc.) and the remaining will be revegetated or landscaped (NWMI 2015c). In addition, approximately 0.1 ha (0.26 ac) of a lot adjacent to the proposed Discovery Ridge site would be temporarily affected to support construction activities and will be revegetated once construction activities are completed (NWMI 2015c).

## 2.3 Facility Operations

If the NRC issues NWMI a construction permit and an operating license, the proposed NWMI facility would commence full operations upon completion of construction and preoperational startup activities. NWMI expects to request an operating license term of 30 years (NWMI 2015a). During preoperation startup, the proposed NWMI facility would undergo a commissioning phase that would involve a series of test operations designed to ensure that the facility is functioning as designed (NWMI 2015a). Preoperation startup activities will be completed within 3 months (NWMI 2015a). The NWMI Environmental Report considered the impacts associated with the preoperational phase within the operating phase of the proposed NWMI facility. Similarly, for the purposes of this environmental analysis, the U.S. Nuclear Regulatory Commission (NRC) staff included the activities and impacts of preoperational activities as part of the operations phase in the impacts assessment in Chapter 4.

**Low-enriched uranium** (LEU) means uranium enriched below 20 percent in the isotope uranium-235.

**Highly enriched uranium** (HEU) means uranium enriched to 20 percent or greater in the isotope uranium-235.

The United States encourages the use of LEU or other non-HEU-based technologies to produce medical radioisotopes because of the additional proliferation concerns associated with HEU (White House 2012).

During operations, NWMI plans to obtain low-enriched uranium (LEU) metal from the U.S. Department of Energy (DOE) Y-12 National Security Complex (Y-12 facility) in Oak Ridge, Tennessee (NWMI 2015a). The American Medical Isotopes Production Act of 2012 (42 U.S.C. 2065(c)(3)(A)(ii)) states that DOE shall establish a program (uranium lease and take-back program) to make LEU available through lease contracts for irradiation for the production of molybdenum-99 (Mo-99) for medical uses. The lease contracts will also provide for the Mo-99 producer (e.g., NWMI) to return eligible leased LEU material to DOE (DOE 2016; NWMI 2016c, 2016d). In January 2016, the DOE's National Nuclear Security Administration established the Uranium Lease and Take-Back Program (DOE 2016). For the purposes of this EIS, the NRC staff assumed that contracts and approvals necessary for NWMI to obtain LEU would be in place. LEU that NWMI determines is not economically viable for the Mo-99 production process will be returned to DOE's Savannah River Site in Aiken, South Carolina, for storage in accordance with the take-back contract. LEU obtained from DOE will be referred to as fresh LEU, and LEU returned to DOE will be referred to as take-back LEU throughout this EIS.

Operational activities would require 98 workers and a total of 486 inbound and outbound shipments annually. Table 2–2 shows the estimated annual inbound and outbound shipments between NWMI and DOE, research reactors, radiopharmaceutical distributors, and waste sites. NRC regulations in 10 CFR Part 71 contain NRC requirements for packaging, preparation for shipment, and transportation of licensed radioactive material. Regulations at 10 CFR 71.5 require licensees that transport licensed radioactive material outside the site of use (e.g., the proposed NWMI facility) to comply with applicable U.S. Department of Transportation (DOT) regulations in 49 CFR Parts 107, 171 through 180, and 390 through 397, as appropriate. NWMI stated it will transport radioactive material, radioactive waste, and medical isotopes in shipping containers that meet applicable NRC and DOT regulations to protect public health and safety (NWMI 2015a).

**Table 2–2. Estimated Annual Shipments to and from the Proposed NWMI Facility**

| Type of Shipments | Annual Shipments |
|---|---|
| **Inbound Shipments (to NWMI facility)** | |
| Fresh LEU from DOE Y-12 facility[a] | 2 |
| Irradiated LEU targets from research reactors | |
| From University of Missouri Research Reactor (MURR) to NWMI facility[b] | 104 |
| From Oregon State University TRIGA Reactor (OSTR) to NWMI facility[c] | 16 |
| From Third Research Reactor to NWMI facility[d] | 16 |
| **Outbound Shipments (from NWMI facility)** | |
| Medical radioisotope product[e] | 104 |
| Radioactive waste shipments to Waste Control Specialists[f] | 200 |
| LEU targets to research reactors | |
| From NWMI facility to MURR | 26 |

| Type of Shipments | Annual Shipments |
|---|---|
| From NWMI facility to OSTR | 8 |
| From NWMI facility to Third Research Reactor | 8 |
| Take-back LEU to DOE Y-12 facility[g] | 2 |

[a] Shipments from Oak Ridge, Tennessee, 950 km (590 mi) from the proposed NWMI facility.
[b] Shipments from Columbia, Missouri, 10 km (6.2 mi) from the proposed NWMI facility.
[c] Shipments from Corvallis, Oregon, 3,320 km (2063 mi) from the proposed NWMI facility.
[d] Shipments will travel up to 3,320 km (2,063 mi) to the proposed NWMI facility.
[e] Shipments to distributors in Hazelwood, Missouri, and Billerica, Massachusetts, 180 km (111 mi) and 2,080 km (1300 mi), respectively, from the proposed NWMI facility. Mo-99 product would be transported by air carrier to Boston Logan International Airport and to Billerica via commercial ground carrier.
[f] Shipments to Andrews, Texas, 1,470 km (913 mi) from the proposed NWMI facility.
[g] Shipments will travel 950 km (590 mi) from the proposed NWMI facility.

Sources: NWMI 2015a, 2016a, 2016c

### 2.3.1 Radioisotope Production Process Overview

> **Target** means material subjected to irradiation in an accelerator or nuclear reactor to induce a reaction or produce nuclear material (10 CFR 110.2).

The NWMI process would involve fabricating LEU targets at the proposed NWMI facility, shipping unirradiated targets to university research reactors, irradiating LEU targets at university research reactors, returning irradiated targets to NWMI, LEU target dissolution, and Mo-99 recovery and purification. The proposed NWMI facility will have the capacity to fabricate and process up to 1,104 LEU targets annually (NWMI 2015a, 2016b, 2016a). Figure 2–4 presents a flow diagram of the process.

For descriptive purposes of the EIS, NWMI's process can be divided into five primary stages:

(1) LEU target fabrication;

(2) LEU target irradiation;

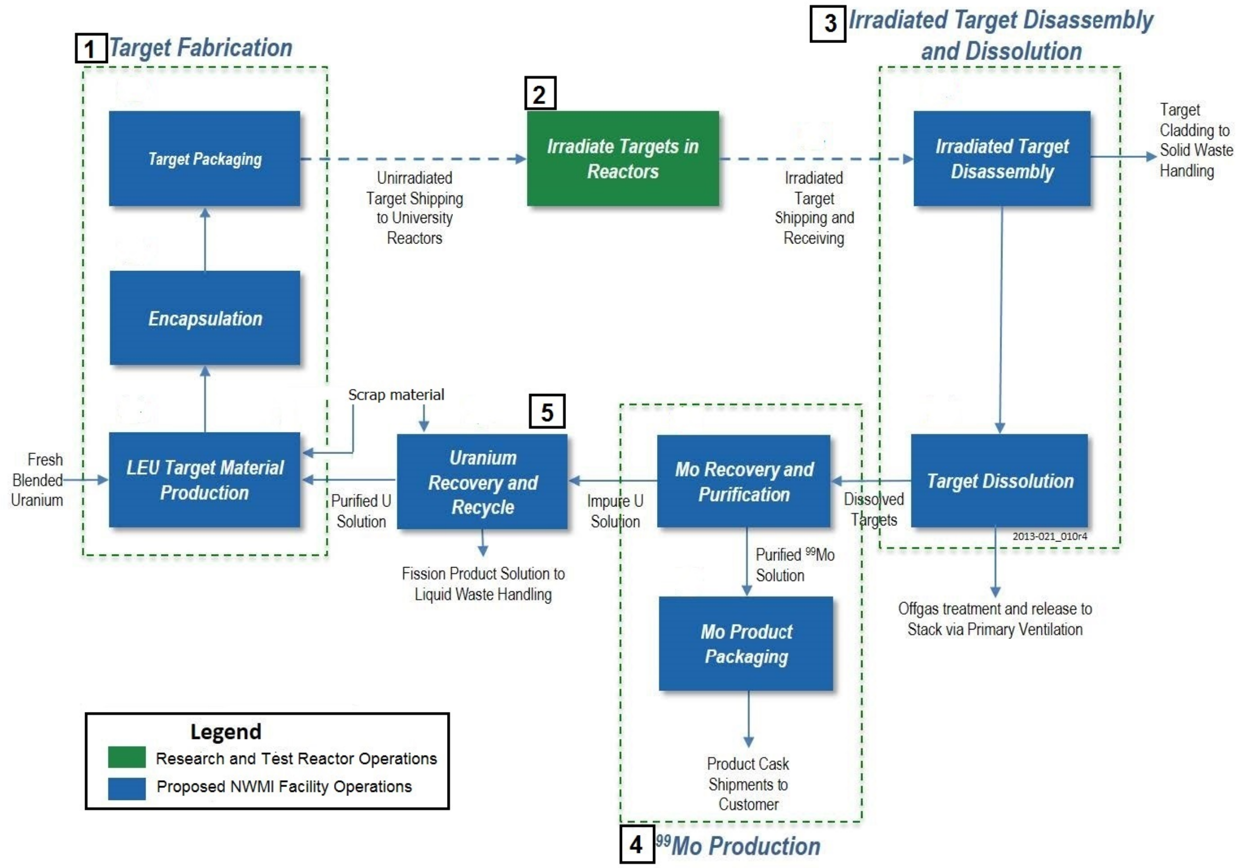
(3) irradiated target disassembly and dissolution;

(4) Mo-99 production (extraction, purification, and shipping); and

(5) uranium recovery and recycle.

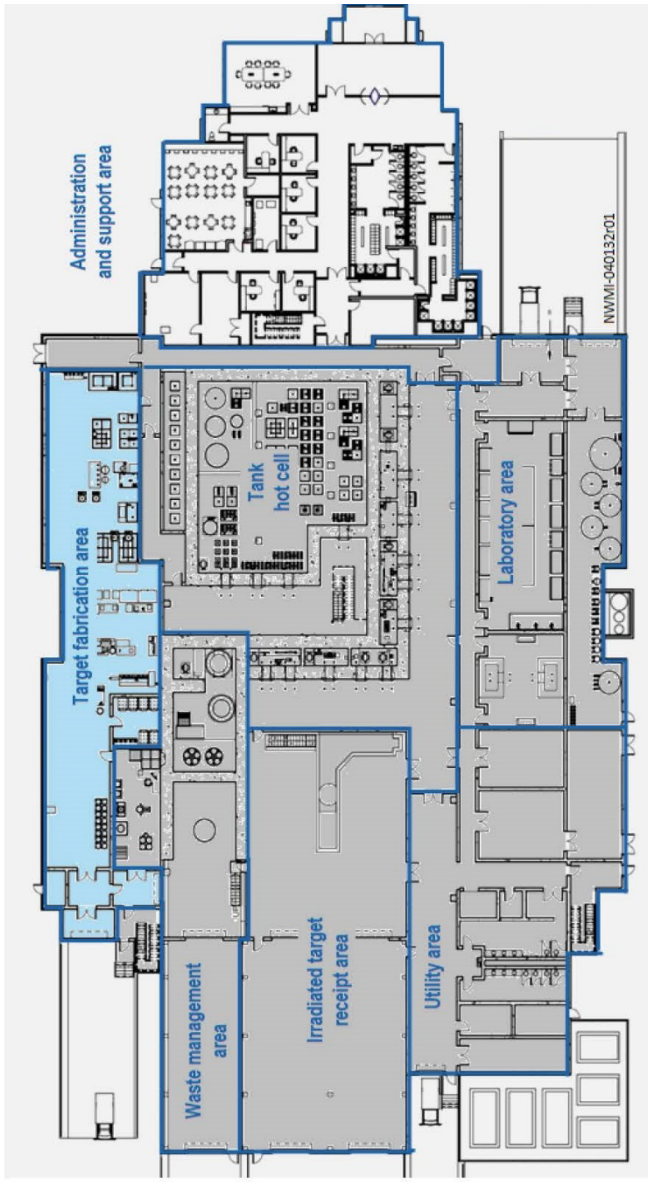
As illustrated in Figure 2–4, several sub-processes would occur within each of the five primary stages identified above. The following sections present an overview of the key factors associated with these processes. Most of the activities, other than LEU target irradiation, would take place within a single building, the RPF Building (NWMI 2015a, 2015d). As described in the following sections, target fabrication would be conducted using contact-handled equipment within the target fabrication area of the RPF building (Figure 2–5). Target disassembly and dissolution, Mo-99 extraction and purification, and uranium recovery would be handled remotely within the RPF hot cell (shielded nuclear radiation confinement chamber) area.

**Figure 2–4. NWMI Radioisotope Production Facility Process**




Source: Modified from NWMI 2015a

**Figure 2–5. General Layout of the Proposed NWMI Radioisotope Production Facility Building**




Source: Modified from NWMI 2015d

*2.3.1.1 LEU Target Fabrication*

The first stage in the NWMI radioisotope production process is fabrication of the LEU target. LEU target fabrication would be conducted within the target fabrication area housed within the RPF building (see Figure 2–5). This area would contain the process equipment for preparation of targets, including concentrators, dissolvers, furnaces, and hardware. This equipment would be contact-handled by the operators (NWMI 2015a).

The target fabrication process would begin with the receipt of fresh LEU (special nuclear material) from DOE. Fresh LEU would be dissolved in nitric acid to form a uranyl nitrate product that is then evaporated to a desired uranium concentration. The uranyl nitrate product would then be chilled, mixed with reagents, and treated with heated silicone oil to form a solid LEU material (gelation broth). The LEU material would be filtered, washed, and reduced to obtain the LEU target material.

The LEU target material would then be encapsulated (loaded and welded), possibly with helium gas, in metal cladding to contain the LEU target material and to form the LEU targets. These LEU targets would then undergo inspection and quality assurance (QA) checks, be packaged and loaded into shielded shipping containers for transport to research reactors. Transportation from the proposed NWMI facility to each research reactor will be via ground transportation.

**10 CFR 70.4, "Definitions," states:**

**Special nuclear material** means plutonium, uranium 233, uranium enriched in the isotope 233 or in the isotope 235, and any other material which the Commission determines to be special nuclear material.

**Special nuclear material scrap** means the various forms of special nuclear material generated during chemical and mechanical processing, other than recycle material and normal process intermediates, which are unsuitable for use in their present form, but all or part of which will be used after further processing.

After the first batch of LEU targets are fabricated from fresh LEU, LEU targets will be fabricated using a combination of (1) fresh LEU, (2) recovered scrap LEU (scrap recovery), and (3) LEU recycled from the processing of irradiated targets (NWMI 2015e). LEU targets that fail inspection or QA checks, will be identified as off-specification uranium targets, and subsequently be disassembled and treated as scrap to recover the LEU target material (NWMI 2015e, 2016d). If an LEU target is identified as an off-specification uranium target because it does not meet target material parameter requirements (e.g., due to deformities), the target material will be dissolved in nitric acid within the Target Fabrication System (step 1 identified in Figure 2–4), to then be used to fabricate targets. If an LEU target is identified as an off-specification uranium target because of the presence of chemical impurities in the target material, the material will go to the Uranium Recovery and Recycle system (Step 5 identified in Figure 2-4 and as discussed in Section 2.3.1.5 below) for recovery and then be used to fabricate targets (NWMI 2015e, 2016d).

*2.3.1.2 LEU Target Irradiation*

Following shipment to licensed research reactors, the LEU targets would undergo neutron irradiation in the reactor. This irradiation causes the uranium-235 in the LEU target to fission and produce Mo-99 and other fission products. NWMI has identified two research reactors, the University of Missouri Research Reactor (MURR) and the Oregon State University TRIGA Reactor (OSTR), to provide irradiation services. NWMI is also considering use of a third research reactor and is performing an analysis to support that selection (NWMI 2015a, 2015c). Irradiating LEU targets at the research reactors is considered a connected action, and this EIS evaluates the environmental impacts associated with target irradiation at MURR, OSTR, and a potential third research reactor to bound this connected action (See Section 1.5 for a discussion on connected actions). The potential third research reactor parameters (e.g., distance from the proposed NWMI RPF and modifications anticipated to support LEU target irradiation) are based on the licensed operating research reactors being considered by NWMI (NWMI 2015a, 2015c).

Annual irradiation capacity at the research reactors is as follows (NWMI 2015a, 2016a, 2016b):

- MURR: 624 LEU targets,
- OSTR: 240 LEU targets, and
- Third Reactor: 240 LEU targets.

Research reactors that plan to irradiate NWMI LEU targets will require facility modifications and equipment refurbishment. Each research reactor that plans to irradiate the NWMI LEU targets will need to separately request an amended operating license from the NRC to allow target irradiation services. The NRC staff will conduct a separate safety review and environmental review for each license amendment request submitted to the NRC. Section 3.10 of this EIS discusses the affected environment of the research reactors and Section 4.13 identifies and discusses facility modifications and the potential impacts from irradiation of the LEU targets at the research reactors.

Following irradiation, the irradiated LEU targets would be loaded onto DOT shielded shipping containers and returned by ground transport to the proposed NWMI facility.

#### *2.3.1.3 Irradiated Target Disassembly and Dissolution*

The NWMI irradiated target receipt bay within the RPF building would be used to receive irradiated LEU targets (in shipping containers) from the ground transport trailers. The shipping containers would be transferred via a bridge crane onto a transfer cart. The transfer cart would then be transferred to the RPF hot cell area for target disassembly and dissolution (see Figure 2–5). Irradiated target processing will occur in shielded hot cells. The hot cells would provide remote operation via shielded windows and through wall manipulators that would be remotely operated from outside the hot cell.

Within the target disassembly hot cells, irradiated LEU targets would be disassembled by puncturing and severing the target in half, and pouring the irradiated LEU material into a transfer container. The metal cladding would be disposed of as solid radioactive waste (see Section 2.7.1 for a discussion of radioactive waste that would be produced at the proposed NWMI facility). The transfer container holding the irradiated LEU material would then be transferred from the target disassembly hot cell to the target dissolution hot cell, where the irradiated LEU material would be dissolved in a nitric acid solution. This dissolver solution would then be diluted, cooled, filtered, and pumped to a tank. An offgas system would be used during this stage to capture fission product gases released from the target dissolution process.

#### *2.3.1.4 Mo-99 Extraction, Purification, and Shipping*

Extraction and purification of Mo-99 from the dissolver solution would occur within the hot cell area and involve a series of three Mo-99 ion exchange columns. The dissolver solution would be pumped through the first ion exchanger to extract and separate the Mo-99 from the uranium and other fission products. The Mo-99 and several other isotopes would be absorbed onto the ion exchange column media. The uranium and fission product solution that flows through the column would then be sent to the uranium recovery and recycle system (see Section 2.3.1.5 below). The absorbed Mo-99 would be removed from the ion exchange column media to obtain a Mo-99 solution. The Mo-99 solution would then be pumped through a second and third ion exchange column to undergo chemical adjustments to remove unwanted isotopes and purify the Mo-99 solution. The Mo-99 solution would be transferred to small vials that are placed into DOT-approved shipping containers and transferred from the hot cell to a shipping/receiving room and loading dock. The Mo-99 product would then be transported by air or ground transportation, depending on which radiopharmaceutical distributor will be receiving the shipment.

#### *2.3.1.5 Uranium Recovery and Recycle*

The uranium and fission product solution that is separated from the Mo-99 after it is pumped through the ion exchange columns (see Section 2.3.1.4 discussion above) would be processed to recover uranium to be used in LEU target fabrication. Before the uranium and fission product solution is processed, it would be held in storage tanks to allow short-lived radionuclides to decay. The uranium and fission product solution would then be diluted and pumped through additional ion exchange columns to separate the remaining fission products from the uranium.

The separated fission product solution would then be sent to liquid waste storage tanks. The uranium removed from the ion exchange columns would be transferred to the target fabrication area, where it would be recycled for fabrication of additional LEU targets.

## 2.4 Power Requirements

Columbia Water and Light would supply electrical power to the proposed NWMI facility (NWMI 2015f). Overall, the proposed NWMI facility would annually consume 10 megawatt-hours. NWMI would equip the facility with an uninterruptible electrical power supply (UPS) system to power safety-related systems and equipment for safe shutdown of the facility in the event of a loss of offsite power. NWMI would also maintain and test a 1,000 kW standby diesel generator to extend the duration of UPS power. The diesel generator will be serviced with a 3,785 L (1,000 gal) diesel tank, stored above ground (NWMI 2015a). NWMI would use natural gas to supply five boilers. NWMI estimates that the total annual natural gas consumption would be $4.3 \times 10^5$ million British thermal units (calculated from NWMI 2015c).

## 2.5 Water Use, Treatment, and Discharges

### 2.5.1 Water Use

Public utility infrastructure (i.e., electric power, natural gas, water, and sanitary sewer) would serve the proposed NWMI facility. Utility providers would extend service lines to connect the proposed NWMI facility to existing service lines, including to public water mains. Utility work would be performed as part of site preparation (NWMI 2016a). Table 2–3 lists the projected water needs to support NWMI facility construction, operations, and decommissioning activities.

**Table 2–3. Water Requirements for NWMI Facility**

| Project Phase and Use | Volume Required (gal) |
|---|---|
| **Construction** | |
| Dust control/soil compaction | – |
| Workforce potable and sanitary use[(a)] | – |
| Washing and miscellaneous uses | – |
| Subtotal (average daily)[(b)] | **6,140** |
| Total (construction phase)[(c)] | **2,088,000** |
| **Operations** | |
| Target fabrication (average daily)[(d)] | 25 |
| Target disassembly and dissolution (average daily)[(d)] | 1.5 |
| Mo-99 recovery and purification system[(d)] | – |
| Uranium recovery and recycle system (average daily) [(d)] | 508 |
| Laboratory facilities (average daily)[(d)] | 2 |
| Facility support (average daily)[(d, e)] | 2 |
| Wash water (average daily) | 366 |
| Potable and sanitary (average daily) | 4,140 |
| Subtotal (average daily) | **5,045** |
| Total (annualized operations)[(f)] | **1,312,000** |

| Project Phase and Use | Volume Required (gal) |
|---|---|
| **Decommissioning** | |
| Dust control/soil compaction | – |
| Workforce potable and sanitary use[(a)] | – |
| Washing and miscellaneous uses | – |
| Subtotal (average daily) | **2,000** |
| Total (decommissioning phase)[(g)] | **960,000** |

[(a)] Portable sanitary facilities would be used to minimize water use by workforce.

[(b)] Total is inclusive of the listed uses during the projected 17-month construction period.

[(c)] Total demand for 17-month construction phase, assuming 20 workdays per month.

[(d)] Facility uses served by the demineralized water system with raw water supplied by public water system.

[(e)] Periodic/intermittent needs to fill/top off the NWMI facility's 180,000-gallon firewater storage tank and to provide cooling system makeup are not included.

[(f)] Total annual water demand assumes 260 days of operation per year.

[(g)] Total demand for assumed decommissioning phase of up to 24 months, assuming 20 workdays per month.

Note: Some values are rounded. To convert gallons (gal) to liters, multiply by 3.7854. To convert gal to cubic meters ($m^3$), divide by 264.2.

Source: Based on values derived or scaled from NWMI 2015a, 2015c, 2016a

Water would be required for various purposes, such as dust suppression and soil compaction during NWMI facility construction. Activities requiring water would include, but would not be limited to, site clearing and grading, facility excavation, support facility construction, roadway development, and installation of site drainage and utilities. Water would also be required to meet the drinking and sanitary needs of the construction workforce. NWMI proposes to use portable restroom facilities, serviced by a commercial vendor (NWMI 2015c).

As proposed, operational water use within the RPF building is divided among four key systems: (1) the demineralized water system (serving process and related uses), the wash water system, the potable and sanitary system (i.e., serving drinking, showers, and toilets), and the firewater system (Table 2–3). During operations, wash water would primarily be required for cleaning tractor trailers (NWMI 2015a, 2015c).

Facility decommissioning activities would require water for many of the same purposes as construction in association with facility demolition and decontamination (see Table 2–3).

### 2.5.2 Water Treatment

Potable water would be supplied to the NWMI facility through a public utility system to support facility operations. The water would require no additional treatment for most facility uses. Nonetheless, the water routed to the process systems must be pretreated by the demineralized water system. Demineralization, also known as ion exchange, refers to the exchange of ions between a solid substance and an aqueous solution (makeup water). This system would supply demineralized water to the RPF building facility processes for water addition, flushing, and chemical dilution. The demineralized water system can also potentially provide makeup water to the steam boilers (NWMI 2015a, 2015c).

Once charged, the steam boiler and chilled water (cooling) systems are closed-loop and require minimal makeup water inputs during operation (NWMI 2015a).

### 2.5.3 Water Discharges

As stated in the applicant's ER, the NWMI RPF building is designed to have zero liquid discharge from the radiologically controlled area of the facility. No radioactive liquid effluents would be discharged to the site environment. RPF processed radioactive liquid wastes would be physically and chemically treated, as necessary, and shipped to an appropriate disposal facility, as further described in Section 2.9 (NWMI 2015a, 2015c).

Nonhazardous, nonradioactive wastewater would be discharged to the municipal sanitary sewer collection and treatment system. This effluent would be primarily comprised of sanitary wastewater (NWMI 2015a). Based on the staff's review of the ER and applicable regulatory information, all wastewater conveyed to the municipal system would have to comply with influent acceptance criteria and applicable pretreatment requirements, as prescribed in applicable ordinances.

## 2.6 Cooling and Heating Dissipation Systems

### 2.6.1 Cooling Systems

The NWMI cooling water systems would control the temperature of process equipment at the proposed NWMI RPF building from process activities and heat of radioactive decay of fission products in the hot cells and target fabrication area. The cooling system consists of a primary closed-loop, an intermediate heat exchanger, a secondary loop, and air-cooled chillers. Water from the primary loop and secondary loop do not come in direct contact because heat from the primary loop to the secondary loop is exchanged through the intermediate heat exchanger. The secondary loop circulates chilled water from air-cooled chillers located outside the RPF building to a heat exchanger that removes heat from the primary loop (i.e., heat is transferred from the primary loop to the secondary loop). The secondary loop water is then circulated to the air-cooled chillers and heat is dissipated to the environment. The primary closed-loop circulates and distributes chilled water from the heat exchanger to various process areas to remove heat; this heated water in the primary loop is then circulated back to the heat exchanger to transfer heat to the chilled secondary loop water.

### 2.6.2 Heating Systems

The RPF building would house five natural gas-fired boilers. One set of three boilers will be dedicated for the heating, ventilation, and air conditioning system (HVAC). One set of two boilers would be dedicated to steam production necessary for process equipment. NWMI anticipates that three boilers will be operational at any one time; the remaining two boilers will be spare (NWMI 2015c). NWMI estimates that the total annual natural gas consumption would be $4.3 \times 10^5$ million British thermal units (NWMI 2015c).

The process steam system will consist of a primary loop, secondary loop, and intermediate heat exchanger. The steam from the boilers flows to an intermediate heat exchanger in the secondary loop. The primary loop then circulates and distributes steam from the heat exchanger to the various process loads in a closed loop (NWMI 2015a).

## 2.7 Radioactive and Nonradioactive Waste

Construction, operations, and decommissioning of the NWMI facility would result in the generation of radioactive and nonradioactive wastes. The information below describes the generation and treatment of radioactive and nonradioactive wastes at the proposed NWMI facility, and the waste minimization and pollution prevention measures.

### 2.7.1 Radioactive Waste

During construction of the proposed NWMI facility, NWMI would not have radioactive material associated with the production of medical isotopes on site; therefore, no radioactive waste would be generated during this phase. During operation of the NWMI facility, processes would generate liquid, solid, and gaseous radioactive waste during the following activities:

- target fabrication (i.e., dissolution and washing process);
- target disassembly and dissolution (i.e., spent metal cladding, fission product gases);
- Mo-99 recovery and purification (i.e., exchange resin);
- uranium recovery and recycle (i.e., exchange resin, fission product solution);
- waste management system (i.e., liquid waste collection, concentration, solidification, and encapsulation process);
- laboratory facility operation (i.e., laboratory glassware, vials, and containers); and
- facility support operations (i.e., potentially radiologically contaminated waste such as failed process equipment, decontamination materials, and personal protective equipment) (NWMI 2015a, 2016c).

#### *2.7.1.1 Gaseous Waste*

Gaseous radioactive waste from routine operations of the proposed NWMI facility would consist of radioactive effluents from hot cell processes, including irradiated LEU target dissolution and uranium recovery and recycling processes. The design of the RPF ventilation system divides the operating areas into pressure zones that draw air from the cleanest part of the facility to the most contaminated area. This design protects workers and members of the public by minimizing the potential spread of radioactive contamination within the facility. Gaseous effluents from the NWMI facility would be released to the environment through one of three vent stacks, each of which would release air from a separate zone or zones of the RPF building. The gaseous effluents would be treated using two high-efficiency particulate air (HEPA) filters to remove radioactive particulates, and carbon absorbers to remove iodine fission products, before they are released through a vent stack in the RPF building. In addition, gas retention systems would temporarily retain effluents containing radioactive gas for a period of time before they are released into the environment, to reduce the level of fission product gasses such as xenon and krypton by decay (NWMI 2015a, 2015g).

NWMI expects gaseous radioactive effluents released into the environment through the vent stacks to contain measureable quantities of noble gases (i.e., xenon and krypton). Table 2–4 lists the quantities of radionuclides that NWMI estimates the facility would release annually. Radioactive iodine, particulates, and tritium could also be present in the airborne effluent exhaust (NWMI 2015a). NWMI would perform monitoring of these releases, as described in Section 4.8.

**Table 2–4. Gaseous Radioactive Effluents**

| Effluent | Rate[(a)] |
|---|---|
| Krypton-85 | 58.4 Ci/yr[(b)] |
| Xenon-131 | 166 Ci/yr |
| Xenon-133 | 498 Ci/yr |

[(a)] The rate is based on 52 weeks of operation
[(b)] Ci/yr = curie(s) per year

Source: NWMI 2015a

### *2.7.1.2 Liquid and Solid Waste*

Operation of the NWMI facility would result in the production of liquid and solid radioactive waste. Liquid radioactive wastes would be generated by target fabrication, target disassembly and dissolution, Mo-99 recovery and purification, uranium recovery and recycle, laboratory facility operation, and facility support operations. Liquid waste would be treated and solidified into a solid waste form suitable for offsite disposal (NWMI 2015a). NWMI estimates that 525,000 kilograms (kg) (1,157,426 pounds (lbs)) of solidified liquid waste would be generated per year. No liquid radioactive material would be released to the environment as a result of routine operations of the NWMI facility (NWMI 2015a). Liquid waste from process operations would be recycled and reused where practicable and, therefore, would be expected to reduce the amount of solidified waste (NWMI 2015a).

Solid radioactive wastes would be generated during target disassembly and dissolution, Mo-99 recovery and purification, uranium recovery and recycle, waste management, laboratory facility operation, and facility support operations. Solid waste will be collected into disposal containers, and most solid waste will be encapsulated in cement (NWMI 2015a, 2015c, 2016c). Large pieces of equipment that may fail and solid waste from laboratory facility operations and facility support operations for which encapsulation on site may be difficult will not be encapsulated (NWMI 2016c). NWMI estimates that 15,000 kg (33,069 lbs) of encapsulated solid waste and an additional 7,000 kg (15,432 lbs) of solid waste not encapsulated, would be generated per year (NWMI 2015c, 2016c). A portion of the solid radioactive waste generated from laboratory operations at the proposed NWMI facility would be mixed (i.e., both hazardous and radioactive) waste. NWMI estimates that less than 760 kg (1,676 lbs) of mixed waste would be generated per year. This quantity of mixed waste is included in the estimates above and in the total hazardous waste generation estimate discussed in Section 2.7.2 (NWMI 2016c).

The NRC classifies solid low-level waste in 10 CFR 61.55 as Class A, Class B, Class C, or greater than Class C (GTCC) waste, depending on the types and concentrations of radionuclides in the waste. Class A wastes generally contain short-lived radionuclides at relatively low concentrations, whereas the half-lives and concentrations of radionuclides in Class B and C wastes are progressively higher. Because of the longer half-lives and higher concentrations of radionuclides in Class B wastes, these wastes must meet more rigorous requirements with regard to their form to ensure stability after disposal (e.g., by adding chemical stabilizing agents, such as cement, to the waste, or by placing the waste in a disposal container or structure that provides stability after disposal). Class C wastes, in addition to meeting Class B requirements, must have additional measures at the disposal facility to protect against inadvertent intrusion (e.g., by increasing the thickness and hardness of the cover over the waste disposal cell). GTCC wastes contain radionuclides at concentrations that are higher than those allowed for Class C wastes. For GTCC wastes, near-surface disposal methods are generally not acceptable.

Operation of the NWMI facility would generate NRC Class A and Class B radioactive waste. Of the 525,000 kg (1,157,426 lbs) of solidified liquid waste that would be generated per year, NWMI estimates that 300,000 kg (661,386 lbs) is projected to be Class B waste and 225,000 kg (496,040 lbs) will be Class A waste (NWMI 2015c). NWMI estimates that all of the 15,000 kg/yr (33,069 lbs/yr) of encapsulated solid waste will be Class B waste, and 7,000 kg/yr (15,432 lbs/yr) of solid waste not encapsulated will be Class A waste (NWMI 2015c, 2016c). Possible volume reduction and optimization activities have the potential to change some Class B waste into Class C; if NWMI anticipates that Class C waste will be produced, NWMI would provide this information in its operating license application and the NRC would review this information and document its review in the supplemented EIS. NWMI expects that no GTCC wastes will be generated (NWMI 2015c).

### 2.7.2 Nonradioactive Waste

#### *2.7.2.1 Liquid Waste*

Nonradioactive liquid waste would be generated during construction. For example, lubricating oil, hydraulic oil, and grease might be necessary to assemble various pieces of equipment and systems. Chemicals, hazardous liquids, compressed gases, flammable liquids, and oxidizers are expected to be on site during construction (NWMI 2015a). NWMI intends to use best management practices and personal protective equipment to minimize waste generation and exposure (NWMI 2015a).

During operations, nonradioactive liquid waste would include hazardous waste, such as chemicals. Table 2–5 lists some of the expected inventory and quantity of chemicals that would be used during operation of the proposed NWMI facility at any given time. Some chemicals would be in liquid form and would be controlled and confined in containers, tanks, pipes, and hot cells. NWMI anticipates that the proposed NWMI facility would generate up to 1,000 kg (2,205 lbs) of hazardous waste per month (NWMI 2015c). However, this estimate includes both radiological and nonradiological waste as well as solid and liquid waste. Therefore, the liquid nonradiological hazardous waste portion will be less than 1,000 kg/month (2,205 lbs/month).

**Table 2–5. Summary of Chemical Inventory and Quantity at the Proposed NWMI Facility**

| Chemical | Quantity[(a)] |
|---|---|
| Nitric Acid | 100,000 L/yr |
| Hydrogen Peroxide | 500 L |
| Ammonium Hydroxide, | 100 L |
| Ammonia | 100 kg |
| Carbon Dioxide | 200 kg |
| Oxygen | 100 kg |
| Nitrogen | 1,800 kg |
| Sulfamic Acid | 20.8 kg/yr |
| Sodium Hydroxide | 70,000 L/yr |
| Reductant | 230 L/yr |
| Sodium Hypochlorite | 1 L |
| Amberlite LA-2 | 25 kg |

| Chemical | Quantity[a] |
|---|---|
| Diethylbenzene | 50 kg |
| Sorbent | 10,000 kg |
| Solvent | 200 L |
| Hexamethylenetetramine | 200 kg |
| Urea | 100 kg |
| Silicone Oil | 100 L |

[a] L = liters; kg = kilograms; yr = year.

Source: NWMI 2015a

NWMI would release nonradiological liquid waste meeting municipal treatment standards to the Columbia, Missouri, sewer system as a result of chemical processes conducted during routine facility operations (NWMI 2015a). NWMI stated it will have administrative controls in place and sampling and monitoring processes to ensure that its nonradioactive effluents meet the requirements pertaining to the types, quantity, and concentrations specified as acceptable for processing by the Columbia wastewater treatment facility. Liquid wastes that do not meet the local municipal wastewater treatment standards would be containerized and shipped to a disposal facility (NWMI 2015a). Additionally, sanitary wastewater from the proposed NWMI facility would be sent to the Columbia sanitary sewer system (NWMI 2015a). Section 4.9.2 of this document contains more information on the liquid nonradioactive waste discharges from the proposed NWMI facility.

#### *2.7.2.2 Solid Waste*

During construction, operations, and decommissioning, NWMI expects to generate the following nonradioactive solid wastes:

- wood,
- metal,
- plastics,
- piping,
- wires,
- batteries,
- office supply waste,
- expired lights and fixtures,
- packaging waste, and
- solidified used oil and solvents.

The solid hazardous waste that would be generated would be a portion of the up to 1,000 kg (2,205 lbs) total (solid and liquid) hazardous waste produced per month that was described in Section 2.7.2.1. The proposed facility would also generate approximately 4,056 kg (8,942 lb) of solid nonradiological, nonhazardous waste (i.e., municipal waste) per year during operation (NWMI 2015c).

NWMI would temporarily collect and store nonradioactive waste on site. NWMI stated that all solid hazardous waste would be managed according to applicable regulations (e.g., the Resource Conservation and Recovery Act (42 USC 6901et seq.) and the Missouri Hazardous Waste Management Law (Missouri Revised Statutes 260.350 to 260.430)) (NWMI 2015a).

### 2.7.3 Waste Minimization and Pollution Prevention Program

NWMI will implement a program of pollution prevention and waste minimization that includes:

- waste minimization and recycling programs specific to various phases of the project (e.g., construction and operations);
- employee training and education;
- recognition of employees for improving environmental conditions; and
- requirements and responsibilities to consider pollution prevention and waste minimization in day-to-day activities (NWMI 2015a).

Section 4.9 discusses the impacts associated with waste management activities at the proposed NWMI facility.

Another facet of NWMI's waste minimization program will be its recycling and reclamation program. This program manages economic and environmental costs and impacts that result in cost savings and reduced waste generation. This program will focus primarily on paper, plastic, administrative supplies, solvent (trichloroethylene) recovery, uranium, and process water (NWMI 2015a).

## 2.8 Storage and Transportation of Radioactive and Nonradioactive Materials and Waste

Construction, operations, and decommissioning of the NWMI facility would result in the accumulation of radioactive and nonradioactive wastes. NWMI does not anticipate any long-term storage or disposal of radioactive or nonradioactive materials on site (NWMI 2015a). NWMI will treat and temporarily store liquid and solid radioactive and nonradioactive waste generated as part of the radioisotope production process within the facility until it can ship the waste off site for disposal (NWMI 2015a). Transportation of radioactive material, radioactive waste, and medical isotopes will be conducted in accordance with NRC and DOT regulations to protect public health and safety during the transportation of these materials (NWMI 2015a). The additional information provided below describes, as applicable, the generation, storage, waste management activities, waste minimization and pollution prevention measures, and transportation of radioactive and nonradioactive waste and materials.

### 2.8.1 Storage and Transportation

#### *2.8.1.1 Radioactive Waste and Other Materials*

After NWMI treats and packages radioactive waste, NWMI stated it will temporarily store radioactive waste at the proposed NWMI facility to allow for decay before offsite transport and disposal. NWMI stated it will store Class B wastes (solidified liquid waste and encapsulated solid wastes) at the proposed NWMI facility for at least 12 to 15 weeks of decay time before shipment off site. NWMI also may temporarily store some Class A waste at the NWMI facility for approximately 12 weeks (NWMI 2015c). Assembled LEU targets would be stored at the NWMI facility until they are shipped to research reactors for irradiation. Because of the short half-life of Mo-99, minimal Mo-99 product temporary storage would occur at the NWMI facility, and it would be shipped out twice per week (NWMI 2015a). Similarly, irradiated targets from research reactors would not be stored at the NWMI facility but would be processed to recover Mo-99. Radioactive waste and other radioactive material would be stored in a manner that would ensure that no uncontrolled release of radioactive materials from the NWMI facility could occur, and that personnel exposures to radiation would be as low as is reasonably achievable and within 10 CFR Part 20 limits (NWMI 2015g). The NWMI facility would have sufficient space to store all radioactive materials (NWMI 2015c).

Class A and Class B wastes generated at the NWMI facility would be transported off site following temporary storage. This waste would be transported by commercial carrier, on public roadways, to Waste Control Specialists in Andrews, Texas (NWMI 2015a, 2015c, 2016c). Other radioactive materials shipped to and from the proposed site would include fresh LEU, unirradiated LEU targets, irradiated LEU targets, Mo-99 product solution, and take-back LEU. Fresh LEU would be shipped, on public roadways, from DOE Y-12 (Oak Ridge, Tennessee) to the proposed NWMI facility. Unirradiated and irradiated LEU targets would be shipped to and from the proposed NWMI facility and MURR (Columbia, Missouri), OSTR (Corvallis, Oregon), and a third research reactor on public roadways. Mo-99 product solution would be shipped, on public roadways, to a distributor in Hazelwood, Missouri, or to the Columbia Regional Airport in Columbia, Missouri, and then transported by air from the Columbia Regional Airport to Logan International Airport in Boston, Massachusetts. From Logan International Airport, the Mo-99 will be transported on public roadways to a distributor in Billerica, Massachusetts (NWMI 2015a). Take-back uranium would be shipped, on public roadways, to DOE's Savannah River Site in Aiken, South Carolina.

NWMI stated that, when transporting waste and other radioactive materials on public roads, NWMI or commercial carriers must comply with the applicable DOT regulations in 49 CFR Parts 172, 173, 177, and 397, as well as the NRC packaging requirements for radioactive material in 10 CFR Part 71 (NWMI 2015a). These regulations help ensure safety on the public roadways. NWMI also stated that for transport of Mo-99 product by air, the air carrier NWMI chooses also must comply with additional DOT regulations in 49 CFR Part 175 (NWMI 2015a).

In accordance with 10 CFR Part 71, waste and other radioactive material shipped to or from the NWMI facility would require packaging meeting one of three DOT packaging classifications: low specific activity (LSA), Type A, or Type B. An LSA package contains low levels of radioactive material. A Type A package meets additional integrity and shielding requirements, and may contain higher radioactivity levels than an LSA package. Type B packages meet the highest integrity and shielding requirements, and may contain higher radioactivity levels than a Type A package. The lettering system for packaging types is not related to the lettering system for waste classification.

#### *2.8.1.2 Nonradioactive Waste and Other Materials*

NWMI does not anticipate any long-term storage or disposal of nonradioactive (hazardous or nonhazardous) materials on site (NWMI 2015a). NWMI stated it will treat and temporarily store liquid and solid nonradioactive waste generated as part of the radioisotope production process within the facility until it can ship the waste off site for disposal (NWMI 2015a). Nonradioactive liquid wastes that do not meet the municipal treatment standards will be containerized, treated (reduced and neutralized), and solidified and shipped to a disposal facility. Solid waste will be transported off site to either a landfill, storage facility, or recycling or recovery facility, as appropriate. For instance, nonhazardous, nonradioactive solid waste (wiring, packaging waste) will be shipped to a landfill (NWMI 2015c). NWMI stated hazardous waste will be handled in accordance with applicable regulations (e.g., the Resource Conservation and Recovery Act) and would be collected by a hazardous waste disposal company for separation, processing, and disposal (NWMI 2015c).

NWMI will develop a chemical management and product handling plan. The storage and treatment of wastes will be conducted in accordance with this plan. Additionally, onsite storage of chemicals and supplies will be performed in accordance with a chemical management and product handling plan to ensure that chemicals are properly stored (e.g., non-compatible chemicals are stored in separate areas, flammable chemicals and oxidizers are stored in separate areas) (NWMI 2015a).

NWMI would temporarily collect and store solid nonradioactive waste on site and then transport waste to a landfill, storage facility, or recycling facility. Transportation will be by ground transportation. NWMI must package and transport hazardous nonradioactive waste in accordance with DOT regulations contained in 49 CFR 171-180.

## 2.9 Facility Decommissioning

The NWMI facility would be decommissioned upon completion of its useful life. In accordance with 10 CFR Part 50, a licensed production or utilization facility that permanently ceases operations submits a decommissioning plan or report. Also, 10 CFR 50.33(k) requires that an operating license applicant submit a report that indicates how reasonable assurance will be provided that funds will be available to decommission the facility.

> Decommission means to remove a facility or site safely from service and reduce residual radioactivity to a level that permits:
>
> - Release of the property for unrestricted use and termination of the license or
> - Release of the property under restricted conditions and termination of the property (10 CFR 50.2)

NWMI anticipates decommissioning of the facility to begin following a 30-year operating period (NWMI 2015a). Decommissioning activities would be similar to construction activities, because they would involve heavy equipment to dismantle buildings and remove roadway and parking facilities (NWMI 2015a). Decommissioning would involve decontamination of the RPF, reduction of residual radioactivity to a level that permits release of the property for unrestricted use and termination of the license. NWMI estimated that the decommissioning period would extend for 18 to 24 months and would require a peak workforce of approximately 81 workers, 1 truck delivery per week, and 20 offsite waste shipments per week (NWMI 2015c, 2016a). Demolition and equipment supporting activities are projected to consume 1,647 L/month (435 gal/month) of diesel fuel (NWMI 2015a, 2015c). Estimates of the types and quantity of radioactive waste that would be disposed of during decommissioning are not known at this time. However, the NRC staff assumes that the types of radioactive waste would be consistent with those discussed in Section 2.7.1. NWMI would be required to conduct decommissioning activities such that radiation doses to occupational workers and members of the public are maintained below 10 CFR Part 20 limits.

NWMI would be required to conduct decommissioning activities in accordance with applicable NRC requirements and any additional Federal, State, and local requirements. For example, any radioactive equipment and materials will be disposed of according to State and Federal laws and regulations. After decommissioning activities are completed, the proposed site could remain industrial or could be converted back to agricultural land or open space.

# 3.0 AFFECTED ENVIRONMENT

The site proposed by Northwest Medical Isotopes, LLC (NWMI) for the NWMI facility is Lot 15 of the Discovery Ridge Research Park located in Boone County, Columbia, Missouri. This chapter describes the existing regional and local environmental conditions in the vicinity of the proposed site for land use and visual resources, air quality and noise, the geologic environment, water resources, ecological resources, historic and cultural resources, socioeconomics, human health, and transportation. Unless otherwise specified, the description of the environment includes the area within a 5-mi (8-km) radius of the proposed site, which is also referred to as the vicinity. This geographic range is consistent with the Final Interim Staff Guidance Augmenting NUREG–1537, Part 1 and 2 (NRC 2012), which identifies that the geographic distance to be considered for environmental impacts is a 5-mi (8-km) radial distance from the proposed facility.

The following description of the affected environment is based on the U.S. Nuclear Regulatory Commission (NRC) staff's independent review of (1) NWMI's Environmental Report (ER) (NWMI 2015a, 2015d); (2) NWMI's responses to the NRC staff's requests for additional information (NWMI 2015c, 2016a, 2016b); (3) the NRC staff's environmental site visit and audit (NRC 2015b); (4) information provided in public scoping comments (NRC 2016a); (5) comments and input provided by other Federal agencies, States, Tribes, and regional and local agencies; and (6) the NRC staff's independent research of the environs surrounding the proposed site.

## 3.1 Land Use and Visual Resources

This section describes the land use and visual resources at the proposed site and in the vicinity of the proposed site. The NRC staff assessed land use and land cover using the National Land Cover Database (USGS 2006; Fry et al. 2011). The NRC staff used the U.S. Department of the Interior, Bureau of Land Management (USDOI-BLM), Visual Resource Management System, to rate the visual resources at the proposed site; this system rates the visual appeal and the sensitivity of changes to an area (BLM 1984).

### 3.1.1 Land Use

#### *3.1.1.1 Site and Immediate Surroundings*

The proposed site is Lot 15 of the Discovery Ridge Research Park located approximately 3 mi (5 km) southeast of the City of Columbia (NWMI 2015a; Figure 2–1). The Discovery Ridge Research Park is 505-ha (1,250-ac) and is owned by the University of Missouri (MU 2016a). Two research facilities are currently in operation within the research park, and the University of Missouri intends to expand the research park for additional research facilities (MU 2016a).

Lot 15 of the Discovery Ridge Research Park is 7.4 acres (ac) (3.0 hectares (ha)) (NWMI 2015a; Figure 2–3). Based on a review of the National Land Cover Database, 100 percent of the site is classified as pasture/hay (USGS 2006; NWMI 2015a). No structures currently exist on the site (NWMI 2015a; NRC2015b). The proposed Discovery Ridge site does not contain prime farmland or other important farmland soils as defined in the Farmland Protection Policy Act of 1981 (7 U.S.C. 4201 et seq.) and implementing regulations (7 CFR Parts 657, 658; NWMI 2015a).

The proposed site is zoned A–1 for agricultural activities (City of Columbia 2016a). However, Section 172.273.1 of the Missouri Revised Statues states that "the curators of the University of Missouri may establish research, development and office park projects, in order to promote cooperative relationships and to provide for shared resources between private individuals, companies and corporations, and the University of Missouri, for the advancement of the university in carrying out its educational mission." In October 2005, the Board of Curators of the University of Missouri identified the site to be developed as a research park pursuant to Statute 172.273 of the Missouri Revised Statutes (MU 2009). In May 2006, the Board approved the Master Plan of the research park, which designated approximately 114 ac (46 ha) as the initial phase for development with the expectation that additional phases of the research park would be added as needed.

In the most recent land use plan, the City of Columbia identifies the Discovery Ridge Research Park, including Lot 15, as "shovel ready" for future industrial development (City of Columbia 2013). The research park is also one of three sites that the City of Columbia (2013) designated as an industrial certified site. The future development goal for the Discovery Ridge Research Park is to increase the number of business and research facilities on site, especially for entities that would benefit from the close proximity to the resources available at the University of Missouri (City of Columbia 2013). In addition, one of the City of Columbia's economic goals is to attract new businesses and increase the number of light industrial and high tech jobs within the Columbia Regional Airport-Discovery Ridge-U.S. Highway 63 Corridor (City of Columbia 2013), which includes Discovery Ridge Research Park.

##### *3.1.1.2 Vicinity*

Table 3–1 lists the major land uses and land covers within a 5-mi (8-km) radius of the proposed site (USGS 2006; Fry et al. 2011; NWMI 2015a). The major land uses and covers include developed areas (25 percent), deciduous forests (31 percent), and hay or pasture (30 percent).

The proposed site is within the limits of the City of Columbia, which had a population of 116,109 as of July 1, 2014 (USCB 2016a). The University of Missouri is located within the City of Columbia and has a student population of 34,748 when in full session (MU 2016b). No other major population centers (more than 25,000 residents) exist within the 5-mi (8-km) vicinity of the proposed site.

The major transportation corridors in the vicinity include Discovery Parkway, U.S. Highway 63, and U.S. Interstate 70 (Figure 3–1). COLT Transload, which is owned by the City of Columbia, provides rail transportation to the City of Columbia. The closest airport to the proposed Discovery Ridge site is the Columbia Regional Airport, which is located 11 km (7 mi) from the proposed site. The Missouri River is the largest river in Boone County and occurs 11.7 km (7.3 mi) to the west of the proposed Discovery Ridge site (see Section 3.4). The Missouri River is the only river large enough to support commercial traffic in Boone County (NWMI 2015a).

**Figure 3–1. Cities and Major Roadways Within 5 mi (8 km) of the Proposed Discovery Ridge Site**

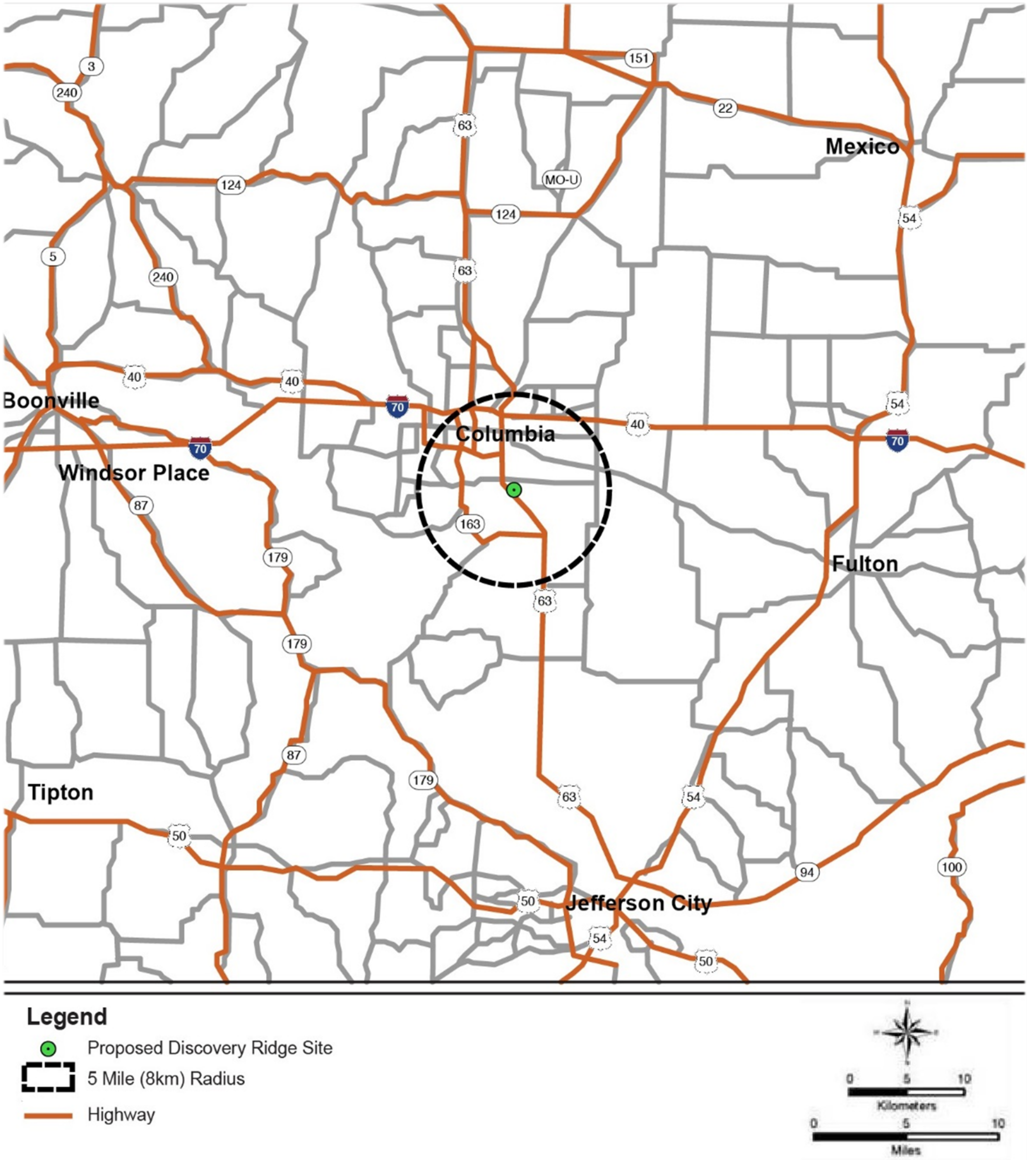



**Table 3–1. Summary of Land Use and Land Cover Within the Proposed Discovery Ridge Site and Vicinity**

| | NWMI Site | | | Vicinity (5 mi) | | |
|---|---|---|---|---|---|---|
| **Land Cover Type** | **ac** | **ha** | **percent** | **ac** | **ha** | **percent** |
| Open Water | | | | 346 | 140 | <1 |
| Developed, Open Space | | | | 4,119 | 1,667 | 8 |
| Developed, Low Intensity | | | | 4,677 | 1,893 | 9 |
| Developed, Medium Intensity | | | | 2,770 | 1,121 | 6 |
| Developed, High Intensity | | | | 911 | 369 | 2 |
| Barren | | | | 94 | 38 | <1 |

| Land Cover Type | NWMI Site | | | Vicinity (5 mi) | | |
|---|---|---|---|---|---|---|
| | ac | ha | percent | ac | ha | percent |
| Deciduous Forest | | | | 15,730 | 6,366 | 31 |
| Evergreen Forest | | | | 534 | 216 | 1 |
| Mixed Forest | | | | 469 | 190 | <1 |
| Shrub/Scrub | | | | 107 | 43 | <1 |
| Grassland | | | | 345 | 140 | <1 |
| Pasture/Hay | 7.4 | 3.0 | 100 | 15,158 | 6,134 | 30 |
| Cultivated Crops | | | | 4,639 | 1,877 | 9 |
| Woody Wetlands | | | | 363 | 147 | <1 |
| Emergent Herbaceous Wetland | | | | 2 | 1 | <1 |
| Total[a] | 7.4 | 3.0 | 100 | 50,262 | 20,339 | 100 |

Key: ac = acre, ha = hectare.

[a] Total may add up to more or less than 100 percent due to rounding.

Sources: USGS 2006; Fry et al. 2011; NWMI 2015a

#### *3.1.1.3 Special Land Uses*

Approximately 7 percent (1,427 ha (3,527 ac)) of the 5-mi (8-km) vicinity surrounding the proposed Discovery Ridge site is parks or conservation areas, such as Rock Bridge State Park, Three River Conservation Area, and the northwest corner of the Mark Twain National Forest (NWMI 2015a). The Missouri Department of Natural Resources (MDNR) manages the Rock Bridge State Memorial Park, which is an 858-ha (2,120-ac) park that consists of karsts, grasslands, and oak woodlands and forests (MDNR 2016a). This State park also contains the Gans Creek Wild Area. The Missouri Department of Conservation (MDC) manages the Three River Conservation Area, which is a 607-ha (1,500-ac) natural preserve that consists mostly of oak forests and woodlands and provides cave habitat for bats (MDC 2016a). A small portion of the Mark Twain National Forest, Cedar Creek Ranger District, is also located within the vicinity of the proposed site (USDA 2016a). The Mark Twain National Forest consists of tall grass prairies and shortleaf pine-oak woodlands.

No active mines or quarries, military reservations, Federally designated wild and scenic rivers, national parks, or Federal lands held in trust for an American Indian tribe occur within 5 mi (8 km) of the proposed site (NWMI 2015a; NRC 2015b; Find the Data 2016). In addition, because no Federally designated coastal zone areas occur within 5 mi (8 km) of the proposed NWMI site the proposed action would not affect any land or water use or natural resource within a coastal zone (NOAA 2016). Thus, no applicant certification and State concurrence (under the Coastal Zone Management Act of 1972, as amended) that the activity is consistent with the State's Coastal Zone Management Plan is needed for the NRC's review of the construction permit for the proposed NWMI facility.

#### *3.1.1.4 Agricultural Resources and Facilities*

Soils that may qualify as prime farmland and farmland of statewide importance are located within the 5-mi (8-km) vicinity of the proposed Discovery Ridge site (Figure 3–2). Prime farmland is defined in the Farmland Protection Policy Act of 1981 as "land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, oilseed, and other agricultural crops with minimum inputs of fuel, fertilizer, pesticides, and labor, and without intolerable soil erosion, as determined by the Secretary [of Agriculture].” The Farmland Protection Policy Act states that farmland of statewide importance includes soils, other than those determined as prime farmland, with similar characteristics as prime farmland locally within the State. The U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), in cooperation with State and local agencies, defines and delineates the soils to consider as prime farmland and farmland of statewide importance (Title 7 of the *Code of Federal Regulations* (CFR) Part 657). However, otherwise qualifying “farmland” soils do not include those on land already in, or committed to, urban development or water storage, as defined in 7 CFR 658.2.

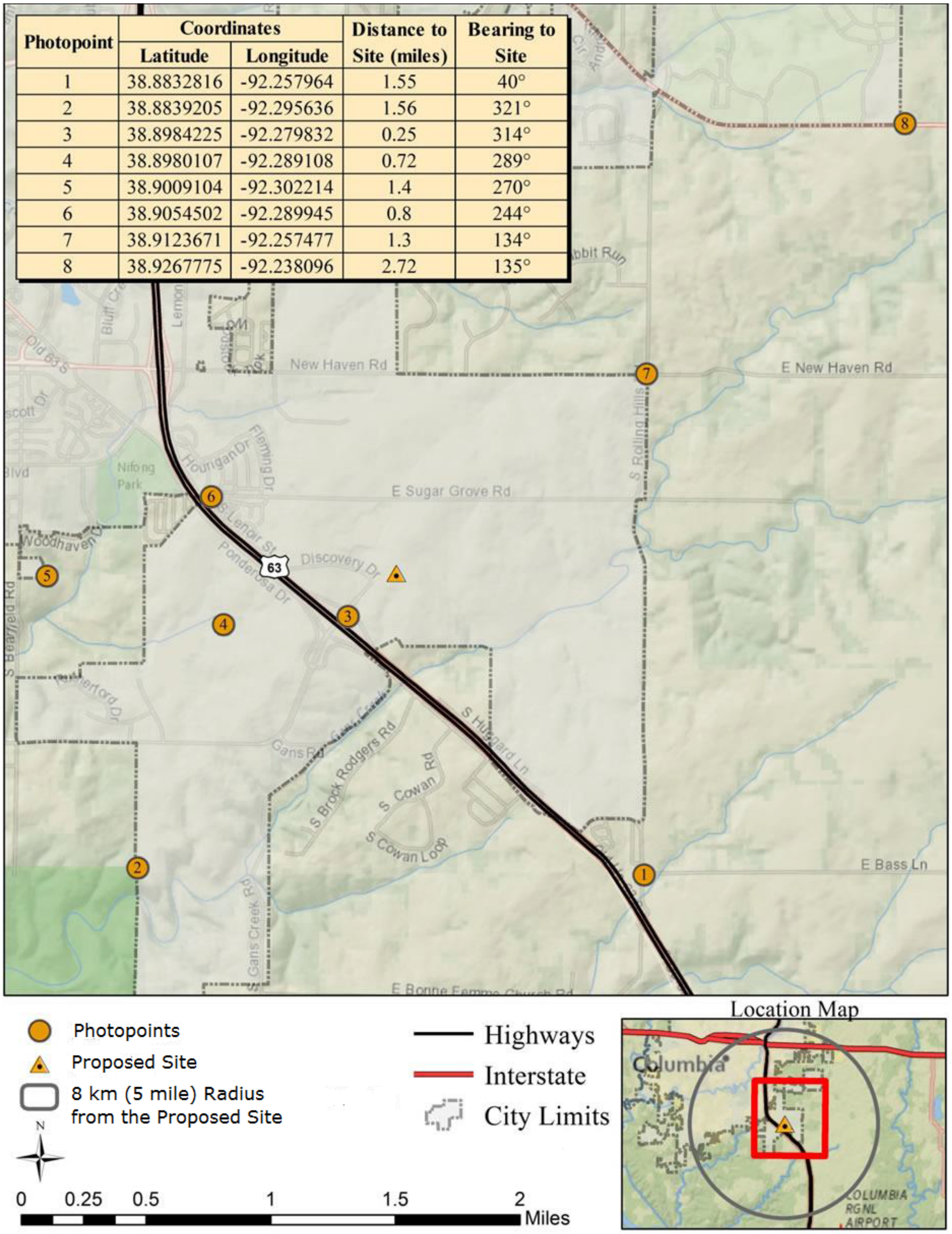
In Missouri, farmlands of statewide importance include the following soils: Weller silt loam, Weller–Urban land complex, Wrengart silty clay loam, and Hatton silt loam (NRCS 2016a, 2016b). Weller silt loam is the most common soil type that qualifies as both prime farmland and farmlands of statewide importance. The proposed Discovery Ridge site does not contain prime farmland or other important farmland soils. Within a 5-mi (8-km) radius of the proposed Discovery Ridge site, approximately 4,218 ha (10,424 ac), or one-fifth of the 5-mi (8-km) vicinity, are prime farmland or statewide important farmland (NRCS 2016a, 2016b; NWMI 2015a).

Principal agricultural products grown in the vicinity include soybeans, sorghum, and oats (USDA 2014). Many farms in the vicinity of the proposed Discovery Ridge site are used for pasture and grazing (USDA 2014; NWMI 2015a).

### 3.1.2 Visual Resources

The visual setting of the area that would be affected by the proposed NWMI facility includes agricultural, residential, and light industrial viewsheds (NWMI 2015a; NRC 2015b, Figures 3–3 through 3–10). Deciduous trees are also visible (NWMI 2015a; NRC 2015b). The viewsheds to the north and south of the proposed site have slightly rolling cultivated fields, roads, and residential buildings. The viewshed to the east is similar, with mostly agricultural fields, and a building associated with the University of Missouri Beef Farm. The viewshed to the west includes roads and agricultural fields.

**Figure 3–2. September 2013 Visual Reconnaissance Photo Locations**



| Photopoint | Coordinates | | Distance to Site (miles) | Bearing to Site |
|---|---|---|---|---|
| | Latitude | Longitude | | |
| 1 | 38.8832816 | -92.257964 | 1.55 | 40° |
| 2 | 38.8839205 | -92.295636 | 1.56 | 321° |
| 3 | 38.8984225 | -92.279832 | 0.25 | 314° |
| 4 | 38.8980107 | -92.289108 | 0.72 | 289° |
| 5 | 38.9009104 | -92.302214 | 1.4 | 270° |
| 6 | 38.9054502 | -92.289945 | 0.8 | 244° |
| 7 | 38.9123671 | -92.257477 | 1.3 | 134° |
| 8 | 38.9267775 | -92.238096 | 2.72 | 135° |



Source: NWMI 2015a

**Figure 3–3. View of Proposed Radioisotope Production Facility Site from Intersection of Rolling Hills and Bass Roads, Photo Location #1**


Source: NWMI 2015a

**Figure 3–4. View of Proposed Radioisotope Production Facility Site from Gans Road, approximately 1.6 km (1 mi) North Photo Location #2**

Source: NWMI 2015a

**Figure 3–5. Direct View of Radioisotope Production Facility Site from Discovery Parkway near the Overpass, Photo Location #3**

Source: NWMI 2015a

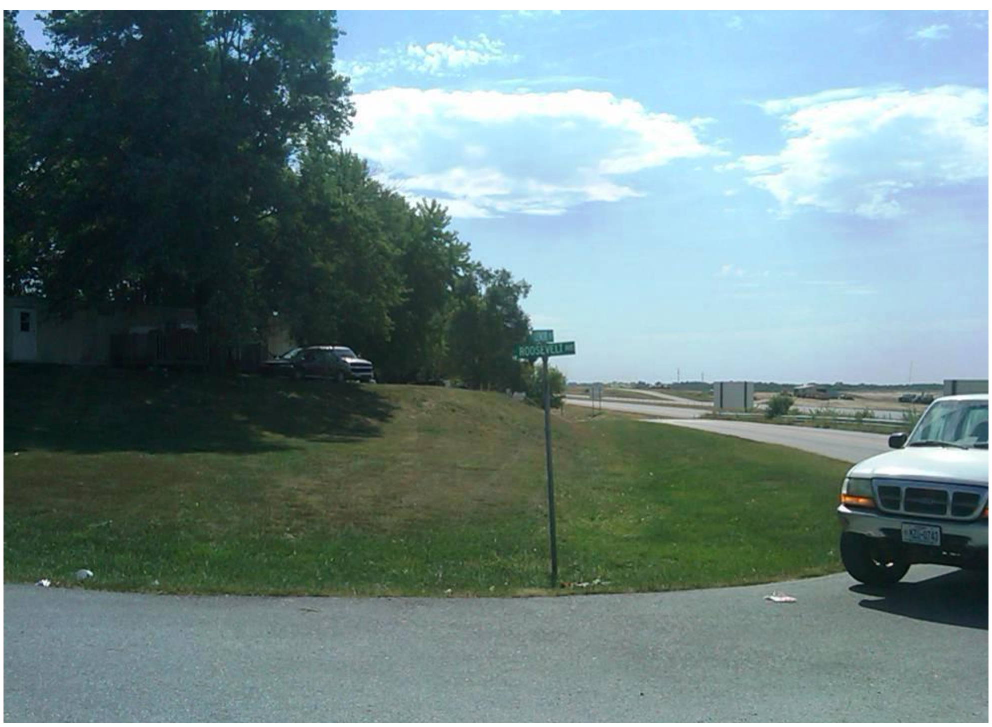
**Figure 3–6. View of Radioisotope Production Facility Site from the North Edge of Perry Phillips Lake, Photo Location #4**

Source: NWMI 2015a

**Figure 3–7. View of Proposed Radioisotope Production Facility Site from Boys and Girls Town of Missouri, Photo Location #5**

Source:  NWMI 2015a

**Figure 3–8. View of Proposed Radioisotope Production Facility Site from S. Lenoir and Roosevelt Avenue, Photo Location #6**



Source:  NWMI 2015a

**Figure 3–9. View of Proposed Radioisotope Production Facility Site from Intersection of New Haven and Rolling Hills Roads, Photo Location #7**


Source: NWMI 2015a

**Figure 3–10. View of Proposed Radioisotope Production Facility Site from Route WW at Old Hawthorne, Photo Location #8**

Source: NWMI 2015a

The proposed site would be within the viewshed of patrons and employees visiting the nearby facilities within the Discovery Ridge Research Park, traveling along nearby roads and highways, and potentially from some of the nearby residences (NWMI 2015a; NRC 2015b). Trees and other vegetation that border many of the residential neighborhoods and some of the business would obstruct the view of the proposed NWMI facility from some of these areas.

The NRC staff rated the visual resources and scenic quality of the existing site using the USDOI-BLM Visual Resource Management System (BLM 1984). The scenic quality classification is the rating of the visual appeal of the land designated for the proposed site. This rating is based on an evaluation of seven key factors—landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. Scenic quality is classified as A, B, or C, with A as the highest quality visual rating. The NRC staff gave the proposed site a C rating, with low scenic quality because of the uniform landform, low vegetation diversity, absence of water, subtle variation of color variations and contrast of vegetation, absence of cultural modifications to adjacent scenery, commonality within the physiographic province, and lack of notable features (NWMI 2015a; NRC 2015b).

The NRC staff also analyzed the sensitivity level, which is a measurement of public concern for scenic quality, using six different indicators—types of users, amount of use, public interest, adjacent land uses, special areas, and other factors. The sensitivity level of public concern for scenic quality is assigned as high, moderate, or low. The NRC staff assigned the proposed site a low sensitivity level because it is located in an area with low scenic values, typical users have low sensitivity to changes in the area's visual quality, the amount of viewer use is low, public interest in changes to the visual quality of the proposed site is low, and the location has no special natural and wilderness areas (NWMI 2015a; NRC 2015b).

## 3.2 Meteorology, Air Quality, and Noise

### 3.2.1 Meteorology and Climatology

The State of Missouri is characterized by a humid continental type climate, subject to frequent changes in temperatures, and strong seasonality (NCDC undated). The lack of topographic barriers allows dry and cool air masses from Canada to reach the region during winter, and during summer moist and warm air masses from the Gulf of Mexico reach the region. Summers are warm, humid, and rainy and winters are moderately cold and snowfalls are common. Climate characteristics vary across the State along a diagonal line trending northwest to southeast. The proposed site is located in Missouri's Northeast Prairie Climate Division 2. The nearest National Climatic Data Center (NCDC) station is the Columbia Regional Airport station. To characterize the region's climate, the NRC staff used a 30-year (1981–2010) climatological data set from the Columbia Regional Airport (NCDC 2010). The Columbia Regional Airport station is 7 mi (11 km) from the proposed Discovery Ridge site.

Figure 3–2 summarizes annual and seasonal precipitation and temperature data for the 1981-2010 record from the Columbia Regional Airport station. Annual average temperature for the 30-year record was 54.6 ºF (12.6 ºC). Average seasonal temperatures for the 30-year record ranged from 75.5 ºF (24.2 ºC) in the summer to 32.1 ºF (0.05 ºC) in the winter. Annual average precipitation was 42.62 in. (1.1 m) and seasonal precipitation ranged from 6.61 in. (16.8 cm) in the winter to 13.20 in. (33.5 cm) in the summer. Monthly average wind speeds range from 7.4 miles per hour (mph) (11.9 kilometers per hour (kph)) in August to 11.3 mph (18.2 kph) in March. Annual mean wind speed is 9.5 mph (15.3 kph). Prevailing wind direction is from the south May through November and from the northwest December through April (NCDC 2014).

**Table 3–2. Annual and Seasonal Precipitation and Temperature Data for Columbia, Missouri**

| | Annual | Winter | Spring | Summer | Fall |
|---|---|---|---|---|---|
| Average Temperature (ºF) | 54.6 | 32.1 | 54.5 | 75.5 | 56.0 |
| Average Precipitation (in.) | 42.62 | 6.61 | 12.38 | 13.20 | 10.43 |

Source: NCDC 2010

NCDC records (NCDC 2016) identify the following extreme weather events in Boone County from 1950 to 2015:

- tornadoes: 26 events,
- floods: 11 events,
- blizzard: 1 event, and
- strong winds: 2 events.

The strongest recorded tornados in the County were classified as F3,[1] which occurred in 1990 and 1998.

### 3.2.2 Air Quality

Under the Clean Air Act of 1970, as amended (CAA) (42 U.S.C. 7401 et seq.), the U.S. Environmental Protection Agency (EPA) has set primary and secondary National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50) for six common criteria pollutants considered harmful to public health and the environment. Primary standards specify maximum ambient concentration levels of the criteria pollutants aimed at providing public health protection including protecting the health of “sensitive” populations, such as asthmatics, children, and the elderly. Secondary standards specify maximum ambient concentration levels of the criteria pollutants aimed at providing public welfare protection including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. The NAAQS criteria pollutants include carbon monoxide (CO), lead (Pb), nitrogen dioxide ($NO_2$), ozone ($O_3$), sulfur dioxide ($SO_2$), and particulate matter (PM). Particulate matter is further categorized by size—particulate matter with aerodynamic diameter of 10 micrometers (μm) or less ($PM_{10}$) and particulate matter with aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$).

The CAA allows for states to adopt additional or more stringent air quality standards. Missouri has adopted the CAA NAAQS in Title 10 of Missouri’s Code of State Regulations (CSR) and has set standards for hydrogen sulfide and sulfuric acid (10 CSR 10-6.010). Table 3–3 presents the NAAQS for the six criteria pollutants and two State standards.

[1] There are five tornado classifications: F0 to F5. F0 tornadoes cause the least damage, and F5 tornadoes are the most dangerous and cause the most damage. Estimated wind speeds for an F3 tornado are 158 to 206 mph and can cause severe damage.

**Table 3–3. Ambient Air Quality Standards**

| Pollutant | Primary/Secondary Standard | Averaging Time | Level |
|---|---|---|---|
| Carbon Monoxide (CO) | Primary | 8-hr | 9 ppm |
| | | 1-hr | 35 ppm |
| Lead (Pb) | Primary and Secondary | Rolling 3-month average | 0.15 μg/m$^3$ |
| Nitrogen Dioxide ($NO_2$) | Primary | 1-hr | 100 ppb |
| | Primary and Secondary | Annual | 53 ppb |
| Ozone ($O_3$) | Primary and Secondary | 8-hr | 0.075 ppm |
| Particulate matter less than 2.5 μm ($PM_{2.5}$) | Primary | Annual | 12 μg/m$^3$ |
| | Secondary | Annual | 15 μg/m$^3$ |
| | Primary and Secondary | 24-hr | 35 μg/m$^3$ |
| Particulate matter less than 10 μm ($PM_{10}$) | Primary and Secondary | 24-hr | 150 μg/m$^3$ |
| Sulfur Dioxide ($SO_2$) | Primary | 1-hr | 75 ppb |
| | Secondary | 3-hr | 0.5 ppm |
| Hydrogen Sulfide ($H_2S$) | State Standard | ½-hr | 0.03 ppm |
| | | ½-hr | 0.05 ppm |
| Sulfuric Acid | State Standard | 1-hr | 30 μg/m$^3$ |
| | | 24-hr | 10 μg/m$^3$ |

Key: ppb = parts per billion; ppm = parts per million; μg/m$^3$ = micrograms per cubic meter.

Sources: EPA 2016f; 10 CSR 10-6.010

The EPA designates areas of “attainment” and “nonattainment” with respect to the NAAQS. Areas for which there are insufficient data to determine designation status are denoted as “unclassifiable.” Areas meeting the standard or expected to be meeting the standard despite a lack of monitoring data are designated “unclassifiable/attainment”. Areas that were once in nonattainment, but are now in attainment, are called “maintenance” areas; these areas are under a 10-year monitoring plan to maintain the attainment designation status. States have primary responsibility for ensuring attainment and maintenance of the NAAQS. Under Section 110 of the CAA (42 U.S.C. 7410) and related provisions, states are to submit, for EPA approval, State Implementation Plans (SIPs) that provide for the timely attainment and maintenance of the NAAQS. Air quality designations are generally made at the county level. For the purposes of planning and maintaining ambient air quality with respect to the NAAQS, EPA has developed Air Quality Control Regions (AQCRs). AQCRs are intrastate or interstate areas that share a common airshed (40 CFR Part 81). The proposed facility site, Discovery Ridge, is located in Boone County which is part of the Northern Missouri Intrastate Air Quality Control Region (40 CFR 81.116). With regard to the NAAQS criteria pollutants, Boone County is designated as an unclassifiable/attainment area for all criteria pollutants (40 CFR 81.326). The nearest designated nonattainment areas to the proposed site are the following:

(1) Franklin County, Missouri: approximately 50 mi (80 km) from the proposed site. Franklin County is part of the Metropolitan St. Louis Interstate AQCR (40 CFR 81.18) and nonattainment for the 8-hr ozone (2008) NAAQS and $PM_{2.5}$ (1997) NAAQS, and

(2) St. Charles County, Missouri: approximately 70 mi (113 km) from the proposed site. St. Charles County is part of the Metropolitan St. Louis Interstate AQCR (40 CFR 81.18) and nonattainment for $PM_{2.5}$.

The EPA promulgated the Regional Haze Rule (RHR) to improve and protect visibility in national parks and wilderness areas from haze, which is caused by numerous, diverse sources located across a broad region (40 CFR 51.308-309). Specifically, 40 CFR Part 81 Subpart D lists mandatory Class I Federal Areas where visibility is an important value. The RHR requires states to develop SIPs to reduce visibility impairment at Class I Federal Areas. The nearest Class I Federal Area to the proposed site is the Hercules-Glades Wilderness Area, approximately 138 mi (222 km) away.

Table 3–4 provides annual emissions of criteria pollutants and carbon dioxide for Boone County. These emissions include both stationary and mobile sources.

**Table 3–4. Boone County Air Emissions Inventory, Tons/Year**

| CO | $NO_x$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
|---|---|---|---|---|---|
| 26,638 | 7,702 | 7,024 | 12,699 | 2,260 | 1,128,841 |

Key: CO = carbon monoxide; NOx = nitrous oxide; $SO_2$ = sulfur dioxide; PM10 = particulate matter of 10 μm or less; PM2.5 = particulate matter 2.5 μm or less; $CO_2$ = carbon dioxide.

Note: to convert tons/year to metric tons/year, multiply by 0.90718

Source: EPA 2011

The General Conformity Rule, established under Section 176(c)(4) of the CAA, ensures that Federal actions conform to SIPs. The Federal agency must conduct a conformity analysis if the proposed action is in a designated nonattainment or maintenance area with respect to NAAQS and would result in the generation of air emissions that would exceed conformity threshold levels of pollutants (de minimis thresholds). Because the proposed NWMI facility would be located in a designated unclassifiable/attainment area, a conformity analysis is not required.

*Regulations*

New facilities that emit air pollutants could be subject to Federal requirements, depending on the location and the type and amount of emitted air pollution. The following discussions summarize these requirements. The MDNR is authorized by the EPA to administer air pollutant emission permits. NWMI may be required to obtain construction and operation permits in accordance with in Title 10 of Missouri's CSR.

New Source Review Program

Construction of a new air pollution source is subject to the New Source Review program. Sources classified as major sources (as defined in 40 CFR 51.165, 40 CFR 51.166, and 40 CFR 52.21) and located in attainment areas are required to obtain a prevention of significant deterioration (PSD) permit. The purpose of the program is to prevent degradation of air quality in areas where air quality is good. New sources of criteria pollutants that are located in an attainment area that exceed 250 tons/year (TPY) emission rate of any criteria pollutant are subject to the permit program and are considered a major source. Further, emissions that exceed de minimis levels are considered significant (40 CFR 51.166) and for the purposes of the NRC staff's air quality analysis, these thresholds will be considered in determining the significance of air quality impacts for construction. The de minimis rates are as follows:

100 TPY of carbon monoxide, 40 TPY of nitrogen oxides, 40 TPY of sulfur dioxide, 40 TPY of volatile organic compounds (ozone precursor), 15 TPY of particulate matter less than 10 microns, and 10 TPY of particulate matter less than 2.5 microns (40 CFR 51.166; 10 CSR 10-6.020). New Source Review requirements are implemented in Title 10 of Missouri's CSR (10 CSR 10-6.060).

Title V of the Clean Air Act

Title V of the CAA (42 U.S.C. 7661–7661f) requires a Federally enforceable operating permit program that applies to large, new, and existing sources of air pollution. Any facility with the potential to emit 100 TPY or more of any criteria pollutant, 10 TPY of any hazardous air pollutant (HAP), or 25 TPY of all HAPs combined is required to obtain a valid Title V permit and is considered a major air source (40 CFR Part 70). For purposes of the NRC staff's air quality analysis, the 100 TPY of any criteria pollutant threshold for a Title V operation permit will be considered in determining the significance of air quality impacts for operation. Title V requirements are implemented in Title 10 of Missouri's CSR (10 CSR 10-6.065).

Greenhouse Gas Tailoring Rule

Gaseous chemicals that trap heat in the atmosphere are known as greenhouse gases (GHGs). The most common GHGs are carbon dioxide, methane, and nitrous oxide. These pollutants are emitted from natural processes and human activities.

On September 22, 2009, the EPA issued a final rule for mandatory GHG reporting from large GHG emission sources in the United States (74 FR 56260). The purpose of the GHG Tailoring Rule is to collect and use comprehensive and accurate data on carbon dioxide and other GHG emissions to inform future policy decisions. In general, the threshold for reporting is 25,000 metric tons carbon dioxide equivalent ($CO_2$eq) emissions per year, excluding mobile-source emissions. GHGs are grouped into a single, representative "pollutant" called $CO_2$eq. $CO_2$eq is a metric used to compare the emissions of GHG based on their global warming potential (GWP). GWP is a measure used to compare how much heat a GHG traps in the atmosphere. GWP is the total energy that a gas absorbs over a period of time compared to carbon dioxide. $CO_2$eq is obtained by multiplying the amount of the GHG by the associated GWP. For example, the GWP of methane is estimated to be 21; therefore, 1 ton of methane emission is equivalent to 21 tons of carbon dioxide emissions.

On May 13, 2010, the EPA issued the GHG Tailoring Rule. This rule set the thresholds for a phase-in approach to regulating GHG emissions under the PSD and Title V permitting programs (75 FR 31514). Beginning on January 2, 2011,[2] operating permits issued to major sources of GHG under the PSD or Title V Federal permit programs must contain provisions requiring the use of best available control technology to limit the emissions of GHGs, if those sources would be subject to PSD or Title V permitting requirements because of their non-GHG pollutant emission potentials and if their estimated GHG emissions are at least 75,000 TPY of $CO_2$eq.

[2] On June 23, 2014, the U.S. Supreme Court issued a decision that EPA may not treat GHGs as an air pollutant for determining whether a source is a major source required to obtain a PSD or Title V permit but could continue to require PSD and Title V permits, which are otherwise required based on emissions of conventional pollutants. In July 2014, the EPA issued a memorandum in response to the Supreme Court's decision and acknowledged that, although the decision is pending judicial action, the EPA will no longer require PSD or Title V permits for GHG-emitting sources that are not sources subject to PSD or Title V permits based on emissions of conventional pollutants (e.g., nitrogen oxides and, carbon monoxide) (EPA 2014a).

### 3.2.3 Noise

Noise is often defined as unwanted sound and can be generated by many sources. Sound intensity is measured in logarithmic units called decibels (dB). A dB is the ratio of the measured sound pressure level to a reference level equal to a normal person's threshold of hearing. Another characteristic of sound is frequency or pitch. Noise may be composed of many frequencies, but the human ear does not hear very low or very high frequencies. To represent noise as closely as possible to the noise levels people experience, sounds are measured using a frequency-weighting scheme known as the A-scale. Sound levels measured on this A-scale are given in units of A-weighted decibels (dBA).

Table 3–5 presents common noise sources and their respective noise levels. A whisper is normally 30 dBA and is considered very quiet. Noise levels can become annoying at 80 dBA and very annoying at 90 dBA. Noise levels attenuate rapidly with distance. When distance is doubled from a point source, noise levels decrease by 6 dBA (FHWA 2011). Generally, a 3-dBA change over existing noise levels is considered to be a "just noticeable" difference, a 5-dBA increase is readily perceptible, and a 10-dBA increase is subjectively perceived as a doubling in loudness (FHWA 2011).

**Table 3–5. Common Noise Sources and Noise Levels**

| Noise Source | Noise Level (dBA) |
|---|---|
| Human hearing threshold | 0 |
| Soft whisper | 30 |
| Quiet residential area | 40 |
| Dishwasher | 55–70 |
| Lawn mower | 65–95 |
| Blender | 80–90 |
| Ambulance siren, jet plane | 120 |

Source: CHC undated

Several different terms are commonly used to describe sounds that vary in intensity over time. The equivalent sound intensity level ($L_{eq}$) represents the average sound intensity level over a specified interval, often 1 hr. The day-night sound intensity level ($L_{DN}$) is a single value calculated from hourly $L_{eq}$ over a 24-hr period, with the addition of 10 dBA to sound levels from 10 p.m. to 7 a.m. This addition accounts for the greater sensitivity of most people to nighttime noise. Statistical sound level ($L_n$) is the sound level that is exceeded "n" percent of the time during a given period. For example, $L_{90}$, is the sound level exceeded 90 percent of time and is considered the background level.

Noise Regulations

There are no Federal regulations[3] for public exposures to noise (EPA 2016e). The EPA recommends an average $L_{DN}$ of 55 dBA as guidelines or goals for outdoors in residential areas (EPA 1974). However, these are not standards. The Federal Housing Administration has

[3] In 1972 Congress passed the Noise Control Act of 1972 establishing a national policy to promote an environment free of noise that impacts the health and welfare of the public. However, in 1982 there was a shift in Federal noise control policy to transfer the responsibility of regulation noise to state and local governments. The Noise Control Act of 1972 was never rescinded by Congress but remains unfunded (EPA 2016e).

established noise assessment guidelines for housing projects and finds that an average $L_{DN}$ of 65 dBA or less is acceptable (HUD 2014). Under the Noise Control Act of 1972 (42 U.S.C. 4901 et seq.), the Occupational Safety and Health Administration established workplace standards for noise. The minimum requirement states that constant noise exposure must not exceed 90 dBA over an 8-hr period. The highest allowable sound level to which workers can be exposed is 115 dBA. Exposure to this level must not exceed 15 min within an 8-hr period. If noise levels exceed these standards, employers are required to provide hearing protection equipment that reduces sound levels to acceptable limits (29 CFR 1910.95).

The City of Columbia has a noise ordinance that prohibits loud and unnecessary noise. The noise ordinance does not establish acceptable noise levels, but it does establish acceptable time frames for when activities can be conducted. For instance, site preparation activities associated with construction shall be conducted during the hours of 7:00 a.m. and 7:00 p.m. (City of Columbia 2016b). Furthermore, the Discovery Ridge Master Plan prohibits “excessive” noise in the Discovery Ridge Research Park (MU 2009) but does not define excessive noise or establish acceptable noise levels.

Existing Noise Levels

Existing noise sources near the proposed site include vehicular traffic along U.S. Highway 63, agricultural equipment, and HVAC systems associated with the nearby buildings (NWMI 2015a). Noise-sensitive receptors within 1 mi (1.6 km) of the proposed site include:

- a residence, approximately 0.27 mi (0.43 km) south of the proposed site;
- New Haven Elementary School, approximately 1 mi (1.6 km) north of the proposed site;
- Analytical Bio-Chemistry (ABC) Laboratories, approximately 0.3 mi (0.48 km) west of the proposed site; and
- IDEXX BioResearch facility (formerly known as Research Animal Diagnostic and Investigative Laboratory – RADIL), approximately 0.1 mi (0.16 km) northwest of the proposed site.

The NRC staff did not identify the existence of any ambient noise surveys for the Discovery Ridge Research Park. Surrounding land uses include agricultural activities. Typical noise levels from agricultural equipment at a 50 ft (15 m) distance are estimated to be 84 dBA (FHWA 2006). However, these noise levels are intermittent, when the equipment is in use. NWMI conducted a noise modeling study using the Federal Highway Administrations Traffic Noise Model 2.5 (NWMI 2016a, 2016d). Based on this model study, during peak traffic periods along U.S. Highway 63, noise levels at the nearest residence to the proposed Discovery Ridge site can reach 69 dBA. As discussed in Section 3.1.1.1, the Discovery Ridge Research Park is designated as an industrial certified site and it has commercial community features (City of Columbia 2016a). During non-peak traffic periods and when equipment noise is not in use, the NRC anticipates that Discovery Ridge Research Park ambient background levels are similar to that of commercial areas. Commercial area noise levels can range from 60 to 70 dBA (Miller 2002). Given that the Discovery Ridge Research Park is an emerging research park that currently has two research and laboratory and office facilities in operation, the NRC staff anticipates that current ambient background noise levels are 60 to 65 dBA.

## 3.3 Geologic Environment

The geologic environment of a location encompasses the physiographic or physical setting and the associated structural features of the Earth’s crust, geologic strata, and soils that comprise the site. Geologic hazards are a condition of the geologic environment and include large-scale hazards such as geologic faulting and earthquakes that comprise a site's seismologic setting as well as local hazards associated with the site-specific attributes of the soil and bedrock at a site.

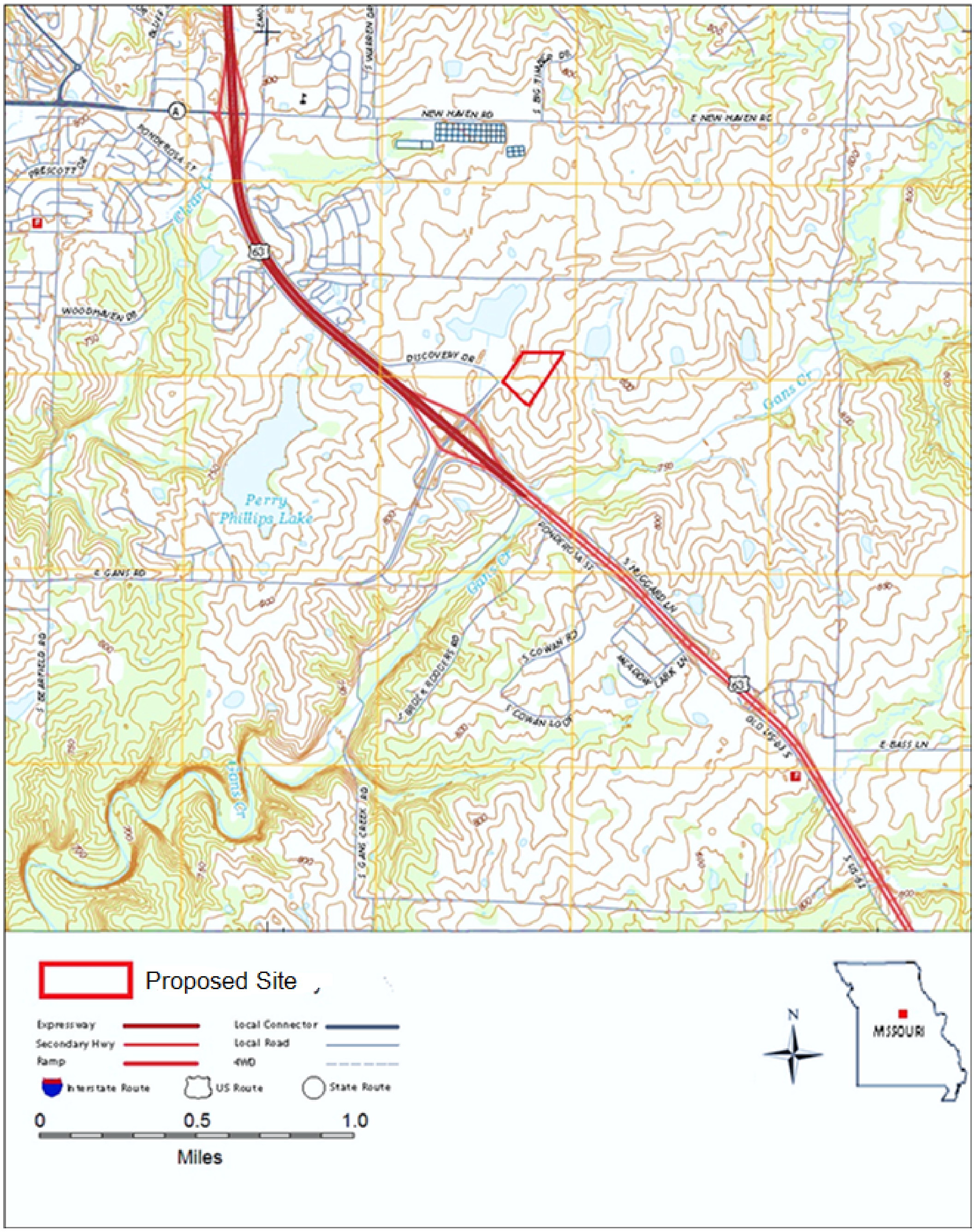
### 3.3.1 Site Geology

The proposed NWMI facility site within the Discovery Ridge Research Park (Discovery Ridge site) is located at the southern edge of the Central Lowland physiographic province and just north of its boundary with the adjacent Ozark Plateaus province (NWMI 2015a; NPS 2015; Miller and Appel 1997; MDNR 2002a). The Missouri River in central Missouri marks the approximate boundary between the two provinces. The Central Lowland province is part of the greater Interior Plains physiographic division whereas the Interior Highlands physiographic division encompasses the Ozark Plateaus province. Physiographic or geomorphic provinces are regions with similar landforms and underlying geology. Provinces are further divided into physiographic sections.

More precisely, the Discovery Ridge site lies within the Dissected Till Plains section of the Central Lowland province (MDNR 2002a; USGS 2014a). Landforms within this section and of the Central Lowland province as a whole are generally flat to gently rolling (NPS 2015). Such low-relief landforms relate partly to the presence of mainly flat-lying rocks deposited primarily in marine and fluvial environments beginning in the Paleozoic Era, some 500 million years ago (Ma). These strata were then eroded during the Mesozoic, which ended about 66 Ma, down to the current bedrock surface consisting of Pennsylvanian-age strata (Miller and Appel 1997). The land surface was then subjected to glaciation during the early to mid-Pleistocene Epoch (i.e., Pre-Illinoian, prior to about 310,000 years before present). Unlike regions to the north and east, later glacial advances did not affect the Missouri region (Sharp 1984; Miller and Appel 1997). Modern drainage development including stream incision, alluvial deposition, and associated erosional processes further shaped the land surface, with these processes continuing into the present day.

As a result, the current land surface across undeveloped portions of the Dissected Till Plains of south-central Boone County exists as a moderately dissected, flat to rolling glacial plain that slopes toward the Missouri River valley (NWMI 2015a). Topography at the Discovery Ridge site mirrors this landform, where the site is generally flat to slightly rolling, with a slope generally to the south and southwest (Terracon 2011a). This observation was confirmed during the NRC staff's environmental site audit in September 2015 (NRC 2015b), when the site predominantly existed as an open grassland. Elevations across the site range from approximately 820 ft (250 m) mean sea level (MSL) in the northwestern corner to about 800 ft (244 m) in the southern corner (Figure 3–11).

**Figure 3–11. Topographic Map of the Discovery Ridge Site and Vicinity**




Source: Modified from USGS 2015a

As indicated above, the surficial geology of Boone County is the product of glacial action and subsequent weathering and erosion. A mantle of glacial drift covers much of the County. Glacial drift consists of undifferentiated sediments deposited either directly by a glacier (i.e., glacial till) or by related glaciofluvial processes (e.g., meltwater stream outwash). These glacial deposits generally range in thickness from a few inches to more than 100 ft (30 m), particularly in areas of the County immediately north and east of the Missouri River. These materials generally consist of a yellowish clay till mixed with sand and pebbles. Deposits of loess (windblown glacial sediment) are also widespread throughout the County, but the deposits are thickest along the bluffs of the Missouri River to the south of the site (BCC 1996).

Glacial drift generally covers the eastern half of Boone County whereas residuum (weathered bedrock material) is the predominant bedrock cover over the western half of the County. This generally supports the overburden mapping information provided in the NWMI ER (NWMI 2015a). Specifically, the surficial geologic unit at the Discovery Ridge site is mapped as glacial drift (unit F). This unit is characterized as light tan to dark gray silty clay and clay till. The clay is mixed with pebbles of limestone, chert, and quartzite. Sands, cobbles, and boulders may occur in pockets, lenses, or as channel deposits. A layer of loess ranging from 1 to 5 ft (0.3 to 1.5 m) thick typically covers the drift. A clay-rich paleosol (i.e., a buried soil horizon) often occurs at depths ranging from 6 to 8 ft (1.8 to 2.4 m). In total, this unit ranges from 10 to 300 ft (3-91 m) thick. However, based on bedrock contour mapping data derived from well logs, the total thickness of the drift and other overburden material in the vicinity of the Discovery Ridge site is approximately 25 ft (7.6 m) (MGS 2016).

Terracon, a consulting engineering firm, performed a preliminary geotechnical investigation of the Discovery Ridge Research Park in 2011, which encompassed the proposed site (i.e., Lot 15 of the research park) (Terracon 2011a). The purpose of the investigation was to provide preliminary geotechnical recommendations concerning earthwork and the design and construction of foundations, floor slabs, and pavements for Discovery Ridge properties (NWMI 2015a).

Terracon drilled nine boreholes (designated B-1 through B-9) across the research park as part of the 2011 study. The borings were advanced to depths ranging from 13 to 20 ft (3.9 to 6.1 m) below ground surface (bgs). Laboratory tests were also conducted on select samples, including soil density, compaction, plasticity and liquid limit tests (NWMI 2015a; Terracon 2011a). All boring samples measured were found to have a relatively high water content, generally in the range of 18 up to 35 percent (Terracon 2011a). For the surveyed areas as a whole, the boring logs indicate the presence of lean to fat clay and fat clay in the upper part and underlain by clay, trace sand, gravels, and cobbles representing glacial drift. Clay fill was encountered in the upper part of two borings completed at locations to the west of the Discovery Ridge site (i.e., borings B-3 and B-4 located west of Discovery Ridge Parkway). A single boring (designated B-5 in Terracon 2011a) drilled on the eastern boundary of Lot 15 is most representative of the proposed site. Table 3–6 summarizes information on the nature of the surficial materials obtained from this boring.

**Table 3–6. Summary of Boring Log B-5 Completed in the Vicinity of the Proposed NWMI Facility Site, Discovery Ridge Research Park**

| Interval Depth, ft. (bgs) | USCS Class Symbol and Name | Interval Description/Interpretation of Surficial Materials |
|---|---|---|
| 0.3 | – | Topsoil |
| 0.3 to 3 | CL–Lean Clay | Lean Clay: brown, trace gray, stiff |
| 3 to 8 | CH-Fat Clay | Fat Clay: gray with red, stiff |
| 8 to 12 | CH–Fat Clay | Fat Clay: reddish brown and light gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift)<br>Water level at 12 ft. bgs after boring completion |
| 12 to 17 | CL–Lean Clay, CH–Fat Clay | Sandy Lean to Fat Clay: reddish brown and light gray, trace gravel, possible cobbles, stiff (Glacial drift);<br>Water level at 16.5 ft. bgs while sampling |

| Interval Depth, ft. (bgs) | USCS Class Symbol and Name | Interval Description/Interpretation of Surficial Materials |
|---|---|---|
| 17 to 20 (bottom of boring) | CH–Fat Clay | Fat Clay; reddish brown and light gray, trace sand and gravel, possible cobbles, very stiff (Glacial Drift) |

Key: bgs = below ground surface; USCS = Unified Soil Classification System.

Source: NRC staff interpretation of information in Terracon 2011a

As shown in Table 3–6, fat clays appear to comprise much of the surficial strata at the Discovery Ridge site. Fat clays include inorganic clay minerals of high plasticity. These materials characteristically have high compressibility, poor shear strength when wetted, and have generally poor workability as a construction material, including for use as structural (engineered) backfill (SCS 1990). Moreover, as indicated by Terracon and as referenced by NWMI in its ER, fat clays are termed expansive or swelling soils because they expand or swell with changes in moisture content (NWMI 2015a; Terracon 2011a). Such soils with a high shrink/swell potential can damage concrete and other structures with changes in moisture content and soil volume. Terracon determined that some of the soils encountered during drilling had moisture levels above their measured plastic limit. Such soils may be prone to rutting and pumping (rebound) when a load is applied, which results in unstable subgrade conditions during construction (Terracon 2011a). Nevertheless, Terracon made no determination about the liquefaction potential of these soil materials (NWMI 2015h).

Weathered bedrock (identified as limestone) was encountered in only two borings (B-6 and B-7) at depths of approximately 17 and 13 ft bgs (5.1 and 4.0 m) bgs, respectively. These boring sites are located approximately 1,000 ft (300 m) south of the proposed NWMI facility site (Lot 15, Discovery Ridge site) and toward the shallow valley traversed by Gans Creek.

While geotechnical investigations conducted to date have not determined the precise depth to or nature of bedrock beneath the proposed site, available mapping data indicate that the depth to bedrock is approximately 25 ft (7.6 m) (MGS 2016). Geologic mapping (Stoeser et al. 2007) reveals that rocks of the Cherokee Group of Pennsylvanian age (i.e., 299 to 318 Ma) immediately underlie the site. This is consistent with the geologic mapping provided in the NWMI ER (NWMI 2015a) and adapted as Figure 3–12.

Sediments comprising the Cherokee Group were mainly deposited in low-relief continental (terrestrial) to tidal environments that included river deltas, coastal plains, and swamps. Across central and eastern Missouri, deposition occurred on an eroded karst surface (i.e., atop carbonate bedrock subject to dissolution) (Thompson 1979). The geologic units comprising the recognized Cherokee Group are further divided into two subgroups, the Cabaniss and Krebs Subgroups. The Cabaniss Subgroup includes cyclically-deposited shale, sandstone, siltstone, clay, and limestone with seven coal beds. Cyclically-deposited rocks derive from sediments deposited in an often-repetitive pattern reflective of changes in the depositional environment from marine to continental and then back again. Rocks of the Cabaniss Subgroup attain a maximum thickness of 200 ft (60 m). Rocks of the lower Krebs Subgroup also include cyclic deposits that predominantly consist of shale and sandstone with limestone, as well as siltstone and two coal beds. The Krebs Subgroup attains a maximum thickness of 110 ft (34 m) (Stoeser et al. 2007). The bedrock immediately to the south along the Gans Creek valley and to the west of the site consists of Osagean Series rocks of Early Mississippian age (345 to 359 Ma). Rock types are predominantly marine limestone with chert and minor dolostone and shale. Recognized geologic units include the Keokuk and Burlington limestones, Elsey (Grand Falls) Formation, Reeds Spring Formation, and Fern Glen Formation (Stoeser et al. 2007; Miller and Appel 1997). The total thickness of the series is as much as 600 ft (180 m) (Stoeser et al. 2007). More recent (2014) geologic mapping completed by the Missouri Geological Survey (MGS) at 1:24000 scale shows that rocks immediately underlying the Discovery Ridge site are comprised of the Krebs Subgroup, described above, while bedrock immediately bordering and encroaching into the site from the south and farther to the west consists of Burlington-Keokuk limestone of Mississippian age (MGS 2016). The former observation is consistent with findings from geotechnical borings B-6 and B-7.

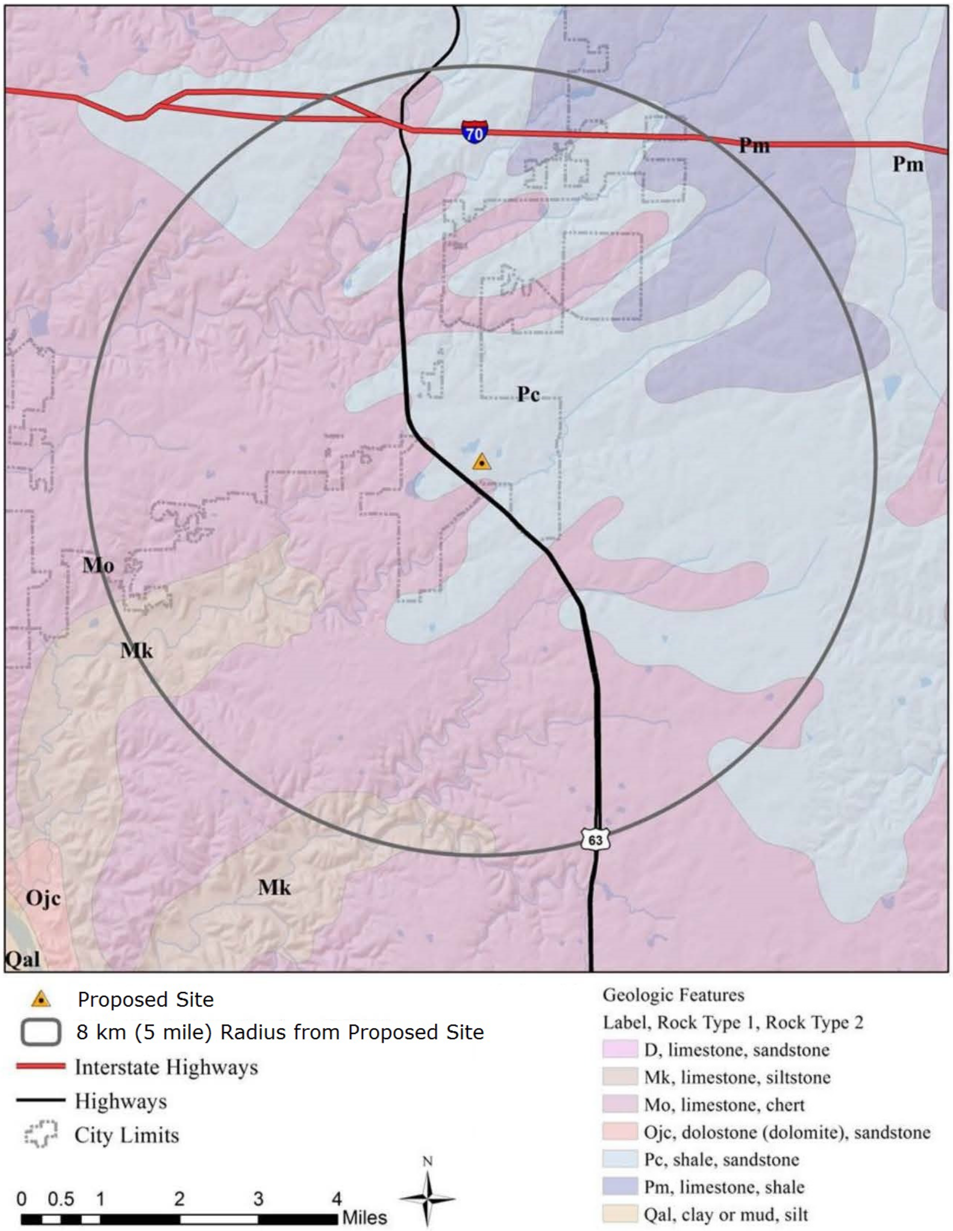
Burlington limestone is the principal limestone exposed in quarries, creek banks, and road cuts near and around Columbia. As referenced by NWMI (2015a), this limestone unit is relatively soluble and contains many caverns and passages indicative of karst terrane. Karst terrane is a landform underlain by soluble carbonate bedrock and characterized by the presence of springs, caves, and sinkholes.

Based on the results of its preliminary geotechnical report and available geological mapping of the area, Terracon concluded that there are no known caves or sinkholes within approximately 1 mi (1.6 km) of the Discovery Ridge Research Park. Karst features are present to the west and southwest of the Discovery Ridge site, with the nearest sinkhole features lying approximately 1.3 mi (2.1 km) southwest (MGS 2016). However, changes in site conditions, such as grading and drainage alteration, can result in sinkholes even in areas with no history of sinkhole development (Terracon 2011a).

Predominantly northwest-trending faulting and folding (e.g., anticlines, synclines and similar features) across the central and northeast Missouri region are mainly attributable to compressional tectonic stress associated with Ouachita belt mountain building and uplift during the Mississippian and Pennsylvanian Periods (Clendenin et al. 1989).

In the ER, NWMI identified the presence of one geologic fault structure within a 5-mi (8-km) radius of the Discovery Ridge site (NWMI 2015a). The Fox Hollow fault is a normal fault that fades into a monoclinal fold at its two ends. The northeast-striking fault terminates approximately 3 mi (4.8 km) south of the site. This fault reportedly exhibits a throw (vertical displacement) of approximately 120 ft (37 m) to the southwest with Mississippian-aged Chouteau Limestone beds faulted against Ordovician-aged Jefferson City Dolomite. No surface expression of this fault was noted during field surveys, and there is no evidence of recent activity or displacement of overlying strata.

**Figure 3–12. Bedrock Geology of the Discovery Ridge Site and Vicinity**




Source: Modified from NWMI 2015a, 2015h

MGS-maintained mapping data for known structural features identify a set of several features as comprising the trace of the Fox Hollow fault and monocline. Traces of this feature run in a southerly direction for a total of 8.5 mi (13.6 km) before intersecting with and crossing a northwest-striking feature (Sapp monocline) at a point located about 10 mi (16 km) south-southwest of the site (MGS 2016).

Available information indicates that there has been no movement on this fault during the Holocene (i.e., during the last 11,700 years). Further, the structure is considered to be early Paleozoic in age and does not constitute an earthquake hazard (MU 2006). The NRC staff's review of the USGS's latest release of the Quaternary Fault and Fold Database found no record of Quaternary faults or folds within a 50-mi (80-km) radius of the proposed site (USGS 2015b). Based on available information, the NRC staff does not consider the fault to be active at present or represent a “capable fault” as defined in Appendix A to 10 CFR Part 100, “Seismic and Geologic Siting Criteria for Nuclear Power Plants”.

Nevertheless, liquefaction features in the St. Louis area (St. Louis–Cape Girardeau features), located about 100 mi (160-km) east of the site, as well as the Wabash Valley liquefaction features further to the east in southern Illinois, indicate the presence of active and recurrent faulting and associated earthquake activity in the Holocene. Thus, these features indicate the likely presence of capable faults in the St. Louis–Cape Girardeau and Wabash Valley regions. More significantly, situated approximately 200 mi (320 km) southeast of the site at its closest point is the seismically active region associated with the Reelfoot scarp and New Madrid Seismic Zone (USGS 2015b; Crone and Wheeler 2000). Section 3.3.3 further describes the seismic setting, including earthquake risk, at the Discovery Ridge site.

Geologic resources, encompassing rock and mineral (fuel and nonfuel) resources, in the vicinity of the site have historically included limestone and refractory clay, as well as lead, zinc, and coal (Thompson 1979). Exposures of Burlington Limestone have been an important resource and serve as the host rock for lead and zinc deposits in the Tri-State mining district of Missouri, Kansas, and Oklahoma (NWMI 2015a). Northern Boone County encompasses major coal producing strata and southern Boone County has high-calcium limestone resources, as noted above. Sand and gravel deposits are also available throughout Boone County and surrounding counties in central Missouri from glacial and floodplain materials (MDNR 2001; USGS 2015c).

### 3.3.2 Soils

A preliminary geotechnical investigation of the Discovery Ridge Research Park found that site soils predominantly consist of lean to fat clay and fat clay, as further described in Section 3.3.1. Soil unit mapping by the NRCS identifies the majority of the Discovery Ridge site (75 percent) as Mexico silt loam, 1 to 4 percent slopes, eroded. This mapping unit generally comprises the middle interior of the site while the remaining four corner areas of the site are comprised of Armstrong loam, 5 to 9 percent slopes, eroded (NRCS 2016a).

The predominant Mexico soils are silty clay loams and silty clay whereas the Armstrong soils are clay loams and clays, with both typically found on hill slopes. Mexico soils are poorly drained soils that developed from loess (wind-deposited sediment) overlying pedisediment. Pedisediments are alluvial materials transported from upslope areas onto an eroded soil surface. Armstrong soils are somewhat poorly drained materials that derive from loess deposits atop glacial till. Both soils have a low infiltration rate (due to clay) and a very high runoff rate as a result. The depth to the water table in these soils generally ranges from 6 to 36 in. (15 to 91 cm) (NRCS 2016a).

As reflected in the preliminary geotechnical investigation conducted by Terracon (2011a) and as indicated in the NRCS characterizations presented above, soil conditions present a number of site development challenges. As a building site, the soils are rated as poorly suited for excavation work because of the depth to the saturated zone, high clay content, and instability of excavation walls. In addition, due to the presence of clays with a high/shrink swell potential, as previously discussed in Section 3.3.1, the soils are rated as very limited for constructing commercial buildings. Shrink/well potential and the relatively shallow depth to the zone of saturation adversely affect the ability of soils to support structural loads (e.g., building slabs, foundations, and pavement structures) without movement and also affect the workability of site soils during construction (NRCS 2016a). NWMI will conduct site-specific geotechnical and hydrologic studies of the Discovery Ridge site (NWMI 2015c). These studies would help to support final facility design and construction planning.

Neither of the onsite soil mapping units are prime farmland or other important farmland soils as defined in the Farmland Protection Policy Act of 1981 and implementing regulations (7 CFR Parts 657, 658; NWMI 2015a).

### 3.3.3 Seismic Setting

As noted in Section 3.3.1, Northeast Missouri is located within the central stable region of the North American craton. The region has had a relatively gentle tectonic history since the beginning of the Paleozoic Era in contrast to adjoining regions (NRC 2014; Reed and Bush 2007; NWMI 2015h). More tectonically active areas that border northeast Missouri to the east and south include the Ozark Uplift, Mississippi Embayment, and the Ouachita Mountain System (Reed and Bush 2007). Across the stable continental region of the United States, most locations can go years without an earthquake strong enough for people to feel. In the central and eastern United States, people can feel earthquakes over a very wide area. For example, people can feel a magnitude 4.0 earthquake at locations as far as 60 mi (100 km) from its source (epicenter) and it may cause damage near its source. An earthquake with a magnitude of 5.5 can be felt as far away as 300 mi (500 km) from its source and can cause damage as far as 25 mi (40 km) away. Usually, the earthquakes that do occur in the eastern and central United States are not traceable to a mapped geologic fault.

Typical of the central United States, the Discovery Ridge site is located within one of the lower earthquake hazard areas in the conterminous United States (NWMI 2015a, 2015h). National seismic hazard data and mapping products maintained by the U.S. Geological Survey (USGS) indicate that earthquake sources in southeast Missouri, associated with the New Madrid Seismic Zone, are the primary driver of earthquake hazard in northeast Missouri (Petersen et al. 2015).

The New Madrid Seismic Zone is associated with reactivated faults that originally formed when North America began to split or rift apart in Cambrian or late pre-Cambrian time (approximately 500 Ma). While rifting ceased, a zone of structural weakness was created, known as the Reelfoot rift (NWMI 2015a, 2015h). The mapped extent of this zone runs for approximately 150 mi (240 km) southward from near Cairo, Illinois, through New Madrid and Caruthersville, Missouri, down through Blytheville, Arkansas, to Marked Tree, Arkansas (NWMI 2015a, 2015h; USGS 2014b). New Madrid was the center of the largest earthquakes ever recorded in the central and eastern United States. A series of earthquakes occurred around New Madrid, Missouri, in 1811–1812 and ranged in magnitude from about 7.0 to 7.5 (USGS 2014b, 2015d). On the Modified Mercalli Intensity (MMI) scale (USGS 2014c), the intensity of these earthquakes ranged from MMI XI to XII (very disastrous to catastrophic shaking) at the epicenter and were estimated to have produced shaking of up to MMI VII (capable of causing slight to moderate damage to structures) in central Missouri (USGS 2014b).

Consistent with the above characterization, and as delineated in Boone County's Hazard Mitigation plan based on Missouri State Emergency Management Agency projections, Boone County lies within the MMI VII shaking intensity zone ("very strong" zone) from postulated earthquakes occurring in the New Madrid Seismic Zone. Additionally, projections made by the State Emergency Management Agency indicate that for the period 2002 to 2052, there is a 25 to 40 percent probability of a magnitude 6.7 earthquake and a 7 to 10 percent probability of a magnitude 7.6 earthquake within the New Madrid Seismic Zone. These events could be expected to result in MMI VI (slight damage) to MMI VII (significant damage to poorly built structures) shaking intensities, respectively, across Boone County (NWMI 2015h; MMRPC 2015).

No earthquakes are known to have had epicenters within Boone County (MU 2006). Since 1976, a total of 104 earthquakes with a magnitude equal to or greater than 2.5 have occurred within a radius of 200 mi (322 km) of the Discovery Ridge site. The vast majority of these earthquakes had epicenters more than 90 mi (140 km) to the east and south in association with the Wabash Valley and New Madrid seismic zones, respectively. The closest of these events occurred on July 31, 2005, near Tipton, Missouri, approximately 27 mi (43 km) southwest of the Discovery Ridge site. The earthquake had a magnitude of 3.3 and produced MMI III to IV (weak to light) shaking near the epicenter, but it was not generally felt north of the Missouri River into Boone County. Over the last 40 years, the largest earthquake in the region was a magnitude 4.7 earthquake on September 26, 1990. This earthquake was centered south of Cape Girardeau near Kelso, Missouri, about 165 mi (265 km) southeast of the Discovery Ridge site. It produced MMI VI (strong) shaking near the epicenter and caused slight damage in Kelso, Chaffee and other nearby communities. This earthquake was widely felt in southeast Missouri as well as in parts of Arkansas, southern Indiana, western Kentucky, and into parts of Tennessee and Ohio, according to reports to the USGS (USGS 2016a).

USGS national seismic hazard data and mapping products specifically provide risk-informed information on probabilistic earthquake ground motions for various return periods. As noted by NWMI (NWMI 2015h), the probabilistic ground motion estimates and current state of geophysical knowledge used in seismic hazard mapping are applied to the seismic design provisions of governing building codes across the Nation, although the ground motions used for building design are not identical to those from the USGS seismic hazard maps. Nevertheless, the USGS probabilistic seismic hazard maps provide a quantitative assessment of relative seismic risk. USGS published its latest seismic hazard data and map updates in 2015 (Petersen et al. 2015).

Based on the USGS's latest seismic hazard mapping data (Petersen et al. 2015), the Discovery Ridge site lies within the fourth lowest hazard area with predicted peak ground accelerations of 0.06 to 0.08 g (i.e., the force of acceleration relative to that of Earth's gravity, g). For the corresponding response spectral accelerations (SA), the site falls within the 0.16 to 0.20 g contours for the 0.2-second SA and the 0.08 to 0.10 g contours for the 1.0-second SA. SA values reflect the response of structures to vibratory ground motion. These values all represent shaking from an earthquake with a 2-percent probability of exceedance (PE) in the next 50 years (i.e., an earthquake with a 2,475-year return period). These values are based on a standard reference condition (firm rock), and ground motions on less competent rock or soil would differ.

As documented in the preliminary safety analysis report, NWMI performed a preliminary seismic design analysis to assess the potential maximum earthquake ground motions for the Discovery Ridge site. Derived ground motion SAs were calculated for site-specific conditions (i.e., for a stiff soil profile (Site Class D)). For a 2-percent PE in 50 years, the analysis yielded maximum earthquake accelerations ranging from 0.341 g (0.2-second period SA) to 0.223 g (1.0-second period SA). The NRC staff will further evaluate the potential maximum earthquake and other seismic design considerations in the Safety Evaluation Report related to the NWMI construction permit application.

## 3.4 Water Resources

Water resources comprise all forms of surface water and groundwater occurring near a site. Surface water encompasses all water bodies that occur above the ground surface, including rivers, streams, lakes, ponds, and other features, such as human-made reservoirs or other impoundments. Groundwater is water that is below the ground surface within a zone of saturation, with the uppermost groundwater surface comprising the water table. Aquifers are subsurface geologic formations capable of yielding a significant amount of groundwater to wells or springs. Lesser amounts of groundwater may also occur in areas above the saturated zone in the form of relatively small and isolated lenses or pockets of groundwater known as “perched” groundwater.

### 3.4.1 Surface Water

#### *3.4.1.1 Surface Water Hydrology*

The Missouri River is the dominant surface water body in Boone County. The Discovery Ridge site is located about 8 mi (13 km) northeast of the river at its closest point. A well-developed dendritic drainage pattern exists across much of Boone County. Surface waters in central and southern Boone County drain into the Missouri River through a number of tributaries, including Bonne Femme, Cedar, Little Cedar, Hinkson, Jemerson, and Perche Creeks. Figure 3–13 shows the named tributaries within a 5-mi (8-km) radius of the Discovery Ridge site, including Bonne Femme, Clear, Little Bonne Femme, Little Cedar, and Hinkson Creeks. In addition, a large lake, Perry Phillips Lake, is located approximately 0.75 mi (1.2 km) west of the site but is not in the drainage area of the site (NWMI 2015a).

No natural surface water features (e.g., headwater tributaries to streams) originate on the proposed Discovery Ridge site. The Discovery Ridge site currently drains south and southwest towards the southwesterly flowing Gans Creek, located approximately 0.35 mi (0.56 km) south of the site at its closest point (see Figures 3–11 and 3–13). Based on observations made by the NRC staff during the environmental site audit in September 2015, most site drainage occurs as overland sheet flow across the site with some drainage conveyed to ditches that border an access road associated with the future extension of Discovery Drive that would connect land parcels bordering the proposed site to the south. The NRC staff observed that these ditches convey runoff further southwest across Lot 9 of the Discovery Ridge Research Park via a meandering drainage way and toward an engineered drainage channel that parallels U.S. Highway 63.

This channel ultimately discharges to Gans Creek south of the site. Topographic maps (USGS 2015a), historical photography, and other records reviewed by Terracon (2011a) indicate that at least some of these drainage features may mark the remnants of a headwater tributary to Gans Creek. Nevertheless, the engineered drainage channel receives runoff from surrounding parcels and drainage and overflow from an existing human-made lake (located to the northwest of the Discovery Ridge site and immediately adjacent to the existing IDEXX BioResearch facility), which serves as a stormwater management pond and has an associated drainage channel.

**Figure 3–13. Major Surface Water Features in the Vicinity of the Discovery Ridge Site**


Source: Modified from NWMI 2015a

The lake was created by the University of Missouri R1 Dam. The lake is ultimately destined to serve various lots within the Discovery Ridge Research Park, as shown in construction maps for the research park (NWMI 2015a; MU 2009). This lake was originally constructed between 1948 and 1959, as reported by Terracon (2011a) (see Figure 3–11). The lake covers about 20 ac (8 ha) (NWMI 2015a).

Additionally, there is another surface water feature just to the northeast of the NWMI facility site, a large farm pond (Figure 3–11). This pond was constructed in the headwaters area of a south-flowing ephemeral tributary to Gans Creek. The pond is estimated to be about 4 ac (0.4 ha) in size. The shallow tributary may receive overflow and seepage from the pond, but it is not affected by runoff from the Discovery Ridge site.

Regardless, Gans Creek is the major surface water body in proximity to the Discovery Ridge site. This perennial to intermittent stream is located within the Bonne Femme (Creek) watershed, which is comprised of two major sub-watersheds: the Bonne Femme and the Little Bonne Femme. In total, the watershed drains approximately 93 square miles ($mi^2$) (241 square kilometers ($km^2$)). The Discovery Ridge site lies within the northern portion of this watershed–Little Bonne Femme sub-watershed (Frueh 2007; NWMI 2015a).

From just south of the site (Figure 3–13), Gans Creek flows beneath U.S. Highway 63 and continues west to southwesterly in a winding path for approximately 6 stream mi (9.7 km) before joining Clear Creek. At this confluence, the Little Bonne Femme Creek begins. Little Bonne Femme Creek continues flowing southwesterly for some 9 mi (14 km) along a winding course before entering the Missouri River. Approximately 2 mi (3.2 km) south of the mouth of Little Bonne Femme Creek, Bonne Femme Creek discharges to the Missouri River (Frueh 2007; NWMI 2015a).

The Bonne Femme watershed is situated on karst terrane, as referenced in Section 3.3.1. Surface water hydrology is complex because of the presence of losing (sinking) and gaining sections of streams where surface water can easily enter the subsurface, providing flow to other streams. Karst streams, and underlying groundwater, are very susceptible to upgradient pollutant sources and contaminant transport. Within the watershed, there are two main recharge areas tied to these losing and gaining sections of stream, the Devil's Icebox cave and the Hunter's Cave recharge areas (Frueh 2007; NWMI 2015a). Carlson et al. (2005) states that Gans Creek is the first gaining stream due to surface water lost through the Devil's Icebox cave. Thus, the Bonne Femme and Little Bonne Femme creeks are interconnected where surface water lost from Bonne Femme Creek is lost through the Devil's Icebox Cave Branch (across the surface water divide) into Gans Creek and is eventually discharged to Little Bonne Femme Creek (Figure 3–13) (Frueh 2007; NWMI 2015a). None of the streams within the Bonne Femme watershed have active stream gaging stations. In general, streams within the watershed exhibit a low base flow with flow rising appreciably in response to precipitation events (Frueh 2007).

There are no floodplains on the Discovery Ridge site. The site and adjacent parcels are located within areas mapped as outside the 500-year flood elevation. The Federal Emergency Management Agency has delineated the floodplain boundary for Gans Creek. The Discovery Ridge site is located approximately 1,400 ft (425 m) north of the 100-year floodplain, and the base elevation of the site lies some 40 ft (15 m) above the floodplain (FEMA 2011a; NWMI 2015h). Therefore, the site is not readily subject to stream flooding.

*3.4.1.2 Surface Water Quality and Use*

Existing and proposed activities within a watershed are regulated under various provisions of the Federal Water Pollution Control Act (i.e., Clean Water Act of 1972, as amended (CWA) (42 U.S.C. 6901 et seq.)). Congress enacted the CWA with the goal of restoring and maintaining the chemical, physical, and biological integrity of the Nation's surface waters.

In accordance with Section 303(c) of the CWA, States have the primary responsibility for establishing, reviewing, and revising water quality standards for the Nation's navigable surface waters. Such standards include the designated uses of a water body or waterbody segment, the water quality criteria necessary to protect those designated uses, and an anti-degradation policy with respect to ambient water quality. As set forth under CWA Section 101(a), water quality standards are intended in part to provide for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. The EPA retains a role in reviewing state-promulgated water quality standards to ensure that they meet the goals of the CWA and Federal water quality standards regulations (40 CFR Part 131).

The State of Missouri, like other States, has established water quality standards, numeric criteria, and associated designated use categories for all waters of the State, including jurisdictional wetlands. Water quality standards provide a means by which attainment of water quality objectives can be measured. The objective is protection of designated uses through the application of narrative or numeric criteria. The level of protection given to a stream, lake, or river is dependent on the expected or "designated use(s)" of that water. The State frequently derives effluent limits contained in National Pollutant Discharge Elimination System (NPDES) permits from water quality standards (MDNR 2016b). NPDES permits are issued in accordance with CWA Section 402. Streams, lakes, and rivers that have identified beneficial uses and have some water year round also have designated hydrologic classifications. Water quality standards, designated beneficial uses, and hydrologic classifications of waters of the State are specified in Title 10, Division 20, Chapter 7 of the Missouri Code of State Regulations.

Within the State, all perennial rivers and streams, streams with permanent pools, and lakes and reservoirs that intersect the flow lines of perennial rivers and streams are designated for the following beneficial uses: aquatic habitat protection; human health protection, whole body contact recreation, and secondary contact recreation; and livestock and wildlife protection and irrigation (10 CSR 20-7.031). These uses apply to Gans Creek and other major streams within a 5-mi (8-km) radius of the Discovery Ridge site. Furthermore, a 3 mi (4.8 km) section of Gans Creek is classified by the State as an Outstanding State Resource Water (10 CSR 20-7.031) and denoted as an environmentally sensitive area by Boone County (Boone County 2016a). Outstanding State resource waters are high-quality waters with a significant aesthetic, recreational, or scientific value and specifically designated as such by the State's Clean Water Commission. Such waters may require exceptionally stringent water quality management requirements to assure conformance with the State's antidegradation policy. This special segment of Gans Creek is located within the Rock Bridge State Park, located approximately 3 mi (4.8 km) southwest of the Discovery Ridge site (see Figure 3–13).

From a hydrologic perspective, Little Bonne Femme and Bonne Femme Creeks and Hinkson Creek are Class P streams (i.e., streams that maintain permanent flow even in drought periods) (Boone County 2016a; MDNR 2015a). Gans Creek is a Class C stream, which is a stream that may cease flow in dry periods but maintain permanent pools that support aquatic life (MDNR 2015a).

CWA Section 303(d) requires States to identify all "impaired" waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards in such waters. Similarly, CWA Section 305(b) requires states to assess and report on the overall quality of waters in their state. States prepare a 303(d) "list" that comprises those water quality limited stream segments that require the development of total maximum daily loads (TMDLs) of pollutants to assure future compliance with water quality standards. The list also identifies the pollutant or stressor causing the impairment, and establishes a priority for developing a control plan to address the impairment. The TMDLs specify the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. Once established, States typically implement TMDLs through watershed-based programs, primarily through the NPDES permit program and associated point and nonpoint source water quality improvement plans and best management practices. States are required to update and resubmit their impaired waters list every 2 years. This process ensures that impaired waters continue to be monitored and assessed until applicable water quality standards are met.

Several of the streams within a 5-mi (8-km) radius of the Discovery Ridge site are either included in their entirety or have segments included in the State of Missouri's 303(d) list (NWMI 2015a; MDNR 2014a, 2015a). In particular, Gans Creek continues to be listed as impaired due to water-borne *E. coli* bacteria. It was first listed in 2012. The reason for its listing is impairment of the beneficial use for whole body contact recreation; the identified pollutant source is a rural nonpoint source runoff. Similarly, Little Bonne Femme and Bonne Femme Creeks are also listed as impaired due solely to *E. coli.* An extensive study to characterize the hydrologic and water quality characteristics of the Bonne Femme watershed, and further focusing on the karst areas of the watershed, was conducted between 2003 and 2007. The CWA Section 319 grant-funded effort was directed by a steering committee composed of members from local, State, and Federal agencies. The effort culminated in the development of a watershed plan for use as a tool for use in preventing further watershed degradation and maintenance of the long-term quality of water resources within the watershed (Frueh 2007).

Water quality studies conducted as part of the watershed investigation included establishing monitoring sites at a number of surface sub-watershed locations. Of particular relevance to the Discovery Ridge site, these included monitoring locations on Clear Creek, Gans Creek, Upper Bonne Femme Creek, Little Bonne Femme Creek, and at the two karst recharge areas including Devil's Icebox cave. Samples were collected at all sites once per quarter beginning in 2003. In addition to measurement of standard physical and water quality parameters, samples were analyzed for various herbicides and for the presence of bacterial contamination. In summary, general water quality parameters were found to be typical for streams in carbonate bedrock areas. Dissolved oxygen levels exceeded the State standard of 5 milligrams per liter (mg/L). Nutrient levels were similar to or less than streams in other comparable agricultural watersheds, and there was no indication of acute contamination at any site. Although field observations and monitoring results revealed nuisance algal growth, no excess nutrient enrichment (eutrophication) was found at any site. One or more herbicides was detected at every site but generally at low levels. Widespread fecal bacterial contamination was evident, with the highest levels found during the spring and summer. The fecal bacteria standard for whole body contact was frequently exceeded. The primary cause of bacterial contamination at most sites was attributed to cattle grazing (Frueh 2007).

The NPDES permit program, as referenced above, addresses water pollution by regulating point sources (i.e., pipes, ditches) that discharge pollutants to waters of the United States (40 CFR Part 122; EPA 2016g). Regulated pollutant discharges include, but are not necessarily limited to, the discharge of facility wastewater and stormwater associated with construction or industrial activity at a site. NPDES permits set forth effluent limits on the discharge and also prescribe effluent monitoring, reporting, and other requirements to ensure that permit terms are being met. Regulated facilities may either require an individual NPDES permit or qualify for a general permit (i.e., a generic permit appropriate for covering a class of dischargers in a geographic area with similar characteristics) (EPA 2016g; MDNR 2016c). The State of Missouri is among the many states that have been authorized by EPA to perform many of the permitting, administrative, and enforcement aspects of the NPDES program, with EPA retaining oversight responsibilities (EPA 2016g). The State of Missouri was first authorized by EPA to assume NPDES permitting authority in 1974; it received general permit authority in 1985. The State of Missouri's regulations for administering its NPDES permit program are contained in Title 10, Division 20, Chapter 6 of the Missouri CSR (10 CSR 20-6.010 and 10 CSR 20-6.200). In addition to State-administered NPDES permit requirements, local jurisdictions, including the City of Columbia, have additional requirements for site development, wastewater discharge, and stormwater management.

The discharge of wastewater to a municipal sanitary sewer system, as proposed by NWMI for the disposal of facility-generated wastewater, does not require an NPDES permit. A wastewater treatment plant (i.e., publicly owned treatment works (POTW)), where sanitary wastewater is ultimately treated, operates under its own NPDES permit. Wastewater collected by the City of Columbia's sanitary sewer system is treated at the Columbia Regional Wastewater Treatment

Plant. The plant has a design treatment capacity of approximately 20 million gallons per day (mgd) (75,700 cubic meters/day ($m^3$/day)) (City of Columbia 2016c).

The introduction of wastewater to a POTW constitutes an "indirect discharge" that is excluded from the definition of "discharge of a pollutant" to waters of the United States (40 CFR 122.2). However, in accordance with CWA Section 307 and EPA's pretreatment regulations (40 CFR Part 403), the discharge of pollutants from non-domestic (e.g., industrial) sources to such systems must meet local (municipal) acceptance criteria and other applicable requirements. This is to avoid interfering with the POTW in a manner that might result in a violation of the POTW's NPDES permit and/or water quality standards (EPA 2015b). For this purpose, the City of Columbia Sanitary Sewer Utility that serves the Discovery Ridge site has specific regulations in the City's Code of Ordinances (Chapter 22, Article VI, "Sewers and Sewage Disposal") to address unlawful discharges, influent limits, and applicable pretreatment requirements (NWMI 2015a; City of Columbia 2015).

In addition, CWA Section 401 requires an applicant for a Federal license or permit to conduct any activities that may result in any discharge of regulated pollutants into navigable waters to provide the licensing agency with a water quality certification from the state in which the discharge would occur. This certification indicates that discharges from the project or facility to be licensed will comply with CWA requirements and will not cause or contribute to a violation of state water quality standards. If the applicant has not received Section 401 certification, the NRC cannot issue a license unless that state has otherwise waived the requirement. The State of Missouri's regulations for administering its water quality certification program are contained in Title 10, Division 20, Chapter 6 of the Missouri CSR (10 CSR 20-6.060).

### 3.4.2 Groundwater

#### *3.4.2.1 Site Description and Hydrogeology*

The Discovery Ridge site is located within the Northeast Missouri Groundwater Province (MDNR 2016d). Groundwater beneath the proposed Discovery Ridge site and across Boone County occurs in unconsolidated and consolidated water-bearing deposits (aquifers). The following discusses the general hydrostratigraphy and other characteristics of these aquifers.

The USGS has broadly classified and grouped the distinct water-bearing geologic units (aquifers) that occur in northeast Missouri. These include the water-bearing sediments associated with the surficial aquifer system and two bedrock aquifer systems—the Mississippian aquifer system and the deeper Cambrian-Ordovician aquifer system (NWMI 2015a, 2016a; Miller and Appel 1997).

Across northeastern Missouri, the surficial aquifer consists mainly of stream-valley fill deposits. These deposits include narrow bands of fluvial and alluvial sediments lying within the valleys where rivers and streams have eroded shallow channels into glacial deposits. In southern Boone County, these materials are essentially limited to the Missouri River valley (Boone County Commission 1996; Miller and Appel 1997). Alluvial deposits consisting of sand and gravel underlying the floodplains of major rivers can yield large quantities of good-quality water. Yields as high as 2,000 gallons per minute (gpm) (7.6 cubic meters per minute ($m^3$/min)) are possible from properly constructed wells (MDNR 2016c).

The shallow glacial drift is not considered a suitable water source due to the limited thickness of the water-bearing strata, low storage, and vulnerability to contamination (MDNR 2016d). As described in Section 3.3.1, the combined thickness of glacial drift and other overburden at the Discovery Ridge site is approximately 25 ft (7.6 m). Groundwater occurring in these materials generally moves from areas of higher elevation to discharge points along streams.

In northern Missouri, the Mississippian aquifer is the uppermost aquifer, with the overlying Pennsylvanian age strata not considered a major aquifer. The Mississippian aquifer extends over all of Missouri north of the Missouri River, except to the south near the Mississippi and the Missouri Rivers where the rocks that compose the aquifer have either been partially or completely removed by erosion. This aquifer encompasses Mississippian age carbonate rocks (principally limestones), including the Keokuk, Burlington, Fern Glen, Sedalia, and Chouteau limestone units (see Section 3.3.1). The Keokuk and the Burlington are the principal hydrogeologic units. Both units consist of crystalline limestone and yield water primarily from solution cavities (NWMI 2015a, 2016a; Miller and Appel 1997).

Carbonate rocks comprising the Mississippian aquifer in northeastern Missouri are stratigraphically equivalent to those of the uppermost aquifer (i.e., Springfield Plateau aquifer) of the Ozark Plateaus aquifer system that extends south from Boone County into southern Missouri. However, east of Boone County, Missouri, the two aquifers have little or no hydraulic connection (Miller and Appel 1997). Pennsylvania-age shale and sandstone generally overlies the Mississippian aquifer in most places, acting as a confining unit. A confining unit comprised of Mississippian-age shale underlies the aquifer in all locations (NWMI 2015a; Miller and Appel 1997). However, the Mississippian aquifer is reported as generally unconfined in the region of the Discovery Ridge site (NWMI 2016a).

Across central and northern Boone County, the units of the Mississippian aquifer average about 200 ft (60 m) thick, but the thickness increases to the northwest and thins to the south as discussed above (Miller and Appel 1997; NWMI 2016a). A review conducted by NWMI of well logs from four wells within a 1-mi (1.6-km) radius of the site indicates that the total thickness of Mississippian age strata is about 240 ft (73 m) (NWMI 2016a).

Recharge of the uppermost aquifer units occurs primarily from precipitation over aquifer outcrop areas or infiltration and leakage down through the overburden and from the overlying glacial drift aquifers, where present. However, some recharge may also occur through vertical leakage from the underlying Cambrian-Ordovician aquifer system. The direction of groundwater flow in the uppermost aquifers beneath the County is generally to the south and southwest with discharge to major streams (Miller and Appel 1997).

The MDNR maintains extensive geospatial data sources on groundwater resources. This includes data extracted from well driller logs submitted to the State. Available MDNR data indicate that the static water level in the uppermost aquifer beneath the site ranges between 625 and 650 ft (190 and 200 m) MSL (NWMI 2015a; 2016a; MGS 2016). For comparison, the mapped depth to groundwater (as measured from the land surface) in the area of the Discovery Ridge site ranges between 110 to 120 ft (34 to 37 m) bgs (MGS 2016).

The Cambrian-Ordovician aquifer system underlies the Mississippian system across the northeastern portion of Missouri north of the Missouri River and encompassing Boone County. Like the Mississippian aquifer, units within the Cambrian-Ordovician aquifer are stratigraphically equivalent to parts of the Ozark Plateaus aquifer system of southern Missouri. While a major water source across the Midwest as a whole, its use in northern Missouri is limited to eight counties just north of the Missouri River, including Boone County, where salinity levels are low enough to make the water potable (Miller and Appel 1997; Wilson 2012). In this eight-county area, this system is the principal water supply source (USGS 1985). In this eight-county area, the hydrogeologic flow system has been shown to be independent of the regional saline-water flow system in northern Missouri (Wilson 2012).

The hydrostratigraphy of the Cambrian-Ordovician aquifer system is principally comprised of carbonate rocks (limestones, dolomites) and sandstones of marine origin with shalely confining units. Significant water-bearing strata within the system, in descending order, include the

Roubidoux (sandstone) Formation and Gasconade Dolomite of Ordovician age and the Cambrian Eminence and Potosi Dolomites (Miller and Appel 1997). On a broader regional basis, the major aquifer zones are the sandstones, which are separated by leaking confining units comprised of dolomite, shale, shaley sandstone, or a combination of these types. Across northern Missouri, the aquifer is confined by the Ordovician age Maquoketa Shale (Wilson 2012).

Within the northeastern Missouri counties, the local aquifer is also referred to as the Kimmswick-Potosi aquifer. It is named for the Ordovician age Kimmswick Limestone and the Potosi Dolomite, which are the geologic units that mark its upper and lowermost extent in the subsurface (USGS 1985). These units are part of the recognized Cambrian-Ordovician aquifer system.

In total, the Cambrian-Ordovician aquifer system attains a thickness of up to 1,500 ft (460 m) below southern Boone County. Flow within the system is generally south with discharge to the Missouri River (Miller and Appel 1997).

NWMI reviewed historical well records for water supply, monitoring, and related well records within a 1-mi (1.6-km) radius of the site on file with the MDNR (NWMI 2016a). These records, for wells with total completion depths ranging from 505 to 1,250 ft (154 to 380 m), indicate a depth to groundwater in the aquifer ranging from about 180 to 325 ft bgs (NWMI 2016a; MDNR 2016e). Review of select well logs indicate that these wells are completed in and draw water from the Cambrian-Ordovician aquifer system. In general, wells completed in the Cambrian-Ordovician aquifer system yield from 15 up to 1,000 gpm (0.06 to 3.8 $m^3$/min) of water (USGS 1985). Similarly, MDNR (2002b) states that wells developed in the Mississippian age limestones and Ordovician and Cambrian age dolomites and sandstones of the Cambrian-Ordovician aquifer system can yield 15 to 500 gpm (0.06 to 1.9 $m^3$/min), with wells exceeding 1,000 gpm (3.8 $m^3$/min) including from the Columbia, Missouri area.

As part of the preliminary geotechnical investigation of the Discovery Ridge site and vicinity, Terracon (2011a) installed a number of soil borings in the glacial drift and uppermost bedrock (see Section 3.3.1). Terracon only observed groundwater in two of the borings at depths of approximately 12 to 18.5 ft (3.7 and 5.6 m) bgs. This included the one boring installed near the proposed NWMI facility site within Lot 15, where saturated conditions were encountered at a depth of 12 ft (3.7 m) bgs (Terracon 2011a). Nevertheless, Terracon indicated that the borehole observations made for the presence of groundwater may have been affected by the low permeability of the surficial materials. The low permeability soils may not have allowed water, even if present, to flow into all the boreholes during the relatively short period of time they were left open for observation. As referenced by Terracon (2011b), pockets and lenses of more permeable and water-bearing glacial materials occur in the vicinity of the site, leading to "perched" groundwater. NWMI has indicated that given the high water content of the site soils at the time the borings were completed, the "groundwater" observed in the boring holes may have been the result of water introduced into the holes during drilling operations (NWMI 2016a).

Furthermore, only two of the borings were advanced far enough to bedrock, at depths of approximately 17 and 13 ft (5.1 and 4.0 m) bgs. No groundwater monitoring wells have been installed on the site to determine the static water table elevation or the depth to groundwater in the uppermost bedrock aquifer beneath the Discovery Ridge site. Overall, the NRC staff considers Terracon's observations and assessments reasonable and that the available data suggest that any lenses or pockets of perched groundwater underlying the Discovery Ridge site are likely to be of limited lateral and horizontal extent.

#### *3.4.2.2 Groundwater Quality and Use*

Boone County's groundwater resources are characterized as large in volume and of high quality (Boone County Commission 1996). The County's public water supply systems obtain nearly all of its potable water from groundwater via deep wells. Across northern Missouri, water from the Cambrian-Ordovician aquifer system ranges from fresh to saline but is generally of good quality in a band parallel to and north of the Missouri River from Boone County and east to the Mississippi River.

Within Boone County, groundwater is principally supplied from two aquifer units, the Roubidoux and the Gunter Member (Boone County Commission 1996). The Roubidoux Formation and Gunter Sandstone Member of the Van Buren Formation are aquifer units within the Cambrian-Ordovician aquifer system. It should be noted, however, that production wells in large aquifer systems typically draw from more than a single hydrostratigraphic unit. Across Boone County, the concentration of total dissolved solids from the aquifer is approximately 500 mg/L (Miller and Appel 1997). Groundwater produced across northeastern Missouri from Cambrian-Ordovician strata is generally of the calcium magnesium, bicarbonate-type and hard to very hard (USGS 1985). Hardness is generally the result of high concentrations of calcium and magnesium.

Five separate water districts produce and distribute potable water to the majority of Boone County (Boone County 2013). The districts operate as independent public utilities, regulated by the State of Missouri. These districts were originally formed for the purposes of meeting the needs of rural populations and of agriculture (Boone County Commission 1996). The Discovery Ridge site lies within the service area of Consolidated Public Water Supply District No. 1, and it would supply water to the proposed NWMI facility site (NWMI 2015a, 2016a). This district serves most of the southern and western portions of the County but has interconnections with adjoining districts, including the City of Columbia, for contingency purposes. A system of 13 deep wells supply the district. The system has a total groundwater production capacity of 11 mgd (49,200 $m^3$/day) (NWMI 2015a; CPWSD 2016).

Groundwater is used extensively and almost exclusively across Boone County for a wide range of purposes, as summarized in Table 3–7.

**Table 3–7. Groundwater Use in Boone County, 2010**

| Category | Volume (mgd) |
|---|---|
| Public supply | 15.89 |
| Domestic, self-supplied | 0.11 |
| Industrial, self-supplied | 0.02 |
| Thermoelectric power, self-supplied | 0.88 |
| Mining, self-supplied | 0.21 |
| Livestock, self-supplied | 0.11 |
| Irrigation, self-supplied | 0.99 |
| **Total** | **18.21** |

Note: To convert from million gallons per day to cubic meters per day, multiply by 3785.4.

Source: USGS 2016b.

In summary, for 2010, groundwater production for public water supply accounted for the largest use by volume in Boone County at 15.89 mgd (60,150 $m^3$/day). Water to meet irrigation and thermoelectric power generation needs constitute the next largest water use categories in the County.

As previously discussed (Section 3.4.2.1), NWMI compiled a list of water supply and other wells within a 1-mi (1.6-km) radius of the Discovery Ridge site based on information sources maintained by the MDNR. The NRC staff reviewed the information provided by NWMI (NWMI 2016a) and other available information. Based on this review, the closest domestic supply well identified (well no. 394516) is located approximately 0.7 mi (1.1 km) northeast of the site (MGS 2016). The University of Missouri Thomas Jefferson Agricultural Institute is the registered owner (MDNR 2016f). This well was installed in October 2006 to a depth of 766 ft (233 m). It has a cased diameter of 6.25 in. (15.9 cm). Well logs for the area indicate that this depth corresponds to the Ordovician age Jefferson City Dolomite and Roubidoux Formations. The log indicates a static water level of 200 ft (60 m) bgs and a yield of 120 gpm (0.45 $m^3$/min) at installation (MGS 2016; MDNR 2016f). This well is hydraulically upgradient of the Discovery Ridge site as the direction of regional groundwater flow is generally from north to south.

A public water supply well (well no. 400126) is located approximately 0.8 mi (1.3 km) south, southeast of the Discovery Ridge site (MGS 2016). Consolidated Public Water Supply District No. 1 is the registered owner (MDNR 2016f). This well is a reconstruction (i.e., refurbishment and/or modification) of a well (well no. 24126) originally drilled in December 1965. Reconstruction was completed on September 20, 2008, and involved deepening the well to 1,475 ft (450 m) further into the Cambrian strata. It has a cased diameter of 12 in. (30.5 cm). The completion log indicates a static water level of 280 ft (85 m) bgs and a yield of 600 gpm (2.3 $m^3$/min) at installation (MGS 2016; MDNR 2016f).

The nearest well identified by NWMI is reportedly located approximately 0.3 mi (0.48 km) west-northwest of the Discovery Ridge site (NWMI 2016a). The location mapped by NWMI places it proximal to Lot 6 of the Discovery Ridge Research Park and near the existing ABC Laboratories facility; this approximate location matches other well records that the NRC staff reviewed (MGS 2016). This well (well no. 013947) was drilled in 1955 and owned by the University of Missouri. It was drilled to a depth of 587 ft (179 m) with a static water level of 270 ft (82 m) bgs at completion (NWMI 2016a). A well log that the NRC staff reviewed indicates that the well was located on the Bradford dairy farm (MGS 2016).

Terracon (2011b) discussed the possible existence of a water well in the above cited area as documented in the 2011 Phase I environmental site assessment report that was prepared for the Discovery Ridge Research Park. In the Phase I report, the location of the well is attributed to the USDA Field Research Building, which lies in Lot 4. As described in the ER, the University of Missouri's Bradford Research and Extension Center encompasses a research farm that provides land, equipment, and facilities to assist university and USDA scientists and extension personnel in performing research (NWMI 2015a). This information collectively suggests that the water well in question was associated with the original Bradford farm.

The NRC staff's opinion is that the well could possibly have been in areas impacted by construction of Discovery Drive and Discovery Ridge Parkway, or by construction of the ABC Laboratories facility. Terracon reported that it did not locate the well during its site reconnaissance as part of the Phase I assessment. However, as stated by Terracon in the Phase I report (Terracon 2011b), the well, if still in existence and not used, should be located and properly abandoned in accordance with MDNR standards.

# 3.5 Ecological Resources

## 3.5.1 Ecoregion

The proposed Discovery Ridge site is located within the north-central portion of the Ozark Highlands ecoregion, which is 108,322 $km^2$ (41,823 $mi^2$) (Karstensen 2010; USGS 2015e). Diverse topography, geologic, soil and hydrological condition have created a wide range of habitat types, including woodlands, forests, wetlands, fluvial features, hills, caves, deep valleys, and various rocks outcrops. Aquatic habitats include rivers, meandering streams, tributaries, seeps, and springs (MDNR 2008). These diverse and unique habitats support a number of plant and animal species, including 200 species largely restricted to the Ozark Highlands, of which 160 species only occur within the Ozark Highlands (USGS 2009).

Historically, this region primarily consisted of woodlands, forests, prairie grasslands, savannas, and wetlands (Epperson 1992; Nigh and Schroeder 2002). Beginning with European settlement, the majority of grasslands and wetlands were converted to agricultural lands for farming and pastures (Nigh and Schroeder 2002). In the late 1880s through 1960, the amount of hickory oak forest decreased as a result of the timber industry. Afterwards, the percent forest cover continued to decline as forests were converted to agricultural lands for pasture and row crops. Upland grasslands and valley bottoms were also converted to agricultural lands for pasture and row crops during this period (Karstensen 2010). From 1973 through 2000, 2.4 percent of forests in the ecoregion were converted to agricultural lands and approximately 1 percent was mechanically disturbed (Karstensen 2010). During this same period, approximately 1 percent of agricultural lands were converted to grasslands, in part due to the Conservation Reserve Program, which offered financial incentives for farmers to suspend agricultural activities and convert the land to native grasslands or forests (Johnson and Maxwell 2001). Dahl (1990) determined that 87 percent of Missouri's original 1.9 million ha (4.8 million ac) of wetlands have been converted to other land uses, such as agriculture (87 percent), urban development (8 percent) and other development (5 percent). The conversion of forest and wetlands to agricultural fields has resulted in the decline of many biological species that depend on large tracts of undisturbed complex, natural habitats, and native species for prey, shelter, and breeding. Species that can survive in low-quality human-modified habitats, such as agricultural fields and developed areas, have generally increased over the past few centuries.

In 2000, the primary undeveloped land cover that provided habitat within the ecoregion included forests (56 percent), agricultural lands (37 percent), open water (1 percent), and wetlands (less than 1 percent) (Karstensen 2010). Developed land accounted for 2.1 percent of the ecoregion.

## 3.5.2 Habitats in the Vicinity of the Proposed Site

Within the vicinity, or a 5-mi (8-km) radius, of the proposed Discovery Ridge site, most of the area (39 percent) is used for agricultural purposes (see Table 3-1). Vegetation and wildlife within agricultural fields surrounding the proposed site are likely to be similar to those found at the proposed site (see Section 3.5.3). This section also describes other types of habitats—forests, grasslands, wetlands, and aquatic—within a 5-mi (8-km) radius of the proposed site. In addition, several communities of concern occur within the vicinity of the site (USDA 2016b; NWMI 2015a) and are highlighted below. MDC (2016b) defines these areas as high-quality ecological communities with intact tracts of habitat containing a diverse assemblage of native species. MDC (2016b) classifies each community as critically imperiled, imperiled, or vulnerable based on criteria such as total number of occurrences, total acres, number of counties in which the community type occurs, number of protected occurrences, and threats to the community, as defined below:

- Critically Imperiled: Extremely rare or some factor(s) such as very steep declines making it especially vulnerable to extirpation from the State.
- Imperiled: Rare due to very restricted range, very few populations or occurrences, steep declines, or other factors making it very vulnerable to extirpation from the State.
- Vulnerable: Restricted range, relatively few populations or occurrences, recent and widespread declines, or other factors making it vulnerable to extirpation.

<u>Forested Habitats</u>

Forests cover 33 percent of the area within a 5-mi (8-km) radius of the proposed Discovery Ridge site (NWMI 2015a). Typical forests are primarily deciduous forests that include white oak (*Quercus alba*) forests, oak dry woodlands, black oak (*Quercus velutina*) woodlands, oak savannas, and sugar maple (*Acer saccharum*) mesic forests (Nigh and Schroeder 2002; NWMI 2015a). Evergreen forests and mixed forests are less common, but they also occur within the vicinity. Historically, forests covered a larger portion of the area; however, many of the forests have been converted into agricultural fields (Karstensen 2010). Remaining forested tracts, especially in riparian areas, provide important habitat for wildlife and birds. Many neotropical migrating birds use forested riparian habitats for resting, foraging, and providing refuge from predators. Two forested communities of concern occur within the vicinity:

- White oak forests (imperiled)—White oak forests generally occur on relatively steep slopes, from the valley bottoms to ridge tops, above river corridors. Hardwood trees comprise a well-developed forest canopy and subcanopy dominated by a mixture of white oak, sugar maple, pawpaw (*Asimina triloba*), and other hardwoods (USDA 2016b). Common shrubs and forb species include fragrant sumac (*Rhus aromatic*), wild blue phlox (*Phlox divaricata*), and woodnettle (*Laportea canadensis*) (USDA, 2016b). Common wildlife species include white-tailed deer (*Odocoileus virginianus*), great crested flycatcher (*Myiarchus crinitus*), and ringed salamander (*Ambystoma annulatum*) (MDC 2010).
- Mixed oak loess/glacial till woodlands (imperiled)—The mixed oak loess/glacial till woodlands generally occur adjacent to the Missouri River floodplains on upland summit crests. White, black, and post oak (*Quercus stellate*) trees comprise a well-developed forest canopy. Common shrubs and forbs include American hazelnut (*Corylus Americana*), elm-leafed goldenrod (*Solidago ulmifolia*), and smooth blue aster (*Aster laevis*). Common wildlife species include wild turkey (*Meleagris gallopavo*), red-headed woodpecker (*Melanerpes erythrocephalus*), and tiger salamander (*Ambystoma tigrinum*) (MDC 2010; USDA 2016b).

As described in Section 3.1.1.3, the Rock Bridge State Memorial Park is within 5 mi (8 km) of the Discovery Ridge site. This park consists of karsts, grasslands, and oak woodlands and forests and also contains the Gans Creek Wild Area (MDNR 2016a). The park provides habitat to a variety of vegetation, birds, and wildlife, including bats that may occur within the Devil's Icebox cave (NRC 2016j).

<u>Grasslands</u>

Grasslands cover less than 1 percent of the area within a 5-mi (8-km) radius of the proposed site (NWMI 2015a). Since the arrival of European settlers, agricultural activities converted the majority of native grasslands into cultivated croplands or pastures. The remaining areas of native grasslands are typically small and disconnected from other patches of native grasslands (Nigh and Schroeder 2002). These small patches provide lower quality habitat than larger connected tracts of grasslands. Predation, for example, is usually higher along the edge of a patch of prairie than at the center of a large continuous patch of prairie, which is likely because prey are more visible and have fewer places to hide from predators along the edge of a patch. Remaining tracts of native grasslands provide an important habitat for wildlife and birds. For example, many birds require grassland habitats for courtship, nesting, foraging, rearing young, roosting, or resting.

The NRC staff notes that cultivated grasses, such as corn and wheat, or pastures with non-native species are sometimes considered grasslands. Because native grasses are relatively rare in the area and native grasses provide substantially higher quality habitat than cultivated grasses or pastures, the NRC staff classified cultivated grasses and pastures as agricultural lands in this environmental impact statement (EIS).

One grassland community of concern occurs within the vicinity:

- Loess/glacial till prairies (critically imperiled)—These prairie communities generally occur in areas of low relief with low slope gradients and narrow drainages. Tall grass prairies are primarily comprised of little bluestem (*Schizachyrium scoparium*), Indian grass (*Sorghastrum nutans*), and sideoats grama (*Bouteloua curtipendula*). Small groves of post oak, American hazelnut (*Corylus Americana*), and prairie willow (*Salix humilis*) occasionally occur within the prairies. Common shrubs and forbs include lead plant (*Amorpha canescens*) and purple prairie clover (*Dalea purpurea*). Common wildlife species include white-tailed deer (*Odocoileus virginianus*), upland sandpiper (*Bartramia longicauda*), and western slender glass lizard (*Ophisaurus attenuates*) (USDA 2016b).

<u>Wetlands</u>

Forest/shrub wetlands and freshwater emergent wetlands cover less than 1 percent of the area within a 5-mi (8-km) radius of the proposed site (NWMI 2015a). Wetlands provide an important, high-value habitat for both terrestrial and aquatic resources. Migrating birds often use wetland sites for feeding and resting. Areas of open water provide an important nursery ground for many developing amphibians (e.g., frogs and salamanders), reptiles (e.g., turtles), and fish. One wetland community of concern occurs within the vicinity:

- Emergent wetlands and shrub swamps (Imperiled)—For emergent wetlands, common plant species include cattails (*Typhaceae latifolia*), bulrushes (*Schoenoplectus* spp), and sedges (*Cyperaceae* spp); and common wildlife species include bitterns (*Botaurus lentiginosus*), pied-billed grebes (*podilymbus podiceps*), and muskrats (*Ondatra zibethicus*). Shrub swamps are wetland thickets with buttonbush (*Cephalanthus occidentalis*) and willows (*Salix* spp). Common wildlife species include yellow warblers (*Dendroica petechia*) and green herons (*Butorides virescens*) (Leahy 2010; MDC 2016b, 2016c).

<u>Aquatic Habitats</u>

Areas of open water, or aquatic habitats, cover 1.5 percent of the area within a 5-mi (8-km) radius of the proposed site (NWMI 2015a). As described in Section 3.4.1, the proposed Discovery Ridge site currently drains south and southwest toward the southwesterly flowing Gans Creek, located approximately 0.35 mi (0.56 km) south of the site at its closest point (see Figures 3–11 and 3–13). Gans Creek is the major water body that provides aquatic habitat in proximity to the Discovery Ridge site. This perennial to intermittent stream is located within the Bonne Femme (Creek) watershed, and the proposed site lies within the northern portion of this watershed, the Little Bonne Femme sub-watershed (Frueh 2007; NWMI 2015a). From just south of the site (Figure 3–13), Gans Creek flows beneath U.S. Highway 63 and continues west to southwesterly in a winding path for approximately 6 stream mi (9.7 km) before joining Clear Creek. Little Bonne Femme Creek begins at this confluence. Little Bonne Femme Creek continues flowing southwesterly for some 9 mi (14 km) along a winding course before entering the Missouri River. Approximately 2 mi (3.2 km) south of the mouth of Little Bonne Femme Creek, Bonne Femme Creek discharges to the Missouri River (Frueh 2007; NWMI 2015a).

The Bonne Femme Stakeholder Committee (BFSC 2007) determined that fish communities within the Bonne Femme watershed and nearby streams generally range from 11 to 17 species, and commonly include shiners, minnows, suckers, redhorse, sunfish, bass, darters and stonerollers. NWMI (2015c) observed creek chub (*Semotilus atromaculatus*) in small pools of Gans Creek on September 30 and October 1, 2015. Gans Creek was not flowing at the time of the observation. The NRC staff also searched FishNet (2014), which is a collaborative effort by the National Science Foundation, National Biological Information Infrastructure, and other natural history and biodiversity institutions to compile a database of fish survey results. FishNet (2014) contained records for two fish species within the vicinity of the proposed Discovery Ridge site. Small mouth bass (*Micropterus dolomieu*) were collected from Little Bonne Femme Creek in October 1978. Smallmouth bass are relatively common within this watershed. In March 1960, orangethroat darter (*Etheostoma spectabile*) were collected from the spring branch of Gans Creek. Orangethroat darter is endemic, or solely unique, to the Mississippi River basin and the Lake Erie basin. However, given the age of the data, it is not certain whether these species still occur within the Bonne Femme watershed.

Portions of Gans Creek are considered Fish Spawning Stream Reaches, which is one of 138 State-designated fish spawning stream segments (MDC 2015). The State designates stream reaches as Fish Spawning Stream Reaches if they contain highly diverse fish communities, provide habitat for fish species of conservation concern, and if they are important to maintaining, restoring, or avoiding future listing of Species of Conservation Concern (MDC 2015).

Streams and other waterbodies within the Bonne Femme watershed also contain many invertebrates, such as mayflies, stoneflies, caddisflies, dragonflies, beetles, small crustaceans, and snails. BFSC (2007) determined that 18 to 27 invertebrate species are estimated to inhabit streams within the Bonne Femme Watershed.

### 3.5.3 Site

The proposed site consists of 7.4 ac (3.0 ha) of agricultural lands. The proposed site has been continuously disturbed from agricultural activities, such as row crops and pasture, during the past several decades. Because of these agricultural activities, plant communities located on the proposed site are primarily limited to non-native or common grasses reminiscent of open pasture land (NWMI 2015c; USDA 2016c; NRC 2016j). Because of the clearing, tilling, and other disturbances associated with agricultural activities, the proposed Discovery Ridge site has no native forests, woodlands, savannas, wetlands, or intact prairies. In addition, no water bodies, aquatic habitats, or riparian zones exist within the boundaries of the proposed Discovery Ridge site (NWMI 2015a, 2015c).

To characterize the vegetation on the proposed Discovery Ridge site, NWMI (2015c) performed a site survey on September 30, and October 1, 2015. NWMI randomly selected two 50-m (164-ft) long transects and established 1 $m^2$ (11 $ft^2$) plots at 5-m (16-ft) intervals along each transect. In addition, NWMI identified plants observed while walking the perimeter of the property. Both the NRC staff and the Missouri Department of Conservation staff reviewed the vegetation survey (NRC 2016j). The most common species to occur on the Discovery Ridge site include tall fescue (*Colium arundinaceum*) and yellow foxtail (*Setaria pumila*), both of which are non-native to Boone County (USDA 2016c; MDC 2016d; NRC2016j). Other vegetative species on the site include Indian grass (*Sorghastrum nutans*), ironweed (*Vernonia* spp.), cocklebur (*Xanthium* spp.), birdsfoot trefoil (*Lotus corniculatus*), red clover (*Trifolium pretense*), teasel (*Dipsacus* spp.), and Queen Anne's lace (*Daucus carota*) (NWMI 2015c, NRC 2016j). These species are either common, weedy, and/or non-native to Boone County (MDC 2016c, 2016d; USDA 2016c; NRC 2016j). The vegetative species that occur on the Discovery Ridge site are indicative of an old field that has been previously disturbed (NWMI 2015c; NRC 2016j). In addition, the present vegetation provides low quality habitat for wildlife and birds (NWMI 2015c; NRC 2016j).

NWMI (2015c) identified one American sycamore (*Platanus occidentalis*) tree on the Discovery Ridge site. During its site audit (NRC 2015b), the NRC staff also identified the American sycamore tree and noted that it was in relatively poor health based on multiple physical abrasions, or removal of bark, and dead branches that did not produce leaves.

The proposed Discovery Ridge site provides low-quality habitat for birds, mammals, amphibians, reptiles, and other wildlife tolerant of open fields, grasses, and regular disturbance associated with cow grazing or other agricultural activities. During its qualitative field survey, NWMI (2015c) noted the presence of nine Eurasian collared-doves (*Streptopelia decaocto*). This species is not native to Missouri and tolerant of human-modified habitats, such as old fields, pastures, and urbanized areas (Audubon 2016). NWMI (2015c) did not observe any other wildlife during its qualitative or quantitative vegetation assessment.

Birds and wildlife may use the proposed site to feed on vegetation, as a temporary resting location, or while traveling among other habitats. Table 3–8 provides a representative list of species tolerant of human-altered landscapes, such as agricultural fields, which may occur on the proposed Discovery Ridge site. Wildlife that requires trees, native plants, shrubs, or uncultivated grasses would not use the proposed site because of the lack of forested areas, wetlands, and native grasslands. Note that Federally-listed species, State-listed species, and birds protected under the Migratory Bird Treaty Act of 1918, as amended (MBTA) (16 U.S.C. 703–712) are described in Section 3.5.4.

**Table 3–8. Typical Wildlife That May Occur on or near the Proposed Site**

| Scientific Name | Common Name |
|---|---|
| **Birds** | |
| *Branta canadensis* | Canadian goose |
| *Cardinalis cardinalis* | northern cardinal |
| *Carduelis tristis* | American goldfinch |
| *Carpodacus mexicanus* | house finch |
| *Charadrius vociferus* | killdeer |
| *Corvus brachyrhynchos* | American crow |
| *Eremophila alpestris* | horned lark |
| *Passer domesticus* | house sparrow |
| *Quiscalus quiscula* | common grackle |
| *Spizella pusilla* | field sparrow |
| *Streptopelia decaocto* | Eurasian collared-doves |

| Scientific Name | Common Name |
|---|---|
| *Sturnella magna* | eastern meadowlark |
| *Sturnus vulgaris* | European starling |
| *Turdus migratorius* | American robin |
| **Mammals** | |
| *Marmota monax* | groundhog |
| *Mephitis mephitis* | striped skunk |
| *Odocoileus virginianus* | white tailed deer |
| *Procyon lotor* | raccoon |
| *Sciurus carolinensis* | grey squirrel |
| *Sylvilagus floridanus* | eastern cottontail |
| *Tamias striatus* | eastern chipmunk |
| *Vulpes vulpes* | red fox |
| **Reptiles and Amphibians** | |
| *Anaxyrus americanus (formerly Bufo americanus)* | Eastern American toad |
| *Chelydra serpentina* | common snapping turtle |
| *Lithobates catesbeianus (formerly Rana catesbiana)* | American bullfrog |
| *Lithobates clamitans (formerly Rana clanitans)* | green frog |
| *Lithobates pipiens (formerly Rana pipiens)* | northern leopard frog |
| *Ophisaurus attenuatus attenuatus* | western slender glass lizard |
| *Terrapene ornata ornata* | ornate box turtle |
| *Thamnophis sirtalis* | eastern garter snake |
| Sources: NWMI 2015a, 2015c; MDC 2016c | |

No natural surface water features (e.g., headwater tributaries to streams) originate on the proposed Discovery Ridge site. As described in Section 3.5.2, the closest surface water feature is Gans Creek, located approximately 0.35 mi (0.56 km) south of the site (see Figures 3–11 and 3–13).

### 3.5.4 Protected Species and Habitats

The U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) jointly administer the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 et seq.). The FWS manages the protection of, and recovery effort for, listed terrestrial and freshwater species, and NMFS manages the protection of and recovery effort for listed marine and anadromous species. In Missouri, the MDC lists species as State-endangered under Missouri's Code of State Regulations (Title 3 of Code of State Regulations, Division 10, "Conservation Commission") and the State Endangered Species Law (252.240). This section discusses these species and species protected under the MBTA.

#### *3.5.4.1 Endangered Species Act*

Action Area

The implementing regulations for section 7(a)(2) of the ESA define "action area" as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." (50 CFR 402.02). The action area effectively bounds the analysis of ESA-protected species and habitats because only species that occur within the action area may be affected by the Federal action.

For the purposes of the ESA analysis in this EIS, the NRC staff considers the action area to include the lands within the 7.4 ac (3.0 ha) proposed site, the adjacent offsite area that would be used as a temporary construction staging area, and the surrounding area where runoff drains and activities would be audible to wildlife. The NRC staff expects all direct and indirect effects of the proposed action to be contained within these areas.

The NRC staff recognizes that while the action area is stationary, Federally listed species can move in and out of the action area. For instance, a flowering plant known to occur near, but outside, of the action area could appear within the action area over time if its seeds are carried into the action area by wind, water, or animals. Thus, in its analysis, the NRC staff considers not only those species known to occur directly within the action area, but those species that may passively or actively move into the action area. The staff then considers whether the life history of each species makes the species likely to move into the action area where it could be affected by the construction, operations, and decommissioning of the NWMI facility.

Overview of Protected Species

Table 3–9 describes the Federally listed species that have the potential to exist within the action area. The NRC staff compiled this table from the FWS's online database (FWS 2015a), correspondence and discussions with the FWS (FWS 2015a; NRC 2015e), and the NWMI ER (NWMI 2015a).

As described in Section 3.5.3, NWMI conducted ecological surveys in the action area and did not observe any Federally protected species on the proposed site (NWMI 2015a). Based on the surveys described in Section 3.5.3, the NRC staff did not identify any Federally listed species that could exist in the action area. In addition, the NRC staff reviewed the habitat requirements for the Federally-listed species in Table 3–9. The NRC staff determined that the proposed site provides unsuitable habitat for all the Federally-listed species in Table 3–9. The NRC staff did not identify any candidate species or proposed or designated critical habitats within the action area. Given the available information, the NRC staff concludes that Federally listed, proposed, or candidate species are unlikely to occur within the action area.

The Gans Creek does not contain marine or anadromous fish species. Therefore, no Federally listed species or habitats under NMFS's jurisdiction occur within the action area.

#### *3.5.4.2 State-listed Species*

Table 3–9 includes the State-listed species that have the potential to occur on or near the proposed Discovery Ridge site. The NRC staff compiled this table from the MDC's description of State-listed species (MDC 2000a, 2000b, 2016b), MDC's Natural Heritage Review (2015 and 2016 [June 2 letter]) reports, and the NWMI ER (NWMI 2015a). As described in Section 3.5.3, NWMI conducted vegetation surveys in the action area and did not observe any State-protected species on the proposed site (NWMI 2015a). Furthermore, habitat to support State-listed species does not occur on site. Based on the surveys described in Section 3.5.3, the NRC staff did not identify any State-listed species that are likely to occur in the action area.

The NRC staff reviewed the habitat requirements for the State-endangered species in Table 3–9. The NRC staff determined that the proposed site provides unsuitable habitat for all the State-endangered species. The Topeka shiner (*Anguilla rostrate*), which is State endangered, historically inhabited the watershed, but its occurrence has not been reported since 1997 (BFSC 2007). MDC's (MDC 2016e) natural heritage report did not identify any state-listed endangered species, state-ranked species, nor any natural communities within the project area. Because no State-listed species have the potential to exist within the proposed Discovery Ridge site, this EIS does not discuss State-listed species in any further detail.

**Table 3–9. Federally and State-Listed Species That May Occur on or near the Proposed Discovery Ridge Site**

| Scientific Name | Common Name | Federal Status[a] | State Status[a] | Habitat |
|---|---|---|---|---|
| **Fish** | | | | |
| *Anguilla rostrate* | Topeka shiner | E | E | Pools of small prairie streams with good water quality and gravel streambeds |
| *Scaphirhynchus albus* | pallid sturgeon | E | E | Missouri River and lower portions of the Mississippi River; Currently extirpated from Missouri |
| **Mammals** | | | | |
| *Myotis grisescens* | gray bat | E | E | Caves year-long |
| *Myotis septentrionalis* | northern long-eared bat | T | | Caves or mines during the winter and trees with loose bark or caves in the summer |
| *Myotis sodalist* | Indiana bat | E | E | Caves during the winter and large diameter trees with loose bark in summer |
| *Spilogale putorius interrupta* | plains spotted skunk | | E | Tallgrass prairies, forests, brushy areas, and cultivated lands with brushy cover |
| **Birds** | | | | |
| *Botaurus lentiginosus* | American bittern | | E | Freshwater marshes with dense stands of reeds and cattails |
| *Calidris canutus rufa* | red knot | T | | Migrate from the artic to South America. Stopover habitat in Missouri most often includes muddy or sandy areas near the Missouri River |

| Scientific Name | Common Name | Federal Status[a] | State Status[a] | Habitat |
|---|---|---|---|---|
| *Charadrius melodus* | piping plover | T | | Wide, flat, open, sandy beaches with very little vegetation; Nesting occurs near small creeks or wetlands |
| *Sterna antillarum* | least tern | E | E | Sand islands along the lower Mississippi River; Historically nested on sand islands along the Missouri River |
| **Plants** | | | | |
| *Trifolium stoloniferum* | running buffalo clover | E | E | Moist, partially shaded woodlands and to a lesser extent, along stream or river terraces |

[a,b] T = threatened, E = endangered

Sources: MDC 2016e; NWMI 2015a; Niles et al. 2008; FWS 2015a, 2015b, 2015c; MDC 2000a, 2000b, 2016b, 2016c; NRC 2015e

#### *3.5.4.3 Migratory Bird Treaty Act*

The FWS administers the MBTA, which prohibits anyone from taking native migratory birds or their eggs, feathers, or nests. Regulations under the MBTA define a "take" differently than the ESA (16 U.S.C. 1532(19)) and define "take" as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to" carry out these activities (50 CFR 10.12). Unlike a "take" under the ESA regulations (50 CFR 17.3), a "take" under the MBTA does not include significant habitat alteration or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, such as breeding, feeding, or sheltering.

The MBTA protects a total of 1,007 migratory bird species (75 FR 9282). FWS (2015a) indicated that 20 migratory birds of concern may occur on or near the proposed Discovery Ridge site (Table 3–10). Near the proposed site, migratory birds rely on riparian, forested, grassland, and wetland habitats as important areas for foraging, resting, and avoiding predators and for breeding for some species. Although these habitats exist in the vicinity of the proposed site, none of them exists on the proposed site. For this reason, the proposed site likely provides low-quality habitat for migratory birds.

**Table 3–10. Migratory Birds of Concern that May Occur near the Proposed Discovery Ridge Site**

| Scientific Name | Common Name | Bird of Conservati on Concern | Occurrence in Project Area |
|---|---|---|---|
| **Birds** | | | |
| *Haliaeetus leucocephalus* | bald eagle | Yes | Year-round |
| *Vireo bellii* | bell's vireo | Yes | Breeding |
| *Thryomanes bewickii ssp. bewickii* | Benwick's wren | Yes | Year-round |

| Scientific Name | Common Name | Bird of Conservation Concern | Occurrence in Project Area |
|---|---|---|---|
| *Coccyzus erythropthalmus* | black-billed cuckoo | Yes | Breeding |
| *Vermivora pinus* | blue-winged warbler | Yes | Breeding |
| *Dendroica cerulea* | cerulean warbler | Yes | Breeding |
| *Spiza americana* | dickcissel | Yes | Wintering |
| *Passerella liaca* | fox sparrow | Yes | Wintering |
| *Ammodramus henslowii* | Henslow's sparrow | Yes | Breeding |
| *Oporornis formosus* | Kentucky Warbler | Yes | Breeding |
| *Ixobrychus exilis* | least bittern | Yes | Breeding |
| *Lanius ludovicianus* | loggerhead shrike | Yes | Year-round |
| *Podilymbus podiceps* | pied-billed grebe | Yes | Breeding |
| *Protonotaria citrea* | prothonotary warbler | Yes | Breeding |
| *Melanerpes erythrocephalus* | red-headed woodpecker | Yes | Year-round |
| *Euphagus carolinus* | rusty blackbird | Yes | Wintering |
| *Cistothorus platensis* | sedge wren | Yes | Breeding |
| *Asio flammeus* | short-eared owl | Yes | Wintering |
| *Hylocichla mustelina* | wood thrush | Yes | Breeding |
| *Helmitheros vermivorum* | worm eating warbler | Yes | Breeding |

Source: FWS 2015a

#### *3.5.4.4 Magnuson–Stevens Fishery Conservation and Management Act*

Magnuson–Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq., herein referred to as MSA), requires Federal agencies to consult with National Marine Fisheries Service (NMFS) on actions that may adversely affect essential fish habitat (EFH). The NMFS has not designated any EFH under the MSA within affected water bodies in the vicinity of the proposed site (NMFS 2016). Because no habitats are designated, no EFH would be affected by the proposed action. Therefore, this section does not discuss species with essential fish habitat.

## 3.6 Historic and Cultural Resources

The National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. 300101 et seq.), requires Federal agencies to consider the effects of their undertakings on historic properties. The historic preservation review process (Section 106 of the NHPA) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800. This section describes the archaeological history of Columbia, Missouri, and Boone County and identifies historic and cultural resources that could potentially be found on or near the Discovery Ridge site. The identification of these resources is based on a review of the Phase I survey of the Discovery Ridge site, historic literature and archaeological records, and an interview with an archaeologist with the MDNR State Historic Preservation Office (SHPO). Additional cultural resource information is available at MDNR in Jefferson City, Missouri.

### 3.6.1 Cultural Background

Human occupation in Missouri is generally characterized according to the following chronological sequence (MAS 2015):

- Paleo-Indian Period (11,500 to 9,900 years before present (B.P.)),
- Archaic Period (9,900 to 3,000 B.P.),
- Woodland Period (3,000 to 1,000 B.P.),
- Mississippian Period (1,000 to 400 B.P.), and
- Protohistoric/Historic Period (400 B.P. to present).

#### *3.6.1.1 Paleo-Indian Period (11,500 to 9,900 B.P.)*

The earliest evidence of people living in Missouri dates to the Paleo-Indian Period. Paleo-Indian sites are generally found upland or on river terraces and are characterized by specific types of projectile points (i.e., fluted Clovis points) and stone tools such as gravers, scrapers, or large blades. These artifacts often occur in association with mastodon remains, suggesting a reliance on the hunting of large mammals for subsistence, along with plants, small game, birds, and amphibians. Most fluted points have been found along major river valleys (e.g., Missouri River), although some have been recovered along streams such as the Moreau River. These finds suggest that the nomadic hunters and gatherers followed these streams in their movement through the Midwest area. Social organization during this period consisted of small, highly nomadic bands of hunter-gathers, leaving Paleo-Indian sites with little detailed archaeological information (NRC 2014; NWMI 2015a).

In Missouri, a distinct cultural tradition appeared in the transition from the Paleo-Indian to Archaic cultural periods: the Dalton Complex. Lasting approximately 1,000 years, from 10,000 to 9,000 B.P., the overall settlement pattern during this period continued to be nomadic and influenced by climatic rather than glacial conditions. Archaeological sites from this period tend to be located in areas that crosscut major resource zones, suggesting a change in subsistence strategies from primarily hunting large mammals to hunting smaller mammals, gathering plant resources, and exploiting marine resources such as mussels. All known Dalton sites in Missouri are small camps, and represent short-term utilization. Artifact assemblages from Dalton sites are characterized by distinct narrow, oval-shaped, unfluted projectile points (NRC 2014; NWMI 2015a).

#### *3.6.1.2 Archaic Period (9,900 to 3,000 B.P.)*

The Archaic Period was a time of major climatic shifts as the environment transitioned from a colder to warmer climate similar to modern conditions. In response to this shift, new technologies and subsistence strategies were developed. The Archaic Period is often subdivided into early, middle, and late periods. The Early Archaic Period is characterized by a shift from nomadic to more sedentary settlement patterns, with central base camps located on river terraces and smaller hunting camps located in upland areas. These sites are found in a variety of environmental settings throughout Missouri, including upland ridges near small ephemeral streams, upland bluff edges, rock shelters, and the margins of high bottomland terraces. The Early Archaic Period also shows an increased reliance on wild plant foods, small game, and aquatic resources.

The Middle Archaic Period is characterized by an increased number of settlement sites on high stream terraces, which may reflect population increases. While subsistence and settlement patterns remained fairly similar to the Early Archaic Period, artifact assemblages suggest increased exploitation of aquatic resources. Also in evidence are new artifacts such as pecked and ground stone tools, used for processing nuts; banner stones that signaled the innovation of a new projectile technology called the atlatl, or spear-thrower; and grooved axes.

The Late Archaic Period is characterized by an increase in the number and size of settlement sites, which indicates a further increase in population and more sedentary lifestyle. New features of Late Archaic artifact assemblages, such as crude ceramic vessels, represent a shift towards increased reliance on horticulture as a subsistence strategy, although hunting and gathering would have continued (NRC 2014; NWMI 2015a).

#### *3.6.1.3 Woodland Period (3,000 to 1,000 B.P.)*

The Woodland Period is also often subdivided into early, middle, and late periods. Early Woodland Period sites are not well represented in the Missouri archaeological record; they tend to be large base camps located in major river valleys, with smaller logistical camp sites located on terraces of smaller water bodies. This period is identified by the presence of Black Sand Incised pottery. In spite of intensive surveys in various areas of the State, only a few unquestionable Early Woodland sites have been identified. While Early Woodland Period subsistence appears to have relied on hunting and gathering, there is evidence for cultivating plants such as sunflowers and cucurbits (i.e., squashes, gourds, melons, etc.) (NRC 2014; NWMI 2015a).

During the Middle Woodland Period, the large and complex Hopewell Culture emerged in the United States, including Missouri. This culture is characterized by village settlements, increased reliance on horticulture, burial mounds, and trade networks. These trade networks facilitated the exchange of exotic materials, such as marine shells from the Gulf Coast, obsidian from the Rocky Mountains, copper from Lake Superior, and mica from the Appalachian Mountains. Middle Woodland artifact assemblages are dominated by ceramics, suggesting an increased reliance on cultivated plants (NRC 2014; NWMI 2015a).

The Late Woodland Period is characterized by an increase in the number of settlement sites, which suggests a rise in population, a change in settlement patterns from large, centralized village sites to smaller, dispersed habitation sites, or both. Late Woodland Period artifact assemblages are characterized by an increase in thin-walled plain ceramic types and stemmed and side-notched projectile points. The sudden appearance of very small, thin triangular projectile points between 1,300 and 1,400 B.P. indicates the invention of bow-and-arrow technology and suggests a corresponding change in hunting techniques. Several Late Woodland sites have been identified in Boone County, including open habitation sites and burial mounds (NRC 2014; NWMI 2015a).

#### *3.6.1.4 Mississippian Period (1,000 to 400 B.P.)*

The Mississippian Period is characterized by major changes in settlement, subsistence patterns, and social structure. This period is not well-documented in the general area of the proposed Discovery Ridge site. Large, highly centralized permanent settlements supported by many satellite villages emerged during this period. The archaeological record of these settlements suggests they were organized as chiefdoms with considerable social stratification. A new type of ceremonial earthen mound, the platform mound, appeared in association with these permanent settlements. Mississippian Period subsistence relied heavily on maize agriculture, as well as hunting and gathering. Craft specialists appeared in the social structure of the Mississippian Period, producing highly specialized lithic and ceramic artifacts, beadwork, and shell pendants. In addition to these specialized artifacts, characteristic Mississippian Period artifacts include small triangular, side-notched and bi-pointed projectile points and slipped and painted pottery (NRC 2014; NWMI 2015a).

Beginning about 1350, the Oneota cultural tradition appeared in the area near the junction of the Grand, Chariton, and Missouri Rivers. The Oneota occupation lasted to the end of the Mississippian period, when Oneota culture blended into what is recognized as the Historic Missouri Indian tribe (NWMI 2015a).

*3.6.1.5 Protohistoric/Historic Period (400 B.P. to Recent History)*

The end of the Mississippian Period is characterized by severe social, political, and demographic changes that resulted from contact with Europeans. In particular, it is believed that the introduction of infectious diseases such as smallpox, yellow fever, typhoid, and influenza severely decimated native populations, which had no immunity to these diseases. The spread of disease, which was often fatal, resulted in the abandonment of villages and the collapse of trade networks. By the time of European contact and settlement, the Mississippian chiefdoms were gone (NRC 2014).

The first major European expedition to Missouri was conducted by French Catholic missionaries sometime in the late 17th to early 18th centuries. Missouri (then called Upper Louisiana) was seen by the French as a place for new economic opportunity, and St. Louis was established as a center for fur trade in the area. By 1719, most of the interior of Missouri had been explored for fur trade and exploitation of mineral resources such as silver and lead (NRC 2014).

Beginning about 1730, the Missouri Indian tribe began to suffer losses due to smallpox and challenges from its enemies to the north, and in turn became increasingly dependent on their allies, the Osage, for protection. By the 1790s the Sac and Fox tribes had conquered and dispersed the Missouri Indian tribe, with those who were not killed joining the Osage, Kansas, and Oto tribes (NWMI 2015a).

The proposed Discovery Ridge site lies in territory claimed at different times by France and Spain until it was sold to the United States in 1803 as part of the Louisiana Purchase. The first permanent European settlers to the area soon followed. The U.S. Congress subsequently established the Territory of Missouri in 1812, and recognized Missouri as a state in 1821 (NWMI 2015a).

Most of the settlers who came to mid-Missouri were attracted to the land and cultivated crops that reproduced the agricultural patterns of their native states, including the slave-holding States of Kentucky, Tennessee, and Virginia. Major crops included hemp and tobacco, which demanded intensive labor for productivity (NWMI 2015a).

*3.6.1.6 Recent History – Columbia*

Columbia was incorporated in 1826, 5 years after Missouri achieved statehood. The city benefited from its proximity to stops on the Santa Fe and Oregon Trails, and later the Missouri Kansas Texas Railroad. The economy of Columbia has historically centered on education. A school for girls was opened in 1833, and an institution called Columbia College was opened in 1834 (NWMI 2015a).

Missouri University was established in Columbia in 1841. This was followed by the Christian Female College in 1851, which later changed its name to Columbia College (although not related to the earlier institution). Baptist Female College, now known as Stephens College, was established in 1855 (NWMI 2015a).

The coming of the railroad in the 1850s opened the interior to greater trade and established the area as a major source of agricultural products (NWMI 2015a). By the onset of the Civil War, slave holding began to drop and agricultural pursuits became almost entirely geared toward corn and wheat production. Columbia's economy also has strong ties to the health care industry, with it being among the top cities in the Nation for medical facilities per capita (NRC 2014; NWMI 2015a).

#### *3.6.1.7 Recent History – Discovery Ridge*

From 1934 to 2006, the Discovery Ridge Research Park was predominantly in crop production, livestock pasture, or vacant farmland. Since 2006, the western and northern portion has been in development as a research park that includes the Missouri University plant genetic research farm, while the eastern portion has remained in agricultural use. Several residential structures were removed from the site since the 1980s, including a small log cabin-type structure that was located on the central portion of the research park. Two small machine-shed structures dating from the 1950s and a Quonset hut used for storage by the USDA remain on site (NWMI 2015a; Terracon 2011a).

### 3.6.2 Historic and Cultural Resources

Databases that the National Park Service (NPS) maintains show 50 properties listed in the National Register of Historic Places in Boone County, with the vast majority of them located in and around Columbia under the National Historic Preservation Act (54 U.S.C. 300101 et seq.). However, no historic properties are located at the Discovery Ridge site. The nearest property in the National Register of Historic Places list is the Maplewood House, which is located about 1 mi (1.6 km) northwest of the proposed NWMI facility site at Discovery Ridge (NWMI 2015a). The view from the Maplewood House of the proposed Discovery Ridge site is obstructed by trees and residential and commercial properties.

NWMI conducted a Phase I survey investigation in October 2013 to inventory and evaluate cultural resources within the Discovery Ridge site. The Phase I investigation included (1) a pre-field evaluation of pertinent literature and records from which the field survey techniques and site designation criteria were developed, (2) an intensive pedestrian survey of the project area, (3) an attempt to recover sufficient data for site designation and evaluation in terms of NRHP eligibility requirements, (4) notation of locational information regarding site provenience and physiographic setting, (5) post-field activities involving data analysis, and (6) report preparation (NWMI 2015a).

A review of relevant publications and archaeological records provides an understanding of the types of historic and cultural resources that could be found at the Discovery Ridge site. Based on the review of historical information, no archaeological sites or historic structures have been recorded nor have any significant historic events occurred within Lot 15. A review of 19th and 20th century plat maps and 20th century USGS topographic quadrangles also revealed no evidence of historic structures on Lot 15.

A Phase I archeological survey was conducted at the proposed Discovery Ridge site, which included shovel tests to interpret the presence of historic and cultural resources. No evidence of historic or cultural resources were found within the Lot 15 survey area. As a result, Lot 15 at the Discovery Ridge site contains no significant cultural resources (NWMI 2015a).

A Cultural Resource Assessment, Section 106 Review, was conducted by the MDNR SHPO for the proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility, Columbia (Lot 15 at Discovery Ridge). The assessment, signed by Toni M. Prawl, Ph.D., Deputy State Historic Preservation Officer, states that, “Adequate documentation has been provided (26 CFR Section 800.11). There will be ‘no historic properties affected’ by the current project.” The assessment also states, the MDNR SHPO has “no objection to the initiation of project activities.” (MDNR 2015b).

## 3.7 Socioeconomics

This section describes current socioeconomic factors that have the potential to be directly or indirectly affected from construction, operations, and decommissioning of the proposed NWMI facility. The NWMI facility and the communities that would support it can be described as a dynamic socioeconomic system. The communities provide the people, goods, and services required to construct, operate, and decommission the proposed NWMI facility. NWMI facility operations, in turn, provide wages and benefits for people and dollar expenditures for goods and services. The measure of a community's ability to support the construction, operations, and decommissioning of the proposed NWMI facility depends on its ability to respond to changing environmental, social, economic, and demographic conditions.

The socioeconomic region of influence (ROI) is defined by the area in which NWMI construction, operations, and decommissioning employees and their families would likely reside, spend their income, and use their benefits—all of which affect economic conditions of the region. For the purposes of analysis and because of the relatively small size of the NWMI operations work force (approximately 100 workers), this area includes all of Boone County and the City of Columbia, Missouri.

### 3.7.1 Population Growth Rates and Projections

The population for Boone County has grown steadily from 1980 through 2010, with the largest increase between 1990 and 2010 (see Table 3–11). Based on population projections from the Missouri Department of Administration, Division of Budget and Planning, the population within Boone County is projected to continue to increase.

**Table 3–11. Boone County Population (1980–2050)**

| Year | Population | Percent Change |
|---|---|---|
| 1980 | 100,376 | – |
| 1990 | 112,379 | 12.0 |
| 2000 | 135,454 | 20.5 |
| 2010 | 162,642 | 20.1 |
| 2014 | 172,717 | 5.8 |
| 2020 | 183,101 | 12.2 |
| 2030 | 204,264 | 11.6 |
| 2040 | 225,427 | 10.4 |
| 2050 | 246,590 | 9.4 |

Sources: Decennial population data for 1970-2010, and estimated 2014 (USCB 2016b); projections for 2020-2030 by State of Missouri, Office of Administration, Division of Budget and Planning (Missouri Office of Administration 2016); 2040-2050 calculated.

### 3.7.2 Race and Ethnicity

Table 3–12 presents the demographic profiles for the City of Columbia and Boone County. In 2010, minorities comprised 23 percent of the total population in the City of Columbia. As shown in Table 3–12, the largest minority populations were Black or African American at 11.1 percent followed by Asians at 5.2 percent. In Boone County, minorities comprised 19 percent of the total population in 2010. The largest minority populations were Black or African American at 9.2 percent followed by Asians at 3.8 percent.

**Table 3–12. Race and Ethnicity for Columbia and Boone County, Missouri, in 2010**

| | Columbia | Boone County |
|---|---|---|
| **Total Population** | **108,500** | **162,642** |
| **Race (percent of total population, Not-Hispanic, Latino, or Spanish ethnicity)** | | |
| White | 77.0 | 81.0 |
| Black or African American | 11.1 | 9.2 |
| American Indian and Alaska Native | 0.3 | 0.3 |
| Asian | 5.2 | 3.8 |
| Native Hawaiian and Other Pacific Islander | 0.1 | 0.1 |
| Some other race | 0.2 | 0.2 |
| Two or more races | 2.7 | 2.5 |
| **Ethnicity** | | |
| Hispanic or Latino (population) | 3,729 | 4,895 |
| Percent of total population | 3.4 | 3.0 |
| **Minority population (including people of Hispanic, Latino, or Spanish ethnicity)** | | |
| Total minority population | 24,958 | 30,965 |
| Percent minority | 23.0 | 19.0 |

Source: USCB 2016c

According to the U.S. Census Bureau's 2014 American Community Survey 1-Year Estimates, since 2010 minority populations in the City of Columbia and Boone County were estimated to have increased by approximately 3,000 to 4,000 persons and now comprise 24 and 20.2 percent of the respective populations (see Table 3–13). In the City of Columbia, the largest increase occurred in the Asian and Black or African American populations, an increase of 10.3 and 6.3 percent, respectively. In Boone County, the largest increase occurred in the Hispanic, Latino, or Spanish origin of any race and Asian populations, an increase of 14.2 and 10.6 percent, respectively.

**Table 3–13. Race and Ethnicity for Columbia and Boone County, Missouri, in 2014**

| | Columbia | Boone County |
|---|---|---|
| **Total Population** | 116,892 | 172,717 |
| **Race (percent of total population, Not-Hispanic, Latino, or Spanish ethnicity)** | | |
| White | 76.0 | 79.8 |
| Black or African American | 11.1 | 8.8 |
| American Indian and Alaska Native | 0.0 | 0.0 |
| Asian | 5.3 | 3.9 |
| Native Hawaiian and Other Pacific Islander | 0.0 | 0.0 |
| Some other race | 0.1 | 0.2 |

| | Columbia | Boone County |
|---|---|---|
| Two or more races | 4.4 | 4.1 |
| **Ethnicity** | | |
| Hispanic or Latino (population) | 3,620 | 5,588 |
| Percent of total population | 3.1 | 3.2 |
| **Minority population (including people of Hispanic, Latino, or Spanish ethnicity)** | | |
| Total minority population | 28,082 | 34,941 |
| Percent minority | 24.0 | 20.2 |
| Source: USCB 2016c | | |

### 3.7.3 Transient Population

Colleges and recreational opportunities attract daily and seasonal visitors who create a demand for temporary housing and services. In 2015, approximately 55,800 students attended colleges and universities within 20 mi (32 km) of the proposed NWMI facility at Discovery Ridge (NCES 2015a). Based on 2014 American Community Survey 1-Year Estimates, approximately 2,227 seasonal housing units are located in Boone County (USCB 2016d).

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. Some migrant workers follow the harvesting of crops, particularly fruit, throughout rural areas of the United States. Migrant workers may be members of minority or low-income populations. Because migrant workers travel and can spend a significant amount of time in an area without being actual residents, they may be unavailable for counting by Census takers. If uncounted, these minority and low-income workers would be “underrepresented” in the decennial Census population counts.

Information about both migrant and temporary farm labor (working less than 150 days) can be found in the 2012 Census of Agriculture. According to the 2012 Census of Agriculture, approximately 470 temporary farm workers were hired to work on 196 farms in Boone County, Missouri. Only one farm in Boone County reported hiring migrant workers in the 2012 Census of Agriculture (NASS 2014).

### 3.7.4 Labor Force, Employment, and Unemployment

This section provides labor force, employment, and unemployment data for the City of Columbia, Boone County, and the State of Missouri. It also presents economic data on employment by industry, income, poverty levels, occupations, wages, poverty rates, and housing.

Table 3–14 shows that Boone County had an estimated available civilian labor force in 2014 of 97,498, with a 2.9 percent unemployment rate. The City of Columbia had an available labor force of 67,702, with a 2.4 percent unemployment rate.

**Table 3–14. Labor Force, Employment, and Unemployment Rates in Missouri, Boone County, and the City of Columbia (2014)**

| | Missouri | Boone County | Columbia |
|---|---|---|---|
| Civilian Labor Force | 3,009,857 | 97,498 | 67,702 |
| Employed | 2,805,646 | 93,405 | 65,355 |
| Unemployed | 204,211 | 4,093 | 2,347 |
| Unemployment rate | 4.2 | 2.9 | 2.4 |

Source: USCB 2016d

Table 3–15 shows employment by industry for Boone County for 2014. According to 2014 American Community Survey estimates, the educational, health, and social services industry represented the largest employment sector in Boone County (36.3 percent) followed by retail trade (14.5 percent) and arts, entertainment, recreation, accommodation, and food services (12.3 percent).

**Table 3–15. Employment by Industry in Boone County for 2014**

| Industry | Employment | Percent |
|---|---|---|
| Total employed civilian workers | 93,405 | – |
| Agriculture, forestry, fishing, hunting, and mining | 800 | 0.9 |
| Construction | 3,151 | 3.4 |
| Manufacturing | 4,153 | 4.4 |
| Wholesale Trade | 1,727 | 1.8 |
| Retail Trade | 13,583 | 14.5 |
| Transportation, warehousing, and utilities | 3,032 | 3.2 |
| Information | 2,209 | 2.4 |
| Finance, insurance, real estate, rental, and leasing | 7,543 | 8.1 |
| Professional, scientific, management, administrative, and waste management services | 5,308 | 5.7 |
| Educational, health, and social services | 33,943 | 36.3 |
| Arts, entertainment, recreation, accommodation, and food services | 11,501 | 12.3 |
| Other services (except public administration) | 3,402 | 3.6 |
| Public administration | 3,053 | 3.3 |

Source: USCB 2016d

### 3.7.5 Income and Wages and Poverty

Table 3–16 presents the median family and per capita income figures for Missouri, Boone County, and the City of Columbia. According to 2014 American Community Survey 1-Year Estimates, Boone County has a higher median household income average than both the State of Missouri and the City of Columbia. The City of Columbia had a lower per capita income average than Boone County and the State of Missouri.

**Table 3–16. Median Family Income and Per Capita Income for the City of Columbia, Boone County, and State of Missouri in 2014**

| | Missouri | Boone County | Columbia |
|---|---|---|---|
| Median household income (dollars)[a] | 48,363 | 50,085 | 46,624 |
| Per capita income (dollars)[a] | 26,126 | 25,928 | 24,656 |
| Families living below the poverty level (percent) | 10.7 | 11.3 | 13.2 |
| Individuals living below the poverty level (percent) | 15.5 | 20.7 | 24.9 |

[a] In 2014 inflation adjusted dollars.

Source: USCB 2016d

Table 3–16 also presents the percentages of families and individuals living below the Federal poverty threshold in Missouri, Boone County, and the City of Columbia. The poverty levels in 2014 were $12,071 for an individual and $24,230 for a family of four (USCB 2016d). According to 2014 American Community Survey 1-Year Estimates, the City of Columbia had a higher percentage of families and people living below the poverty level than Boone County as a whole.

### 3.7.6 Housing

Table 3–17 lists the total number of occupied and vacant housing units, vacancy rates, and median value in Boone County and the City of Columbia. Based on 2014 American Community Survey estimates, there were approximately 73,000 housing units in Boone County, of which nearly 67,000 were occupied. The median values of owner-occupied housing units in Boone County was $170,700. The vacancy rate for all housing was 8.2 percent and 2.3 percent for rental units alone (USCB 2016e).

**Table 3–17. Housing Unit Characteristics for Boone County and City of Columbia in 2014**

| | Boone County | Columbia |
|---|---|---|
| **Total housing units** | **73,173** | **49,842** |
| Occupied housing units | 67,198 | 45,405 |
| Total vacant housing units | 5,975 | 4,437 |
| Percent total vacant | 8.2 | 8.9 |
| Owner occupied units | 37,296 | 21,561 |
| Median value (dollars) | 170,700 | 185,600 |
| Owner vacancy rate (percent) | 0.0 | 0.0 |
| Renter occupied units | 29,902 | 23,844 |
| Median rent (dollars/month) | 802 | 814 |
| Rental vacancy rate (percent) | 2.3 | 1.7 |

Source: USCB 2016e

### 3.7.7 Local Employers

Table 3–18 lists the 10 largest employers in the City of Columbia and Boone County. These employers provide a variety of products and services, including educational and medical services, local government, financial and insurance services, and wholesale distribution.

**Table 3–18. Ten Largest Employers in the City of Columbia and Boone County (2014)**

| Employer | Number of Employees | Product/Service |
|---|---|---|
| University of Missouri | 8,750 | Educational services |
| University Hospitals and Clinics | 5,575 | Medical services |
| Columbia Public Schools | 2,417 | Educational services |
| Boone Hospital Center | 1,750 | Medical services |
| City of Columbia | 1,416 | City government |
| Truman Memorial Veteran’s Hospital | 1,276 | Medical services |
| Veterans United Home Loans | 1,400 | Financial services |
| Shelter Insurance Companies | 1,109 | Insurance services |
| MBS Textbook Exchange | 863 | College textbook wholesaler |
| State Farm Insurance | 850 | Insurance services |

Source: Columbia Daily Tribune 2015a

### 3.7.8 Taxes

The Missouri personal income tax rates range from 1.5 to 6 percent, assessed over 10 income brackets. The rates start at 1.5 percent on the first $1,000 of taxable income. The rate increases 0.5 percent on each additional $1,000 up to $9,000. The tax rate for income above $9,000 is 6 percent (MDOR 2016).

Missouri has a State sales tax of 4.225 percent that is levied on the purchase price of tangible personal property or taxable services sold at retail. The City of Columbia and Boone County have additional sales tax rates of 3.75 and 1.75 percent, respectively. These rates are in addition to the State tax rate of 4.225 percent.

The Missouri corporate tax rate is 6.25 percent. Only income earned in Missouri is taxed (MDOR 2016). Missouri permits companies to choose the formula that results in the lesser corporate income tax liability. Missouri also allows a portion of Federal income tax payments to be deducted before computing taxable income.

Missouri local governments rely on real (real estate) and personal property tax revenue to fund school districts, public transport, infrastructure, and other municipal government projects. Property tax rates are set each year by local taxing jurisdictions within the limits set by the Missouri Constitution and laws. Rates are based on the revenues that had been permitted for the prior year with an allowance for growth based on the rate of inflation (Boone County Collector of Revenue 2016).

Taxes are levied against property based on the rates as permitted by voters, collected by the collector and then distributed back to the taxing entities. In other words, Boone County collects property taxes on behalf of the taxing entities within the County (Boone County Collector of Revenue 2016).

The amount of property taxes imposed on any taxpayer is determined by two separate factors:

(1) The assessed value of the property, as established by the local assessor.

(2) The tax rates set by local taxing jurisdictions plus the $0.03 State tax rate. In 2015, Boone County levied a property tax rate of $0.2846, the City of Columbia a tax rate of $0.4100, and Columbia Public Schools a tax rate of $5.4656. (Boone County Collector of Revenue 2016).

### 3.7.9 Education

There are six public school districts located within Boone County. The Columbia Public School District services the population within the 5-mi (8-km) radius of the proposed NWMI facility at Discovery Ridge. Total enrollment in the Columbia School District was 17,872 during the 2013-2014 school year (NCES 2015b).

### 3.7.10 Public Recreation for Boone County

The parks and open spaces within Boone County are listed in Table 3–19, along with their approximate distance from the proposed NWMI facility at the Discovery Ridge site.

**Table 3–19. Parks within a 5-mi (8-km) Radius of the Proposed NWMI Facility Site**

| Park/Open space | Approximate distance from proposed site (mi/km) | General direction | Park/Open space | Approximate distance from proposed site (mi/km) | General direction |
|---|---|---|---|---|---|
| A. Perry Philips Park | 0.7/1.1 | West | Eastport Park | 3.6/5.8 | Northeast |
| Nifong Park | 1.1/1.8 | Northwest | Stephens Lake Park | 3.6/5.8 | North |
| Gans Creek Recreation Area | 1.3/2.1 | Southwest | Cliff Drive Park | 3.7/5.9 | Northwest |
| Rock Bridge Memorial State Park | 2/3.2 | Southwest | Rock Bridge Park | 3.7/5.9 | Northwest |
| Rock Quarry Park | 2/3.2 | Northwest | Woodridge Park | 3.8/6.1 | North |
| Waters-Moss Memorial Wildlife Area | 2.2/3.5 | Northwest | Columbia Country Club | 4/6.4 | North |
| Old Hawthorne Gold Club | 2.6/4.5 | Northwest | A.L. Gustin Golf Course | 4.1/6.6 | Northwest |
| Grindstone Nature Area | 2.8/4.5 | Northwest | Paquin Park | 4.2/6.8 | Northwest |
| Shepard Park | 2.8/4.5 | North | Willis Quad | 4.2/6.8 | Northwest |
| American Legion Park | 2.9/4.6 | North | Peace Park | 4.3/6.9 | Northwest |
| Old 63 Roadside Park | 3.0/4.8 | Northwest | Grasslands Park | 4.5/7.2 | Northwest |
| Capen Park | 3.1/4.9 | Northwest | Oakwood Hills Park | 4.5/7.2 | Northwest |
| Highpointe Park | 3.2/5.1 | Northwest | Flat Branch Park | 4.6/7.4 | Northwest |

| Park/Open space | Approximate distance from proposed site (mi/km) | General direction | Park/Open space | Approximate distance from proposed site (mi/km) | General direction |
|---|---|---|---|---|---|
| Three Creeks Conservation Area | 3.2/5.1 | South | McKee Street Park | 4.8/7.7 | North |
| Cosmo-Bethel Park | 3.6/5.8 | West | Forum nature Area | 5/8 | Northwest |

Source: NWMI 2015a

In addition to the parks, several other public facilities are located within a 5-mi (8-km) radius of the proposed NWMI facility at Discovery Ridge, including:

**Aquatic centers** – The Columbia Parks and Recreation Department manages four outdoor and two indoor pools. Only two of these facilities, Douglass Family Aquatic Center and Stephens Lake Swimming Beach and Spraygrounds are located within a 5-mi (8-km) radius of the proposed NWMI facility at Discovery Ridge. The Douglass Family Aquatic Center is an outdoor facility that consists of a recreational pool, a slide, and a spray park. The Stephens Lake Swimming Beach and Spraygrounds consists of a lake and spraygrounds.

**Columbia Area Seniors Center** – The Columbia Area Seniors Center offers services and activities for seniors, including meals, computers, and meeting places for activities.

**Armory Sports & Recreation Center** – This indoor facility is used for basketball, volleyball, meetings, aerobics, and other programs. The facility includes a gymnasium, classroom, meeting room, aerobics room, a cardio/strength training area, computer room, general recreation room, and locker rooms (NWMI 2015a).

### 3.7.11 Public Services

<u>Medical</u>

The City of Columbia and Boone County have many medical care facilities, including four hospitals and one veteran's hospital. Boone Hospital Center has 321 beds, Landmark Hospital of Columbia has 42 beds, the University of Missouri Hospital has 528 beds, and Woman's and Children's Hospital has 98 beds (American Hospital Directory 2016).

<u>Emergency Services</u>

The Columbia/Boone County Office of Emergency Management is located in the City of Columbia. The Public Joint Communications Center coordinates County and City-wide responses and supports other local governments during major disasters and emergencies. It also prepares other governmental entities, private business, volunteer organizations, and citizens to respond and recover from major emergencies and disasters. The Public Joint Communications Center has a 24-hr dispatching service for City and County police and law enforcement, fire and rescue, and emergency medical services (Boone County).

<u>Public Water</u>

Table 3–20 lists the public water suppliers in Boone County and provides water source and population served for those suppliers. The Columbia Water Treatment Plant is owned by the City of Columbia and operated by the Water and Light Department. The service territory of the Columbia Water Treatment Plant includes the City of Columbia, where the majority of customers

reside. Public Water Supply District 9 currently provides service to the northeast portion of the proposed NWMI facility site.

**Table 3–20. Public Water Supply Systems in Boone County**

| Public Water System | Source | Population Served[a] |
|---|---|---|
| Ashland | Groundwater | 3,707 |
| Boone County Consolidated Public Water Supply District 1 | Groundwater | 21,500 |
| Boone County Public Water Supply District 10 | Groundwater | 4,625 |
| Boone County Public Water Supply District 4 | Groundwater | 6,455 |
| Boone County Public Water Supply District 9 | Groundwater | 12,200 |
| Centralia | Groundwater | 4,027 |
| Columbia | Groundwater | 100,733 |
| University of Missouri Columbia | Groundwater | 40,319 |

[a] Safe Drinking Water Search for the State of Missouri.

Source: EPA 2016g

## 3.8 Human Health

The proposed NWMI facility is a potential source of radiation and chemical exposure to onsite workers and offsite members of the public. Human health can be adversely affected by radioactive and chemical materials in the environment. The following sections discuss potential receptors in the vicinity of the Discovery Ridge site to radioactive and chemical materials, existing conditions at the Discovery Ridge site and surrounding area, and laws and regulations to protect workers and the public against potential health risks from exposure to radioactive materials and hazardous chemicals used, generated, and released from the licensed facility.

### 3.8.1 Sensitive Receptors

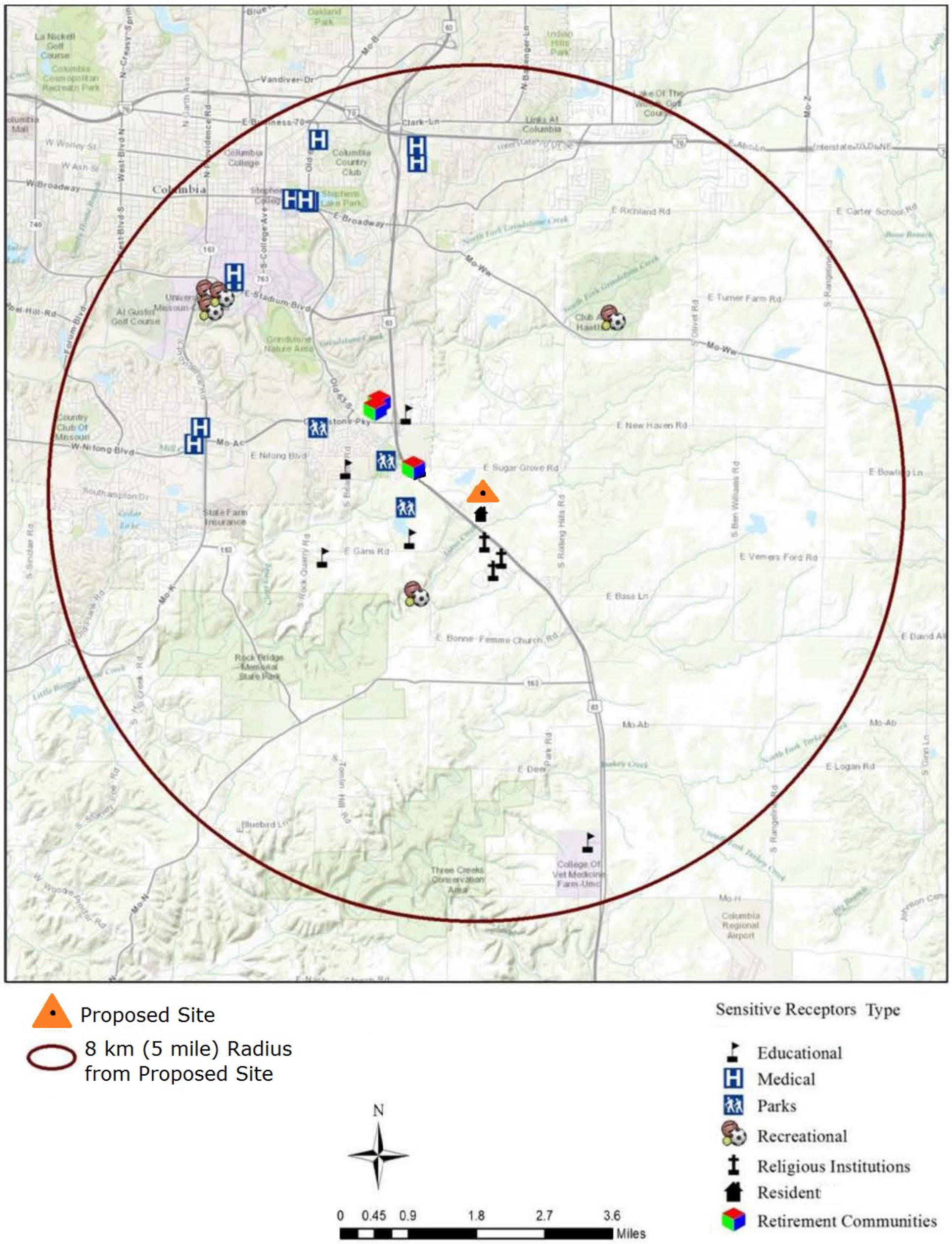
The NRC evaluates the potential human health impacts in a region of interest (ROI) primarily within a 5-mi (8-km) radius from the proposed NWMI facility. Figure 3–14 identifies sensitive receptors (schools, medical facilities, parks, recreational areas, religious institutions, and retirement communities) that are within a 5-mi (8-km) radius of the proposed Discovery Ridge site. Table 3–21 identifies the distances to the nearest sensitive receptors from the proposed Discovery Ridge site. As discussed in Section 3.4.2, the nearest domestic supply well is located approximately 0.7 mi (1.1 km) northeast of the site and a public water supply well is located approximately 0.8 mi (1.3 km) south, southeast of the Discovery Ridge site.

**Table 3–21. Sensitive Receptors from the Discovery Ridge Site**

| | Distance (mi) | General Direction |
|---|---|---|
| Resident | 0.27 | South |
| Elementary School | 1.0 | Northwest |
| Child Care/Preschool | 1.7 | North |
| Hospital | 3.3 | West |

| | Distance (mi) | General Direction |
|---|---|---|
| Retirement/Assisted Living Facility | 0.91 | Northwest |
| Source: NWMI 2015a | | |

**Figure 3–14. Location of Sensitive Receptors Near the Proposed Discovery Ridge Site**




Source: Modified from NWMI 2015a

### 3.8.2 Radiation and Nuclear Hazards

#### *3.8.2.1 Pathways for Human Exposure to Radiation and Radioactivity*

Radioactive material released into the environment can expose individuals through the following pathways:

- Inhalation exposure pathway: inhaling contaminated airborne emissions;
- Direct radiation: material that is deposited on the ground from passing airborne emissions becomes an external exposure source of direct radiation; exposure to radioactive waste or other radioactive material.
- Ingestion exposure pathway: Radioactive materials can be transported through a variety of routes into the human diet. Drinking milk or eating meat from animals that grazed on open pasture on which radioactive material was deposited; eating vegetables grown that are contaminated with radioactive material; and direct consumption of contaminated surface water or groundwater.

#### *3.8.2.2 Major Sources and Levels of Radiation*

*Naturally Occurring Background Sources*

Naturally occurring background radiation is always present and originates from cosmic, terrestrial, and internal (within the human body) sources. Cosmic radiation comes from the sun and stars, and the dose received varies with weather and elevation. In the City of Columbia, where the proposed site is located, the average annual dose from cosmic radiation is approximately 28 millirem (mrem) (NWMI 2015a).

Terrestrial radiation comes from naturally occurring radionuclides in soil, water, and air. Areas with high natural soil concentrations of radioactive uranium or thorium are typically associated with higher terrestrial radiation doses, due to the dose from other radionuclides, particularly radon, which are produced by the decay of uranium and thorium. Based on Missouri's average uranium and thorium concentrations, the average annual terrestrial radiation dose at the proposed site is approximately 228 mrem (NWMI 2015a).

Internal radiation comes from the radioisotopes potassium-40 and carbon-14, which occur naturally in the human body. A person's average annual internal radiation dose is approximately 30-40 mrem (NWMI 2015a; EPA 2016i).

*Current Human-Made Sources of Radiation:*

As discussed in Section 3.8.1, there are numerous medical facilities in the ROI. These facilities may use ionizing radiation for medical imaging or treatment (NWMI 2015a). The average person receives a dose of about 310 mrem per year from human-made radiation sources; about 96 percent of this dose comes from medical procedures (NRC 2016e).

The University of Missouri research reactor (MURR) is located approximately 4 mi (6.4 km) from the proposed Discovery Ridge site. The radiological environmental monitoring program at MURR, and the environmental effects of operation of the MURR, are discussed in detail in Section 3.10.1. The regulations at 10 CFR 50.47 require that, in general, nuclear power reactors shall have an emergency planning zone (EPZ) that consists of an area about 50 mi (80 km) in radius. The Callaway Energy Center, a nuclear power plant, is located about 28 mi (45 km) southeast of the proposed NWMI facility site; therefore, the proposed site is within the EPZ for the Callaway Energy Center.

The Callaway Energy Center has a radiological environmental monitoring program that includes collection of water, terrestrial, air, and biological samples. Surface water, groundwater, drinking water, and sediment samples are collected on either a monthly, quarterly, or semi-annual basis, and are analyzed for gamma-emitting isotopes. The water samples are also analyzed for tritium. Soil samples are collected on an annual basis and analyzed for gamma-emitting isotopes. Continuous air monitoring is performed to monitor for iodine-131 and other gamma isotopes in air; the filters from the continuous air monitor systems are analyzed weekly. Biological sampling includes collection and gamma isotope analysis of milk, fish, and vegetation on either a monthly or semi-annual basis. Although radionuclides were detected in water, terrestrial, air, and biological samples in 2012, 2013, and 2014, the types and quantities of radionuclides were consistent with naturally occurring levels and/or historical data at the Callaway site. The Callaway Energy Center's radiological environmental monitoring program also measures direct ambient gamma radiation at 40 locations using thermoluminescent dosimeters (TLDs). During 2012, 2013, and 2014, the dose levels measured by these TLDs were similar to historical results (AMEREN 2013, 2014, 2015).

Analytical Bio-Chemistry Laboratories Inc. (ABC) currently engages in the industrial and commercial use of radiation. The ABC Laboratories facilities, located approximately 500 ft (152 m) and 5 mi (8 km) from the proposed site, use radiation and radioactive materials for various research and analysis purposes. Although occupational dose monitoring is conducted for ABC Laboratories personnel, no radiological environmental monitoring program is currently required for the ABC Laboratories facilities (NWMI 2015a; NRC 2015h).

Historical radionuclide releases to the environment have occurred at the ABC Laboratories site approximately 5 mi (8 km) northeast of the proposed NWMI facility site. In 1968, two sanitary lagoons were constructed for collection of liquid effluents containing radionuclides, primarily carbon-14. In 1986, these lagoons were closed, and they were later backfilled. Also in 1986, a third lagoon was constructed and placed into use. The third lagoon was closed in 2004, drained in 2011, and backfilled in 2012. Low levels of radioactivity continue to be present at the lagoons. However, surveys have shown these levels of radioactivity to be very low. In 2011, the NRC determined that the portion of the site containing the two older backfilled lagoons met the criteria in 10 CFR 20.1402 for unrestricted use, and that area was released for unrestricted use. In 2013, the NRC approved a partial site release for unrestricted use for the portion of the ABC Laboratories site containing the newer backfilled lagoon (NWMI 2015a; ABC 2010, 2011; NRC 2011a, 2013c, 2013d).

In addition, the University of Missouri's Pickard Hall, which is also within the ROI, contains legacy radium contamination from radioactive material separation activities conducted in the 1900s through 1930s. Although personnel monitoring is conducted for selected Pickard Hall faculty and staff, and an internal standard operating procedure is used to help avoid the further spread of radioactive contamination within the building or to the environment, no radiological environmental monitoring program is associated with the University of Missouri's Pickard Hall (NWMI 2015a; MU 2013). The radioactive material separation activities performed in Pickard Hall resulted in some radium contamination of subsurface soil in the immediate vicinity of Pickard Hall, in addition to the contamination within the building. The internal standard operation procedure used at Pickard Hall helps to avoid any further spread of the subsurface soil contamination by limiting disturbance of the subsoil (NWMI 2015a; MU 2013).

#### *3.8.2.3 Regulations Governing Dose from Human-Made Sources of Radiation*

The Atomic Energy Act of 1954, as amended (42 U.S.C. 2011 et seq.), gives the NRC authority to issue and enforce standards that provide an adequate level of protection for public health and safety and that protect the environment. The NRC staff evaluates the latest radiation protection recommendations from national and international scientific bodies as a basis for its radiation protection standards (10 CFR Part 20). A radioisotope production facility utilizing enriched uranium must receive a license from the NRC and comply with NRC regulations and conditions specified in the license to operate. A licensee is required to comply with occupational dose limits for adults (10 CFR Part 20, Subpart C) and radiation dose limits for individual members of the public (10 CFR Part 20, Subpart D).

The NRC staff evaluates the impact to human health from human-made sources of radiation or radioactive material by comparing the estimated dose to a person (occupational worker or member of the public) from the radiation source to the NRC's radiation protection dose limits in 10 CFR Part 20. The dose limits in 10 CFR Part 20 do not apply for radiation doses received by patients during medical imaging or treatment. Dose is calculated based on the amount of material, and either the amount of time spent in the vicinity of the radioactive material, or the amount of time an individual's body retains radioactive material that has been inhaled or ingested.

The NRC regulations at 10 CFR 20.1201 establish occupational dose limits for adults. The regulations at 10 CFR 20.1201 specify an annual maximum allowable occupational dose (total effective dose equivalent or TEDE) of 5 rem to a radiation worker from exposure to radiation and radioactive material at a licensed facility. The regulations at 10 CFR 20.1201 also specify limits on occupational doses to individual organs or tissues, including a 50 rem annual maximum allowable dose to the skin of the extremities.

Under 10 CFR 20.2206, the NRC requires licensees to submit an annual report of their results of individual monitoring for each individual who required monitoring under 10 CFR 20.1502 during a given year. The NRC regulations at 10 CFR 20.2202 and 20.2203 require licensees to submit reports of incidents and occurrences involving personnel radiation exposures that exceed regulatory limits. Licensees are required to investigate incidents and occurrences and to take corrective actions as necessary.

The NRC regulations at 10 CFR 20.1301 specify an annual maximum allowable dose of 100 mrem to a member of the public from exposure to radiation and radioactive material at a licensed facility. In addition, 10 CFR 20.1101(d) imposes a 10 mrem constraint on dose from airborne radioactive material released into the environment. This dose constraint, which is applicable to the proposed NWMI facility, implements 10 CFR 20.1101(b), which requires NRC licensees to use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve doses to members of the public and occupational workers that are as low as is reasonably achievable. The NRC regulations at 10 CFR 20.1302(a) require licensees to make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas (both within and outside the site boundary), and to measure concentrations of radionuclides in effluents released from the facility, to demonstrate compliance with dose limits for individual members of the public. The NRC regulations at 10 CFR 20.2203 require licensees to submit reports of incidents and occurrences involving radiation exposures to members of the public that exceed regulatory limits.

### 3.8.3 Chemical Hazards

Chemicals enter the body through the skin, by inhalation, or by ingestion. Chemical exposure produces different effects on the body, depending on the chemical and the amount of exposure. Chemicals can cause cancer, affect reproductive capability, disrupt the endocrine system, and have other health effects. Acute effects from chemical exposure occur immediately (e.g., when somebody inhales or ingests a poisonous substance). Chronic or delayed effects result in symptoms, such as skin rashes, headaches, breathing difficulties, and nausea (NRC 2013b).

The EPA is responsible for the regulation of most chemicals that can enter the environment. The EPA regulates the management, including treatment, storage, and disposal, of hazardous chemicals. The EPA administers the following Federal acts related to chemical contamination: the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA); Toxic Substances Control Act (TSCA); Resource Conservation and Recovery Act (RCRA); Clean Water Act (CWA); Safe Drinking Water Act (SDWA); Clean Air Act (CAA); and Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (NRC 2013b). Other Federal acts are also implemented in the EPA's regulations, as applicable.

EPA and MDNR regulations require reporting of environmental releases of certain toxic chemicals manufactured, processed, or otherwise used at a facility, if those releases are above threshold quantities (EPA 2016b, 2016h; NRC 2013b). Such releases from facilities must be reported to the EPA Toxics Release Inventory (TRI) Program in accordance with Section 313 of the Emergency Planning and Community Right-to-Know Act. Chemicals covered by the TRI program are those that cause cancer or other chronic human health effects, significant adverse acute human health effects, or significant adverse environmental effects. The current TRI toxic chemical list contains 594 chemicals. Within a 5-mi (8-km) radius of the Discovery Ridge site there are 11 facilities that release TRI chemicals to the environment and are required to submit annual reports on releases to the EPA (EPA 2016h; EPA 2016b).

EPA and MDNR regulations also require permitting of facilities that generate hazardous wastes above threshold quantities. Within the Discovery Ridge Research Park, two facilities, ABC and IDEXX Bioresearch, are EPA and MDNR permitted hazardous waste generators. These facilities conduct analytical testing in biological or pharmaceutical applications. Reagent grade organic and inorganic chemicals, some of which are hazardous materials, are used to conduct analytical research at these facilities (EPA 2016d). ABC is a large quantity generator and in 2013 this facility generated 17.8 tons of hazardous waste. IDEXX is a small quantity generator (EPA 2016d). The University of Missouri South Farm (approximately 1.0 mi (1.6 km) from Discovery Ridge) and the Columbia Environmental Research Center (0.9 mi (1.5 km) from Discovery Ridge) are also permitted small quantity hazardous waste generators (EPA 2016d). These facilities are periodically inspected to ensure compliance with applicable waste management regulations.

### 3.8.4 Other Hazards

The proposed NWMI facility will be an industrial facility with many of the typical occupational hazards found at other industrial manufacturing or production facilities. Workplace hazards can be grouped into physical hazards (e.g., hazards from slips, trips, and falls from a height and those from transportation, temperature, humidity, and electricity); physical agents (e.g., noise, vibration, and ionizing radiation); chemicals; and psychosocial issues (e.g., work-related stress) (NRC 2013b). Occupational hazards are regulated by the Occupational Safety and Health Administration (OSHA) regulations in Title 29 of the *Code of Federal Regulations* Part 1910. The NRC has a memorandum of understanding with OSHA regarding the responsibilities of each agency with regard to occupational safety and health at NRC-licensed facilities (OSHA 2013).

## 3.9 Transportation Environments

This section describes the local transportation systems, including roadway networks and traffic volumes near the Discovery Ridge site.

### 3.9.1 Roads

Figures 2–1 and 2–2 show major roads and transportation features in the vicinity of the proposed NWMI facility site at Discovery Ridge. The proposed NWMI facility site is located just north of Discovery Ridge Drive within the City of Columbia limits. Discovery Drive and Discovery Parkway would provide access to the proposed NWMI facility site.

Discovery Parkway intersects with U.S. Highway 63, a four-lane divided highway in Boone County, about 0.25 mi (0.4 km) to the south. The proposed NWMI facility at the Discovery Ridge site would have easy direct access via on- and off-ramps to U.S. Highway 63. U.S. Highway 63 proceeds north and intersects U.S. Interstate 70 approximately 5 mi (8 km) to the north. U.S. Highway 63 continues to Jefferson City, Missouri, 31 mi (50 km) to the south. U.S. Interstate 70 proceeds approximately 125 mi (201 km) east to St. Louis, Missouri, and 125 mi (201 km) west to Kansas City, Missouri. Current average daily traffic volumes for nearby roads are listed in Table 3–22.

**Table 3–22. Average Daily Traffic Counts in the Vicinity of the Proposed NWMI Facility Site 2013**

| Road | Section | Average Daily Traffic |
|---|---|---|
| Discovery Parkway | South of Discovery Lane | 644 |
| Discovery Parkway | South of U.S. Highway 63 (traffic heading north) | 498 |
| Discovery Parkway | South of U.S. Highway 63 (traffic heading south) | 1,379 |
| Gans Road | East of Bearfield Road | 1,035 |
| Ponderosa Street | South of Nifong Boulevard | 1,017 |
| U.S. Highway 63 | North of Route 740 | 47,234 |
| U.S. Highway 63 | South of Route 740 | 26,288 |
| U.S. Highway 63 | South of Grindstone Parkway | 28,944 |
| U.S. Highway 63 | South of Discovery Parkway | 26,288 |

Source: MODOT 2013

### 3.9.2 Airports

The nearest airport is the Columbia Regional Airport approximately 7 mi (11 km) south of the proposed NWMI facility site at Discovery Ridge. The airport is owned and operated by the City of Columbia. It is also the only public use airport in Boone County.

For the 12-month period ending October 31, 2015, the airport had 22,950 aircraft operations or approximately 63 per day, 75 percent general aviation, 9 percent military, 11 percent air taxi, and 5 percent air carrier. At that time, 34 aircraft were based at the airport that were 50 percent single-engine, 26 percent multi-engine, and 24 percent jet (AMR 2016).

Two small private airports are located within 10 mi (16 km) of the proposed NWMI facility site at Discovery Ridge. These airports include the Cedar Creek Airport, approximately 6 mi (10 km) east and the Sugar Branch Airport, 10 mi (16 km) west of the proposed NWMI facility.

Two helicopter ports are located within 10 mi (16 km) of the proposed NWMI facility site at Discovery Ridge. These two heliports support hospital operations and include the University

Hospitals and Clinics heliport and the Boone Hospital Center heliport, both of which are located approximately 4 mi (6 km) northwest.

### 3.9.3 Rail

The nearest Union Pacific siding is in Jefferson City, approximately 20 mi (32 km) south of the proposed NWMI facility site at Discovery Ridge. Union Pacific operates approximately 85 trains each day (UP 2015).

Owned by the City of Columbia and operated by Columbia Water & Light, COLT Railroad provides rail service to the City of Columbia from Norfolk Southern Railroad's main line in Centralia, Missouri. COLT Railroad's two locomotives move over 1,500 cars a year. The rail line generally parallels State Highway B to Hallsville and State Highway 124 to Centralia. In the City of Columbia, the rail line is located just west of the Highway B industrial area, crosses U.S. Highway 63 approximately 3 mi (5 km) north of U.S. Interstate 70, and ends south of Rogers Street near the city center, approximately 5 mi (8 km) northwest of the proposed NWMI facility site at Discovery Ridge (CTR 2016).

## 3.10 Research Reactors

This section provides the existing regional and local environmental conditions at the research reactors where low-enriched (LEU) targets will be irradiated. This section will discuss in detail only the resources and environments that could potentially be affected by irradiation of LEU targets. The level of detail varies depending upon the potential for impacts, which is discussed in Section 4.13. Some resources are not considered in detail because irradiation of LEU targets at the research reactors are not anticipated to impact that resource area as explained in Section 4.13. For example, irradiation of LEU targets will not result in land disturbance, external building modifications, or additional water use; therefore, there would be no impacts on land use, geology, cultural resources, or water resources. Further, as discussed in Section 4.13, the irradiation of LEU targets will not require additional workers at MURR and would only add about 10 additional workers at the Oregon State TRIGA Research Reactor (OSTR) for 8 weeks per year; therefore, the irradiation of targets would have no noticeable socioeconomics impact.

### 3.10.1 University of Missouri Research Reactor

The University of Missouri Research Reactor (MURR) is located in Boone County, Columbia, Missouri. MURR is a pressurized, light-water moderated and cooled reactor. The reactor is fueled with high-enriched uranium fuel and has a maximum steady-state power level of 10 megawatts thermal (MW(t)) (MU 2006). MURR is situated on a 7.5 ac (3 ha) lot in a portion of the University Research Park, approximately 1-mi (1.6-km) southwest of the Missouri University at Columbia main campus (MU 2006). The staff at MURR consists of approximately 140 full-time employees (MURR 2006). MURR is 4 mi (6.4 km) from the Discovery Ridge site.

The Missouri River is approximately 8.5 mi (13.6 km) west of MURR and the nearest stream is Hinkson Creek, approximately 305 m (1,000 ft.) south of MURR. Makeup secondary coolant water as a result of evaporative losses, 50 gpm (28 million gallons per year), is obtained from five wells owned and operated by the University of Missouri (MU 2006). The National Register of Historic Places (NRHP 2015) lists a number of historical sites within 1.0 mi (1.6 km) from MURR, including: Sanborn Field and Soil Erosion Plots, Sanford F. Conley House, and the Francis Quadrangle Historic District. A review of archaeological records of the MDNR and Archeology Survey of Missouri found no evidence of archeological sites on the 7.5 ac (3.0 ha) MURR site (MU 2010).

Air Quality and Noise

Boone County, where MURR is located, is designated unclassifiable/attainment for all NAAQS. The nearest resident is 0.5 mi (0.8 km) north of MURR. Existing noise sources near MURR include vehicular traffic along South Providence Road (Route 63), cooling towers associated with MURR, and sports venues (within 0.3 mi (0.48 km) of MURR). The MURR site is located within the University Research Park; therefore, the NRC staff estimates background noise levels of 65 dBA, which are typical of commercial areas.

Human Health

The routine operation of MURR results in the release of airborne radioactive effluents to the environment. MURR technical specifications (TS) limit the concentration of radionuclides in these effluents to help ensure that the public dose limits in 10 CFR 20.1301 will not be exceeded (MU 2016c). In addition, MURR is required to comply with 10 CFR 20.1101(d), which, as discussed in Section 3.8.2.3, requires licensees to maintain public doses ALARA by establishing a 10 mrem constraint on public dose from airborne radioactive material released into the environment. Table 3–23 summarizes the average concentration, total activity released, and percent of TS limits for airborne argon-41 (Ar-41) releases in each of the years 2013 through 2015. Other than Ar-41, no other radionuclides were released at average concentrations greater than 1 percent of MURR TS limits for any of the years 2013 through 2015 (MU 2014, 2015a, 2016d).

**Table 3–23. MURR Ar-41 Effluents**

| Reporting Period[(a)] | Average Concentration[(b)] | Total Release | % of TS Limit |
|---|---|---|---|
| 2015 | 1.64E-6 μCi/mL[(c)] | 7.35E2 Ci[(d)] | 48.9% |
| 2014 | 2.59E-6 μCi/mL | 1.16E3 Ci | 74.3% |
| 2013 | 2.73E-6 μCi/mL | 1.22E3 Ci | 78.1% |

(a) January 1 through December 31

(b) Averaged over the 1-year reporting period

(c) μCi/mL = microcurie(s) per milliliter

(d) Ci = curies

Sources: MU 2014, 2015a, 2016d

Routine operation of MURR also results in the release of liquid radioactive effluents to the environment. These effluents are released to the sanitary sewer. In 2013 through 2015, the activity released consisted primarily of tritium (hydrogen-3 or H-3). Table 3–24 summarizes the sanitary sewer radioactive effluents for each of the years 2013 through 2015. During these years, MURR was in compliance with the sanitary sewer effluent regulations in 10 CFR 20.2003 (MU 2014, 2015a, 2016d), which require that monthly average liquid effluent radionuclide concentrations be below the values listed in 10 CFR Part 20, Appendix B, Table 3 for releases to sewers.

**Table 3–24. MURR Sanitary Sewer Radioactive Effluents**

| Reporting Period[a] | Total H-3 Release | Total Other Radionuclide Release |
|---|---|---|
| 2015 | $1.04x10^{-1}$ Ci[b] | $1.78x10^{-2}$ Ci |
| 2014 | $2.60x10^{-1}$ Ci | $2.43x10^{-2}$ Ci |
| 2013 | $9.82x10^{-1}$ Ci | $2.13x10^{-2}$ Ci |

[a] January 1 through December 31
[b] Ci = curies

Sources: MU 2014, 2015a, 2016d

No liquid radioactive wastes were reported by MURR as having been packaged and shipped offsite during the 2013, 2014, or 2015 reporting periods (MU 2014, 2015a, 2016d).

Solid radioactive wastes produced by operation of the MURR include high-level and low-level radioactive wastes. All solid radioactive wastes produced at MURR are packaged and shipped off site for disposal. The high-level solid waste consists of used nuclear fuel. The U.S. Department of Energy maintains title to all nuclear fuel used at MURR, and is obligated by contract to take possession of the fuel after its use at MURR. Used fuel does not leave the MURR reactor pool until a predetermined cooling period has elapsed since the element was last removed from the reactor core, and the element has been loaded into NRC-approved shipping containers for shipment (MU 2006).

The solid, low-level radioactive wastes produced by MURR and shipped off site for disposal during 2013 through 2015 are summarized in Table 3–25.

**Table 3–25. MURR Solid Low-Level Radioactive Waste Shipments**

| Reporting Period[a] | Total Volume | Total Activity |
|---|---|---|
| 2015 | 629 $ft^3$[b] | 657 mCi[c] |
| 2014 | 850 $ft^3$ | 508 mCi |
| 2013 | 554 $ft^3$ | 1,205 mCi |

[a] January 1 through December 31
[b] $ft^3$ = cubic feet
[c] mCi = millicuries

Sources: MU 2014, 2015a, 2016d

MURR reports personnel doses by dividing workers into dosimetry groups, each of which performs different types of work at MURR. The MURR reactor operations, reactor health physics, and shipping groups would be responsible for handling, packaging, and shipping the LEU targets at MURR (NWMI 2015a). Tables 3–26, 3–27, and 3–28 summarize the personnel doses for the operations, health physics, and shipping groups, respectively, in 2013 through 2015. These doses are within the occupational dose limits for adults listed in 10 CFR 20.1201 (MU 2014, 2015a, 2016d).

**Table 3–26. MURR Occupational Doses (Operations Group)**

| Reporting Period[a] | Total TEDE[b,c] | Highest Individual TEDE | Highest Individual Extremity Dose |
|---|---|---|---|
| 2015 | 17,406 mrem[d] | 975 mrem | 3,060 mrem |
| 2014 | 26,527 mrem | 1,460 mrem | 2,223 mrem |
| 2013 | 19,489 mrem | 1,236 mrem | 1,556 mrem |

[a] January 1 through December 31
[b] Total TEDE = Collective TEDE to all individuals in dosimetry group
[c] TEDE = total effective dose equivalent
[d] mrem = millirem

Sources: MU 2014, 2015a, 2016d

**Table 3–27. MURR Occupational Doses (Health Physics Group)**

| Reporting Period[a] | Total TEDE[b,c] | Highest Individual TEDE | Highest Individual Extremity Dose |
|---|---|---|---|
| 2015 | 2,930 mrem[d] | 1,115 mrem | 2,269 mrem |
| 2014 | 2,530 mrem | 776 mrem | 1,312 mrem |
| 2013 | 1,621 mrem | 425 mrem | 866 mrem |

[a] January 1 through December 31
[b] Total TEDE = Collective TEDE to all individuals in dosimetry group
[c] TEDE = total effective dose equivalent
[d] mrem = millirem

Sources: MU 2014, 2015a, 2016d

**Table 3–28. MURR Occupational Doses (Shipping Group)**

| Reporting Period[a] | Total TEDE[b,c] | Highest Individual TEDE | Highest Individual Extremity Dose |
|---|---|---|---|
| 2015 | 5,683 mrem[d] | 2,098 mrem | 4,283 mrem |
| 2014 | 5,558 mrem | 1,441 mrem | 3,805 mrem |
| 2013 | 4,623 mrem | 1,565 mrem | 3,397 mrem |

[a] January 1 through December 31
[b] Total TEDE = Collective TEDE to all individuals in dosimetry group
[c] TEDE = total effective dose equivalent
[d] mrem = millirem

Sources: MU 2014, 2015a, 2016d

MURR has an environmental monitoring program to measure offsite doses resulting from MURR facility operations. This program includes the use of 40 environmental monitoring stations, each consisting of a three-chip environmental TLD, at various locations within the fenced, licensed area and also beyond the fenced area at distances up to 907 m (2,976 ft) from the facility stack. The total net dose equivalent measured at all 40 locations in 2013 was

257 mrem, and the total net dose equivalents measured in the years 2009 through 2012 ranged from 201 to 371 mrem. Approximately 60 percent of these total doses were received at two TLDs located immediately adjacent to two separate loading docks that are part of the MURR laboratory building, and well within the fenced area; most other TLDs receive little or no dose (NWMI 2015a).

The MURR environmental monitoring program also includes semi-annual collection and analysis of environmental samples from eight locations near the MURR facility. Soil and vegetation samples are taken at all eight locations, water samples are taken at three of the eight locations, and subsurface soil samples are taken at six of the eight locations. Sampling performed in 2013 through 2015 has shown minimal environmental impact from MURR operation (MU 2014, 2015a, 2016d).

Transportation Environments

MURR is approximately 3.5 mi (5.6 km) southwest of the Interstate-70/U.S. Highway 63 intersection. U.S Highway 63 runs north-south and Interstate-70 east-west. Major access roads to MURR include North Providence Road to the east of MURR and E. Stadium Blvd to the North. Research Park Drive provides direct access to the site. Table 5–2 provides average daily traffic counts in the vicinity of MURR. For instance, in 2013, average daily traffic counts along Providence Road (Route 163), south of Route 740 was 29,802.

### 3.10.2 Oregon State University Research Reactor

The OSTR is located in Benton County, Corvallis, Oregon. OSTR is a water cooled reactor. The reactor is fueled with TRIGA (uranium/zirconium hydride) fuel and operates at a maximum power level of 1.1 MW(t). OSTR is located within the Oregon State University Radiation Center Complex, which is a 47,000 $ft^2$ (4,366 $m^2$) facility. The Williamette River is approximately 1.60 mi (2.6 km) east of OSTR. OSTR is 2,000 mi (3,219 km) from the proposed NWMI facility at the Discovery Ridge site.

The National Register of Historic Places (NRHP 2015) lists a number of historical sites within 0.5 mi (0.8 km) from the OSTR site boundary, including the J. Leo Fairbanks House and the College Hill West Historic District John Bexell House. Makeup coolant water for the secondary coolant system, approximately 1,500 gal (5,700 L) per day as result of evaporative losses, is obtained from the City of Corvallis (OSU 2004, 2006).

Air Quality and Noise

Benton County is designated unclassifiable/attainment with respect to NAAQS (40 CFR 81.338). Residential development is concentrated north of the OSTR and the nearest resident is 0.25 mi (0.4 km) north of OSTR. Existing noise sources near (within 0.5 mi (0.8 km)) OSTR include vehicular traffic and sport venues (Goss Stadium, Reser Stadium). Due to the proximity of the residential areas to OSTR, NRC staff estimates background noise levels of 55 dBA, which are typical of residential areas.

Human Health and Waste Management

The routine operation of the OSTR results in the release of airborne radioactive Ar-41 effluent to the environment. The typical concentration (averaged over a one year reporting period) of Ar-41 at the point of release from the OSTR is $1.4 \times 10^{-7}$ microcuries per milliliter (µCi/mL), which corresponds to a total annual release of approximately 20 curies of Ar-41 (NWMI 2015c). OSTR technical specifications ensure that the public dose from OSTR's airborne Ar-41 effluent is in compliance with the public dose limit in 10 CFR 20.1301 and the 10 mrem constraint in 10 CFR 20.1101(d) by requiring that annual average concentration of Ar-41 at the point of discharge from the OSTR facility not exceed 4x10$^{-6}$ μCi/mL (OSU 2016); OSTR's annual average Ar-41 release concentration is well within this limit. No measureable quantities of radionuclides other than Ar-41 are released from OSTR (NWMI 2015c).

Routine operation of OSTR also results in the release of liquid radioactive effluents to the environment. These effluents are released to the sanitary sewer. In July 2012 through June 2015, the activity released consisted primarily of H-3. Sewer radioactive effluents are reported for the Oregon State University (OSU) Radiation Center as a whole, rather than for the OSTR and Radiation Center laboratories separately; therefore, reported values include liquid effluent activity released for both the OSTR and the Radiation Center Laboratories. For the OSU Radiation Center, during each of the annual reporting periods July 2012 to June 2013, July 2013 to June 2014, and July 2014 to June 2015, the monthly average concentrations of H-3 in liquid effluents were less than 10 percent of 10 CFR Part 20, Appendix B, Table 3 limits on releases to sewers, and the monthly average concentrations of all other radionuclides were less than 1 percent of 10 CFR Part 20, Appendix B, Table 3 limits. Therefore OSTR, and the OSU Radiation Center, were in compliance with the sanitary sewer effluent regulations in 10 CFR 20.2003 (OSU 2013, 2014, 2015a).

OSTR produces other liquid radioactive wastes that are packaged and transferred off site for disposal. From July 2012 to June 2015, a total of 13.5 gal (51 L) of liquid waste containing 3.25x10$^{-3}$ Ci of total activity was transferred off site (OSU 2013, 2014, 2015a).

Solid radioactive wastes are produced by operation of the OSTR. All solid radioactive wastes produced at OSTR are packaged and shipped off site for disposal. During OSTR's current 20-year license term, starting in 2008 and continuing through 2028, the OSTR licensee does not anticipate the need to ship any high-level radioactive waste (OSU 2008). The solid, low-level radioactive wastes produced at OSTR and transferred off site for disposal during each of the annual reporting periods of July 2012 to June 2013, July 2013 to June 2014, and July 2014 to June 2015, are summarized in Table 3–29.

**Table 3–29. OSTR Solid Low-Level Radioactive Waste Shipments**

| Reporting Period[a] | Total Volume | Total Activity |
|---|---|---|
| 2014-2015 | 23 ft$^{3}$[b] | 5.19x10$^{-3}$ Ci[c] |
| 2013-2014 | 38 ft$^{3}$ | 1.25x10$^{-4}$ Ci |
| 2012-2013 | 34 ft$^{3}$ | 4.62x10$^{-3}$ Ci |

[a] July 1 through June 30
[b] ft$^{3}$ = cubic feet
[c] Ci = curies

Sources: OSU 2013, 2014, 2015a

OSTR facility operating personnel would be responsible for handling, packaging, and shipping the LEU targets at OSTR. Table 3–30 summarizes the personnel doses for OSTR facility operating personnel during each of the annual reporting periods of July 2012 to June 2013, July 2013 to June 2014, and July 2014 to June 2015. These doses are within the occupational dose limits for adults listed in 10 CFR 20.1201.

**Table 3–30. OSTR Occupational Doses**

| Reporting Period[(a)] | Total TEDE[(b,c)] | Highest Individual TEDE | Highest Individual Extremity Dose |
|---|---|---|---|
| 2014-2015 | 749 mrem[(d)] | 210 mrem | 942 mrem |
| 2013-2014 | 2,229 mrem | 639 mrem | 914 mrem |
| 2012-2013 | 867 mrem | 203 mrem | 778 mrem |

(a) July 1 through June 30

(b) Total TEDE = Collective TEDE to all facility operating personnel

(c) TEDE = total effective dose equivalent

(d) mrem = millirem

Sources: OSU 2013, 2014, 2015a

OSTR has an environmental monitoring program to measure offsite doses resulting from facility operations. This program includes the use of nine environmental monitoring stations, each consisting of a three-chip environmental TLD, at locations along the fence that surrounds the reactor. Over a 7-year period ending in 2014, the average annual net dose equivalents measured at these stations ranged from 7 to 18 mrem (NWMI 2015a).

The OSTR environmental monitoring program also includes annual collection and analysis of environmental samples from 22 locations near the OSTR facility. Soil samples are collected at four locations, water samples (when available) are collected at four locations, and vegetation samples are collected at 14 locations. Sampling performed during each of the annual reporting periods of July 2012 to June 2013, July 2013 to June 2014, and July 2014 to June 2015 found levels of environmental radioactivity consistent with naturally occurring radioactivity and comparable to values reported in previous years (OSU 2013, 2014, 2015a).

Transportation Environments

OSTR is bordered to the west by 35th Street, to the south by South Jefferson Way, to the north by South Campus Way, and to the east by the South 30th St. Major roads in the vicinity of OSTR include U.S. Route 20 to the south (0.7 mi (1.1 km) away), NW Harrison Boulevard to the north (0.5 mi (0.8 km) away), State Highway 99W to the east (1.4 mi (2.3 km) away), and Interstate-5 (I-5) to the east (11.4 mi (23.2 km) away). Annual average daily traffic volume along these roads are as follows (ODOT 2014a, 2014b):

- Harrison Street/East of State Highway 99W: 11,000-12,900,
- along State Route 34 (at State Route 99W intersection): 20,001–30,000,
- along State Route 99W (at State Route 34 intersection): 15,001–2000
- along Interstate 5 (at State Route 34 intersection): 30,001–50,000, and
- along U.S. Route 20 (near 35th street intersection): 16,300–16,900.

### 3.10.3 Third Research Reactor

NWMI is also considering use of a third research reactor and is performing an analysis to support that selection (NWMI 2015a, 2015c). NWMI has stated that the third research reactor will be similar to the OSTR and located on a university campus (NWMI 2015a). Therefore, the research reactor design and operations will be similar to what is discussed for the OSTR in

Section 3.10.2 above. Distance of the third research reactor to the proposed NWMI facility at Discovery Ridge will be bounded by 2,000 mi (3,219 km) since the OSTR is the greatest distance between the proposed Discovery Ridge site and any operating research reactor in the continental United States. An NRC licensed research reactor is required to comply with 10 CFR Part 20 dose limits. Further, the operating license includes a TS requiring that an annual report be submitted to the NRC that discloses radioactive effluents released, an estimate of radionuclides present in effluents, and radiological exposure received by facility personnel.

# 4.0 ENVIRONMENTAL IMPACTS OF CONSTRUCTION, OPERATIONS, AND DECOMMISSIONING

This chapter addresses potential environmental impacts related to the proposed construction, operations, and decommissioning of the Northwest Medical Isotopes, LLC (NWMI), medical radioisotope production facility (NWMI facility). The U.S. Nuclear Regulatory Commission (NRC) standard of significance for impacts uses the Council on Environmental Quality (CEQ) terminology for "significantly" (Title 40 of the *Code of Federal Regulations* (40 CFR 1508.27)).

Because the significance and severity of an impact can vary with the setting of the proposed action, both "context" and "intensity," as defined in CEQ regulation 40 CFR 1508.27, were considered. Context is the geographic, biophysical, and social context in which the effects would occur. Intensity is the severity of the impact. Based on this, the NRC established three levels of significance for potential impacts: SMALL, MODERATE, and LARGE. The definitions of these three significance levels, which are presented in the Interim Staff Guidance to NUREG-1537 (NRC 2012), follow:

> SMALL—environmental effects are not detectable or are so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. In assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC's regulations are considered SMALL.
>
> MODERATE—environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> LARGE—environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

For this environmental impact statement (EIS), the NRC staff characterized impact levels using the above definitions (NRC 2012). These impacts are grouped and presented according to the resource area. Within each resource area, the NRC staff determined the impacts during each of the three phases: construction, operations, and decommissioning. As described in Section 1.6, preconstruction is related to the building of the proposed NWMI facility and a combined construction (preconstruction and NRC-authorized construction) impact level is provided. When the combined construction impact category level is SMALL for any resource area (land use, water resources, etc.), no further breakdown of impacts between preconstruction and NRC-authorized construction will be provided. When the combined construction impact category level is greater than SMALL for any resource area, the impact from solely NRC-authorized construction activities will be discussed separately. The impacts from operations of the proposed medical radioisotope production facility presented in this Chapter considers those activities associated with facility operations identified in Section 2.3, including preoperation startup activities, transportation of material to and from the proposed facility, and processes conducted inside the facility building (target fabrication and scrap recovery, irradiated target disassembly and dissolution, Mo-99 recovery and purification, and uranium recovery and recycling).

The NRC staff characterizes the impacts to resources as a single level or as a range of impact levels. A range of impacts may be provided if environmental conditions are uncertain or if there are multiple circumstances associated with environmental conditions surrounding the proposed or alternate sites. For example, a range of impacts may be appropriate to characterize impact levels if the environment changes in time or space, such as the impacts may be smaller at certain times or in certain places and larger at other times or places.

# 4.1 Land Use and Visual Resources

## 4.1.1 Land Use

### *4.1.1.1 Construction*

The proposed Discovery Ridge site currently includes 7.4 acres (ac) (3.0 hectares (ha)) of pastoral land (NWMI 2015a; NRC 2015b, USGS 2006; Fry et al. 2011). The facility would occupy a rectangular area approximately 213 by 91 meters (m) (700 by 300 feet (ft)) at the outer perimeter and cover approximately 1.95 ha (4.8 ac) (NWMI 2015a). The restricted area would be the area inside the fence surrounding the facility. The unrestricted area would be the area outside the fence surrounding the main building (NWMI 2015a).

Construction of the proposed NWMI facility would permanently disturb and convert 7.4 ac (3.0 ha) of agricultural land into an industrial area that would include facility buildings, an administrative building, an employee parking lot, facility access roads, and other support facilities (Table 4–1). In addition, 0.26 ac (0.1 ha) of an offsite adjacent lot (Lot 14) in the research park would be temporarily converted from agricultural land to a construction material staging area (NWMI 2015a, 2015c). Once construction activities are complete, NWMI would restore temporarily affected areas with vegetation that is common to the Discovery Ridge Research Park (NWMI 2015c). The remaining portion of the site would likely remain as open or landscaped areas in accordance with the Discovery Ridge Research Park covenants (MU 2009, NWMI 2015a). Ground vegetation would include grasses, shrubs, trees and/or ornamental flowers including native species (NWMI 2015c). The potential temporary and permanent conversion of up to 7.66 ac (3.1 ha) of pasture/hay would be minor when compared to the 15,158 ac (6,134 ha) of pasture/hay remaining within 5 mi (8 km) of the proposed site.

Land use impacts would be confined to the proposed 7.4 ac (3.0 ha) site and 0.26 ac. (0.1 ha) of offsite agricultural lands immediately adjacent to the proposed site. Therefore, no coastal zones or areas with a special land use or mineral resources (as described in Section 3.1) would be affected by the proposed construction of the NWMI facility (NWMI 2015a; NRC 2015b; NRCS 2016a, 2016b; Find the Data 2016; NOAA 2016).

Based on the relatively small amount of pasture/hay that would be permanently converted to other land uses, the lack of important farmland soils within affected areas, the location of the proposed facility within an area designated as an industrial certified site, and the lack of special land use or mineral resources on site, land use impacts from construction would be SMALL.

**Table 4–1. Acres of Land Required for Construction of the Proposed NWMI Facility**

| Land Cover Type | Permanent Disturbance | | Temporary Disturbance | | Total Land Cover Within 5 mi (8 km) | | |
|---|---|---|---|---|---|---|---|
| | ac | ha | ac | ha | ac | ha | Percent |
| Open Water | | | | | 346 | 140 | <1 |
| Developed, Open Space | | | | | 4,119 | 1,667 | 8 |
| Developed, Low Intensity | | | | | 4,677 | 1,893 | 9 |
| Developed, Medium Intensity | | | | | 2,770 | 1,121 | 6 |
| Developed, High Intensity | | | | | 911 | 369 | 2 |
| Barren | | | | | 94 | 38 | <1 |

| Land Cover Type | Permanent Disturbance | | Temporary Disturbance | | Total Land Cover Within 5 mi (8 km) | | |
|---|---|---|---|---|---|---|---|
| | ac | ha | ac | ha | ac | ha | Percent |
| Deciduous Forest | | | | | 15,730 | 6,366 | 31 |
| Evergreen Forest | | | | | 534 | 216 | 1 |
| Mixed Forest | | | | | 469 | 190 | <1 |
| Shrub/Scrub | | | | | 107 | 43 | <1 |
| Grassland | | | | | 345 | 140 | <1 |
| Pasture/Hay | 7.4 | 3.0 | 0.3 | 0.1 | 15,158 | 6,134 | 30 |
| Cultivated Crops | | | | | 4,639 | 1,877 | 9 |
| Woody Wetlands | | | | | 363 | 147 | <1 |
| Emergent Herbaceous Wetland | | | | | 2 | 1 | <1 |
| **Total[a]** | **7.4** | **3.0** | **0.3** | **0.1** | **50,262** | **20,339** | **100** |

[a] Total may add up to more or less than 100 percent due to rounding.

Sources: USGS 2006; Fry et al. 2011; NWMI 2015a

#### *4.1.1.2 Operations*

Operation of the NWMI facility would not require any new land or require land use changes beyond that required for construction. Therefore, land use impacts during operations would be SMALL.

#### *4.1.1.3 Decommissioning*

Decommissioning activities would be similar to construction activities because they would involve heavy equipment to dismantle buildings and remove roadway and parking facilities. Land requirements to perform these activities would be the same or less than those required during construction (NWMI 2015a). After decommissioning activities are complete, the proposed site could remain industrial or could be converted back to agricultural land. Given that the site is located within a currently existing research park, it is likely that the site would remain for industrial use, assuming the research park is still operating. Given that land requirements would be similar to those described during construction and that, after decommissioning is complete, land would either be industrial, agricultural, or open space, land use impacts during decommissioning would be SMALL.

### 4.1.2 Visual Resources

#### *4.1.2.1 Construction*

As described in Section 3.1.2, the visual setting of the proposed NWMI facility includes agricultural, residential, light industrial, and forested viewsheds. The proposed site is currently used for agricultural purposes, and no existing structures or natural or built barriers, screens, or buffers occur on site. NWMI would build a Radioisotope Production Facility (RPF) building that would be approximately 65 ft (20 m) high, 350 ft (107 m) long, and 185 ft (56 m) wide

(NWMI 2015a). The highest point at the NWMI facility would be the three exhaust stacks that extend 75 ft (66 m) from the ground (NWMI 2015a). The high bay, which would be the second story above the process area, would be 65 ft (19.8 m) high. NWMI (2015a) estimated that the stacks would be visible from 2 mi (3.2 km) away. Figure 4–1 is a conceptual rendering of the proposed NWMI facility based on these dimensions.

The activities associated with construction of the NWMI facility (e.g., excavation, earthmoving, pile driving, and erection) would require large equipment, would significantly alter onsite conditions, and would partially obstruct views of the existing landscape. However, as described in Section 3.1.2, the NRC staff determined that the proposed site has low scenic quality because of a lack of notable features, uniform landform, low vegetation diversity, an absence of water, mute colors, cultural modifications to adjacent scenery, and a commonality within the physiographic province. The NRC staff also determined that the proposed site has a low sensitivity rating because it is in an area with low scenic values resulting from a low amount of use by viewers, low public interest in changes to the visual quality of the proposed site, a low sensitivity to changes in visual quality by the type of users in the area, and a lack of special natural and wilderness areas. In addition, the viewshed surrounding the proposed site is partially aesthetically altered by light industrial buildings, research facilities, residences, and roads. Further, once construction activities are complete, NWMI would revegetate open areas with grasses, shrubs, trees and/or ornamental flowers including native species (NWMI 2015c). Vegetation could partially mitigate impacts to visual resources given that the majority of the surrounding viewshed is pasture, hay, or grasses. Based on the low scenic quality and light industrial viewshed within the vicinity, construction-related aesthetic impacts would be SMALL.

#### *4.1.2.2 Operations*

The appearance of the NWMI facility would not change during operation, other than a small steam plume that may be visible coming from the exhaust stack. The steam plume from the exhaust stack is expected to be minimal because opacity associated with the natural gas-fired boilers tends to be low, and, as described in Section 4.2.1.2, emissions will not be significant. The plume would be more visible during periods of cold weather, although the size of the plume would still be relatively small. Therefore, visual impacts during operations would be SMALL.

**Figure 4–1. Conceptual Rendering of Proposed NWMI Facility**

Source: NWMI 2015a

#### *4.1.2.3 Impacts from Decommissioning*

Decommissioning activities would be similar to construction activities because they would involve heavy equipment to dismantle buildings and remove roadway and parking facilities. After NWMI completes decommissioning activities, the proposed site could remain industrial or could be converted back to agricultural land. Given that the site is located within a currently existing research park, it is likely that the site would remain for industrial use, assuming the research park is still operating. As the proposed NWMI facility is located in a certified industrial site and the viewshed surrounding the proposed site is partially aesthetically altered by light industrial buildings, the NRC staff would not expect any changes to the landscape to significantly affect any viewsheds. Therefore, visual impacts during decommissioning would be SMALL.

## 4.2 Air Quality and Noise

Air and noise emissions would occur during construction, operations, and decommissioning of the proposed NWMI facility. Emission sources, pollutants, and durations would be different for each phase and are discussed below. The region of influence (ROI) for this air quality analysis is Boone County, which is designated as an attainment/unclassifiable area for all criteria pollutants. The ROI for the noise analysis is a 1-mi (1.6-km) radius from the site boundary of the proposed NWMI facility.

### 4.2.1 Air Quality

#### *4.2.1.1 Construction*

During construction, earth-moving equipment, non-road vehicles, and worker and delivery vehicles will be sources of air emissions. Earth moving activities, including excavation, clearing, and compacting, will generate fugitive dust on site. Operation of construction equipment will emit criteria pollutants (particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides) on site from the combustion of fuels in equipment. Table 4–2 identifies construction equipment, total activity, and material moved during construction. Employee and delivery and shipment vehicular exhaust will emit criteria air pollutants (particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides) and generate fugitive dust emissions, some of which would occur on site and others would occur off site. However, fugitive dust emissions should be minimal for vehicles when traveling on paved roads off site. A peak workforce of 82 and a total of 21 deliveries and shipments per week are anticipated during construction (NWMI 2015c). Completion of the proposed NWMI facility is estimated to take up to 17 months. Fugitive dust emissions are anticipated to be greatest during the initial site preparation activities and would vary depending on the level of activity. Therefore, fugitive dust emissions and equipment exhaust emissions will be localized and temporary.

**Table 4–2. Equipment and Activity Parameters During Construction**

| Equipment Type | Total Activity (hours) | Material Moved (tons) |
|---|---|---|
| Bulldozer | 100 | 12,000 |
| Excavator | 120 | 12,000 |
| Front Loader | 60 | 24,000 |
| Compactor | 120 | N/A |
| Grader | 80 | N/A |
| Paver | 80 | N/A |

| Equipment Type | Total Activity (hours) | Material Moved (tons) |
|---|---|---|
| Asphalt Roller | 80 | N/A |
| Source: NWMI 2015a | | |

Construction-related emissions from earth-moving activities, equipment, and on-road vehicles are presented in Table 4–3. Overall construction-related emissions for criteria pollutants are well below the significant de minimis levels under the New Source Review program and the 250 tons/year (TPY) threshold for a major source as discussed in Section 3.2.2 of this EIS. Total greenhouse gas emissions (GHGs) (approximately 750 tons of carbon dioxide equivalents ($CO_2$eq) per year) would be well below the 75,000 TPY of $CO_2$eq (68,000 metric TPY) threshold for prevention of significant deterioration (PSD) and Title V permits set in the Greenhouse Gas (GHG) Tailoring Rule and the U.S. Environmental Protection Agency's (EPA's) mandatory GHG Tailoring Rule (74 FR 56260). Further, construction-related emissions would be less than 1 percent of Boone County annual emissions. Therefore, the NRC staff does not expect increases in air emissions from construction activities to contribute to concentrations that would exceed National Ambient Air Quality Standards (NAAQS) in Boone County.

**Table 4–3. Estimated Emissions During Construction**

| | Emissions[(a)] (tons) | | | | | |
|---|---|---|---|---|---|---|
| Source | CO | $NO_x$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| Construction Equipment Exhaust | 0.10 | 0.71 | 0.12 | 0.03 | 0.02 | 66 |
| On-road vehicles Exhaust[(b)] | 3.9 | 0.8 | 0.006 | 0.02 | 0.02 | 659 |
| Fugitive dust[(c)] | - | - | - | 1.6 | 0.28 | - |
| **Total** | **4.0** | **1.5** | **0.13** | **1.7** | **0.3** | **725** |

[(a)] Total emissions during the 17-month construction phase.

[(b)] On-road vehicle exhaust emissions account for worker vehicles and delivery vehicles (concrete trucks, asphalt trucks, earth haulers, and miscellaneous material deliveries).

[(c)] Fugitive dust emissions account for earth moving activities and wind erosion of bare ground areas.

Key: CO = carbon monoxide; $NO_x$ = nitrogen oxides; $SO_2$ = sulfur dioxide; $PM_{10}$ = particulate matter of 10 microns (μm) or less; $PM_{2.5}$ = particulate matter of 2.5 μm or less; $CO_2$ = carbon dioxide.

Source: NWMI 2015a, 2015c. 2016a

The nearest Class I Federal Area to the proposed site is the Hercules-Glades Wilderness Area, approximately 70 mi (113 km) away. EPA recommends that sources located within 62 mi (100 km) of a Class I Federal Area be modeled to consider adverse impacts (EPA 1992). Given the distance and estimated emissions from construction, the NRC staff does not anticipate that activities from construction could adversely affect air quality and air quality-related values (e.g., visibility or acid deposition) in the nearest Class I Federal Area. NWMI may need to obtain an air construction permit from MDNR prior to commencing construction in accordance with 10 CSR 10-6.060. NWMI intends to initiate the permit review and applicability determination with MDNR (NWMI 2015c).

The emission estimates presented in Table 4–3 do not account for best management practices (BMPs) or mitigative measures that can be implemented during construction-related activities to reduce emissions. For instance, NWMI proposes to control particulate matter by watering unpaved and disturbed areas, stabilizing spoil piles, revegetating slopes, and minimizing soil disturbance via phased grading (NWMI 2015a). Furthermore, to reduce equipment related emissions, NWMI proposes to implement the following measures: reduce equipment idle times, use ultra-low sulfur diesel fuel, and install pollution control devices on construction equipment.

Given that (1) air emissions during construction would be local and temporary (duration of 17 months), (2) Boone County is designated as an attainment/unclassifiable area, (3) construction emissions are well below major air source thresholds, and (4) construction emissions are not expected to contribute to concentrations that would exceed the NAAQS, the NRC staff concludes that air quality impacts during construction would be SMALL.

*4.2.1.2 Operations*

Air emissions sources from operation of the proposed NWMI facility would be predominantly from: (1) target fabrication and irradiated target processing; (2) fuel combustion associated with processing and facility heating purposes; and, (3) vehicular traffic from workers commuting and from shipments and deliveries during operations.

As discussed in Section 2.3.1, NWMI facility operations will include target preparation and processing for extraction of molybdenum-99 (Mo-99), which involves dissolution of uranium in nitric acid. Dissolution will result in gases, which include nitrogen oxides (NWMI 2016a). The offgas will pass through a reflux condenser and nitrogen oxide absorbers prior to being filtered and discharged into the process exhaust system (NWMI 2015a). Total nitrogen oxide emissions from the radioisotope production process would be 0.05 TPY (0.04 MT/year) (NWMI 2015c, 2016a).

Fuel combustion sources housed in the NWMI facility will include five gas-fired boilers and a diesel generator. NWMI boilers will be used for the heating, ventilation, and air conditioning (HVAC) system and for process steam used to provide heating for process equipment (NWMI 2015a, 2015b, 2015c). Three boilers are expected to be operating at any one time (two heating and one process steam boiler) (NWMI 2015c). The diesel generator will be used for emergency power, if needed, and will be operated for routine testing and maintenance (NWMI 2015a). The operation of the gas-fired boilers and diesel generator will emit criteria pollutants (carbon monoxide, particulate matter, nitrogen oxides, and sulfur dioxide) and GHGs. Annual emissions from these combustion sources are presented in Table 4–4. NWMI may need to obtain an air permit from MDNR to install and operate these fuel combustion sources accordance with 10 CSR 10-6.060 or 10 CSR 10-6.065. NWMI intends to initiate the permit review and applicability determination with MDNR (NWMI 2015c).

Vehicle exhaust from workers and from shipments and deliveries during operations will emit criteria pollutants (carbon monoxide, particulate matter, nitrogen oxides, and sulfur dioxide) and GHGs. During operations, 98 workers will be commuting to and from the proposed site. Shipments to and from the proposed site will include fresh low-enriched uranium (LEU), unirradiated LEU targets, irradiated targets, Mo-99 product, spent LEU, and waste. The total projected annual number of shipments is 484 or approximately 10 shipments/week (NWMI 2015c, 2016a). Vehicle emissions during operations is presented in Table 4–4.

**Table 4–4. Emissions Sources and Estimated Emissions During Operations**

| | Emissions During Operation (tons/year) | | | | | |
|---|---|---|---|---|---|---|
| Source | CO | $NO_x$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| Target processing | - | 0.05 | - | - | - | - |

| | Emissions During Operation (tons/year) | | | | | |
|---|---|---|---|---|---|---|
| Diesel Generator[a] | 0.23 | 0.5 | 0.17 | 0.03 | 0.03 | 48.5 |
| Gas-Fired Boilers[b] | 18 | 11 | 0.13 | 0.40 | 0.40 | 26,000 |
| Vehicles exhaust[c] | 2.7 | 0.3 | 0.004 | 0.010 | 0.009 | 432 |
| **Total** | **21** | **12** | **0.3** | **0.44** | **0.44** | **26,500** |

[a] Diesel generator emissions are based on emission factors from EPA 2010 and assumes generator operated 24 hours per year.

[b] Gas-fired boilers emissions account for operation of 4 boilers as a bounding condition, each operated for 50 weeks per year, 7 days/week, and 24 hours a day. Emissions are based on emission factors from EPA.

[c] Vehicle exhaust emissions include worker vehicle emissions and shipment and delivery vehicles.

Source: NWMI 2015a, 2015c

Operation-related emissions from predominant sources are presented in Table 4–4. Total operational emissions for criteria pollutants are well below the significant de minimis levels discussed under the New Source Review program and Title V major operating source threshold (100 TPY) discussed in Section 3.2.2 of this EIS. Total GHGs (approximately 27,000 tons $CO_2$eq) per year) would be well below the 75,000 TPY of $CO_2$eq (68,000 metric TPY) threshold for PSD and Title V permits set in the Greenhouse Gas (GHG) Tailoring Rule. Further, operation-related emissions for carbon monoxide, nitrogen oxides, sulfur dioxide, and particulate matter are less than 1 percent of Boone County annual emissions and carbon dioxide emissions are less than 5 percent. Therefore, the NRC staff does not expect increases in air emissions from operations to contribute to concentrations that would interfere with the maintenance of NAAQS or degrade Boone County's attainment/unclassifiable designation.

The nearest Class I Federal Area to the proposed site is the Hercules-Glades Wilderness Area, approximately 70 mi (113 km) away. EPA recommends that sources located within 62 mi (100 km) of a Class I Federal Area be modeled to consider adverse impacts (EPA 1992). Given the distance and estimated emissions from operation, the NRC staff does not anticipate that activities from operation could adversely affect air quality and air quality-related values (e.g., visibility, acid deposition) in the nearest Class I Federal Area.

NWMI proposes to develop a comprehensive program for controlling GHG emissions associated with operation of the NWMI facility. This will include developing a GHG emission inventory, implementing methods for avoiding or minimizing GHG emissions identified in the inventory and encouraging carpooling and other measures to minimize GHG emissions due to vehicle traffic during operation (NWMI 2015a).

Given that operation-related air emissions are well below the significant de minimis levels and Title V major source threshold, operational emissions are not expected to contribute to concentrations that would exceed NAAQS or degrade Boone County's air quality designation (attainment/unclassifiable area) therefore, the NRC staff concludes that air quality impacts during operation would be SMALL.

#### *4.2.1.3 Decommissioning*

Decommissioning activities would be similar to construction activities. The decommissioning activities would include, for example, vehicular traffic, earth-moving equipment, demolition of structures, and dismantlement and decontamination of systems over a period of up to 24 months (NWMI 2015a, 2016a). Equipment, worker vehicles and truck shipments will emit criteria air pollutants (particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides) and GHGs. Demolition and dismantlement of structures will emit fugitive dust. A daily peak workforce of 81 and a total of 21 deliveries and shipments per week are anticipated during decommissioning (NWMI 2015c). Equipment used and diesel fuel consumption for decommissioning activities would be similar to those presented in Table 4–2. Emissions from decommissioning would be localized and temporary and are presented in Table 4–5. Emissions are well below the significant de minimis levels discussed under the New Source Review program and the 250 TPY threshold for a major source as discussed Section 3.2.2 of this EIS. Therefore, the NRC staff does not expect increases in air emissions from decommissioning activities to contribute to concentrations that would exceed the NAAQS or prevent Boone County from maintaining its attainment designation.

**Table 4–5. Air Emissions During Decommissioning**

| | Emissions[a] (tons) | | | | | |
|---|---|---|---|---|---|---|
| Source | CO | $NO_x$ | $SO_2$ | $PM_{10}$ | $PM_{2.5}$ | $CO_2$ |
| Construction Equipment Exhaust | 0.10 | 0.71 | 0.12 | 0.03 | 0.02 | 66 |
| On-road vehicles Exhaust[b] | 5.5 | 1.0 | 0.009 | 0.1 | 0.1 | 920 |
| Fugitive dust | - | - | - | 1.6 | 0.28 | - |
| **Total** | **5.6** | **1.7** | **0.13** | **1.7** | **0.4** | **986** |

[a] Total emissions during 24-month decommissioning phase.

[b] On road emissions calculated from EDF-3124-0005 (NWMI 2016a) and based on a 24-month decommissioning duration.

Source: NWMI 2015a, 2015c, 2016a

Given that air emissions during decommissioning would be local and temporary (decommissioning phase of up to 24 months) and that decommissioning-related emissions are well below major air source thresholds, the NRC staff concludes that the air quality impact associated with the decommissioning phase would be SMALL.

### 4.2.2 Noise

#### *4.2.2.1 Construction*

Noise sources associated with building the proposed NWMI facility will include construction equipment on site and workforce and shipment/delivery vehicles. Increased traffic volumes because of 82 workers and 21 deliveries per week can increase noise emissions along road and highways near the proposed Discovery Ridge site. While workers would be able to access the site using a combination of routes, it is reasonable to assume that U.S. Highway 63, St. Lenoir Street, Discovery Drive, and Discovery Parkway will experience an increase in traffic volumes as a result of the construction workforce and deliveries because these are access roads to the proposed site. NWMI modeled highway noise to estimate noise levels when an additional 100 vehicles are added to peak traffic volume along U.S. Highway 63 (NWMI 2015c, 2016a, 2016d). An additional 100 vehicles will increase noise by 1 decibel on the A-weighted scale (dBA) at 85 m (280 ft) distance from U.S. Highway 63 and at the nearest residence to the proposed Discovery Ridge site. Most people are unable to discern noise level differences less than 3 dBA.

Noise emissions will vary with each phase of construction and will depend on the duration and mix of equipment used. The types of equipment that would be used on site during construction are listed in Table 4–2. Noise emissions from equipment that will be used during construction are predicted to be in the 80- to 85-dBA range at a 50-ft (15-m) distance (FHWA 2006); however, noise levels attenuate rapidly with distance. As discussed in Section 3.2.3, the nearest noise sensitive receptor is the IDEXX BioResearch facility, which is approximately 0.16 km (0.1 mi; 528 ft) from the proposed site. At a distance of 0.16 km (0.1 mi; 528 ft), the NRC staff estimates noise levels from construction equipment to be 59 to 64 dBA (GSU 2016). The nearest residence is approximately 0.4 km (0.27 miles; 1,425 ft) from the proposed site. At this distance, the NRC staff estimates noise levels from construction equipment to be 50 to 55 dBA (GSU 2016). Noise levels from construction equipment can further be dampened by the existing building walls at the IDEXX BioResearch facility and existing walls of the nearest residence. Noise levels from construction equipment to noise sensitive receptors are not anticipated to exceed the existing noise levels from traffic on U.S. Highway 63 (69 dBA), agricultural equipment (84 dBA), or estimated ambient background noise levels (60 to 65 dBA) and, therefore, will not be noticeable. Further, noise from construction equipment would be localized, short term, and intermittent during operation of equipment.

Control measures that could be used to minimize noise emissions from construction activities include routine maintenance of equipment (e.g., lubrication of moving parts, replacement/adjustment of worn or loose parts), industry best practices (e.g., minimizing equipment idle time and simultaneous use of equipment), shielding high noise sources, and conducting activities during daytime when noise levels are greatest.

Given the minor (1 dBA) increase in noise levels as a result of additional vehicle traffic and estimated noise levels from construction equipment not exceeding existing ambient noise levels, the NRC staff concludes that offsite noise impacts from construction would be SMALL.

#### *4.2.2.2 Operations*

Noise sources during operation would be primarily from workforce and shipment vehicles. Noise from operating equipment would be contained inside buildings and is not anticipated to be audible outside the proposed NWMI building at the site. Increased traffic volumes because of a daily workforce of 98 and 10 deliveries per week can increase noise emissions along nearby road and highways. NWMI modeled highway noise to estimate noise levels when an additional 100 vehicles are added to peak traffic volume along U.S. Highway 63 (NWMI 2015c, 2016a, 2016d). An additional 100 vehicles will increase noise by 1 dBA at 85 m (280 ft) distance from U.S. Highway 63 and at the nearest residence. Most people are unable to discern noise level differences less than 3 dBA. Further, increase in noise levels from vehicles will not be continuous, but rather intermittent during work shifts.

Given that noise levels from operating equipment are not expected to be audible beyond the building facility and additional noise levels from worker and shipment vehicles are minor (increase of 1 dBA), the NRC staff concludes that offsite noise impacts during operation would be SMALL.

#### *4.2.2.3 Decommissioning*

Noise emissions during decommissioning would be similar to those generated during construction. Increased noise levels would occur from increased traffic volumes and from the use of equipment on site. A daily peak workforce of 81 and a total of 21 deliveries and shipments a week are anticipated during decommissioning. NWMI modeled highway noise to estimate noise levels when an additional 100 vehicles are added to peak traffic volume along U.S. Highway 63 (NWMI 2015c, 2016a, 2016c, 2016d). An additional 100 vehicles will increase noise by 1 dBA at 85 m (280 ft) distance from U.S. Highway 63 and at the nearest residence.

Most people are unable to discern noise level differences less than 3 dBA. Further, increase in noise levels from vehicles will not be continuous but rather intermittent during work shifts.

Equipment used during decommissioning activities would be similar to those presented in Table 4–2. Therefore, as discussed above, noise levels from demolition equipment and vehicles to noise sensitive receptors are not anticipated to exceed existing noise levels from traffic on U.S. Highway 63 (69 dBA), agricultural equipment (84 dBA), or estimated ambient background noise levels (60-65 dBA) near the Discovery Ridge site and, therefore, will not be noticeable.

Given the minor (1 dBA) increase in noise levels as a result of additional vehicles and given that estimated noise levels from decommissioning activities would be bounded by existing ambient noise levels, the NRC staff concludes that offsite noise impacts from decommissioning would be SMALL.

## 4.3 Geologic Environment

### 4.3.1 Construction

Construction of the proposed NWMI facility at the Discovery Ridge site will temporarily disturb the entire site (7.4 ac (3.0 ha)), as detailed in Section 4.1.1.1. Ground-disturbing activity, including site clearing, grading, grubbing, surface compaction, excavation work, and construction-related vehicle traffic, would expose site soils and sediments to wind and water erosion. Site development and associated ground disturbance exceeding 1 ac (0.4 ha) in size requires a permit from the City of Columbia in accordance with Chapter 12A, Article II (Land Preservation) of the City's Code of Ordinances (City of Columbia 2015). This permit is required before any site work can begin, and this authorization is in addition to any other required approvals, such as permits from the Missouri Department of Natural Resources (MDNR). The NWMI Environmental Report (ER) (NWMI 2015a) lists relevant construction-related permit requirements, which the NRC has summarized in Appendix B of this EIS.

Further, the City of Columbia requires that the project proponent submit a detailed site development plan for City approval. This development application package must include a soil erosion and sediment control plan and a stormwater management plan (City of Columbia 2015, 2016d). These plans entail the implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development. For example, BMPs include use of gravel aprons to stabilize construction site entrances; sediment traps, sediment fencing, check dams and staked hay bales to manage runoff and erosion; use of fugitive dust controls, mulching and geotextile matting, stockpile covers, and rapid reseeding of disturbed areas to limit soil loss; and the retention of native vegetation and drainage ways, where practicable. These measures would serve to minimize soil erosion and loss and ensure that soil impacts are limited to the immediate construction site, while also ensuring that the impacts are temporary in nature. NWMI states that dust production and erosional impacts due to site clearing and grading would be mitigated by using construction and erosion control BMPs (NWMI 2015a). Section 4.4.1 presents additional information on relevant stormwater discharge and management requirements.

NWMI would be required to obtain the appropriate permits from the County and City, if not already obtained by the developer for the Discovery Ridge Research Park (NWMI 2015a).

Following site grading, trenching and excavation, work for utility routings and emplacement of foundation structures (i.e., footings and floor slabs) for the NWMI facility would be conducted. Earthwork associated with utility infrastructure should be minimal. Discovery Ridge Research Park already has the necessary utility infrastructure (i.e., electric power, natural gas, water, and sanitary sewer) required to support the proposed NWMI facility on Lot 15. The utility providers will extend service lines to the NWMI facility site from utility connections presently located at the southwest corner of the site (MU 2009; NWMI 2015a). Utility routings and other foundation slabs and footings typically require excavation to a depth of about 5 ft (1.5 m). Excavation work would also be involved for a stormwater detention basin (NWMI 2015a).

Mineral and other geologic resources would be required to support facility construction such as granular stone (e.g., typically crushed aggregate (sand and gravel)), as summarized in Section 2.2, Table 2–1. As noted in Section 3.3.1, construction aggregate is widely available throughout Boone County and northeast Missouri. NWMI estimates that 4,260 cubic yards ($yd^3$) (3,360 cubic meters ($m^3$)) of concrete would also be used for facility construction, in addition to precast concrete, and would be obtained from offsite commercial vendors (NWMI 2015a, 2015c). Consequently, no onsite concrete batch plant would be required. The mineral products that comprise concrete (i.e., Portland cement, sand, gravel, and other additives) are widely available in the region or are not otherwise limited in commercial availability.

With regard to excavation for facility structures, portions of the RPF building would be located at a floor elevation of 15 ft (4.6 m) below finished grade, based on preliminary facility designs. This below-grade portion would house the process hot cells and waste storage areas (i.e., high-integrity container vault) (see Section 2.3.1). The design calls for the subflooring to consist of a reinforced concrete mat slab 18 to 24 in. (46 to 61 cm) thick. The maximum depth of excavation could range from 17 to 23 ft below grade (5.2 to 7 m) (NWMI 2015a, 2015c). NWMI estimates that approximately 9,000 $yd^3$ (6,900 $m^3$) of earthwork material will be generated by site construction and excavation activities (see Section 2.2) (NWMI 2015a, 2015c). NWMI indicated its desire to limit overexcavation and to reuse excavated soils for backfill (NWMI 2015a, 2015c). However, soils at the Discovery Ridge site present a number of construction challenges and limitations for workability and stability that in turn can affect excavation work and needed material.

The geotechnical study (Terracon 2011a) found that site soils classify as lean to fat clay and fat clay, as further described in Section 3.3.1. The soils are rated as poorly drained with low permeability. At the time they were evaluated by Terracon (2011a), site soils exhibited a high water content with the potential for perched groundwater conditions. Most significantly, the fat clays have a high/shrink swell potential. High shrink/swell soils are difficult to work and undesirable for backfill. Consequently, these conditions may require additional overexcavation and removal of site soils in excavations and foundation cuts so that they can be replaced with suitable engineered backfill to properly support and safeguard concrete structures. Terracon (2011a) identified the need for the use of engineered backfill to provide a low-volume change layer for proper support of concrete surfaces. Therefore, additional excavation may be required and some or a substantial proportion of the excavated material may need to be replaced with engineered backfill.

As discussed in Sections 3.3.1 and 3.3.2, the depth to bedrock beneath the Discovery Ridge site has not been determined with accuracy, and the relative proximity of karst terrane presents an additional concern. Available information indicates that the depth to weathered bedrock ranges between 13 and 25 ft (4 to 7.6 m) below ground surface (bgs), with the true depth likely to be on the higher end of the cited range. Depending on the final depth of excavation and depth to bedrock, excavation may require techniques such as drilling, ripping, or blasting. The integrity of the bedrock surface requires assessment with respect to the possible presence of karst features.

In addition, the potential for wet soils at relatively shallow depths and the possibility of a shallow water table (see Section 3.3.1) or perched groundwater could require the use of bracing, even in shallow trenches, and other measures (e.g., cofferdams) during construction of the below-grade portion of the facility that ultimately impacts the final facility design and, therefore, excavation work.

NWMI will conduct site-specific geotechnical and hydrological studies of the Discovery Ridge site to characterize site conditions in support of final facility design (NWMI 2015c). These studies would include drilling a suite of boreholes to a maximum depth of 50 ft (12 m) bgs, or up to 20 ft (6.1 m) into competent bedrock. Soil and rock profiles would be characterized for each boring and engineering, geotechnical, and hydrologic properties would be determined. Depth to groundwater and groundwater quality would also be characterized during these studies (NWMI 2015c, 2016a).

Mineral and other geologic resources, such as granular stone (e.g., typically crushed aggregate (sand and gravel)), would be required to support facility construction, as summarized in Section 2.2, Table 2–1. As noted in Section 3.3.1, construction aggregate is widely available throughout Boone County and northeast Missouri.

NWMI estimates that 4,260 $yd^3$ (3,360 $m^3$) of concrete would also be used for facility construction, in addition to precast concrete, which would be obtained from offsite commercial vendors (NWMI 2015a, 2015c). Consequently, no onsite concrete batch plant would be required. The mineral products that comprise concrete (i.e., Portland cement, sand, gravel, and other additives) are widely available in the region or are not otherwise limited in commercial availability.

NWMI estimates that approximately 9,000 $yd^3$ (6,900 $m^3$) of earthwork material will be generated by site construction and excavation activities (see Section 2.2). As stated in the ER, NWMI assumes that these excavated soils and sediments would be used as backfill. As referenced above, some or a substantial proportion of this excavated material may need to be replaced with engineered backfill, although soils with the necessary engineering properties are readily obtainable throughout the Columbia area.

Construction activities would require the consumption of geologic resources and would have the potential to increase soil erosion, but the necessary geologic resources are widely available within the region and erosion would be managed with the implementation of BMPs as required by permit requirements. Site conditions such as depth to bedrock, high shrink/swell soils, and wet, low permeability soils would increase the potential for construction impacts and the possible need for construction mitigation. However, completion of detailed site-specific geotechnical studies would serve to reduce the cited uncertainties with respect to site geologic and soil conditions. As a result, the NRC staff concludes that the impacts on the geologic environment from the construction of the proposed NWMI facility would be SMALL overall.

### 4.3.2 Operations

During facility operations, previously disturbed areas would not be subject to long-term soil erosion. Areas disturbed during construction would be within the footprint of the completed facility or overlain by other impervious surfaces (e.g., roadways and parking lots), or revegetated.

NWMI would conduct all facility process activities within enclosed buildings, and vehicle traffic would be confined to paved surfaces (e.g., roads and parking areas) that service the facility. As a result, incremental impacts on geology and soils would be negligible during operations.

The NRC staff does not expect site geologic conditions to affect the operation of the NWMI facility. The proposed site is located in a region with a relatively low seismic hazard compared with adjoining regions, as described in Section 3.3.3. Final facility design and construction would comply with applicable building codes and standards, which provide for the evaluation of site geologic and soil conditions, including potential seismic hazards. Completion of site-specific geotechnical and hydrological studies, as discussed in Section 4.3.1, would inform final design and construction considerations. Therefore, the NRC staff concludes that the operational impacts associated with the geologic environment at the proposed site would be SMALL.

### 4.3.3 Decommissioning

Compacted site soils and underlying sediments would be disturbed by facility demolition and decontamination work. The impacts on site geology and soils would be similar in scope to those described for construction. Site clearing to restore the proposed site to a reusable condition would be subject to applicable permits and approvals (e.g., demolition or clearance permit), and the applicable provisions, including Chapter 6, Article II (Building Code) of the City of Columbia's Code of Ordinances (NWMI 2015a; City of Columbia 2015).

Before beginning to dismantle onsite structures, decommissioning contractors would remove waste materials and contaminated media from the structures. Materials would be packaged and properly disposed of as discussed in Section 4.9. Thus, these materials would not pose a contamination threat to site soils or water resources. Soils and other media would be sampled to determine the presence of any contamination and associated waste management requirements. NWMI would be required to conduct all decommissioning activities in accordance with a decommissioning plan submitted to the NRC for approval and applicable regulations, as described in Section 2.9.

The NRC staff concludes that impacts on the geologic environment from facility decommissioning would be SMALL.

## 4.4 Water Resources

### 4.4.1 Surface Water

#### *4.4.1.1 Construction*

Surface water resources would not be directly impacted by site construction activities. No natural surface water features occur on the Discovery Ridge site. As discussed in Section 3.4.1.1, the natural hydrologic regime of the site and immediate vicinity has been altered by previous development activities that include pond and stormwater management facility construction. The closest natural watercourse is Gans Creek, which is located approximately 0.35 mi (0.56 km) south of the site at its closest point.

During construction, however, stormwater runoff from construction areas could potentially affect downstream surface water quality if not properly managed. As detailed in Section 4.3.1, NWMI would be required to obtain a Land Disturbance Permit from the City of Columbia and submit related plans for City approval before any ground-disturbing activities or facility construction could begin on the site. The City would require that appropriate soil erosion and sediment control BMPs be used to minimize soil erosion and the stormwater transport of suspended sediment and other pollutants. These measures must also address construction site pollutants that could affect offsite surface water quality.

Construction stormwater runoff is also subject to regulation in accordance with Section 402 of the Federal Water Pollution Control Act (i.e., Clean Water Act (CWA) of 1972, as amended (33 U.S.C. 1251 et seq. )), and the Missouri Clean Water Law. CWA Section 402 establishes the National Pollutant Discharge Elimination System (NPDES) (see Section 3.4.1.2). Specifically, the State of Missouri has developed an NPDES general permit (i.e., Missouri State Operating Permit MO-RA) that must be obtained by owners and operators for the discharge of stormwater and certain non-stormwater discharges (e.g., dewatering) from land-disturbance sites that disturb 1 ac (0.4 ha) or more, or less than 1 ac (0.4 ha) but are part of a larger development. General permit MO-RA has an effective date of February 2012, and is valid until February 2017 (states typically reauthorize general permits every 5 years). Facilities that discharge stormwater to a combined storm sewer are exempt from stormwater permit requirements (MDNR 2012, 2016g). This State general permit requires permit holders to develop and implement a stormwater pollution prevention plan (SWPP), the purpose of which is in part to ensure the proper design, implementation, management, and maintenance of BMPs to prevent the introduction of sediment and other pollutants in stormwater discharges (MDNR 2012).

NWMI indicates that it would obtain coverage under a Missouri General Operating Permit, if applicable for the site, or would comply with criteria and standards of the Discovery Ridge Master Storm Water Management Plan (NWMI 2015a). A separate County approval, a Stormwater Discharge Permit, may also be required for the discharge of any stormwater into a municipal storm sewer system or other publicly owned storm sewer system. The approval ensures that the receiving system has adequate capacity for any increases in peak flow rates and volumes (Boone County 2010, 2016b).

Finally, a stormwater management plan must also be prepared and approved by the City of Columbia in accordance with Chapter 12A, Article V (Stormwater Management) of the City's Code of Ordinances. As indicated in Section 4.3.1, the City must approve the plan before a Land Disturbance Permit can be issued. The stormwater management plan must in part address BMPs used to control the peak flow rates of stormwater discharge associated with specified design storms and to reduce the generation of stormwater runoff.

No surface water or onsite groundwater would be withdrawn to support facility construction. Section 4.4.2 presents the NRC's analysis of groundwater use impacts.

There would also be no sanitary wastewater discharges during construction. In accordance with common construction practices and as stated by NWMI (2015c), portable restroom facilities, serviced by a commercial vendor, would be used during site construction. Section 4.9 describes waste management impacts in detail.

The proposed site is not located in an area susceptible to flooding or in a delineated floodplain, as discussed in Section 3.4.1. The NRC staff does not expect that site construction activities would have any direct impact on the floodplain of Gans Creek, which is located approximately 0.35 mi (0.56 km) south of the NWMI facility site at is closest point.

Under CWA Section 401, an applicant for a Federal license or permit to conduct any activities, including facility construction or operation, that may cause a discharge into navigable waters is required to provide the Federal licensing agency with a certification from the state or agency having jurisdiction in which the discharge would originate (see Section 3.4.1.2). This water quality certification signifies that discharges from the project or facility to be licensed by the Federal agency will comply with CWA requirements and will not cause or contribute to a violation of state water quality standards. A Federal agency cannot issue a license or permit to an applicant until the required certification is provided, or the responsible state or agency has waived the requirement. The NRC recognizes that some NPDES-delegated states explicitly integrate their 401 certification process with NPDES permit issuance. The State of Missouri regulations for administering its water quality certification process are at 10 CSR 20-6.060.

The only regulated direct discharges from the proposed facility involve stormwater associated with construction activity. As previously described, NWMI would obtain coverage under a State-issued NPDES general permit (i.e., Missouri State Operating Permit MO-RA) for such discharges. Permit provisions are intended to ensure that the State's water quality standards are met. NWMI has stated that no State certification is required under CWA Section 401 (NWMI 2015a). NWMI also has stated that it would seek a waiver from the State (NWMI 2015c). However, because the NRC cannot issue a construction permit without the required certification, NWMI must provide the NRC with either a 401 certification from the State of Missouri, a waiver, or other State documentation that a Section 401 certification is not necessary.

No natural surface water features occur on the proposed site, and previous activities have altered the natural hydrology of the site. NWMI must prepare site-specific plans and implement BMPs in accordance with local and MDNR requirements to mitigate the potential impacts on surface water quality associated with construction activities. NWMI would not divert or withdraw surface water to support facility construction. Based on these considerations, the NRC staff concludes that the impacts on surface water hydrology, quality, and use from the construction of the proposed NWMI facility would be SMALL.

#### *4.4.1.2 Operations*

During operations, there would be no direct impact on surface water features and no direct discharge of industrial wastewater to surface water bodies. The NRC staff anticipates that there would be no measurable impacts on surface water quality. Stormwater would be collected and discharged from the NWMI facility property to lined, engineered stormwater basins. NWMI would use BMPs to manage stormwater runoff from paved and compacted surfaces to drainage ditches and basins (NWMI 2015a).

The University of Missouri (MU) will require that stormwater discharges from the NWMI facility site comply with the master stormwater management plan developed for the Discovery Ridge Research Park (MU 2009; NWMI 2015a). This would include compliance with applicable provisions of City ordinances. More precisely, the site-specific stormwater management plan (see Section 4.4.1.1) required by the City of Columbia must address BMPs used to control the peak flow rates of stormwater discharge associated with specified design storms and to reduce the generation of stormwater runoff. As a required element of the plan, NWMI will have to maintain a written operation and maintenance manual for the facility's permanent stormwater management facilities to ensure that the permanent stormwater facilities, once constructed, continue to function as designed.

Additionally, as referenced in Section 4.4.1.1, a separate Stormwater Discharge Permit may also be required from Boone County for the discharge of facility stormwater runoff into a municipal storm sewer system. However, NWMI may be able to address this requirement as part of the discharge approval process under the Discovery Ridge Research Park master stormwater management plan.

NWMI states that it would obtain an NPDES general permit for stormwater discharges associated with industrial activity (NWMI 2015a, 2015c) (see Appendix B). Under Section 402 of the CWA and MDNR's regulations for implementing the NPDES permit program for stormwater (10 CSR 20-6.200), certain industrial activities require a permit from the MDNR for their stormwater discharges. If applicable, MDNR may either issue NWMI a general permit for the appropriate industrial category or will require that the facility be covered under an NPDES individual permit (MDNR 2014b). Nonetheless, NWMI does not appear to fall into any of the industrial classifications requiring permit coverage. It also appears that the nature of NWMI's proposed activities would meet the "no exposure" exemption criteria as no industrial materials, products, or wastes will be exposed to stormwater runoff from the NWMI facility. Stormwater runoff from the facility site would normally only consist of runoff from landscaped grounds, parking lots, roads, and roof drainage. NWMI may still be required to file a "no exposure certification" form with MDNR (MDNR 2014b).

The RPF building of the NWMI facility is designed to have zero liquid discharge from the RCA. There would be no liquid radioactive effluents released from the facility (NWMI 2015a, 2015c). Sections 2.7, 2.8, and 4.9 of this EIS separately discuss the treatment and handling of waste from the RCA.

Facility discharges would be limited to sanitary effluent. This sanitary wastewater would be conveyed to the City of Columbia Sanitary Sewer Utility. NWMI would also obtain a sanitary sewer connection approval from the City of Columbia (NWMI 2015a, 2015c). As previously described in Section 3.4.1.2, wastewater discharges to a municipal sanitary sewer system do not require an NPDES permit, although the discharge would need to comply with the system's influent acceptance and treatment criteria. Influent requirements are prescribed in the City's Code of Ordinances (Chapter 22, Article VI, Sewers and Sewage Disposal) and specifically address unlawful discharges, influent limits, and applicable pretreatment requirements (NWMI 2015a; City of Columbia 2015). Wastewater would also need to meet the NRC's release criteria under 10 CFR 20.2003.

Wastewater from the NWMI facility would be discharged to the City of Columbia sanitary sewer system at an average rate of approximately 4,570 gallons per day (gpd) (17,300 liters per day (Lpd)) (NWMI 2015a, 2015c). This is equivalent to approximately 0.0046 million gallons per day (mgd/day) (17.4 cubic meters per day ($m^3$/day)). The Columbia Regional Wastewater Treatment Plant (WWTP) would be ultimately the point of treatment because this facility serves the entire City of Columbia. The Columbia WWTP has a design treatment capacity of 20 mgd (75,700 $m^3$/day) with an average demand of 16 mgd (60,600 $m^3$/day) (City of Columbia 2016c). NWMI's additional wastewater volume would constitute a very small percentage (i.e., 0.12 percent) of the available treatment capacity of the WWTP; the proposed discharge would be unlikely to have any impact on the WWTP.

Finally, fuels and chemicals stored on the NWMI facility site could have substantial, localized water quality impacts if such materials were to be released to the environment. NWMI would maintain an emergency response plan and operating procedures to address chemical hazards, including spill response and mitigation (NWMI 2015a). A sizable volume of diesel fuel would also be stored on site. Current plans call for a 1,000-gal (3,780-L) aboveground storage tank for use in supplying the RPF backup generator (NWMI 2015a). This storage volume falls below the threshold requiring the preparation of a Spill Prevention, Control, and Countermeasure (SPCC) Plan under CWA Section 311 and implementing regulations. SPCC plans must be prepared by covered facilities to prevent, prepare, and respond to oil discharges potentially affecting navigable waters of the United States (40 CFR Part 112). NWMI will evaluate the need to prepare an SPCC plan to support facility operations and/or construction before initiating site work (NWMI 2015a).

In summary, no hazardous or radiological liquid effluent discharge would occur from the facility. NWMI would convey sanitary wastewater to a municipal wastewater treatment plant that has adequate treatment capacity. Stormwater discharges from the NWMI facility would be of a nonindustrial nature and would be managed by engineered facilities and in accordance with local and State regulations. NWMI will maintain appropriate plans and procedures to address any inadvertent spills of chemical or petroleum products. Based on these considerations, the NRC staff concludes that the impacts on surface water hydrology, quality, and use from the NWMI facility operations would be SMALL.

#### *4.4.1.3 Decommissioning*

No natural surface water features occur on the proposed site, and there would be no direct impacts on surface water resources as a consequence of facility decommissioning activities. No surface water would be used during decommissioning.

As previously referenced in Section 4.3.3, decommissioning contractors would conduct work in accordance with a decommissioning plan submitted to the NRC for approval and in accordance with permits and approvals from the City of Columbia. During decommissioning, NWMI would be responsible for removing waste materials and contaminated media from the facility and packaging them for proper disposal. As necessary, contractors would sample soils and other media to determine the presence of any contamination and associated waste management requirements. Further, appropriate waste handling and stormwater pollution prevention practices and spill prevention and response procedures would be observed during decommissioning to ensure that no materials or contaminants are released to soils or exposed to stormwater.

The NRC staff expects that ground-disturbing activities associated with decommissioning would require coverage under a State-issued NPDES general permit for the discharge of stormwater from land-disturbance sites, as described in Section 4.4.1.1 for construction. BMPs, including the use of structural controls, such as sediment fencing and sediment basins, and the use of mulching, geotextile matting, and rapid reseeding of disturbed areas, would be used to prevent soil erosion and loss and any potential offsite water quality impacts.

As no natural surface water features would be impacted during decommissioning, there would be no diversion or withdrawal of surface water, and all work would be accomplished in accordance with a decommissioning plan, procedures, and permits to protect surface water quality, the NRC staff concludes that the impacts on surface water resources from facility decommissioning would be SMALL.

### **4.4.2 Groundwater**

#### *4.4.2.1 Construction*

Excavation depths could range from 17 to 23 ft below grade (5.2 to 7 m) for portions of the RPF, as described in Section 4.3.1. During the preliminary geotechnical investigation of the Discovery Ridge Research Park in 2011, the geotechnical contractor encountered groundwater in two soil borings at depths of approximately 12 to 18.5 ft (3.7 and 5.6 m) bgs (see Section 3.4.2.1). Therefore, groundwater dewatering may be required during construction. NWMI will conduct site-specific geotechnical and hydrologic studies of the Discovery Ridge site (NWMI 2015c). These studies would help to determine whether a seasonally high water table or perched groundwater exists beneath the site, as well as guide any necessary construction accommodations and final facility design.

NWMI estimated the maximum potential dewatering rate for site excavations (NWMI 2016a). NWMI used very conservative parameters for runoff area and precipitation yielding a maximum dewatering rate of 1,400 gal (5,300 L) per hour. Dewatering at this rate would be necessary only in the deepest excavation and only during a heavy precipitation event. During dewatering, contractors would pump the groundwater to a detention/retention pond (NWMI 2016a). The State-issued NPDES general permit for the discharge of stormwater from land-disturbance sites (see Section 4.4.1.1) allows for the discharge of uncontaminated groundwater if the discharge is properly controlled and addressed under the project-site SWPP (MDNR 2012). The NRC staff expects that dewatering could have minor effects on the vertical and horizontal extent of shallow groundwater, if present, and on groundwater flow direction, but any effects would be localized and temporary.

Site groundwater conditions could potentially affect facility construction and final design. These include the potential for wet subsurface conditions, including a seasonally high water table or perched groundwater beneath the site. To address these potential issues, site-specific geotechnical and hydrologic studies are planned that will characterize site conditions in support of final facility design. These studies would ensure that the completed facility incorporates any necessary design features such as foundations protected with water barrier systems (e.g., sealants) and foundation drainage and water diversion systems (NWMI 2016a).

NWMI does not plan to install any groundwater wells, and there would be no use of onsite groundwater to support construction activities. Consolidated Public Water Supply District No. 1 would supply water required to support site construction activities (NWMI 2015a, 2015c). As noted in Section 4.3.1, water lines and other utilities are already in place at the southwest corner of the Discovery Ridge site. During the course of construction and before the establishment of permanent utility connections with the NWMI facility, the NRC staff expects that construction contractors would truck water to the point of use on the site, or water would be conveyed through a temporary water tap.

Water would be required during construction for such uses as dust control and soil compaction. For example, NWMI has proposed twice-daily watering of the construction site as a fugitive dust BMP (NWMI 2015a). Some potable water would also be required to meet the drinking and sanitary needs of the construction workforce during the construction period. As stated in Section 4.4.1.1, the construction contractor would provide portable restroom facilities for the construction workforce. This measure would reduce the quantity of water required for potable and sanitary uses. These facilities would be serviced off site by a commercial vendor, alleviating any potential surface water or groundwater quality concerns. While water would also be used to produce concrete, this water consumption would occur off site as NWMI proposes to use ready-mix concrete supplied by commercial vendors instead of operating an onsite concrete batch plant (NWMI 2015c).

As presented in Section 2.6 and summarized in Table 2–3, construction activities would require an average of 6,140 gpd (23,200 Lpd) of water. This is equivalent to 0.0061 mgd (23.1 $m^3$/day). Total projected water use for the 17-month construction period is approximately 2.1 million gal (7.9 million L).

Consolidated Public Water Supply District No. 1, which is the utility that serves the Discovery Ridge site, uses groundwater as its supply source (Section 3.4.2.2). The system has a total groundwater production capacity of 11 mgd (49,200 $m^3$/day) and currently supplies approximately 1.45 mgd (5,490 $m^3$/day) to customers (NWMI 2015a). The projected average daily water needs for NWMI facility construction would be a very small percentage (less than 1 percent) of the district's total production and available supply capacity.

Dewatering may be necessary during construction but site-specific geotechnical and hydrologic studies will further characterize subsurface conditions, and dewatering activities would be conducted in accordance with regulatory requirements. NWMI would not use groundwater from onsite sources during construction, and the estimated water demand to support construction activities would be less than 1 percent of the public utility's total production and available excess capacity. As a result, the NRC staff concludes that the impacts on groundwater hydrology, quality, and use from construction of the NWMI facility would be SMALL.

#### *4.4.2.2 Operations*

The NRC staff expects that there would be no measurable impacts on groundwater hydrology or groundwater quality associated with normal operations of the NWMI facility. As discussed in Section 4.4.2.1, due to the potential for a seasonally high water table or perched groundwater beneath the site, the below-grade portions of the facility may incorporate a foundation drainage collection and water diversion system. Any impacts on groundwater elevations and flow direction beneath the site associated with the operation of these features would likely be very localized.

There would be no radioactive liquid effluents released from the facility because the RPF building is designed to have zero liquid discharge. NWMI would conduct all material, chemical, and waste handling activities within the confines of the NWMI facility, precluding any releases to the environment, including soils and groundwater. Stormwater runoff from the NWMI facility site would be managed by an engineered stormwater management system, including necessary detention/retention structures, constructed and operated in compliance with State and municipal stormwater management plans, procedures, and practices (see Section 4.4.1.2).

As described in Section 4.4.1.1, the only liquid waste stream discharged from the facility would be sanitary wastewater. NWMI would discharge this wastewater to the City of Columbia Sanitary Sewer Utility, where it would be treated in the Columbia Regional WWTP, which has excess treatment capacity available.

No onsite groundwater would be used during operations. A public water utility, Consolidated Public Water Supply District No. 1, provides water service to the Discovery Ridge Research Park. Water would be required to meet the potable and sanitary needs of the facility staff and to provide water for fire protection, wash water, and RPF process makeup needs. Section 2.5 and Table 2–3 further describes these requirements. Facility operations would require an average of 5,045 gpd (19,100 Lpd) of water, equivalent to 0.005 mgd (18.9 $m^3$/day). Total annual water use would be approximately 1.3 million gal (4.9 million L). Based on the process water balance for the facility (NWMI 2015c), process losses are projected to average 475 gpd (1,798 Lpd), which reflects a consumptive use rate of approximately 9 percent. These in-facility losses represent water lost to the atmosphere as water vapor, incorporated into packaged waste products, or other miscellaneous losses. Even so, the projected average daily water use of the NWMI facility is a negligible percentage of the production capacity of the water district and represents a very small increase (about 0.3 percent) in the volume of water the district supplies to its customers.

As facility operations would have no offsite impact on groundwater hydrology, there would be no discharge of wastewater to groundwater, and water to support facility operations would be a very small percentage of the production capacity and current demand of the public water supply district, the NRC staff concludes that the impacts on groundwater hydrology, quality, and use from the operation of the NWMI facility would be SMALL.

#### *4.4.2.3 Decommissioning*

The potential decommissioning impacts on and associated mitigation measures for groundwater are similar to those described in Sections 4.3.3 and 4.4.1.3. In summary, contractors would perform demolition and site restoration activities in accordance with applicable local and State permits and approvals, including a State-issued NPDES general permit for the discharge of stormwater from land-disturbance sites, as described in Section 4.4.1.1 for construction. BMPs would be used to prevent soil erosion and loss and any potential impacts to surface water and groundwater incidental to site decommissioning activities. Specifically, waste handling and pollution prevention practices and spill prevention and response procedures would be observed during decommissioning, so that no materials or contaminants would be released to soils or exposed to stormwater, where they could contaminate underlying groundwater.

NWMI would be required to conduct necessary surveys of the soils and subsurface to comply with the NRC's radiological criteria for license termination in 10 CFR Part 20, Subpart E. The NRC staff also expects that NWMI would sample soils and other media as necessary in accordance with other required local and State permits and approvals to ensure that no nonradiological contamination remains in excess of action levels.

Water would be required to support decommissioning work, as summarized in Section 2.5 and Table 2–3. As for facility construction and operations, the NRC staff assumes that Consolidated Public Water Supply District No. 1 would supply water to support facility decommissioning. NWMI contractors would either truck water to the site or it could be supplied through a temporary water line as decommissioning activities progress. NWMI estimates that decommissioning activities would require an average of 2,000 gpd (7,600 Lpd) of water, equivalent to 0.002 mgd (7.6 $m^3$/day). Total projected water use for the 24-month decommissioning period is approximately 0.96 million gal (3.6 million L). The volume of water required would be less than that required for facility construction, with negligible impacts on local or regional groundwater supply capacity. It is expected that portable restroom facilities, serviced by a commercial vendor, would be used during site decommissioning to meet the needs of decommissioning personnel. Thus, there would be no onsite discharge of sanitary waste streams. Therefore, based on the stated findings and assumptions, the NRC staff concludes that impacts on groundwater resources from decommissioning of the NWMI facility would be SMALL.

## 4.5 Ecological Resources

### 4.5.1 Construction

As described in Section 4.1, construction of the proposed NWMI facility would permanently convert 7.4 ac (3.0 ha) of agricultural land into an industrial area (Table 4–1) (NWMI 2015a, 2015c). In addition, 0.26 ac (0.1 ha) of agricultural land would be temporarily converted from agricultural land to a construction staging area (NWMI 2015a, 2015c). Once construction activities are complete, 68 percent of the site will be covered by buildings, roads, or parking lots, and 32 percent of the site will be covered with grasses, shrubs, and/or ornamental flowers, including native species (NWMI 2015a, 2015c). Directly affected vegetation would be limited to common or non-native grasses, which are abundant within the region and provide relatively low-quality habitat for birds and wildlife in comparison to forests, grasslands, and wetland habitats. In addition to a loss of habitat, noise from construction activities could disturb birds and wildlife. In response to such disturbances and loss of habitat, birds and wildlife could move out of the immediate area and find adequate, similar habitat (e.g., agricultural fields) within the vicinity. Once construction activities are complete, birds and wildlife could return to the area. Using regionally native species to revegetate disturbed areas should help reduce the risk of reintroduction of non-native plants to the watershed (MDC 2016e).

During construction, bird collisions with construction equipment and the new facility could result in increased mortality caused by the presence of tall structures and artificial night lighting. NWMI may use tall cranes to build the facility, which, when built, would be at a height of 65 ft (20 m) for the high bay roof (NWMI 2015a). In addition, the facility stacks would be 75 ft (23 m) (NWMI 2015a). Migratory songbirds would be most likely to collide with artificially lighted structures or cranes because of their propensity to migrate at night, their low flight altitudes, and their tendency to be trapped and disoriented by artificial light (Ogden 1996; NRC 2013a).

NWMI (2015a) stated that, during construction at night, BMPs, such as light source shielding and appropriate directional lighting, would be used to mitigate impacts associated with artificial nighttime illumination. NRC (2013b) reviewed bird collisions with plant structures at nuclear power plants and determined that collision rates were negligible sources of bird mortality with plants that have cooling towers 100 ft (30 m) in height. The NWMI facility and construction equipment would be similar or smaller in size and height than an operating nuclear power plant; therefore, the impacts from bird collisions at the NWMI site would be bounded by the conclusions the NRC staff reached in its review of bird collisions at operating nuclear power plants with cooling towers 100 ft (30 m) in height.

Construction of the NWMI facility is not expected to result in any direct impacts to aquatic resources, such as habitat loss, because no aquatic resources occur on site and no surface water or groundwater would be used for construction activities. As described in Section 3.4, water drains off the proposed site to the south and southwest toward the southwesterly flowing Gans Creek, located approximately 0.35 mi (0.56 km) south of the site at its closest point (see Figures 3–11 and 3–13). Converting land from open fields to impermeable surfaces, such as rooftops and paved roads, will increase runoff to Gans Creek. Runoff from the proposed site could affect offsite aquatic resources by damaging downstream aquatic habitat and functions (MDC 2016e). For example, runoff can increase turbidity or introduce various chemicals or other pollutants that decrease water quality. However, impacts to Gans Creek and other nearby waterbodies are expected to be minimal because of the distance to the waterbodies, appropriate soil erosion and sediment control BMPs would be employed to minimize the transport of suspended sediment and other pollutants, and NWMI would be required to develop a site-specific program to prevent pollution from stormwater runoff (see Sections 4.3 and 4.4).

An inadvertent release of pollutants could flow to nearby surface water or groundwater features, including Devil's Icebox cave located within Rock Bridge Memorial State Park. However, no hazardous or radiological liquid effluent discharge would occur from the facility and NWMI would convey sanitary wastewater to a municipal wastewater treatment plant that has adequate treatment capacity. In addition, NWMI will maintain appropriate plans and procedures to address any inadvertent spills of chemical or petroleum products.

Given that construction would not permanently or temporarily affect any high-quality habitats, such as grasslands, forests, or wetlands; permanently and temporarily affected habitats (agricultural fields) are abundant within the region; mortality from bird collisions is expected to be negligible; and no aquatic features or State-listed species occur on the Discovery Ridge site, the NRC staff concludes that impacts to ecological resources during construction would be SMALL.

### 4.5.2 Operations

During operations, impacts to ecological resources could result from bird collisions, herbicide applications for landscape maintenance activities, elevated noise levels, and increased turbidity or introduction of pollutants from site runoff. As described above, mortality from bird collisions is expected to be negligible, given that the tallest structure would be a stack no higher than 75 ft (23 m). Disturbance from daily activities, herbicide applications, or elevated noise levels are likely to have minimal impacts on wildlife and plant species, given that the species identified at the proposed site are generally tolerant of human disturbances because the land has been actively farmed for the past several decades. In response to any disturbances, birds and wildlife could move out of the immediate area and find adequate, similar habitat (agricultural fields) within the vicinity. In addition, NWMI would mitigate impacts from herbicide applications by implementing BMP requirements that would limit their use and contain the broad application throughout the site.

Operation of the NWMI facility is not expected to result in any direct impacts to aquatic resources, because no aquatic resources occur on site and wastewater would be conveyed to a municipal wastewater treatment plant (NWMI 2015a). Indirect impacts during operations could include runoff that may contain sediments, contaminants from road and parking surfaces, or herbicides. Increased runoff could affect offsite aquatic resources by damaging downstream aquatic habitat and functions (MDC 2016e). However, as described in Section 4.4, impacts to aquatic resources are expected to be minimal because of the distance to the nearest waterbody and NWMI would be required to develop a site-specific program to prevent pollution from stormwater runoff. In addition, NWMI will maintain appropriate plans and procedures to address any inadvertent spills of chemical or petroleum products.

Given that mortality from bird collisions is expected to be negligible, habitat disturbances during operations would be minimal, any disturbed wildlife could find similar habitat in the vicinity, and no aquatic features or State-listed species occur on the proposed site, the NRC staff concludes that impacts to ecological resources during operations would be SMALL.

### 4.5.3 Decommissioning

Decommissioning activities would have impacts that are similar to the impacts that would occur during construction of the proposed facility. For example, NWMI would use construction equipment to dismantle large buildings, which could result in disturbances to wildlife and birds and potential runoff to nearby waterbodies. In addition, some land on the proposed site could be used as staging areas for the equipment and to conduct certain dismantling activities. As described above, if noise or other activities disturb birds or wildlife, similar habitat is available in nearby offsite areas. Once activities are complete, birds and wildlife could return to the area. No surface water would be used during decommissioning and impacts from runoff would be minimal, based on the distance to the nearest waterbodies, and because BMPs would be required in NWMI's stormwater permit. Therefore, impacts during decommissioning are expected to be SMALL.

### 4.5.4 Federally Protected Species

Section 3.5 describes the special status species and habitats that have the potential to be affected by the proposed action. The discussion of species and habitats protected under the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) includes a description of the action area as defined by the ESA section 7 regulations at 50 CFR 402.02. The action area encompasses all areas that would be directly or indirectly affected by the proposed construction, operations, and decommissioning of the NWMI facility.

Appendix D contains information on the NRC staff's section 7 consultation with the U.S. Fish and Wildlife Service (FWS) for the proposed action. The NRC did not consult with the National Marine Fisheries Service (NMFS) as part of the construction permit review because (as described in Section 3.5) no species or habitats under NMFS's jurisdiction occur within the action area.

In Section 3.5, the NRC staff concludes that no Federally listed species are likely to occur in the action area. The NRC staff also concludes that no candidate species, proposed species, or designated critical habitat occur in the action area. Thus, the NRC staff concludes that the proposed action would have no effect on Federally listed species or habitats under FWS's jurisdiction.

As discussed in Section 3.5, no species or habitats under NMFS's jurisdiction occur within the action area. Thus, the NRC staff concludes that the proposed action would have no effect on Federally listed species or habitats under NMFS's jurisdiction.

As discussed in Section 3.5, NMFS has not designated essential fish habitat (EFH) pursuant to the Magnuson–Stevens Fishery Conservation and Management Act, as amended (16 U.S.C. 1801 et seq.) within affected water bodies in the vicinity of the proposed site. Thus, the NRC staff concludes that the proposed action would have no effect on EFH.

## 4.6 Historic and Cultural Resources

This section describes the potential impacts from constructing, operating, and decommissioning the proposed NWMI facility at Discovery Ridge Research Park on historic and cultural resources.

### 4.6.1 Historic and Cultural Resources

The National Historic Preservation Act (NHPA) of 1966, as amended (54 U.S.C. 300101 et seq.), requires Federal agencies to consider the effects of their undertakings on historic properties. Construction, operations, and decommissioning of the NWMI facility is an undertaking that could potentially affect historic properties. Historic properties are defined as resources eligible for listing in the National Register of Historic Places (NRHP). The criteria for eligibility are listed in 36 CFR 60.4 and include (1) association with significant events in history, (2) association with the lives of persons significant in the past, (3) embodiment of distinctive characteristics of type, period, or construction, and (4) sites or places that have yielded, or are likely to yield, important information.

The historic preservation review process (Section 106 of the NHPA) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800.

### 4.6.2 Proposed Action

In accordance with the provisions of the NHPA, the NRC is required to make a reasonable effort to identify historic properties included in, or eligible for, inclusion in the NRHP in the area of potential effect (APE). The APE for this proposed action is Lot 15 at Discovery Ridge Research Park and any other properties that may be affected by the construction, operations, and decommissioning of the proposed NWMI facility. The APE may extend beyond Lot 15 in those instances where construction, operations, and decommissioning activities may effect an historic property. This determination is made irrespective of land ownership or control. Cultural resource investigations and surveys conducted on Lot 15 are described in Section 3.6.2.

If historic properties are present within the APE, the NRC is required to contact the State Historic Preservation Officer (SHPO), assess the potential impact, and resolve any possible adverse effects of the undertaking on historic properties. In addition, the NRC is required to notify the SHPO if historic properties would not be affected by the undertaking or if no historic properties are present. The SHPO is part of the MDNR.

### 4.6.3 Consultation

In accordance with 36 CFR 800.8(c), on November 19, 2015, the NRC initiated consultations on the proposed action by writing to the ACHP and MDNR (NRC 2015f). In a response dated December 9, 2015, MDNR indicated that adequate documentation had been provided (as required by 36 CFR Section 800.11), and there will be “no historic properties affected” by the proposed NWMI facility (see Appendix D).

The NRC staff also initiated consultation with the following Federally recognized tribes on November 20, 2015 (see Appendix D for a copy of these letters):

- Absentee-Shawnee Tribe of Indians of Oklahoma,
- Caddo Nation of Oklahoma,
- Cherokee Nation,
- Cheyenne and Arapaho Tribes,
- Chickasaw Nation,
- Choctaw Nation of Oklahoma,
- Citizen Potawatomi Nation,
- Delaware Nation,
- Eastern Shawnee Tribe of Oklahoma,
- Iowa Tribe of Kansas and Nebraska,
- Iowa Tribe of Oklahoma,
- Miami Tribe of Oklahoma,
- Muscogee (Creek) Nation,
- Omaha Tribe of Nebraska,
- Osage Nation,
- Otoe-Missouria Tribe of Indians,
- Pawnee Nation of Oklahoma,
- Peoria Tribe of Indians of Oklahoma,
- Ponca Tribe of Indians of Oklahoma,
- Ponca Tribe of Nebraska,
- Prairie Band Potawatomi Nation,
- Quapaw Tribe of Oklahoma,
- Sac and Fox Nation of Missouri in Kansas and Nebraska,
- Sac and Fox Nation, Oklahoma,
- Sac and Fox Tribe of the Mississippi in Iowa,
- Shawnee Tribe,
- United Keetoowah Band of Cherokee Indians of Oklahoma,
- Winnebago Tribe of Nebraska,
- Wyandotte Nation,

- Kaw Nation, Oklahoma, and
- Yankton Sioux Tribe of South Dakota.

In its letters, the NRC provided information about the proposed action, defined the APE, and indicated that the NRC intends to comply with Section 106 through the National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. 4321 et seq.) process, pursuant to 36 CFR 800.8(c). The NRC invited participation in the identification and possible decisions concerning any historic properties and also invited participation in the scoping process.

In response, the NRC was contacted by several tribes, including the Miami Tribe of Oklahoma, Pawnee Nation of Oklahoma, Quapaw Tribe of Oklahoma, and United Keetoowah Band of Cherokee Indians of Oklahoma. The Miami Tribe of Oklahoma indicated that the Tribe is not currently aware of any existing documentation directly linking a specific Miami cultural or historic site to the project site at Discovery Ridge, and also indicated the project site is within the extended homelands of the Miami Tribe. The Pawnee Nation of Oklahoma indicated that the proposed project site at Discovery Ridge would have no potential to adversely affect known archaeological, historic, or sacred Pawnee sites. The Quapaw Tribe of Oklahoma and the United Keetoowah Band of Cherokee Indians of Oklahoma indicated that the project site is outside their area of historic interest and deferred consultation to Federally recognized tribes with more of a historic interest in the proposed site. The NRC was also contacted by two other tribes. One tribe requested consulting party status on the NWMI project; the other indicated that the project site is not in their area of historic interest and deferred consultation to other tribes.

#### *4.6.3.1 Construction*

Construction would convert agricultural land and open space to industrial use. Since no historic properties (as defined by 36 CFR 800.4(d)(1)) would be affected and no archaeological sites or evidence of cultural resources were identified during the Phase I survey, historic and cultural resources are not likely to be impacted by the construction of the proposed NWMI facility at the Discovery Ridge site. Construction of the NWMI facility would also have little or no visual impact. The nearest NRHP site, the Maplewood House, is about 1 mi (1.6 km) away to the northwest, and its view is obstructed by trees and residential and commercial properties. Based on these factors, as well as tribal input and cultural resource assessment and consultations, construction of the NWMI facility would not impact any known historic and cultural resources at the Discovery Ridge site.

#### *4.6.3.2 Operations*

Because no historic properties (as defined by 36 CFR 800.4(d)(1)) would be affected and no archaeological sites or evidence of cultural resources were identified during the Phase I survey, historic and cultural resources would not likely be impacted during NWMI facility operations at the Discovery Ridge site. The completed NWMI facility would also have little or no visual impact. The nearest NRHP site, the Maplewood House, is about 1 mi (1.6 km) away to the northwest, and its view is obstructed by trees and residential and commercial properties. Based on these factors, as well as tribal input and cultural resource assessment and consultations, operation of the NWMI facility would not impact any known historic and cultural resources at the Discovery Ridge site.

#### *4.6.3.3 Decommissioning*

Because no historic properties (as defined by 36 CFR 800.4(d)(1)) would be affected and no archaeological sites or evidence of cultural resources were identified during the Phase I survey, historic and cultural resources would not likely be impacted during the decommissioning of the NWMI facility. Decommissioning the NWMI facility would also have little or no visual impact.

The nearest NRHP site, the Maplewood House, is about 1 mi (1.6 km) away to the northwest, and its view is obstructed by trees and residential and commercial properties. Based on these factors, as well as tribal input and cultural resource assessment and consultations, decommissioning the NWMI facility would not impact any known historic and cultural resources at the Discovery Ridge site.

## 4.7 Socioeconomic Impacts

This section describes the potential socioeconomic impacts from constructing, operating, and decommissioning the proposed NWMI facility at Discovery Ridge Research Park. The impact analysis considers potential changes in regional employment, housing availability, tax revenues, and public services. For the purposes of this analysis, the socioeconomic ROI is the City of Columbia and Boone County, Missouri.

### 4.7.1 Construction

#### *4.7.1.1 Employment*

Construction of the proposed NWMI facility would require an average of 38 workers over 17 months or up to 82 workers during peak construction (NWMI 2015a). At peak, this number of workers represents less than a tenth of a percent of the civilian labor force in Boone County in 2014 (see Table 3–16). As a result, nearly all construction workers would likely reside within the ROI, or adjacent counties and communities, and commute to the work site. Even if construction were to generate additional employment in the ROI, two to three times the average number of construction workers would represent less than a quarter of a percent of the civilian labor force. This would have no noticeable effect on employment levels in the ROI. Given the small number of construction workers, employment impacts during construction would be SMALL.

#### *4.7.1.2 Housing*

Construction workers would likely commute from within the ROI to the proposed work site at Discovery Ridge. This would result in little, if any, increased demand for temporary housing. As discussed in Section 3.7.6, there is plenty of available rental housing in the City of Columbia and Boone County. Given the small number of construction workers, housing impacts during construction would be SMALL.

#### *4.7.1.3 Tax Revenue*

Tax revenue generated during the construction of the proposed NWMI facility would include revenue from property taxes paid by NWMI, income and property taxes paid by construction workers residing in the ROI, and sales and use taxes received from the purchase and rental of equipment, material, and commercial services in the ROI. Increased tax revenue would benefit the City of Columbia, Boone County, and Columbia Public Schools.

Communities within the ROI could experience a short-term economic benefit from increased tax revenue and income generated by construction expenditures. After construction, local communities could experience a return to preconstruction economic conditions. The increase in tax revenue may have a noticeable effect in the ROI. However, given the relative short-duration of construction (17 months) and the small number of workers, tax revenue impacts in the ROI during construction would be SMALL.

#### *4.7.1.4 Public and Educational Services*

Construction workers and their families living within the ROI would continue to use existing public and educational services. These services would be able to handle any changes in demand from the small number of construction workers. Therefore, impacts on public and educational services during construction would be SMALL.

#### *4.7.1.5 Summary of Construction Impacts*

Communities within the ROI would benefit from increased employment, tax revenue, and income generated during construction. However, the small number of construction workers, the availability of rental housing, and the short duration of construction (17 months) would generate little if any noticeable socioeconomic impact within the ROI. The creation of 38 to 82 (peak) construction jobs would help maintain employment levels in the ROI and increase property and sales tax revenue in the ROI, but any changes would be minimal. Therefore, the overall socioeconomic impact from the construction of the proposed NWMI facility would be SMALL.

### 4.7.2 Operations

#### *4.7.2.1 Employment*

Approximately 98 jobs would be added to the local economy during NWMI facility operations (NWMI 2015a). This number of workers represents approximately one tenth of a percent of the civilian labor force in the City of Columbia and Boone County in 2014 (Table 3–16). Even if NWMI facility operations were to generate additional employment in the ROI, two to three times the number of operations workers would represent approximately one half of a percent of the civilian labor force. This would have no noticeable effect on employment levels in the ROI. Given the small number of operations workers, employment impacts during operations would be SMALL.

#### *4.7.2.2 Housing*

NWMI estimates that 98 workers would be needed during operation of the proposed NWMI facility (NWMI 2015a). Any operations workers relocating to the ROI would likely purchase permanent housing. As discussed in Section 3.7.6, there is plenty of available housing in the City of Columbia and Boone County. Given the small number of operations workers, housing impacts during operations would be SMALL.

#### *4.7.2.3 Tax Revenue*

Tax revenue generated during NWMI facility operations would include revenue from property taxes paid by NWMI, income and property taxes paid by workers residing in the ROI, and sales and use taxes received from the purchase and rental of equipment, material, and commercial services in the ROI. Estimated NWMI total annual tax payments (approximately $2.5 million) would comprise less than 1 percent of the City of Columbia’s 2015 fiscal year total revenues (approximately $325 million) (City of Columbia 2016e). Regardless, this increased tax revenue would benefit the City of Columbia, Boone County, and Columbia Public Schools.

Communities within the ROI could experience a minor economic benefit from increased tax revenue and income generated by any workers and their families relocating to the ROI. This increase in tax revenue may have a noticeable effect in the ROI. However, given the small number of workers, overall tax revenue impacts in the ROI during operations would be SMALL.

#### *4.7.2.4 Public and Educational Services*

Operations workers and their families living in the ROI would continue to use existing public and educational services. These services would be able to handle any changes in demand from the small number of operations workers. Therefore, impacts on public and educational services during operations would be SMALL.

#### *4.7.2.5 Summary of Operations Impacts*

Communities within the ROI would benefit from increased employment, tax revenue, and income generated during NWMI facility operations. However, the small number of operations workers and the availability of housing would generate little if any socioeconomic impact within the ROI. The creation of 98 jobs would help maintain employment levels and increase property, income, and sales tax revenue in the ROI, but any changes would be minimal. Therefore, the overall socioeconomic impact from the operation of the proposed NWMI facility would be SMALL.

### 4.7.3 Decommissioning

#### *4.7.3.1 Employment*

Decommissioning the proposed NWMI facility would require an average of 38 workers over 18 to 24 months or up to 81 workers during peak decommissioning (NWMI 2015a). At peak, this number of workers represents less than a tenth of a percent of the civilian labor force in Boone County in 2014 (Table 3–16). In addition, some operations workers may be kept on to support decommissioning. As a result, nearly all workers would likely reside within the ROI, or adjacent counties and communities, and commute to the work site. Even if decommissioning were to generate additional employment in the ROI, two to three times the average number of decommissioning workers would represent less than a quarter of a percent of the civilian labor force. This would have no noticeable effect on employment levels in the ROI. Given the small number of decommissioning workers, employment impacts during decommissioning would be SMALL.

#### *4.7.3.2 Housing*

Decommissioning workers would likely commute from within the ROI to the proposed NWMI facility. As previously discussed, some operations workers may be kept on to support decommissioning, thereby reducing the need for new hires. This would result in little, if any, increased demand for temporary housing. As discussed in Section 3.7.6, there is plenty of available rental housing in the City of Columbia and Boone County. Given the small number of decommissioning workers, housing impacts during decommissioning would be SMALL.

#### *4.7.3.3 Tax Revenue*

NWMI would continue to pay property taxes during decommissioning. The assessed property taxes would be based on the property tax rates at the time. Revenue loss would directly affect the City of Columbia and Boone County and the communities and other local taxing districts closest to, and most reliant on, the revenue from NWMI. However, the loss in tax revenue should be small in comparison to the established tax base of the City of Columbia and Boone County. Therefore, tax revenue impacts during decommissioning would be SMALL.

#### *4.7.3.4 Public and Educational Services*

Decommissioning workers and their families living in the ROI would continue to use existing public and educational services. Any temporary increase in population during decommissioning would be small relative to the projected population of the City of Columbia and Boone County. Public and educational services in the City of Columbia and Boone County would be able to handle any changes in demand during decommissioning. Therefore, impacts on public and educational services during decommissioning would be SMALL.

#### *4.7.3.5 Summary of Decommissioning Impacts*

The small number of decommissioning workers, the availability of housing, and the short duration of decommissioning (18 to 24 months) would generate little if any socioeconomic impact within the ROI. The creation of 38 to 81 (peak) decommissioning jobs would help maintain employment levels in the ROI, but any changes would be minimal. NWMI would continue to pay property taxes during decommissioning. Therefore, the overall socioeconomic impact from decommissioning the proposed NWMI facility would be SMALL.

## 4.8 Human Health

This section provides the NRC's assessment of the potential radiological and nonradiological effects from the proposed NWMI facility. Radioactive and nonradioactive materials would routinely be used at the proposed NWMI facility. The NRC regulations, other Federal regulations, State of Missouri regulations, and local regulations would control the use and discharge of these materials to protect facility workers and members of the public.

Radiological exposures from the proposed NWMI facility would include offsite doses to members of the public and onsite doses to facility workers. The NRC's radiation safety and dose limit requirements, which are found in 10 CFR Part 20, are discussed in detail in Section 3.8.2. The NRC has the authority to enforce these requirements to help ensure an adequate level of protection for workers, members of the public, and the environment.

Nonradiological exposures from the proposed NWMI facility to workers and members of the public would be regulated by applicable Federal (e.g., Clean Air Act, Clean Water Act, and Resource Conservation and Recovery Act (RCRA) (42 USC 6901 et seq.)), State (e.g., Missouri Hazardous Waste Management Law, Missouri Air Conservation Law, and Missouri Clean Water Law), and local laws and regulations. Occupational hazards would also be regulated by the Occupational Safety and Health Administration's (OSHA's) regulations in Chapter 29 of the *Code of Federal Regulations* (NWMI 2015a).

### 4.8.1 Construction

#### *4.8.1.1 Radiological*

No radioactive material associated with the application will be present at the proposed site during the construction phase of the proposed NWMI facility (NWMI 2015a, 2015c). As a result, no radioactive waste associated with the NWMI processes will be produced during construction. Therefore, the NRC staff concludes that there will be no impacts from potential radiological exposures during construction and impacts would be SMALL.

#### *4.8.1.2 Nonradiological*

Members of the public would not have access to the construction site. As discussed in Section 4.2.1.1, the NRC expects air pollutants from worker vehicles and fossil-fueled equipment (e.g., excavation and earth-moving equipment and electric generators), but the impact to the public would be SMALL because the effects would not be noticeable.

Construction workers would encounter potential hazards typical of any industrial construction site. As discussed in Section 3.8.4, workplace hazards can be grouped into physical hazards (e.g., slips and trips; falls from height; and those related to transportation, temperature, humidity, and electricity); physical agents (e.g., noise and vibration); chemicals; and psychosocial issues (e.g., work-related stress). NWMI would employ normal construction safety practices contained in OSHA regulations, such as safety training, safety equipment, and supervision of the work force to promote worker safety and reduce the likelihood of worker injury during construction (NWMI 2015a). However, construction accidents could occur. Over the projected 12-month period when construction activities would occur, the average number of workers at the site would be 38 with a peak of 82 (NWMI 2015a). The NRC staff used data from the U.S. Bureau of Labor Statistics (BLS) for nonfatal workplace injuries and illnesses to calculate the potential number of reportable cases at the proposed NWMI construction site based on the average number of workers. The U.S. Department of Labor (DOL) data for 2014 showed that private industry reported an incidence rate of 3.2 cases per 100 equivalent full-time workers (DOL 2014). Conservatively assuming the peak workforce of 82 workers during the construction period, the BLS rates would result in 2.6 recordable cases during the 12 months of construction. With the use of normal construction safety practices at the proposed NWMI construction site, the NRC staff concludes that recordable cases during construction should be consistent with the DOL data.

During construction, NWMI would store nonradioactive chemical sources on site in liquid; gaseous; and solid forms, including fuels, oils, and solvents necessary for site preparation and construction. Chemicals, hazardous liquids, and gases may also be encountered during construction. Such chemicals may take the form of compressed gases, oxidizers, flammable liquids, and other gases. The impact of these chemicals would be mitigated by the use of access controls, proper personal protective equipment and other typical construction safety practices to ensure safe working conditions and reduced instances of accidents or exposure to hazardous materials. If a spill or accident occurs during construction, an emergency response plan would be used to reduce the impact to human health and the environment (NWMI 2015a).

Given that access to the site would be restricted, that NWMI would implement normal construction safety practices contained in OSHA regulations, and that hazardous chemicals stored or used at the construction site would be managed in accordance with applicable Federal and State regulations, the NRC staff concludes that nonradiological impacts to human health during construction would be SMALL.

### 4.8.2 Operations

#### *4.8.2.1 Radiological*

During operation, LEU targets will be fabricated at the proposed NWMI facility. These will be transported offsite, irradiated, transported back to the proposed facility, and processed to produce Mo-99. Byproducts of the processing of these targets include some recyclable material (take-back LEU) and radioactive waste, which will be managed accordingly. Gaseous effluents meeting approved regulatory criteria will be released to the environment. Liquid and solid radioactive wastes would be managed as discussed in Sections 2.7.1.2 and 4.9.1 of this EIS (NWMI 2015a).

Radioactive material would be located in the facility hot cell area, irradiated target receipt and unloading area, target fabrication area, and waste management areas. Radioactive liquid and gaseous effluents from activities at the proposed facility would be contained within the process waste management or offgas systems (NWMI 2015a).

NWMI plans to maintain radiation exposure to facility workers to within the occupational dose limits in 10 CFR 20.1201. Radiation exposure to personnel within the proposed facility would be minimized to as low as is reasonably achievable (ALARA) using shielding, optimized process designs, radiological work planning, protective equipment and materials, access controls, and contamination control measures. All personnel whose duties require entry into restricted areas (areas that are access-controlled due to actual or possible elevated radiation levels) will wear individual dosimetry devices, such as thermoluminescent dosimeters, to monitor radiation dose from external sources. Selected personnel will also have radiation dose from internal sources (i.e., dose from inhaled or ingested radionuclides) monitored by bioassay. NWMI would administratively control individual occupational external radiation doses to 500 millirem (mrem) per year (10 percent of the 10 CFR 20.1201 limit). Additionally, NWMI would administratively control individual occupational total effect dose equivalent (combined dose from external and internal sources) to 2,000 mrem per year (40 percent of the 10 CFR 20.1201 limit) (NWMI 2015g).

At the site boundary, the combination of shielding within the facility and distance from the facility would ensure that the direct radiation dose to members of the public in this area would be negligible (NWMI 2015a).

As described in Section 2.7.1.1, radioactive gaseous effluents would be released into the environment from the facility stack. The ventilation system is designed to provide confinement of hazardous chemical fumes and airborne radiological materials. Each exhaust filter train will consist of prefilters, two stages of HEPA filters, carbon adsorbers, and isolation dampers. The radionuclides of interest in these gaseous effluents would be krypton-85, metastable xenon-131, and xenon-133. Smaller amounts of radioactive iodines, particulates, tritium, and other noble gasses would also be released. NWMI determined that the dose from tritium would be negligible relative to the dose from other radionuclides released (NWMI 2016c). The exhaust stacks will be provided with continuous monitors for noble gases, particulates, and iodine. The stack monitoring system is designed to continuously monitor stack releases.

NWMI estimates that the maximum dose to the public from normal operational stack releases would be 3.6 mrem per year (NWMI 2015a, 2016a). The estimated dose is well below the annual dose limit of 100 mrem in 10 CFR 20.1301, and is also within the requirements in 10 CFR 20.1101(d) that impose a constraint of 10 mrem per year on individual dose to a member of the public from radioactive gaseous effluents.

The ER states that NWMI will have a radiological effluent monitoring program to ensure that the types and quantities of radioactive material released from the proposed facility are within expected parameters, such that the limits in 10 CFR 20.1301 and 10 CFR 20.1101(d) would not be exceeded. The radiological effluent monitoring program would include gaseous effluent monitoring (NWMI 2015a). The program would also include environmental monitoring that would comprise:

- waterborne exposure pathway monitoring (sampling and analysis of nearby surface water and groundwater);
- direct exposure pathway monitoring (use of thermoluminescent dosimeter monitoring stations both on site and at the fence line of the proposed facility); and,
- airborne exposure pathway monitoring (use of continuous air monitoring stations at the fence line) (NWMI 2015a, 2016a).

Additional environmental monitoring for the ingestion exposure pathway (i.e., sampling and analysis of milk for iodine-131 and other gamma-emitting radioisotopes) may also be performed, if it is determined to be necessary as a result of radioactive iodine and particulate activity being measured during airborne effluent monitoring or air sampling (NWMI 2015a).

As stated in Section 2.7.1.2, no liquid radioactive material would be released to the environment as a result of routine operations of the proposed NWMI facility. All liquid radioactive waste produced at the proposed facility would be solidified for disposal. Should any inadvertent liquid release to the environment occur, the waterborne exposure pathway monitoring performed as part of NWMI’s effluent monitoring program, along with additional ad hoc sampling that would be performed as necessary, would allow the inadvertent release to be detected and its environmental and public dose impacts quantified (NWMI 2016a).

As described in detail in Section 2.8, transportation of radioactive materials, both on public highways and by air, would occur in conjunction with operation of the proposed NWMI facility. Radioactive materials transported to and from the NWMI facility site would include fresh LEU, unirradiated and irradiated LEU targets, Mo-99 product solution, and take-back LEU. When transporting waste and other radioactive materials on public roads, NWMI or commercial carriers must comply with the applicable U.S. Department of Transportation (DOT) regulations in 49 CFR Parts 172, 173, 177, and 397, as well as the NRC packaging requirements for radioactive material in 10 CFR Part 71. For transport of Mo-99 product by air, the air carrier chosen by NWMI must also comply with additional DOT regulations in 49 CFR Part 175 (NWMI 2015a).

Using the RADCAT/RADTRAN code, NWMI estimated that the total incident-free dose to the general public from all public highway radioactive material transportation associated with the proposed NWMI facility (including transportation of waste, which is discussed in Section 4.9.1) would be 47,300 person-mrem per year, and 0.393 mrem per year to the maximally exposed individual member of the public located along a highway transportation route. The total population dose is approximately 0.6 percent of the approximately 7,740,000 person-mrem received annually within a 5-mi (8-km) radius of the proposed NWMI facility from background radiation (NWMI 2015a, 2016c). Additionally, the annual dose to a maximally exposed individual from highway transportation of radioactive material is small relative the NRC's 100 mrem annual public dose limit in 10 CFR 20.1301. For air transport of Mo-99 product, NWMI assumed that no commercial airliners carrying members of the public as passengers would be used, and it determined that the dose to members of the public on the ground would be negligible (NWMI 2015a, 2016c).

The NRC has previously evaluated the environmental impact of the transportation of radioactive materials on public roads and by air. The NRC concluded in 1977 that when radioactive material transportation is performed in compliance with all Federal regulations, the impact of such transportation is small (NRC 1977). The Commission determined that the environmental impacts, radiological and nonradiological, of normal (incident-free) transportation of radioactive materials and the risks and consequences of accidents involving radioactive material shipments in packages for which the NRC has issued design approvals meeting the performance standards of 10 CFR Part 71 were small (49 FR 9375). Regulations, shipping practices, and cask designs for transporting radioactive material have remained essentially unchanged since 1977. Although more recent NRC assessments of the safety of radioactive materials transportation have focused on nuclear power reactor spent fuel, rather than the types of radioactive materials that would be transported in conjunction with the proposed NWMI facility, these assessments have shown, through the use of more advanced calculation methodologies, that the impacts associated with transportation of nuclear power reactor spent fuel are smaller than originally thought in 1977 (NRC 2014a). Since transportation performed in conjunction with operation of the proposed NWMI facility would be performed in compliance with DOT and NRC regulations, the NRC staff concludes that the impacts from transportation of radioactive materials during operation would be SMALL.

As described above, NWMI would have facility design features and use procedures to minimize radiation exposure to occupational workers and members of the public. The maximum dose to a member of the public would be well within the annual dose limit of 100 mrem in 10 CFR 20.1301. In addition, NWMI plans to administratively control doses to occupational workers such that these doses would be well below the limits in 10 CFR 20.1201 (NWMI 2015g). The NRC staff is conducting an independent review of the potential dose to occupational workers and the public from operation of the proposed NWMI facility. This independent evaluation will be documented in the NRC staff's safety evaluation report (SER). If the NRC staff determines in its SER that the maximum doses to workers and the public are within the dose limits in 10 CFR Part 20, the NRC staff concludes that the impacts from potential radiological exposures during operation would be SMALL.

#### *4.8.2.2 Nonradiological*

The proposed NWMI facility would be designed with engineering controls (e.g., shields, double-valves, ventilation system, glove boxes, fume hoods, safety switches, and safe-storage facilities) to minimize the exposure of workers to chemicals (NWMI 2015a).

NWMI would be expected to incorporate mechanisms for maintaining a safe working environment based on OSHA requirements, industry standards, and the experience of the managerial staff. General areas within the proposed facility and laboratory spaces would be expected to be kept clean and orderly. NWMI would store hazardous material (e.g., acids, bases, oxidizers, gases, and pyrophoric metals) in appropriate safety containers and cabinets (NWMI 2015a).

In addition to supervision and oversight of facility operations, NWMI would implement a training program that would emphasize workplace safety (NWMI 2015a). There would also be requirements for protective equipment commensurate with the hazards. These requirements would range from a description of appropriate clothing for workers (e.g., no shorts or open-toed shoes in the facility or the laboratory) to protective equipment (e.g., gloves, safety glasses, and laboratory coats). For more potentially hazardous operations, such as target solution preparation, which involves the handling of acids, workers would be required to use face shields, aprons, and heavy nitrile gloves. As discussed in Section 2.8.1.2, NWMI will develop a chemical management and product handling plan. The storage and treatment of wastes will be conducted in accordance with these plans. Additionally, the storage of chemicals and supplies on site will be performed in accordance with a chemical management and product handling plan to ensure that chemicals are properly stored (e.g., incompatible chemicals are stored in separate areas, flammable chemicals and oxidizers are stored in separate areas) (NWMI 2015a).

As discussed in Sections 2.7.2.1 and 4.2.1.2, nonradioactive pollutants may be present in wastewater and air emissions released into the environment during normal operations. Solid nonradioactive wastes would also be generated. After initial use, NWMI expects the majority of chemicals to be reused, discharged to the municipal sewer, or shipped off site as waste as discussed in Sections 2.7 and 2.8 (NWMI 2015a).

Given that NWMI would manage and minimize worker hazards by complying with OSHA and State of Missouri regulations and by using multiple planned features (e.g., facility design, supervision, training, and protective equipment), the NRC staff concludes that nonradiological impacts to workers and members of the public during routine facility operations would be SMALL.

### 4.8.3 Decommissioning

#### *4.8.3.1 Radiological*

Following cessation of proposed NWMI facility operations, residual radioactive contamination would remain in the hot cell and process areas of the facility. The potential radiological impacts from decommissioning would be associated with this contamination. During decommissioning operations, contaminated areas and equipment would be decontaminated; proper radiation protection procedures would be followed during these activities to keep exposure to occupational workers ALARA. Piping and vessels would be decontaminated, rinsed, and sampled to ensure that the removal of radioactive material has been achieved. If an area or piece of equipment could not be adequately decontaminated, a fixative would be applied to prevent the spread of the residual contamination. Materials with residual contamination would be disposed of as radioactive waste (see discussion of impacts related to radioactive waste disposal in Section 4.9.1) (NWMI 2015a).

With the cessation of proposed facility operations, radioactive gaseous effluents released into the environment from operations would effectively stop. However, during decommissioning activities, workers and members of the public would continue to be exposed to negligible or low levels of radioactive material within the facility and from radioactive gaseous effluents resulting from decommissioning activities involving the dismantlement and decontamination of equipment and systems and the handling and packaging of radioactive waste. The NRC's radiation protection standards and dose limits for occupational workers and members of the public during decommissioning are the same as those for the operating facility.

Before initial operation of the proposed NWMI facility, NWMI would conduct a radiological survey of the proposed site to establish a baseline for decommissioning (NWMI 2015c). As discussed in Section 2.9, NWMI would be required to conduct decommissioning activities in accordance with applicable NRC requirements and any additional Federal, State, and local requirements. The NRC would terminate the license if the decommissioning were performed in accordance with the facility's approved decommissioning plan, and if the termination radiation survey and associated documentation demonstrated that the facility and site were suitable for release in accordance with the criteria in 10 CFR Part 20, Subpart E. After decommissioning activities are completed in compliance with regulations, the proposed site could be released for unrestricted or restricted use, as determined by 10 CFR Part 20, Subpart E criteria.

Based on the expected reduced levels of radioactive material in the facility, and the radiological controls expected to be used to ensure doses to occupational workers and members of the public that are in compliance with radiation protection standards, the NRC staff concludes that the impacts from potential radiological exposures during decommissioning would be SMALL.

#### *4.8.3.2 Nonradiological*

Nonradiological health impacts on the public and workers from decommissioning and demolition activities would be similar to construction activities. Decommissioning and demolition activities would involve the use of heavy construction and demolition equipment and the transport of new and waste materials and personnel to and from the site. The public and workers could be exposed to dust and vehicle exhaust and noise. Workers could also experience occupational injuries. Nonradiological hazards would also be associated with emissions, discharges, and waste from processes within the facility and from accidental spills and releases. NWMI would manage nonradioactive wastes generated by decommissioning the NWMI facility, including solid wastes, liquid wastes, discharges, and air emissions, in accordance with applicable Federal, State, and local laws and regulations and with applicable permit requirements. As discussed in Section 4.2, the NRC staff determined that air pollutants from worker vehicles and fossil-fueled equipment (e.g., demolition, excavation, and earth-moving equipment and electric generators) would have a SMALL impact on air quality. In addition, NWMI's access controls would help ensure that only authorized personnel would come on site. Given that NWMI would prohibit members of the public from accessing the site during decommissioning and that NWMI would manage nonradioactive wastes generated by decommissioning the NWMI facility in accordance with applicable Federal, State, and local laws and regulations and with applicable permit requirements, the NRC staff expects decommissioning activities to result in minimal human health impact to members of the public.

Decommissioning and demolition workers would encounter potential hazards typical of any industrial construction and demolition site. As discussed in Section 3.8, workplace hazards can be grouped into physical hazards (e.g., slips and trips; falls from height; and those related to transportation, temperature, humidity, and electricity); physical agents (e.g., noise and vibration); chemicals; and psychosocial issues (e.g., work-related stress). NWMI would implement normal construction safety practices contained in OSHA regulations, such as safety training, safety equipment, and supervision of the work force, to promote worker safety and reduce the likelihood of worker injury during decommissioning. However, decommissioning accidents could occur. Over the projected decommissioning phase, NWMI estimates a peak workforce of 81 workers at the site. The NRC staff used data from the BLS for nonfatal workplace injuries and illnesses to calculate the potential number of reportable cases at the proposed NWMI construction site based on the average number of workers. The DOL data for 2014 showed that private industry reported an incidence rate of 3.2 cases per 100 equivalent full-time workers (DOL 2014). Conservatively assuming the peak workforce of 81 workers during the construction period, the BLS rates would result in 2.6 recordable cases a year. With the use of normal construction safety practices at the proposed NWMI decommissioning site, the NRC staff concludes that recordable cases during construction should be consistent with the DOL data.

During decommissioning, nonradioactive chemical sources would be managed in the same manner as during construction and operation.

Inasmuch as access to the site would be restricted, that NWMI would implement normal safety practices contained in OSHA regulations, and that chemicals stored or used at the site would be managed in the same manner as during construction and operation, the NRC staff concludes that nonradiological impacts to human health during decommissioning would be SMALL.

## 4.9 Waste Management

### 4.9.1 Radioactive Waste

This section describes potential impacts related to the production and transportation of solid low-level radioactive wastes during operation and decommissioning of the proposed NWMI facility.

As discussed in Sections 2.7.1 and 2.8.1, radioactive waste would be produced during the operation and decommissioning phases of the proposed NWMI facility. Radioactive waste would include gaseous effluents, which would be released to the environment; and low-level solid waste, including solidified liquid waste, which would be packaged and transported off site for disposal. No high-level solid waste would be produced at the proposed facility. No liquid radioactive waste would be released into the environment or shipped off site; all liquid radioactive wastes would be solidified before disposal. No radioactive wastes would be disposed of or permanently stored at the proposed facility site.

Gaseous effluents are discussed in Section 2.7.1.1, and the impact from handling of these effluents and their release to the environment is discussed in Section 4.8.2.1. The production of solid low-level radioactive waste, a small portion of which could be mixed (both radiological and hazardous) waste, at the proposed NWMI facility, is discussed in Section 2.7.1.2. Upper-bound estimates of the quantities of solid waste that would be produced are provided in Section 2.7.1.2; when practical, methods including process liquid recycle and reuse would be used to reduce the amount of waste produced (NWMI 2015a, 2015c).

The solid radioactive waste produced at the proposed NWMI facility would include both Class A and Class B waste. As described in Section 2.7.1.2, possible volume reduction and optimization activities have the potential to change some Class B waste into Class C; if NWMI anticipates that Class C waste will be produced, NWMI would provide this information in its operating license application and the NRC would review this information and document its review in the supplemented EIS. No greater than Class C wastes will be generated by facility operations (NWMI 2015c).

NWMI plans to ship radioactive waste from the proposed facility to Waste Control Specialists (WCS) in Andrews, Texas (NWMI 2015a). WCS accepts mixed waste (i.e., waste that is both hazardous and radioactive), in addition to nonhazardous radioactive waste (WCS 2016). In the event that NWMI loses access to a low-level waste disposal facility, the NRC staff expects that any low-level waste would have to be stored either within the facility or in a new storage facility that NWMI would construct either on site or at an offsite location. The storage of low-level waste would continue until a low-level waste facility is available. Low-level waste, regardless of its location, must be stored in accordance with Federal and state regulations to ensure the safety of workers and members of the public.

As described in Section 2.8.1.1, transportation of radioactive waste on public highways would also occur in conjunction with operation of the proposed NWMI facility. When transporting waste, NWMI or commercial carriers must comply with the applicable DOT regulations in 49 CFR Parts 172, 173, 177, and 397, as well as the NRC packaging requirements for radioactive material in 10 CFR Part 71 (NWMI 2015a).

The environmental impact of transporting radioactive waste on public roads was included in the discussion of the impacts of transporting radioactive materials in Section 4.8.2.1. The NRC has previously evaluated the environmental impact of the transportation of radioactive waste on public roads. The NRC concluded that when radioactive waste transportation is performed in compliance with all Federal regulations, the impact of such transportation is small (NRC 1977). Therefore, since waste transportation performed in conjunction with the operation of the proposed NWMI facility would be performed in compliance with DOT and NRC regulations, the NRC staff concludes that the impacts from transportation of radioactive waste produced during operation and decommissioning of the proposed facility would be SMALL.

The proposed NWMI facility’s waste management systems, engineering design features, and contamination control and radiological safety procedures would help ensure that doses to facility personnel and members of the public from the production, handling, and packaging of radioactive waste are reduced to levels that are ALARA. In addition, all activities at the proposed facility, including handling of radioactive waste, would be conducted such that radiation doses to occupational workers and members of the public are maintained below 10 CFR Part 20 limits, as discussed in Section 4.8.2.1. Radioactive waste at the proposed facility is expected to be managed in accordance with regulatory requirements. The NRC staff concludes that the impacts from production and handling of radioactive waste at the proposed NWMI facility during operations and decommissioning would be SMALL.

### 4.9.2 Nonradioactive Waste

As discussed in Section 2.7.2, NWMI would acquire, use, and store solid and liquid nonradioactive waste.

RCRA waste regulations govern the disposal of solid and hazardous waste. RCRA, Subtitle C, establishes a system for controlling hazardous waste, and RCRA, Subtitle D, encourages states to develop comprehensive plans to manage nonhazardous solid waste and mandates minimum technological standards for municipal solid waste landfills. EPA has delegated the primary responsibility for implementing RCRA regulations to the State of Missouri (EPA 2015c).

NWMI will implement waste management systems to control, handle, process, store, and transport nonradioactive waste generated during construction, operations, and decommissioning (NWMI 2015a). As described in Section 2.7.3, NWMI's nonradioactive waste management program is based on a pollution prevention and waste minimization framework. The design of the NWMI facility would also incorporate features to minimize the release of chemicals or other nonradioactive materials into the environment (NWMI 2015a). Additionally, during operations, NWMI would contain chemicals within closed systems and use the chemicals in controlled processes (NWMI 2015a). The NRC staff expects that the waste management systems would ensure that the nonradioactive wastes generated at the proposed NWMI facility would be managed in accordance with applicable Federal and State of Missouri regulations.

As discussed in Section 2.7, the proposed NWMI facility would generate less than 1,000 kg (2,205 lb) of hazardous waste per month, making it a small quantity hazardous waste generator under EPA regulations. The proposed facility would also generate approximately 4,056 kg (8,942 lb) of nonradiological, nonhazardous waste (i.e., municipal waste) per year during operation (NWMI 2015c). NWMI expects that nonradiological hazardous wastes from construction or operation of the proposed facility would be collected by a hazardous waste disposal company such as Veolia or Clean Harbors for separation, processing, and disposal. Other solid waste (municipal waste or construction debris) generated by the construction or operation of the proposed facility would be picked up and disposed of at the City of Columbia sanitary landfill (NWMI 2015c).

Nonhazardous waste would be temporarily stored on site before being transported to the local disposal or recycling facility (NWMI 2015a). Hazardous nonradioactive waste will be temporarily stored on site and then would be collected by the hazardous waste disposal company for separation, processing, and disposal. The NRC staff determined that adequate storage capacity occurs within the facility to accommodate the waste generated and stored between shipments to offsite disposal facilities.

Based on NWMI's proposed waste management systems, processes to minimize chemical contamination, and because NWMI would operate within applicable Federal and State of Missouri regulations, the NRC staff concludes impacts from nonradioactive waste would be SMALL during construction, operations, and decommissioning.

## 4.10 Transportation

This section describes potential non-radiological transportation impacts during the construction, operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site. The impact analysis considers changes in traffic volumes on the existing roadway network. The radiological impacts of transporting radioactive materials and waste are discussed in Section 4.8 and 4.9.

### 4.10.1 Construction

Transportation impacts occurring during the construction of the proposed NWMI facility would be caused by an increase in commuter vehicles and construction trucks on local roads. Construction workers would arrive via site access roads as discussed in Section 3.9.1 and traffic volumes on these roads would increase during shift changes. In addition, trucks would deliver construction equipment and material to the work site and remove construction waste material, thereby adding to traffic volumes on site access roads. The increase in vehicular traffic would peak during certain hours of the day (e.g., shift changes), resulting in temporary levels of service impacts and possible delays at intersections.

During construction, an average daily workforce of 38 workers would be commuting to and from the construction site at Discovery Ridge for 17 months. During peak construction, up to 82 workers could be commuting daily to the construction site. In addition, an average of 20 trucks per week (4 trucks per day) would deliver construction equipment and material to the work site. An additional 1 truck per week would remove construction waste (NWMI2015a).

Because of the small size of the average daily workforce, the low number of daily truck deliveries and shipments, combined with the short duration of construction (17 months), and easy access to U.S. Highway 63, there would be little if any noticeable traffic volume-related level of service impacts. Therefore, transportation impacts would be SMALL.

### 4.10.2 Operations

Transportation impacts occurring during preoperations and operation of the proposed NWMI facility would be caused by an increase in commuter vehicles and delivery trucks on the local roadway network. Operations workers would arrive via site access roads as discussed in Section 3.9.1 and traffic volumes on these roads would increase during shift changes. In addition, trucks would deliver production material, ship products, and remove waste material, thereby adding to the traffic volumes on site access roads. The increase in vehicular traffic would peak during certain hours of the day (e.g., shift changes), resulting in temporary levels of service impacts and possible delays at intersections.

During operations (30 years), 98 workers would be commuting to and from the proposed NWMI facility at Discovery Ridge (NWMI 2015a). In addition, an average of 2 to 4 trucks per week would deliver nonradioactive material; an average of 2 to 3 trucks per week would deliver irradiated LEU targets; and another 2 trucks per year would deliver fresh LEU (NWMI 2015a).

In addition, outbound truck traffic would include the following:

(1) an average of 1 truck shipment per week of LEU targets to irradiation facilities,

(2) an average of 2 shipments per week of medical isotope product through the Columbia Regional Airport,

(3) an average of 3 to 4 shipments per week of waste, and

(4) an average of 2 truck shipments per year of take-back LEU (NWMI 2015c).

Medical isotope product shipments to customers would be transported from the NWMI facility by truck to the Columbia Regional Airport, approximately 7 mi (11 km) away. Radioactive and nonradioactive waste would also be transported via common truck carrier from the NWMI facility to an offsite storage, treatment, or disposal facility.

The relatively small size of the workforce and low number of daily truck deliveries and shipments would generate little if any noticeable traffic volume-related level of service impacts. Therefore, given the size of the operations workforce, the number of trucks, and easy access to U.S. Highway 63, transportation impacts during NWMI facility operations would be SMALL.

### 4.10.3 Decommissioning

Transportation impacts occurring during the decommissioning would be caused by an increase in commuter vehicles and trucks on the local roads. Decommissioning workers commuting to the work site would arrive via site access roads and traffic volumes on these roads could increase during shift changes. In addition, trucks would deliver equipment and material to the work site and remove waste material, thus adding to traffic volumes on site access roads. The increase in vehicular traffic would peak during certain hours of the day (e.g., shift changes) resulting in temporary levels of service impacts and possible delays at intersections.

During construction, an average daily workforce of 38 workers would be commuting to and from the work site at Discovery Ridge for 18 to 24 months. During peak decommissioning activities, up to 81 workers could be commuting daily. In addition, an average of 1 truck per week would deliver equipment and material to the work site. An additional 20 trucks per week would remove construction waste (NWMI 2015a).

Because of the small size of the average daily workforce, the low number of daily truck deliveries and shipments, combined with the short duration of decommissioning (18 to 24 months), and easy access to U.S. Highway 63, there would be little if any noticeable traffic volume-related level of service impacts. Therefore, transportation impacts would be SMALL.

## 4.11 Accidents

This section discusses the environmental impacts associated with potential radiological and hazardous chemical accidents that might occur at the proposed NWMI facility. In addition to this EIS, the NRC staff will perform an independent verification of the potential accident scenarios and associated consequences at the proposed NWMI facility in its SER. The SER is part of the regulatory process that the NRC uses to decide whether to issue a construction permit and operating license for the proposed NWMI facility.

The term “accident,” as used in this section, refers to any off-normal event that may affect the health or safety of facility workers and/or members of the public due to the release of, or exposure to, radioactive material or hazardous chemicals. The accidents described in this section are associated with processes and activities that would occur at the proposed NWMI facility.

Potential initiating events and credible operational accidents for the proposed NWMI facility constitute the design-basis accidents (DBAs). For example, NWMI considered a fire at the proposed facility as a credible DBA scenario (NWMI 2015a). The proposed NWMI facility would be required to be designed and built to withstand any internal (e.g., caused by a component failure) or external (e.g., caused by a weather event) DBA without loss of systems needed to ensure safety.

This EIS considers hypothetical accidents that would be considered to bound any DBA at the proposed NWMI facility, and uses the impacts from those hypothetical, bounding accidents as the basis for determining the environmental impacts from potential accidents at the proposed facility. Although some types of accidents could involve both radiological and chemical hazards, for this EIS, the radiological and chemical hazards of potential accidents are considered separately. Radiological consequences of accidents at the proposed NWMI facility are discussed in Section 4.11.1, and chemical consequences of accidents are discussed in Section 4.11.2.

NWMI evaluated the consequences of accidents at the proposed facility, and the controls it would use to prevent or mitigate the consequences of accidents, against the performance requirements in 10 CFR 70.61. The NRC performance requirements for accidents in 10 CFR 70.61 require that NWMI limit the risks of credible high-consequence and intermediate-consequence radiological and/or chemical events by applying engineered controls and/or administrative controls to reduce the likelihood and consequences of these events, and assure that all nuclear processes are subcritical under normal and credible abnormal conditions. To comply with 10 CFR 70.61, NWMI must have controls that:

- for any credible high-consequence radiological and/or chemical accident, either reduce the likelihood of the accident such that it would be highly unlikely, or reduce the consequences such that it would either be intermediate-consequence or low-consequence (i.e., less than intermediate-consequence);
- for any credible intermediate-consequence radiological and/or chemical accident, either reduce the likelihood of the accident such that it would be unlikely, or reduce the consequences such that it would be low-consequence (i.e., less than intermediate consequence); and,
- limit the risk of nuclear criticality accidents by assuring that under normal and credible abnormal conditions, all nuclear processes are subcritical.

Threshold consequence levels that define high- and intermediate-consequence radiological or chemical accidents for the purposes of evaluating compliance with 10 CFR 70.61 are provided in Sections 4.11.1 and 4.11.2.

### 4.11.1 Radiological Accidents

This section discusses the potential onsite and offsite radiological consequences of accidents at the proposed NWMI facility, and controls to prevent or mitigate the potential consequences. The results of the radiological accident analyses in this section are compared to the threshold consequence values in 10 CFR 70.61. The values are intended to be compared to the unmitigated consequences of credible accident scenarios. The threshold consequence values that define high- and intermediate-consequence radiological accidents for the purposes of evaluating compliance with 10 CFR 70.61 are provided in Table 4–6.

**Table 4–6. Definition of High- and Intermediate-Consequence Radiological Accidents**

| Receptor | High Consequence | Intermediate Consequence |
|---|---|---|
| Worker | Dose >100,000 mrem[(a)] | Dose >25,000 mrem, and <100,000 mrem |
| Member of the Public | Dose >25,000 mrem, or >30 mg[(b)] soluble uranium uptake | Dose >5,000 mrem, and <25,000 mrem |
| Environment outside of the Restricted Area Boundary | (Accidents are not defined as high-consequence based on the environment outside of the restricted area boundary) | 24-hour-averaged release of radioactive material outside the restricted area in concentrations >5,000 times the values in 10 CFR Part 20, Appendix B, Table 2, “Effluent Concentrations” |

(a) mrem = millirem
(b) mg = milligram

For evaluation of the radiological consequences for members of the public from potential accidents at the proposed NWMI facility, NWMI considered a variety of potential nuclear criticality or radioactive material accidents, including:

- liquid spills or sprays with radiological and/or criticality safety consequences;
- target dissolver offgas accidents with radiological consequences;

- leaks into auxiliary services or systems with radiological and/or criticality safety consequences;
- loss of electrical power with radiological consequences; and
- natural phenomena (external events) with radiological consequences (NWMI 2015g, 2015i).

Other events were either determined to be bounded by the events listed above; were determined, based on low likelihood and/or consequences, to pose an acceptably low level of risk; or, they have not yet been fully evaluated by NWMI (NWMI will provide additional information for these events in the operating license application that it will submit for future NRC review) (NWMI 2015i).

The accidents listed above include one hypothetical radioactive material accident, based on events unique to the design of the proposed facility, that NWMI stated would result in radiological consequences for members of the public that would bound those of any credible radiological accident. NWMI identified this accident as a fire-related gross failure of the target dissolution offgas treatment system. The target dissolution offgas treatment system is essentially a filtration system designed to collect the radioactive iodine and noble gasses released during routine operation of the target dissolution systems. For the bounding radiological accident at the proposed NWMI facility, the failure of the target dissolution offgas treatment system would release all radioactive iodine and noble gas isotopes retained in that system out of the 75 ft (22.9 m) facility stack without mitigation. NWMI performed its analysis based on the assumption that 12 irradiated LEU targets per week, for 12 weeks immediately preceding the accident, had been processed upstream of the offgas treatment system. NWMI stated that its analysis of this accident is based on extremely conservative initial conditions and assumptions, including:

- maximum accumulation of radioactive iodine and noble gasses in the offgas treatment system based on the assumed target processing history (i.e., all iodine and noble gases in the targets are released into the offgas system, and no iodine or noble gases are captured by other scrubbing systems or retained in the target dissolution system);
- greater release of material from the offgas treatment system than would be expected to occur during an actual offgas treatment system fire; and
- no mitigation (e.g., from filtration or plate-out of iodine) of the release between the offgas treatment system and the facility stack (NWMI 2015a, 2015i, 2016a).

In addition, NWMI applied a safety margin of 1.32 to the source term inventory used for the analysis (NWMI 2016a) (i.e., the amount of radioactive material that could be released was multiplied by 1.32 to account for any uncertainty in the material quantity estimate). Because of these conservative initial conditions and assumptions, NWMI's bounding radiological accident is a hypothetical radioactive material release with a maximized source term, and all material in the source term is released to the environment (no mitigation). All credible internally or externally initiated DBAs that could cause a radiological release from the proposed facility to the environment would be bounded by this accident.

NWMI calculated the potential doses to offsite members of the public for its bounding unmitigated radiological accident as follows:

- The total effective dose equivalent (TEDE) to a member of the public at the nearest fence line, 10 m (32.8 ft) from the facility stack, would be 360 mrem.

- The TEDE at the furthest fence line, 91 m (299 ft) from the facility stack, would be 700 mrem.
- The TEDE at the nearest residence, 430 m (1,411 ft) from the facility stack, would be 3,100 mrem.
- The TEDE at the point of maximum offsite dose would be 22,600 mrem, received 1,100 m (3,609 ft) from the facility stack (NWMI 2016a).

The TEDE increases with increasing distance from the point of release because the release point is elevated above ground level (due to the 75 ft (22.9 m) stack), and most of the radioactive material will be blown some distance from the release point before it reaches ground level, where it could be inhaled by an individual. Beyond 1,100 m (3,609 ft) from the stack, however, the doses start to decrease, because beyond that point the radioactive material has become more diluted/dispersed in the air and the ground-level concentration is lower.

The NRC staff considered the consequences of the radiological accident that NWMI stated would be the bounding radiological accident for the proposed NWMI facility, without regard to the likelihood that this accident could actually occur. Based on the maximum offsite dose calculated by NWMI of 22,600 mrem, and the 10 CFR 70.61 threshold consequence values listed in Table 4–6, if the bounding radiological accident for the proposed NWMI facility were to occur, it would be intermediate-consequence for members of the public. If, as NWMI stated, the consequences of this accident for members of the public bound those of any other credible radiological accident, then any other unmitigated, credible accident at the proposed NWMI facility would be either intermediate- or low-consequence for radiological consequences to members of the public.

NWMI also provided analyses of radiological consequences to facility staff (occupational workers) from possible accidents at the proposed NWMI facility. NWMI identified a credible type of radioactive material accident involving a spill of liquid Mo-99 product solution, and calculated that for this accident, the unshielded direct radiation dose rate to a worker located 1 m (3.3 ft) from the spill would be 1,500,000 mrem per hour. This dose rate could lead to a high-consequence (>100,000 mrem) or intermediate-consequence (>25,000 mrem) dose to a worker in a short period of time (NWMI 2015i). NWMI also identified credible scenarios, including spills or leaks from process vessels that could result in accidents involving an inadvertent nuclear criticality. Due to the intense levels of radiation that can be produced during a nuclear criticality accident, these types of accidents could have very significant dose consequences for facility staff, especially any staff located in the immediate vicinity of the accident. Therefore, NWMI qualitatively assumed that these accidents could be high-consequence for facility staff (NWMI 2015i). Given the types of accidents described by NWMI which could have radiological consequences for NWMI facility personnel, the NRC staff assumes that unmitigated, credible accidents at the proposed NWMI facility could be high-, intermediate-, or low-consequence for radiological consequences to facility staff.

NWMI has proposed in its preliminary safety analysis report to have various controls (including engineering design features and administrative controls) that would prevent the initiation of nuclear or radioactive material accidents, or mitigate their consequences (NWMI 2015i). These would include controls that would mitigate the consequences of radiological accidents, but which were not credited in the analyses above, such as:

- use of hot cells, confinement boundaries, and shielding in process areas;
- double-wall piping;
- sumps to capture and remove spilled liquids;

- radiation monitoring;
- an emergency nitrogen purge system that will limit the likelihood of fires by preventing the buildup of flammable hydrogen gas in the process vessels; and,
- design of the facility ventilation system and dissolution offgas treatment system, including the use of filters to remove radioactive gasses and particulates (NWMI 2015a, 2015i).

NWMI has also proposed to have additional preventative controls specific to nuclear criticality accidents, including:

- geometry of, and spacing between, process vessels; and,
- geometry of liquid collection sumps (NWMI 2015i).

NWMI stated that, for any accident with high radiological consequences for workers, members of the public, and/or the environment (as determined by the criteria in 10 CFR 70.61), the controls proposed in its preliminary safety analysis report would either reduce the likelihood such that it would be highly unlikely; or, reduce the consequences such that it would be intermediate- or low-consequence. Additionally, NWMI stated that for any accident with intermediate radiological consequences for workers, members of the public, and/or the environment (as determined by the criteria in 10 CFR 70.61), the controls proposed in its preliminary safety analysis report would either reduce the likelihood such that it would be unlikely; or, reduce the consequences such that it would be low-consequence (NWMI 2016c, 2016d). NWMI also stated that nuclear criticality controls proposed in its preliminary safety analysis report would be designed such that process systems would remain subcritical under normal and credible abnormal operating conditions (NWMI 2015i).

The NRC staff is conducting an independent review of the radiological consequences of accidents at the proposed NWMI facility, and of the controls proposed by NWMI. The NRC staff will document this review in its SER. The NRC staff will determine whether the controls will be designed, implemented, and maintained to ensure they are available and reliable to perform their preventative and mitigating functions when needed. The NRC staff will also determine whether the controls are sufficient to ensure that the likelihood and/or consequences of any credible radiological accidents at the proposed NWMI facility would be reduced such that the proposed facility would be in compliance with the performance requirements in 10 CFR 70.61 and any other applicable NRC regulations. If the NRC staff determines in its SER that the proposed NWMI facility would comply with 10 CFR 70.61 and any other NRC regulations applicable to radiological accident consequences, the NRC staff concludes that the impacts from potential nuclear or radioactive material accidents at the proposed facility would be SMALL.

### 4.11.2 Hazardous Chemical Accidents

This section discusses the potential onsite and offsite hazardous chemical exposure consequences of accidents at the proposed NWMI facility, and controls to prevent or mitigate the potential consequences. The results of the chemical accident analyses in this section are compared to the threshold consequences in 10 CFR 70.61, which are intended to be compared to the unmitigated consequences of credible accident scenarios. The general threshold consequences that define high- and intermediate-consequence hazardous chemical accidents for the purposes of evaluating compliance with 10 CFR 70.61 are provided in Table 4–7.

**Table 4–7. Definition of High- and Intermediate-Consequence Chemical Accidents**

| Receptor | High Consequence | Intermediate Consequence |
|---|---|---|
| Worker | Could endanger the life of a worker | Could lead to irreversible or other serious, long-lasting health effects to a worker |
| Member of the Public | Could lead to irreversible or other serious, long-lasting health effects to any individual located outside the controlled area | Could cause mild transient health effects to any individual located outside the controlled area |

The accidents that involve hazardous chemicals, and that could result in chemical exposure to workers or members of the public, include the following:

- chemical burns from contaminated solutions during sample analysis;
- nitric acid fume release; and,
- release of other chemicals, such as hydrogen peroxide, ammonia, or carbon dioxide, that would be present at the proposed facility (NWMI 2015a, 2015i).

The chemical accidents evaluated by NWMI are hypothetical severe chemical accidents that NWMI considered to bound any other potential chemical accident at the proposed NWMI facility. The accidents involve unmitigated releases of chemicals that would be used in conjunction with the processing of licensed radioactive material at the proposed facility. NWMI's analyses used the Areal Locations of Hazardous Atmospheres (ALOHA) computer code (NWMI 2015a). ALOHA is an atmospheric dispersion model that evaluates releases of hazardous chemical vapors. The use of this code for chemical accident analyses is consistent with methodologies described in the NRC's Nuclear Fuel Cycle Facility Accident Analysis Handbook (NRC 1998).

In its analysis, NWMI evaluated the unmitigated release from tank breach or rupture of the following chemical materials:

- nitric acid ($HNO_3$, 10.4 M aqueous solution),
- hydrogen peroxide ($H_2O_2$, 10.4 M aqueous solution),
- ammonia ($NH_3$, gas), and
- carbon dioxide ($CO_2$, gas) (NWMI 2015a).

For liquid chemicals (aqueous solutions), the release scenario assumed a breach in a chemical tank resulting in an unconfined spill and subsequent evaporation. For gases, the release scenario assumed a ruptured tank resulting in an immediate release to the atmosphere. The chemicals selected for analysis were chosen based on quantity used at the facility and availability in the ALOHA code's library, which includes chemicals that could pose an airborne dispersion hazard. For the chemicals analyzed, the material at risk (MAR) was based on the estimated maximum inventory of each chemical at the proposed NWMI facility. These inventory values are considered to be conservative, bounding conditions. In addition, no credit was taken for depletion or plate-out of any chemicals, either within the proposed NWMI facility or during transport to receptor locations (NWMI 2015a).

For evaluating possible chemical release exposures to members of the public, NWMI assumed that the releases would occur at ground level. NWMI calculated airborne chemical concentrations at the location of a maximally exposed offsite individual (MOI) at a point along the boundary fence estimated to be 24 m (80 ft) from the release point (based on the general layout of the proposed facility and where chemicals would be located), and at the location of the nearest resident, 430 m (1,425 ft) from the release point. Concentrations were calculated based on 1-hour release/exposure scenarios. NWMI assumed average meteorological conditions for these calculations. The results, in units of parts per million (ppm), are listed in Table 4–8 (NWMI 2015a).

To determine human health impacts associated with the accidental release of hazardous chemicals, estimated airborne chemical concentrations are compared against protective action criteria (PAC) limits. PAC limits are essential components of planning for the uncontrolled release of hazardous chemicals. These limits, combined with estimates of exposure, provide the information necessary to identify and evaluate accidents for the purpose of taking appropriate protective actions. During an emergency response to an uncontrolled chemical release, these limits may be used to evaluate the severity of the event, to identify potential outcomes, and to decide what protective actions should be taken. In anticipation of a possible uncontrolled release, these limits may also be used to estimate the consequences of the possible uncontrolled release and to plan emergency responses (DOE 2008).

U.S. Department of Energy (DOE) guidance states that PAC values equivalent to the 1-hour Acute Exposure Guideline Levels (AEGLs), which are developed by EPA and the National Academy of Sciences, should be used to assess the potential impacts associated with the accidental release of hazardous chemicals. Three levels of AEGL values (AEGL-1, AEGL-2, and AEGL-3) are used for each of five exposure periods (10 minutes, 30 minutes, 1 hour, 4 hours, and 8 hours). The three levels of AEGL values are distinguished by varying degrees of severity of toxic effects based on exposure to the chemical concentration values associated with each AEGL level over the given exposure period. The three AEGL levels are defined as follows:

(1) AEGL-1 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible on cessation of exposure.

(2) AEGL-2 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

(3) AEGL-3 is the airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death (DOE 2008).

In addition to the estimated chemical concentrations calculated by NWMI, Table 4–8 lists, for comparison, the PAC-1, PAC-2, and PAC-3 values (for nitric acid and ammonia, these are equivalent to 1-hour AEGL-1, AEGL-2, and AEGL-3 values, respectively) for each chemical evaluated by NWMI in its accident analysis. For hydrogen peroxide and carbon dioxide, AEGL values are not available. DOE guidance states that if AEGL values do not exist for a given chemical, Emergency Response Planning Guideline (ERPG) values, or in the absence of ERPG values, Temporary Emergency Exposure Limit (TEEL) values, should be used in place of AEGL values to determine PACs. ERPG and TEEL values are similar to AEGL values, but they are developed by the American Industrial Hygiene Association (AIHA), and by DOE, respectively. Additionally, ERPG values are always based on 1-hour exposures, and TEEL values are based on 15-min exposures, in contrast to the range of exposure times for which AEGL values are available (DOE 2008). The PACs in Table 4–8 for hydrogen peroxide are based on ERPGs for that chemical, and the PACs for carbon dioxide are based on TEELs.

**Table 4–8. NWMI Hazardous Chemical Concentrations**

| Chemical | MAR[d] | Concentration at MOI[g] | Concentration at Nearest Resident | PAC[i]-1 | PAC-2 | PAC-3 |
|---|---|---|---|---|---|---|
| Nitric acid[a] | 5,000 L[e] | 1,200 ppm[h] | 19.1 ppm | 0.16 ppm | 24 ppm | 92 ppm |
| Hydrogen[b] peroxide | 500 L | 1.74 ppm | 0.963 ppm | 10 ppm | 50 ppm | 100 ppm |
| Ammonia[a] | 100 kg[f] | 36,800 ppm | 123 ppm | 30 ppm | 160 ppm | 1,100 ppm |
| Carbon dioxide[c] | 200 kg | 28,500 ppm | 95.1 ppm | 30,000 ppm | 40,000 ppm | 50,000 ppm |

[a] PACs for nitric acid and ammonia are based on 1-hour AEGLs. Source for AEGLs: EPA 2016a.
[b] PACs for hydrogen peroxide are based on ERPGs. Source for ERPGs: AIHA 2013.
[c] PACs for carbon dioxide are based on TEELs. Source for TEELs: ATL International 2016.
[d] MAR = material at risk
[e] L = liters
[f] kg = kilograms
[g] MOI = maximally exposed offsite individual
[h] ppm = parts per million
[i] PAC = protective action criteria

Source for MARs and concentrations: NWMI 2015a

Comparison of the concentrations to the corresponding PACs in Table 4–8 indicates that possible chemical accidents involving releases of nitric acid and/or ammonia would pose a much greater risk to human health than accidents involving hydrogen peroxide or carbon dioxide. For nitric acid and ammonia, the MOI could be exposed to concentrations that are significantly greater than PAC-3 values. At these concentrations, it is predicted that individuals could experience life-threatening health effects or death. Additionally, the individuals at the nearest residence could be exposed to concentrations that are above PAC-1 values but below PAC-2 values, and these individuals could experience transient, non-disabling health effects including notable discomfort or irritation. However, since the effects on individuals at the nearest residence would be non-disabling, the effects would likely not impair the individuals' ability to take protective action (i.e., seek shelter or evacuate to a location further away from the proposed NWMI facility).

NWMI additionally stated that another liquid-form chemical, sodium hydroxide (NaOH, 19 M aqueous solution), that would be used at the proposed facility would have an MAR of 1,900 L (502 gal). NWMI did not provide an analysis (calculation of estimated concentrations at the MOI and/or nearest residence) of a chemical accident involving a sodium hydroxide release, but NWMI stated that it assumed, based on the large MAR quantity and the low PACs for sodium hydroxide, that a sodium hydroxide release could cause PAC-2 limits to be exceeded at locations occupied by members of the public (NWMI 2015a).

The NRC staff considered the consequences of the chemical accidents that NWMI stated would be bounding chemical accidents for the proposed NWMI facility, without regard to the likelihood that these accidents could actually occur. Based on the analysis provided by NWMI and the threshold consequences listed in Table 4-7, if a bounding severe chemical accident for the proposed NWMI facility were to occur, it could be high-consequence for members of the public (for nitric acid, ammonia, or sodium hydroxide release). The NRC staff assumes that smaller, less severe releases of nitric acid, ammonia, or sodium hydroxide could be intermediate- or low-consequence for members of the public. NWMI's analysis shows that bounding hydrogen peroxide or carbon dioxide release accidents would be low-consequence for members of the public. NWMI did not provide an analysis of possible chemical exposures to workers at the proposed NWMI facility, but stated that for a bounding chemical accident involving a nitric acid release, chemical exposures to workers would be much higher than the exposure to the MOI (NWMI 2015i). Therefore bounding severe chemical accidents at the proposed NWMI facility could also be high-consequence for the facility staff. Given the bounding analyses provided by NWMI, the NRC staff assumes that unmitigated, credible accidents at the proposed NWMI facility could be high-, intermediate-, or low-consequence for chemical exposure to members of the public or facility staff, depending on the type and quantity of chemicals involved.

NWMI has proposed in its preliminary safety analysis report to have various controls (including engineering design features and administrative controls) that would prevent the initiation of hazardous chemical accidents, or mitigate their consequences. These would include controls that would mitigate the consequences of chemical accidents, but which were not credited in the analyses above, such as:

- use of procedures for handling chemicals;
- design and construction of chemical preparation and storage areas; and,
- use of confinement boundaries and barriers in process areas, to confine spills or releases and protect workers from liquid sprays (NWMI 2015i).

NWMI stated that, for any chemical release accident with high consequences for workers or members of the public (as determined by the criteria in 10 CFR 70.61), the controls proposed in its preliminary safety analysis report would either reduce the likelihood such that it would be highly unlikely; or, reduce the consequences such that it would be intermediate- or low-consequence. Additionally, NWMI stated that for any chemical release accident with intermediate consequences for workers or members of the public (as determined by the criteria in 10 CFR 70.61), the controls proposed in its preliminary safety analysis report would either reduce the likelihood such that it would be unlikely; or, reduce the consequences such that it would be low-consequence (NWMI 2016c, 2016d).

The NRC staff is conducting an independent review of the consequences of hazardous chemical accidents at the proposed NWMI facility, and of the controls proposed by NWMI. The NRC staff will document this review in its SER. The NRC staff will determine whether the controls will be designed, implemented, and maintained to ensure they are available and reliable to perform their preventative and mitigating functions when needed. The NRC staff will also determine whether the controls are sufficient to ensure that the likelihood and/or consequences of any credible hazardous accidents at the proposed NWMI facility would be reduced such that the proposed facility would be in compliance with the performance requirements in 10 CFR 70.61 and any other applicable NRC regulations. If the NRC staff determines in its SER that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations to hazardous chemical accident consequences, the NRC staff concludes that the impacts from potential hazardous chemical accidents at the proposed facility would be SMALL.

## 4.12 Environmental Justice

This section describes the potential human health and environmental effects from the construction, operations, and decommissioning of the proposed NWMI facility on minority and low-income populations living near the proposed Discovery Ridge site. The NRC strives to identify and consider environmental justice issues in agency licensing and regulatory actions primarily by fulfilling its NEPA responsibilities for these actions.

Under Executive Order (EO) 12898 (59 FR 7629), Federal agencies are responsible for identifying and addressing, as appropriate, potential disproportionately high and adverse human health and environmental impacts on minority and low-income populations. In 2004, the Commission issued a Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions (69 FR 52040), which states that "[t]he Commission is committed to the general goals set forth in EO 12898, and strives to meet those goals as part of its NEPA review process."

The CEQ provides the following definitions to consider when conducting environmental justice reviews within the framework of NEPA in *Environmental Justice: Guidance under the National Environmental Policy Act* (CEQ 1997):

> **Disproportionately High and Adverse Human Health Effects.** Adverse health effects are measured in risks and rates that could result in latent cancer fatalities, as well as other fatal or nonfatal adverse impacts on human health. Adverse health effects may include bodily impairment, infirmity, illness, or death. Disproportionately high and adverse human health effects occur when the risk or rate of exposure to an environmental hazard for a minority or low-income population is significant (as employed by NEPA) and appreciably exceeds the risk or exposure rate for the general population or for another appropriate comparison group.

> **Disproportionately High and Adverse Environmental Effects.** A disproportionately high environmental impact that is significant (as employed by NEPA) refers to an impact or risk of an impact on the natural or physical environment in a low-income or minority community that appreciably exceeds the environmental impact on the larger community. Such effects may include ecological, cultural, human health, economic, or social impacts. An adverse environmental impact is an impact that is determined to be both harmful and significant (as employed by NEPA). In assessing cultural and aesthetic environmental impacts, impacts that uniquely affect geographically dislocated or dispersed minority or low-income populations or American Indian tribes are considered.

The environmental justice analysis assesses the potential for disproportionately high and adverse human health or environmental effects on minority populations and low-income populations that could result from the construction, operations, and decommissioning of the NWMI facility. In assessing the impacts, the following definitions of minority individuals and populations and low-income population were used (CEQ 1997):

> **Minority individuals**. Individuals who identify themselves as members of the following population groups: Hispanic, Latino or Spanish origin, American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, or two or more races—meaning individuals who identified themselves on a Census form as being a member of two or more races (e.g., Hispanic and Asian).

> **Minority populations**. Minority populations are identified when the minority population of an affected area exceeds 50 percent or the minority population percentage of the

affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

**Low-income population.** Low-income populations in an affected area are identified with the annual statistical poverty thresholds from the [U.S.] Census Bureau's Current Population Reports, Series P60, on Income and Poverty.

Methodology for Assessing Environmental Justice Impacts

The NRC addresses environmental justice issues and concerns by first identifying potentially affected minority and low-income populations and then determining whether there would be any potential human health or environmental effects and whether any of these effects would be disproportionately high and adverse. Adverse health effects are measured in terms of the risk and rate of fatal or nonfatal impacts on human health. Disproportionately high and adverse human health effects may occur when the risk or rate of exposure to an environmental hazard would be significant for a minority or low-income population and exceed the risk or rate of exposure for the general population or some other comparable population. Disproportionately high environmental effects refer to impacts or risks of impacts on the natural or physical environment in a minority or low-income community that are significant and that appreciably exceed the environmental impact on the larger community. Such effects may include biological, cultural, economic, or social impacts.

Consistent with the Commission's Policy Statement (69 FR 52040), affected populations are defined as minority and low-income populations who reside within a 5-mi (8-km) radius of the proposed NWMI facility site. Data on minority and low-income populations are usually collected and analyzed at the Census tract or Census block group level.

The U.S. Census Bureau (USCB) compiles demographic information at the Census tract and block group levels in small geographic areas. A Census tract is a small area that is a statistical subdivision of a county or statistically equivalent entity. A block group is a statistical subdivision of a Census tract. A Census block is the smallest geographic entity for which the USCB collects and tabulates demographic data.

Minority population data are available for Census block groups within a 5-mi (8-km) radius of the proposed NWMI facility site. Low-income population data are only available at the Census tract level because of the limited availability of poverty and income data at the block group level. To protect confidentiality, USCB does not publish information about small geographic areas if the population size is too small. Race and ethnicity and poverty and income data were used to determine the presence of minority and low-income populations. If the center point of the Census tract and block group is within the 5-mi (8-km) radius boundary, data from the entire Census tract or Census block group was used.

Minority Population

According to the 2010 Census, approximately 23 percent of the City of Columbia population (which includes more than one Census tract and block group) identified themselves as minority. In Boone County, approximately 19 percent of the population identified themselves as minority. According to the U.S. Census Bureau's 2014 American Community Survey 1-Year Estimates, since 2010 minority populations in the City of Columbia and Boone County were estimated to have increased by approximately 3,000 to 4,000 persons and now comprise 24 and 20.2 percent of the respective populations (see Table 3–15). (UCSB 2016b).

Approximately 22 percent of the population identified themselves as minority individuals (Table 4–9) within the 5-mi (8-km) radius of the proposed Discovery Ridge site (MCDC 2016a). The largest minority group was Black or African American at 10.3 percent, followed by Asian at 5.4 percent (MCDC 2016a).

Census block groups were considered minority population block groups if the percentage of the minority population within any block group exceeded 22 percent. Eleven of the 30 Census block groups were found to have meaningfully greater minority populations. These block groups are concentrated northwest and west of the proposed NWMI facility site near the City of Columbia. The Discovery Ridge site is located in Census Tract 10.02, Block Group 3, with a minority population of 12.5 percent.

**Table 4–9. Minority Populations in Census Block Groups Within 5 mi (8 km) of the Discovery Ridge Site**

| Census Tract | Block Group | Total Population | Minority Population[(a)] | Percent Minority |
|---|---|---|---|---|
| 2 | 1 | 665 | 139 | 20.9 |
| 2 | 2 | 1,065 | 171 | 16.1 |
| 3 | 1 | 641 | 66 | 10.3 |
| 3 | 2 | 1,151 | 81 | 7.0 |
| 3 | 3 | 1,218 | 229 | 18.8 |
| **5** | **1** | **1,441** | **536** | **37.2** |
| 5 | 2 | 1,353 | 258 | 19.1 |
| 6 | 1 | 1,151 | 82 | 7.1 |
| **10.01** | **1** | **1,316** | **373** | **28.3** |
| **10.01** | **2** | **864** | **222** | **25.7** |
| 10.01 | 3 | 2,476 | 446 | 18.0 |
| 10.02 | 1 | 2,979 | 462 | 15.5 |
| **10.02** | **2** | **2,194** | **529** | **24.1** |
| 10.02 | 3 | 777 | 97 | 12.5 |
| 11.01 | 1 | 2,815 | 522 | 18.5 |
| 11.01 | 2 | 3,304 | 666 | 20.2 |
| 11.01 | 3 | 2,509 | 501 | 20.0 |
| 11.03 | 1 | 1,421 | 136 | 9.6 |
| **11.03** | **3** | **1,281** | **312** | **24.4** |
| 11.03 | 4 | 1,537 | 284 | 18.5 |
| 11.04 | 1 | 3,444 | 508 | 14.8 |
| **11.04** | **3** | **3,265** | **796** | **24.4** |
| **15.02** | **2** | **2,172** | **822** | **37.8** |
| **15.02** | **3** | **712** | **396** | **55.6** |
| **16.01** | **3** | **3,498** | **969** | **27.7** |
| **21** | **2** | **1,472** | **858** | **58.3** |
| **21** | **3** | **832** | **264** | **31.7** |
| 22 | 1 | 3,230 | 674 | 20.9 |
| 22 | 2 | 2,203 | 389 | 17.7 |

| Census Tract | Block Group | Total Population | Minority Population[(a)] | Percent Minority |
|---|---|---|---|---|
| 22 | 3 | 1,320 | 62 | 4.7 |

[(a)] Includes people of Hispanic, Latino, or Spanish origin.
Census block groups with minority population percentages greater than 22 percent are in bold.

Source: USCB 2010 Census Summary File 1, Table P9, Hispanic or Latino or Not Hispanic or Latino by Race (USCB 2016b)

Low-Income Population

According to 2010–2014 American Community Survey estimates, an average of 11.3 percent of families and 20.7 percent of all people residing in Boone County were identified as living below the Federal poverty threshold. In addition, the City of Columbia had an average of 13.2 percent of families and 24.9 percent of all people identified as living below the Federal poverty level. The Federal poverty threshold for a family of four was $22,314 in 2010 and $24,230 in 2014 (USCB 2016d).

Table 4–10 lists low-income population Census tracts within a 5-mi (8-km) radius of the Discovery Ridge site and the estimated average number of people living below the poverty level. According to the USCB's American Community Survey 5-Year Estimates for 2010–2014, 40.6 percent of the total population within that radius was identified as living below the Federal poverty level (MCDC 2016a).

Census tracts were considered low-income population Census tracts if the percentage of individuals living below the Federal poverty threshold exceeded 40.6 percent. Five of the nine Census tracts were found to have meaningfully greater low-income populations. These Census tracts are concentrated northwest and west of the proposed NWMI facility site.. The existing research park and proposed Discovery Ridge site are located in Census Tract 10.02 with an estimated 16.7 percent of its population living below the poverty level (USCB 2016d).

**Table 4–10. Percentage of People and Families in Census Tracts Within 5 mi (8 km) of the Discovery Ridge Site Whose Income is Below the Poverty Level**

| Census Tract | Total Population | Percentage of People Below Poverty Level | Percentage of Families Below Poverty Level |
|---|---|---|---|
| 2 | 1,749 | 29.5 | 25.9 |
| **3** | **3,097** | **66.8** | **10.3** |
| **5** | **2,760** | **70.5** | **77.1** |
| 10.01 | 4,644 | 40.2 | 11.7 |
| 10.02 | 6,052 | 16.7 | 15.8 |
| **11.01** | **8,824** | **56.2** | **14.6** |
| 11.03 | 6,989 | 16.5 | 4.4 |
| **21** | **3,649** | **49.4** | **45.8** |
| **22** | **7,223** | **72.8** | **67.3** |

Census tracts with percentages of people below the poverty level is greater than 40.6 percent are in bold.

Source: USCB American Community Survey 5-Year Estimates, 2010–2014, Table DP03, Selected Economic Characteristics (USCB 2016d).

Impact Analysis

Chapter 4 presents an assessment of the environmental effects from constructing, operating, and decommissioning the proposed NWMI facility at Discovery Ridge for all affected resource areas. The NRC uses this information to determine if there would be any human health or environmental effects that could disproportionately affect minority and low-income populations and whether any of these effects would be high and adverse.

The following sections in Chapter 4 describe the potential human health and environmental effects from constructing, operating, and decommissioning the proposed NWMI facility that could impact minority and low-income populations:

- radiological human health impacts (Sections 4.8.1.1, 4.8.2.1, and 4.8.3.1);
- nonradiological human health impacts (Sections 4.8.1.2, 4.8.2.2, and 4.8.3.3);
- noise impacts (Section 4.2.2); and
- traffic impacts (Section 4.10).

The NRC also considered whether there would be any environmental impacts that would affect a specific minority and low-income population and whether there would be any unique effects that could appreciably exceed or (are) likely to appreciably exceed those for the general population.

Subsistence Consumption of Fish and Wildlife

The special pathway receptors analysis is an important part of the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area, such as migrant workers or Native Americans.

Section 4–4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information about the consumption patterns of populations that rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this EIS, the NRC considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts on American Indians, Hispanics, migrant workers, and other traditional lifestyle special pathway receptors.

Based on the description of air- and water quality impacts and the discussion of human health effects in this EIS, it is unlikely that there would be any disproportionately high and adverse human health impacts in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife. Thus, constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site would not have disproportionately high and adverse human health and environmental effects on these populations.

### 4.12.1 Construction

Potential impacts to minority and low-income populations from the construction of the proposed NWMI facility at the Discovery Ridge site would mostly consist of environmental effects (e.g., noise, dust, and traffic). Noise and dust impacts during construction would be short term and primarily limited to onsite activities (Section 4.2.2.1). Minority and low-income populations residing along site access roads could be affected by an increase in the number of commuter vehicle and truck traffic traveling to and from the proposed work site. However, these effects are not likely to be different than what was previously experienced during the construction of other research facilities at Discovery Ridge Research Park (e.g., Missouri University plant genetic research farm, IDEXX BioResearch). Given the short duration of construction, the small size of the average daily workforce, the small number of trucks, and the easy access to U.S. Highway 63, it is not likely that the construction of the proposed NWMI facility would have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near Discovery Ridge.

### 4.12.2 Operations

Potential impacts to minority and low-income populations during NWMI facility operations would mostly consist of radiological and nonradiological human health and environmental (e.g., noise and traffic) effects. Everyone living near Discovery Ridge and the proposed NWMI facility could be affected by operations activities, including minority and low-income populations. Any human health and environmental effect would depend on the magnitude of the change from current environmental conditions. Minority and low-income populations residing along site access roads could be affected by the increased commuter vehicle and truck traffic during certain hours of the day.

As discussed in Section 4.8.2.1 of this EIS, the potential radiological dose to the public from NWMI facility operations would be well within NRC and applicable Federal, State, and local regulatory limits. As a result, everyone living near the proposed NWMI facility site, including minority and low-income populations, would not be adversely affected by radiation exposure during facility operations. Permitted nonradiological air emissions would also be required to remain within regulatory limits (Section 4.2.1.2).

As discussed in Section 4.2.2.2 of this EIS, noise levels may increase along U.S. Highway 63 because of increased commuter vehicle and truck traffic during NWMI facility operations. This may not be noticeable, however, given the relatively small size of the daily workforce and the limited number of truck deliveries and shipments. Based on this information, operation of the proposed NWMI facility would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near Discovery Ridge.

### 4.12.3 Decommissioning

Similar to construction, potential impacts to minority and low-income populations during the decommissioning of the proposed NWMI facility at the Discovery Ridge site would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, and traffic). Noise and dust impacts during decommissioning would be short term and primarily limited to onsite activities (Section 4.2.2.3). Minority and low-income populations residing along site access roads could be affected by an increase in the number of commuter vehicle and truck traffic traveling to and from the proposed work site. However, because of the temporary nature of decommissioning, these effects are not likely to be high and adverse and would be intermittent, only occurring when trucks and vehicles pass by during certain hours of the day. Given the short duration, the small size of the average daily workforce, the small number of trucks, and the easy access to U.S. Highway 63, it is not likely that decommissioning the proposed NWMI facility would have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near Discovery Ridge.

## 4.13 Research Reactors

As discussed in Section 2.3.1.3, once the LEU targets are fabricated at the proposed NWMI RPF, the LEU targets will be transported to research reactors for irradiation. Research reactors that irradiate NWMI's LEU targets will need to submit an application for a separate license amendment to provide irradiation services to NWMI. The NRC must issue each reactor facility a license amendment before NWMI's LEU targets can be irradiated at each reactor. The NRC will conduct a separate safety and environmental review of each license amendment application submitted to the NRC. However, since irradiation of LEU targets is a connected action to the proposed action, the NRC will assess the environmental impact associated with irradiating LEU targets at the research reactors in this EIS.

On January 31, 2016, the NRC issued the Oregon State University TRIGA Research Reactor (OSTR) a license amendment that consisted of changes to the facility operating license and technical specifications (TS) that would allow the irradiation of up to three medical isotope production targets containing fissionable material in the OSTR to demonstrate the production of Mo-99 (NRC 2016d; OSU 2012). Oregon State University (OSU) has submitted to the NRC a letter stating OSU's intent to submit a license amendment application in 2017 pertaining to the irradiation of LEU targets in the OSTR that would be fabricated by the proposed NWMI facility (OSU 2015b). The University of Missouri Research Reactor (MURR) has submitted a letter intent to submit a license amendment in 2016 pertaining to the irradiation of LEU targets (MU 2016e).

### 4.13.1 University of Missouri Research Reactor Site

#### *4.13.1.1 Facility Modifications and Equipment Refurbishment*

Facility modifications and equipment refurbishment at MURR are anticipated to be conducted prior to supporting the handling and irradiation of LEU targets. Facility modifications and equipment refurbishment activities will be completed inside the existing MURR building and will consist of (NWMI 2015a, 2015c):

- installation of 3 graphite reflector elements in the reactor,
- fabrication of a target transfer cask,
- construction of an airlock on the beamport floor of the reactor containment,
- installation of storage areas for irradiated targets, and
- refurbishment of the overhead crane and freight elevator.

Facility modifications and equipment refurbishment activities are anticipated to be completed within 2 months and will require up to 6 temporary construction workers (NWMI 2015c). No excavation or ground-disturbing activities are anticipated to occur in connection with facility modifications and equipment refurbishment activities (NWMI 2015c). Additional traffic and vehicle-related emissions will be minimal in connection with the construction workers and single delivery of transfer cask and storage racks (NWMI 2015c). No additional water use to complete modifications is anticipated (NWMI 2015c).

The NRC staff does not expect any impacts to ecological resources given that modification activities would be internal and limited to the existing MURR facility. The NRC staff has identified no foreseeable land and visual impacts, given that modifications would not change any land use on or off site and external changes to the MURR facility would not occur. The NRC staff has identified no foreseeable air quality and offsite noise impacts given that additional air and noise emissions from the additional 6 worker vehicles and single deliveries would be minimal and additional noise levels from facility modification activities would be contained inside the MURR building. No impacts to water resources are expected, because there would be no changes in water use from facility modifications and refurbishment. There would be no socioeconomic, environmental justice, or cultural impacts associated with facility modifications given the short duration of facility modifications (2 months), minimal additional workers needed, and modifications would be internal and limited to the existing MURR facility. In addition, facility modification and refurbishment activities will not change the types or quantities of effluents that may be released, nor are these activities expected to result in a significant increase in individual or cumulative public or occupational radiation exposure (NWMI 2016c).

#### *4.13.1.2 Irradiation Services*

Irradiation services provided by MURR will result in an additional 26 deliveries per year to MURR and 104 offsite shipments per year to the proposed NWMI facility, target handling of up to 624 LEU unirradiated targets, and irradiation of up to 624 LEU targets at MURR (NWMI 2015a, 2016a, 2016b). Irradiation services at MURR will not change land use, will not require additional employees, and no additional water use will be required to support operation activities (NWMI 2015c). Additionally, no anticipated changes in the sources, types, and quantities of nonradiological effluent releases and waste streams are expected from irradiation of LEU targets (NWMI 2015c). Therefore, the NRC staff does not expect impacts to ecological resources, land use, visual, geological resources, water resources, historic or cultural resources, or socioeconomics from LEU target handling and irradiation at MURR. The potential impacts from additional deliveries, target handling, and target irradiation to air quality and noise, human health, and transportation environments are discussed below.

<u>Air Quality and Noise</u>

Deliveries and offsite shipments associated with MURR irradiation services will result in air criteria pollutant and GHG emissions as a result of vehicle exhaust. Target deliveries and shipments will result in an additional 130 vehicles per year and an additional annual 780 mi (1,255 km) (each vehicle would travel 6 mi (10 km), which is the distance between MURR and the proposed NWMI facility). The NRC staff estimates that an addition 780 mi (1,255 km) will emit less than 1 ton of criteria pollutants and GHGs. No additional workforce vehicle emissions would result from irradiation services; therefore, workforce vehicle emissions are anticipated to remain the same. Boone County is designated an attainment/unclassifiable area with respect to all NAAQS. The additional emissions associated with vehicle deliveries and shipments would be less than 1 ton of criteria pollutants and GHGs and the NRC staff does not anticipate that these additional emissions would deteriorate air quality in Boone County. Therefore, the NRC staff concludes that air quality impacts from irradiation services at MURR are SMALL.

Additional noise associated from irradiation services at MURR will result from additional vehicle shipments and deliveries along the main roads, North Providence Road and Stadium Road, which provide access to MURR. Sound levels would increase at a rate of 3 dBA per doubling of traffic volumes. An increase in noise levels from an additional 130 vehicles per year as a result of LEU target deliveries and offsite shipments along the access roads to MURR will not be noticeable (see discussion below). Furthermore, noise from the additional vehicles will be intermittent and for short periods of time. Therefore, the NRC staff concludes that offsite noise impacts from irradiation services at MURR would be SMALL.

<u>Human Health</u>

Activities performed at MURR in conjunction with providing irradiation services would include:

- handling of unirradiated LEU targets;
- operating the reactor to irradiate targets; and
- handling, packaging, and shipping of irradiated LEU targets (NWMI 2015a).

These activities could result in additional radiation dose to occupational workers and/or members of the public. MURR has extensive experience in handling irradiated reactor fuel, fueled experiments, and other materials that have high direct dose rates. For example, MURR staff perform a minimum of 16 fuel-handling evolutions for each week of operation. All high direct dose rate materials are handled using shielding, radiation safety procedures, and other measures to keep doses to MURR staff ALARA. Because these measures are used, the additional occupational dose associated with handling irradiated LEU targets is anticipated to be minimal relative to historical occupational doses received at MURR (see Section 3.10.1). Since unirradiated LEU targets or fuel produce only very low levels of radiation, the additional occupational dose from handling unirradiated LEU targets would also be very small. Additionally, given the similarity of the proposed activities to the fuel-handling evolutions currently performed at MURR, a measureable increase in the direct dose to the public (which is currently very low as discussed in Section 3.10.1) is unlikely to occur (NWMI 2015a).

No radiological gaseous emissions are expected from the targets, although gaseous releases from the operation of the reactor can change based on how often and at what power level the reactor is operated. At MURR, no change in radiological gaseous effluents would be expected because the operating tempo of the reactor would not change (NWMI 2015c). Therefore, there would be no increase in radiation doses to the public from gaseous effluents. Additionally, no changes in the sources, types, or quantities of nonradiological gaseous effluents are anticipated at MURR, and no changes in any radiological or nonradiological liquid waste streams are expected (NWMI 2015c).

The University of Missouri Department of Environmental Health and Safety requires MURR to implement health and safety policies and procedures that require the identification of industrial hazards before performance of jobs (NWMI 2015c). Procedures for ensuring occupational health and safety at MURR are not expected to change. In addition, MURR maintains an emergency response plan for handling any emergencies or accidents at the facility (NWMI 2015c). The regulations at 10 CFR 50.54(q) require that any changes to this emergency plan that could reduce its effectiveness must be approved by the NRC.

No significant change in radiation doses to the public, and only a minimal increase in occupational radiation doses to MURR staff, is expected to occur as a result of the irradiation services that would be performed at MURR. In addition, no changes in nonradiological (chemical or occupational) hazards to MURR staff or members of the public are anticipated. Therefore, the NRC staff concludes that human health impacts from irradiation services provided by MURR would be SMALL.

NWMI stated that the nonradiological waste streams at MURR are not expected to increase as a result of the irradiation services provided by MURR. In addition, NWMI stated that the liquid radioactive waste stream is not expected to increase (NWMI 2015c). The NRC staff expects that the types of irradiation services performed at MURR would not cause any significant additional nonradiological waste, or liquid radioactive waste, to be generated because these types of services do not generate these wastes. The solid low-level radioactive waste stream at MURR is expected to increase by 4 to 6 cubic feet annually; however, this volume of waste would be small (about 1 percent increase by volume) relative to the amount of low-level radioactive waste currently generated at MURR (see Section 3.10.1), and all of this additional waste would be expected to be Class A, the lowest (least radioactive) level of radioactive waste (NWMI 2015a, 2016c). Because only minimal additional radioactive or nonradioactive waste would be produced, the NRC staff concludes that waste management impacts from irradiation services provided by MURR would be SMALL.

Transportation

Major roads in the vicinity of MURR include South Providence Road to the east of MURR and E. Stadium Boulevard to the north of MURR. Access to MURR is by South Providence Road. MURR is approximately 2.5 miles (5.6 km) south of U.S. Interstate 70. Irradiation services provided by MURR will add an estimated 130 vehicles per year as a result of LEU target deliveries and shipments. The addition of 130 truck deliveries and shipments per year (less than one per day) would result in little if any noticeable traffic volume-related level of service impacts in the vicinity of MURR. Therefore, traffic volume-related transportation impacts from irradiation services provided by MURR would be SMALL.

### 4.13.2 Oregon State University TRIGA Reactor Site

#### *4.13.2.1 Facility Modifications and Equipment Refurbishment*

Facility modifications and equipment refurbishment at OSTR are anticipated to be conducted prior to supporting the handling and irradiation of LEU targets. Facility modifications and equipment refurbishment will be completed inside the existing OSTR building and will consist of (NWMI 2015a, 2015c):

- refurbishment or replacement of overhead crane,
- fabrication of a target transfer cask, and
- installation of target storage containers.

Facility modifications and equipment refurbishment activities are anticipated to be completed within 2 months and they will require up to two temporary construction workers (NWMI 2015c). No excavation or ground-disturbing activities are anticipated to occur in connection with facility modifications and equipment refurbishment activities (NWMI 2015c). Additional traffic and vehicle-related emissions will be minimal in connection with two construction workers and a single delivery of transfer cask and storage racks. No additional water use to complete modifications is anticipated (NWMI 2015c).

The NRC staff does not expect any impacts to ecological resources, given that modification activities would be internal and limited to the existing OSTR building. The NRC staff has identified no foreseeable land and visual impacts because modifications would not change any land use on or off site and external changes to the OSTR building would not occur. The NRC staff has identified no foreseeable air quality or offsite noise impacts, given that additional air and noise emissions from an additional 2 worker vehicles and single deliveries would be minimal and additional noise levels from facility modification activities will be contained inside the OSTR building. No impacts to water resources are expected because there would be no changes in water use from facility modifications and refurbishment. There would be no socioeconomic, environmental justice, or cultural impacts associated with facility modifications, given the short duration of facility modifications (2 months), minimal additional workers needed, and modifications would be internal and limited to the existing OSTR facility. In addition, facility modification and refurbishment activities will not change the types or quantities of effluents that may be released, nor are these activities expected to result in a significant increase in individual or cumulative public or occupational radiation exposure (NWMI 2016c).

#### *4.13.2.2 Irradiation Services*

Irradiation services provided by OSTR will result in an increase in workload (NWMI 2015c). For the weeks that OSTR provides irradiation services (8 weeks out of the year), facility operations are anticipated to increase from a 40-hour work week irradiation schedule to a 24 hour per day, 7 day per week schedule. This will also require an additional 10 staff to support the increase in operations for irradiation services; the additional employees are anticipated to be drawn from the existing university population (NWMI 2015c). Irradiation services will add the following activities at OSTR: 8 deliveries per year to OSTR; 16 offsite shipments per year to the proposed NWMI facility; handling of up to 240 LEU unirradiated targets; and, irradiation of up to 240 LEU (NWMI 2015a, 2015c, 2016b). Irradiation services at OSTR will not change land use and no additional water use will be required to support operation activities (NWMI 2015c). Additionally, no anticipated changes in the sources, types, and quantities of nonradiological effluent releases and waste streams are expected from irradiation of LEU targets (NWMI 2015c). Therefore, the NRC staff does not expect impacts to ecological resources, land use, visual, geological resources, water resources, historic or cultural resources from LEU target handling and irradiation at the OSTR. Further, the 10 additional employees drawn from the university population would not have an appreciable impact on socioeconomic conditions; therefore, no socioeconomic impacts would be expected as a result of irradiation services provided by OSTR. The potential impacts from additional deliveries, additional workforce, LEU target handling, and LEU target irradiation to air quality and noise, human health, and transportation are discussed below.

<u>Air Quality and Noise</u>

Vehicles would be the source of air emissions from irradiation services provided by OSTR. Target deliveries and shipments will result in an additional 24 vehicles per year, and the additional staff will result in 10 additional vehicles daily for up to 8 weeks. The additional staff is anticipated to be drawn from the existing university population; therefore, it is reasonable to assume that the workforce will commute up to 100 mi/day (161 km/day) and, therefore, an additional total 56,000 mi/year (90,160 km/year). Applying passenger vehicle exhaust emission factors (EPA 2008), the NRC staff estimates that worker vehicle emissions will emit less than 1 TPY of each criteria air pollutant and 22 TPY of GHGs. The offsite shipments and deliveries will be sent to and from the proposed NWMI facility in Columbia, Missouri (approximately 2,000 mi (3,218 km)). Applying truck exhaust emission factors (EPA 2008), the NRC staff estimates that delivery and shipment vehicle emissions will emit less than 1 TPY of each criteria air pollutant and 28 TPY of GHGs. Emissions from vehicle sources to support irradiation services are not significant. Benton County, where OSTR is located, is designated in attainment/unclassifiable area for all NAAQS. Given the estimated emissions from vehicle exhaust, the NRC staff does not anticipate that these additional emissions would deteriorate air quality in Benton County. Therefore, the NRC staff concludes that air quality impacts from irradiation services at the OSTR would be SMALL.

Sources of noise from irradiation services provided by OSTR will be from the additional workforce and delivery/shipment vehicles along the main roads that provide access to OSTR. Additional workforce travel will be temporary (8 weeks out of the year) and will consist of 10 vehicles. Sound levels increase at a rate of 3 dBA per doubling of traffic volumes. An increase in noise levels from an additional 10 worker vehicles per year and 24 delivery/shipments per year along the access roads to OSTR relative to current traffic levels (see discussion below) near the roads in the vicinity of OSTR are not anticipated to be noticeable. Further, noise from the additional worker vehicles and delivery/shipment vehicles will be intermittent and for short periods of time. Therefore, the NRC staff concludes that offsite noise impacts from irradiation services at the OSTR would be SMALL.

<u>Human Health</u>

Activities performed at OSTR in conjunction with providing irradiation services would include:

- handling of unirradiated LEU targets;

- operating the reactor to irradiate targets; and
- handling, packaging, and shipping of irradiated LEU targets (NWMI 2015a).

These activities could result in additional radiation dose to occupational workers and/or members of the public. OSTR has experience in handling irradiated reactor fuel, specifically TRIGA fuel, which also has high direct dose rates. All high direct dose rate materials are handled using shielding, radiation safety procedures, and other measures to keep doses to OSTR staff ALARA. Historically, occupational doses at OSTR have not significantly increased due to increased handling or movement of irradiated TRIGA elements. Although irradiated LEU targets at OSTR are expected to have an associated dose rate approximately three times that of irradiated TRIGA fuel elements handled previously, the dose rate to personnel would be reduced by the use of an irradiated LEU target transfer cask with better radiation shielding than the cask routinely used for moving the TRIGA elements. Therefore, routine handling of irradiated LEU targets at OSTR is not expected to significantly increase occupational doses. Since unirradiated LEU targets or fuel produce only very low levels of radiation, the additional occupational dose from handling unirradiated LEU targets would also be very small. Additionally, given the similarity of the proposed activities to the fuel-handling activities previously performed at OSTR, a measureable increase in the direct dose to the public (which is currently very low as discussed in Section 3.10.2) is unlikely to occur (NWMI 2015a).

No radiological gaseous emissions are expected from the targets themselves, although gaseous releases from the operation of the reactor can change based on how often and at what power level it is operated. At OSTR, the average annualized concentration of gaseous radioactive effluents, particularly Ar-41, would increase because of the reactor's increased operating tempo. Conservatively, the average annualized concentration of Ar-41 released at OSTR could increase by a factor of 4.8 if OSTR switched to 24 hours per day, 7 days per week, and 365 days per year operation (NWMI 2015c). As discussed in Section 3.10.2, OSTR's current typical average annualized effluent concentration of Ar-41 is $1.4 \times 10^{-7}$ microcuries per milliliter, compared to a TS limit of $4 \times 10^{-6}$ microcuries per milliliter. If OSTR's current average annualized effluent concentration increased by a factor of 4.8, it would still be well below the TS limit, ensuring that radioactive effluents from OSTR would continue to not cause the public dose limit in 10 CFR 20.1301 and the 10 mrem dose constraint in 10 CFR 20.1101(d) to be exceeded.

No changes in the sources, types, or quantities of nonradiological gaseous effluents are anticipated at OSTR, and no changes in any radiological or nonradiological liquid waste streams are expected (NWMI 2015c).

Oregon State University Enterprise Risk Services requires individuals working at OSTR to implement health and safety policies and procedures that require the identification of industrial hazards prior to the performance of jobs (NWMI 2015c). Procedures for ensuring occupational health and safety at OSTR are not expected to change. In addition, OSTR maintains an emergency response plan for handling any emergencies or accidents at the facility (NWMI 2015c). The regulations at 10 CFR 50.54(q) require that any changes to this emergency plan that could reduce its effectiveness must be approved by the NRC.

Only minimal increases in radiation doses to OSTR staff and members of the public are expected to occur as a result of the irradiation services that would be performed at OSTR, and these doses are expected to remain in compliance with regulatory limits. In addition, no changes in nonradiological (chemical or occupational) hazards to OSTR staff or members of the public are anticipated. Therefore, the NRC staff concludes that human health impacts from irradiation services provided by OSTR would be SMALL.

NWMI stated that the nonradiological waste streams at OSTR are not expected to increase as a result of the irradiation services provided by OSTR. In addition, NWMI stated that the liquid radioactive waste stream is not expected to increase (NWMI 2015c). The NRC staff expects that the types of irradiation services performed at OSTR would not cause any significant additional nonradiological waste, or liquid radioactive waste, to be generated because these types of services do not generate these wastes. The solid low-level radioactive waste stream at OSTR is expected to increase by 4 to 6 cubic feet annually; however, this volume of waste would be small (about a 15 to 25 percent increase by volume) relative to the amount of low-level radioactive waste currently generated at OSTR (see Section 3.10.2). Further, all this additional waste would be expected to be Class A, the lowest (least radioactive) level of radioactive waste (NWMI 2015c, NRC 2016c). Because only minimal additional radioactive or nonradioactive waste would be produced, the NRC staff concludes that waste management impacts from irradiation services provided by OSTR would be SMALL.

Transportation

Given an additional 10 workers commuting daily to the OSTR during 8 weeks of facility operations and 24 truck deliveries and shipments per year during irradiation services, there would be little if any noticeable traffic volume-related level of service impacts in the vicinity of OSTR. Therefore, traffic volume-related transportation impacts from irradiation services provided by OSTR would be SMALL.

### 4.13.3 Third Research Reactor

#### *4.13.3.1 Facility Modifications and Equipment Refurbishment*

Facility modifications and equipment refurbishment at a yet to be identified third research reactor are anticipated to be conducted before the handling and irradiation of LEU targets. Facility modifications and equipment refurbishment activities will be completed inside the existing research reactor building and will consist of (NWMI 2015c):

- refurbishment of an existing overhead crane,
- fabrication of a target transfer cask, and
- installation of target storage containers.

Facility modifications and equipment refurbishment activities are anticipated to be completed within 2 months and will require up to 2 temporary construction workers (NWMI 2015c). No excavation or ground-disturbing activities are anticipated to occur in connection with facility modifications and equipment refurbishment activities (NWMI 2015c). Additional traffic and vehicle-related emissions will be minimal in connection with two construction workers and single delivery of the transfer cask, storage racks, and equipment for crane refurbishment. No additional water use to complete modifications is anticipated (NWMI 2015c).

The NRC staff does not expect any impacts to ecological resources given that modification activities would be internal and limited to the existing research reactor building. The NRC staff has identified no foreseeable land and visual impacts because the modifications would not change any land use on or off site and external changes to the research reactor building would not occur. The NRC staff has identified no foreseeable air quality and offsite noise impacts because additional air and noise emissions from the additional two worker vehicles and single deliveries would be minimal and additional noise levels from facility modification activities will be contained inside the research reactor building. No impacts to water resources are expected, because there would be no changes in water use from facility modifications and refurbishment. Similar to the MURR and OSU research reactor, there would likely be no noticeable socioeconomic, environmental justice, or cultural resource impacts associated with facility modifications, given the short duration of facility modifications (2 months), and the few (2) additional workers needed. Modifications would be completed inside buildings and limited to the existing research reactor facility. In addition, facility modification and refurbishment activities will not change the types or quantities of effluents that may be released, nor would these activities be expected to result in a significant increase in individual or cumulative public or occupational radiation exposure (NWMI 2016c).

#### *4.13.3.2 Irradiation Services*

Irradiation services provided by a third research reactor will result in an increase in workload (NWMI 2015c). For the weeks that a third research reactor provides irradiation services (8 weeks out of the year), facility operations are anticipated to increase from a 40-hour work week irradiation schedule to a 24 hours a day, 7 days a week schedule. This will also require an additional 10 staff to support the increase in operations for irradiation services, which is anticipated to be drawn from the university population. Irradiation services will add the following activities at a third research reactor: 8 deliveries per year to a third research reactor; 16 offsite shipments per year to the proposed NWMI facility; handling of up to 240 LEU unirradiated targets; and, irradiation of up to 240 LEU targets (NWMI 2015a, 2015c, 2016b). Irradiation services at a third research reactor will not change land use and no additional water use will be required to support operation activities (NWMI 2015c). Additionally, no anticipated changes in the sources, types, and quantities of nonradiological effluent releases and waste streams are expected from irradiation of LEU targets (NWMI 2015c). Therefore, the NRC staff does not expect any impacts to ecological resources, land use, visual, geological resources, water resources, and historic or cultural resources at the third research reactor from LEU target handling and irradiation. Further, the 10 additional workers drawn from the existing university population would have no socioeconomic impact; therefore, LEU target irradiation at an existing research reactor would result in no socioeconomic impacts. The potential impacts from additional deliveries, the additional workforce, LEU target handling, and LEU target irradiation to air quality and noise, human health, socioeconomics, and transportation environments are discussed below.

<u>Air Quality and Noise</u>

Vehicles would be the source of air emissions from irradiation services provided by a third research reactor. Target deliveries and shipments will result in an additional 24 vehicles per year and the additional staff will result in 10 additional vehicles daily for up to 8 weeks. The additional staff is anticipated to be drawn from the existing university population (NWMI 2015c); therefore, it is reasonable to assume that the workforce will commute up to 100 mi/day (161 km/day) and therefore an additional total 56,000 mi/year (91,160 km/day). Applying passenger vehicle exhaust emission factors (EPA 2008), the NRC staff estimates that worker vehicle emissions will emit less than 1 TPY of each criteria air pollutant and 22 TPY of GHGs. The offsite shipments and deliveries will be sent to and from the proposed NWMI facility in Columbia, Missouri. The distance travelled from offsite shipment and deliveries would be no greater than the distance travelled between the proposed NWMI facility and OSTR because this is the greatest distance between the proposed NWMI facility and any operating research reactor. Therefore, up to 2,000 mi (3,218 km) will be traveled by each delivery or off-shipment, resulting in a total of less than 1 TPY of each criteria air pollutant and 28 TPY of GHGs. Emissions from vehicle sources to support irradiation services are not significant. Given the estimated emissions from vehicle exhaust, the NRC staff does not anticipate that these additional emissions would deteriorate air quality in the county where a third research reactor is located. Therefore, the NRC staff concludes that air quality impacts from irradiation services at a third research reactor would be SMALL.

Sources of noise from irradiation services provided by a third research reactor will be from the additional workforce and delivery/shipment vehicles along the main roads that provide access to a third research reactor. Additional workforce travel will be temporary (8 weeks out of the year) and will consist of 10 vehicles. The 24 additional delivery/shipment vehicles a year will not occur at the same time. An increase in noise levels from an additional 10 worker vehicles per year and 24 delivery/shipments per year along the access roads to a third research reactor are not anticipated to be noticeable because they will be intermittent, for short periods of time, and the increase in additional vehicles is not significant. Therefore, the NRC staff concludes that offsite noise impacts from irradiation services at a third research reactor would be SMALL.

Human Health

Activities performed at a third research reactor in conjunction with providing irradiation services would include:

- handling of unirradiated LEU targets;
- operating the reactor to irradiate targets; and
- handling, packaging, and shipping of irradiated LEU targets (NWMI 2015a, 2015c).

These activities could result in additional radiation dose to occupational workers and/or members of the public. A third research reactor would use shielding, radiation safety procedures, and other measures to keep doses to staff ALARA. While some increase in occupational dose would be observed, the dose increase would not be significant because of the established radiation protection measures and radioactive material handling experience at a third research reactor (NWMI 2015c). Additionally, similarly to MURR and OSTR, a measureable increase in the direct dose to the public is unlikely to occur, because the current direct offsite dose at a third research reactor is presumably very low, and new activities performed at a third research reactor would be similar to fuel handling activities currently performed at that reactor (NWMI 2016c).

No radiological gaseous emissions would be expected from the LEU targets, although gaseous releases from the operation of the reactor could change based on how often and at what power level the reactor is operated. At a third research reactor, the average annualized concentration of gaseous radioactive effluents, particularly Ar-41, would be expected to increase due to the reactor's increased operating tempo. However, a third research reactor would have a TS that would limit any increases in Ar-41 effluents such that the public dose limits in 10 CFR 20.1301 would not be exceeded (NWMI 2015c).

No changes in the sources, types, or quantities of nonradiological gaseous effluents are anticipated at a third research reactor, and no changes in any radiological or nonradiological liquid waste streams are expected (NWMI 2015c).

Similar to MURR and OSTR, a third research reactor would be expected to implement occupational health and safety policies and procedures that would require compliance with Federal, State, and local regulations. A third research reactor would also be expected to maintain an emergency response plan for handling any emergencies or accidents at the facility. This plan would follow NRC guidance for emergency plans found in NUREG–1537 and the associated Interim Staff Guidance (NWMI 2015c). The regulations at 10 CFR 50.54(q) would require that any changes to this emergency plan that could reduce its effectiveness must be approved by the NRC.

Only minimal increases in radiation doses to a third research reactor staff and members of the public are expected to occur as a result of the irradiation services that would be performed at a third research reactor, and these doses are expected to remain in compliance with regulatory limits. Additionally, no changes in nonradiological (chemical or occupational) hazards to staff at a third research reactor or members of the public are anticipated. Therefore, the NRC staff concludes that human health impacts from irradiation services provided by a third research reactor would be SMALL.

NWMI stated that the nonradiological waste streams at a third research reactor would not be expected to change as a result of the irradiation services provided by a third research reactor. In addition, NWMI stated that the liquid radioactive waste stream is not expected to change (NWMI 2015c). The NRC staff expects that the types of irradiation services performed at a third research reactor would not cause any significant additional nonradiological waste, or liquid radioactive waste, to be generated because these types of services do not generate these wastes. The solid low-level radioactive waste stream at a third research reactor would be expected to increase by 4 to 6 cubic feet annually; however, this volume of waste is small relative to the amount of low-level radioactive waste currently generated at other research and test reactors such as OSTR (see Section 3.10.2), and all of this additional waste would be expected to be Class A, the lowest (least radioactive) level of radioactive waste (NWMI 2015a, 2016c). Since only minimal additional radioactive or nonradioactive waste would be produced, the NRC staff concludes that waste management impacts from irradiation services provided by a third research reactor would be SMALL.

Transportation

Given an additional 10 workers commuting daily to a third research reactor during 8 weeks of target irradiation and 24 truck deliveries and shipments per year during irradiation services, there would be little if any noticeable traffic volume-related level of service impacts in the vicinity of a third research reactor. Therefore, traffic volume-related transportation impacts from irradiation services provided by a third research reactor would be SMALL.

## 4.14 Cumulative Impacts

The NRC staff considered potential cumulative impacts in the environmental analysis of the construction, operations, and decommissioning of the proposed NWMI facility. Cumulative impacts may result when the environmental effects associated with the proposed action are overlaid or added to temporary or permanent effects associated with other past, present, and reasonably foreseeable actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. An impact that may be SMALL by itself could result in a MODERATE or LARGE cumulative impact when considered in combination with the impacts of other actions on the affected resource. Likewise, if a resource is regionally declining or imperiled, even a SMALL individual impact could be important if it contributes to, or accelerates, the overall resource decline.

For the purposes of this cumulative impacts analysis, past actions are those before the receipt of the NWMI construction permit application. Present actions are those related to the resources at the time of construction of the NWMI facility, and future actions are those that are reasonably foreseeable through the end of operation and decommissioning. The geographic area over which past, present, and reasonably foreseeable actions would occur depends on the type of action considered and is described below for each resource area.

To evaluate cumulative impacts, the incremental impacts of the proposed action, as described in Sections 4.1 to 4.12, are combined with other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such actions. The NRC staff used the information provided in the ER; responses to RAIs; information from other Federal, State, and local agencies; scoping comments; and information gathered during the visits to the potential NWMI facility site to identify other past, present, and reasonably foreseeable actions.

Table 4–11 identifies recent past, present, and reasonably foreseeable future actions within the geographic extent of analysis. To be considered in the cumulative impacts analysis, the NRC staff determined whether the project would occur within the noted geographic areas of interest and within the noted timeframes, whether it was reasonably foreseeable, and whether there would be potential overlapping effects with the proposed project. For past actions, consideration within the cumulative impacts assessment is resource- and project-specific. In general, the effects of past actions are included in the description of the affected environment in Chapter 3, which serves as the baseline for the cumulative impacts analysis. However, past actions that continue to have an overlapping effect on a resource potentially affected by the proposed action are considered in the cumulative impacts analysis.

Further, the NRC staff considers the potential cumulative, or overlapping, impacts from climate change on environmental resources that could be impacted by the proposed NWMI facility. Changes in climate have broad implications on water resources, land use and development, and ecosystems. In accordance with 10 CFR Part 51 Appendix A, the level of detail provided within the cumulative discussions below will be commensurate with the potential for adverse or significant impacts to a specific resource area. However, climate change impacts on construction and operation of the proposed NWMI facility, are considered outside the scope of the EIS; this EIS documents the potential impacts from construction, operations, and decommissioning of the proposed NWMI facility on the environment. External events and extreme weather event impacts on the proposed NWMI facility will be assessed in the NRC staff's SER.

**Table 4–11. Past, Present, and Reasonably Foreseeable Projects and Other Actions Retained for the Cumulative Impacts Analysis – Discovery Ridge**

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| **Nuclear Projects** | | | |
| Callaway Plant | Nuclear power plant, one 1,236 MWe Westinghouse 4-loop pressurized water reactor | 28 mi (46 km) southeast of site | Operational (NRC 2015j) |
| University of Missouri Research Reactor | Research reactor, one 10 MWt open pool pressurized water reactor | 4 miles (6.6 km) northwest of site | Operational (MU 2016f) |

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| **Research and Manufacturing Facilities** | | | |
| Discovery Ridge Research Park | Research Park being developed on University of Missouri lands with potential expansion to 550 ac (220 ha) | Proposed site would be within research park | Research park currently has two tenants (ABC Laboratories and IDEXX BioResearch) occupying two of 14 lots comprising Phase I (139 ac (56 ha)) of the park's development. Proposed NWMI facility would occupy one of four lots comprising Phase II (additional 55 ac (22 ha)). Potential total future build out of 550 ac (220 ha). No other proposed tenants identified at this time. (MU 2009, 2016g) |
| ABC Laboratories | Analytical biochemical testing serves | 0.3 mi (0.5 km) west of site | Operational (ABC 2016) |
| IDEXX BioResearch | Animal bioresearch health monitoring and diagnostic testing laboratory | 0.1 mi (0.16 km) northwest of site | Operational (IDEXX 2015; MU 2016g) |
| Boone Quarries | Crushed Limestone Quarry | 8 mi (12.9 km) northwest of site | Operational (Con-Ag undated) |
| **Fossil Fuel Projects** | | | |
| University of Missouri Combined Heat and Power Plant | Conventional Steam Coal (50.7 MW); Natural Gas-Fired Combustion Turbine (22.8 MW); Petroleum 3.5 MW) | 4.4 mi (7 km) northwest of site | Operational (EIA 2015a) |
| Columbia Municipal Power Plant | Natural Gas-Fired Combustion Turbine (47.5 MW); Conventional Steam Coal (38.5 MW); Petroleum (12.6 MW); Landfill Gas (3 MW) | 5 mi (8km) north-northwest of site | Operational (EIA 2015b) |
| Columbia Energy Center | Natural Gas-Fired Combustion Turbine (140 MW) | 8.2 mi (13.2 km) north of site | Operational (EIA 2015c) |
| **Transportation Projects** | | | |
| Discovery Parkway | Proposed construction of major collector from Gans Road to New Haven Road | Adjacent to northwestern portion of site at nearest location | Initial segment to completed intersection with Discovery Drive. Construction planned through FY 2017 (CATSO 2014) |

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| Gans Road | Proposed new extension, level of service upgrades, and interchange improvements to Gans Road between U.S. 63 Interchange and Providence Road | 0.4 mi (0.6 km) south of site at nearest location | Construction proposed to continue through 2023 (CATSO 2014; NWMI 2015a) |
| Columbia Regional Airport | Public airport | 6.4 mi (10 km) southeast of site | Operational. Proposed runway expansion and improvements under consideration (CRA 2012) |
| **Medical Facilities** | | | |
| University Hospital | Hospital that performs radiological procedures | 4 mi (6.5 km) northwest of site | Operational (MU 2016h) |
| Boone Hospital Center | Hospital that performs radiological procedures | 4 mi (6.5 km) north-northwest of site | Operational (Boone County 2016c) |
| **Parks/Recreation Sites** | | | |
| Nifong Park | 58 ac (23 ha) park offering picnicking, fishing, and hiking. Other amenities include Walters-Boone County Historical Museum, historic Maplewood home and grounds, and Boone Junction Historical Village | 1 mi (1.6 km) west of site | Operational. Minor park improvements planned though 2017. Managed by the City of Columbia (City of Columbia 2016f; NWMI 2015a) |
| A. Perry Phillips Park | 140 ac (57 ha) park offering picnicking, fishing, boating, and hiking. | 0.7 mi (1.1 km) west of site | Operational. Park dedicated in 2011 and being developed over several years in conjunction with adjacent Gans Creek Recreational Area. Planned improvements through 2018 include an ice skating center and an indoor sports center. Managed by the City of Columbia (City of Columbia 2016g; NWMI 2015a) |
| Gans Creek Recreational Area | 320 ac (130 ha) park offering five multipurpose athletic fields | 0.8 mi (1.3 km) southwest of site | Operational. Two additional athletic fields under construction, with planned future construction of playground, restroom, and concession facilities. Managed by the City of Columbia (City of Columbia 2016h) |

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| Rock Bridge State Park | 2,273 ac (920 ha) park containing unique geological features and offering picnicking, hiking, cycling, and horseback riding. | 1.8 mi (2.9 km) southwest of site | Operational. Managed by Missouri Department of Natural Resources (MDNR undated; USA Parks 2015) |
| Other Recreational Areas | Various parks, campgrounds, and natural areas | Within 10 mi (16 km) | Operational |
| **Other Projects/Actions** | | | |
| Discovery Park | 105 ac (42 ha) residential and commercial development center | 0.4 mi (0.6 km) southwest of site | Under construction. (Columbia Daily Tribune 2015b) |
| Ed's Mobile Home Park/Sunset Mobile Home Park | Residential Development | 0.6 mi (1 km) northwest of site | Shut down October 1, 2015. (The Columbian Missourian 2015) |
| Old Hawthorne Golf Club | Private country club and residential community | 2.5 mi (4 km) northeast of site | Operational. Golf course opened in 2007 and construction of associated residential community is ongoing (Hawthorne 2016) |
| KOMU TV | Network television station | 1.1 mi (1.7 km) southeast of site | Operational (KOMU 2016) |
| Other Future Development | Construction of housing units and associated commercial buildings; roads, bridges, and rail; water and/or wastewater treatment and distribution facilities, and associated pipelines as described in local land use planning documents. | Throughout region | Construction would occur in the future as described in State and local land use planning documents. |

*Climate Change*

Climate change is the decades or longer change in climate measurements (e.g., temperature, precipitation) that has been observed on a global, national, and regional level (EPA 2014; IPCC 2007a; USGCRP 2014). Climate change can vary regionally, spatially, and seasonally depending on local, regional, and global factors. Just as the regional climate differs throughout the world, the impacts of climate change can vary between locations. Climate change research indicates that the cause of the Earth's warming over the last 50 years is due to the buildup of GHGs in the atmosphere resulting from human activities (USGCRP 2014).

In the United States, the U.S. Global Change Research Program (USGCRP) reports that, from 1895 to 2012, average surface temperature has increased from 1.3 °F to 1.9 °F (0.72 C to 1.06 °C), and since 1900, average annual precipitation has increased by 5 percent

(USGCRP 2014). On a seasonal basis, warming has been the greatest in winter and spring. From 1895 to 2011, an increase in the length of the freeze-free season, the period between the last occurrence of 32 °F (0 °C) in the spring and first occurrence of 32 °F (0 °C) in the fall, has been observed for the contiguous United States; between 1991 and 2011, the average freeze-free season was 10 days longer than that between 1901 and 1960 (USGCRP 2014). Since the 1970s, the United States has warmed at a faster rate as the surface temperature rose at an average rate of 0.17 to 0.25 °C (0.31 to 0.45°F) per decade. Observed climate-related changes in the United States include increases in the frequency and intensity of heavy precipitation, earlier onset of spring snowmelt and runoff, rise of sea level in coastal areas of the United States, increase in occurrence of heat waves, and a decrease in occurrence of cold waves (EPA 2014; NOAA 2013a; USGCRP 2009, 2014).

Temperature data indicate that the Midwest region, where the proposed Discovery Ridge site is located, experienced a 0.06 °C (0.11 °F) per decade increase in annual mean temperature during the 1900 to 2010 period (NOAA 2013b). Temperature data for the recent past indicate an increased rate of warming for the Midwest: 0.12 °C (0.22 °F) per decade for the 1950 to 2010 time period and a 0.26 °C (0.47 °F) temperature increase for the 1979 to 2010 time period. Average annual precipitation data for the Midwest exhibit an increasing trend of 0.31 in. (0.79 cm) per decade for the long-term period (1895 to 2011) (NOAA 2013b). Precipitation data over the 1958 to 2007 period exhibit clear trends toward more very heavy precipitation events (defined as the heaviest 1 percent of all daily events) for the Nation as a whole and particularly in the Northeast and Midwest.

Future GHG emission concentration and climate models are commonly used to project possible climate change. Climate models indicate that over the next few decades, temperature increases will continue due to current GHG concentrations in the atmosphere (USGCRP 2014). Over the longer term, the magnitude of temperature increases and climate change effects will depend on both past and future GHG emissions (IPCC 2007a; USGCRP 2009, 2014). For the 2021–2050 time period (relative to 1971–1999), climate model simulations indicate an increase in annual mean temperature of 2.5 to 3.5 °F (1.4 to 1.9 °C) for the entire Midwest region for both a low- and high-GHG emission modeled scenario. For mid-century (2041–2070) annual mean temperatures are projected to increase even greater; climate model simulations indicate an increase in annual mean temperature of 3.5 to 4.5 °F (1.9 to 2.5 °C) for a low-GHG emission modeled scenario and an increase in annual mean temperature of 4.5 to 5.5 °F (2.5 to 3.0 °C) for a high-GHG emission modeled scenario for the Midwest. Further, by mid-century the annual number of days above 95 °F (35 °C) are projected to increase by up to 25 days for Missouri. In addition, the length of the average frost-free season (the period between the last occurrence of 32 °F (0 °C) in the spring and first occurrence of 32 °F (0 °C) in the fall is projected to increase by up to 23 days (USGRP 2014).

Climate model simulations indicate spatial differences in annual mean precipitation changes for the Midwest. For the 2021–2050 time period (relative to 1971–1999), models indicate an increase of 0 to 3 percent in annual mean precipitation for the northeast region of Missouri, while the southeastern region would experience a decrease of 0 to 3 percent. However, these changes in precipitation were not significant as the models indicate changes that are less than normal year-to-year variations and, therefore, less certain than annual mean temperature changes (NOAA 2013b; USGCR 2014). However, by mid-century increases in the frequency and intensity of extreme precipitation are projected to increase, while at the same time the average maximum number of consecutive days with less than 0.01 in of precipitation will increase (indicative of drought conditions) throughout the entire Midwest region (USGCRP 2014).

Changes in climate have broad implications for air quality, water resources, land use and development, and ecosystems. For instance, changes in precipitation patterns and increase in air temperature can affect water availability and quality, distribution of plant and animal species, land-use patterns, and land-cover, which can in turn affect terrestrial and aquatic habitats. Although the future effects of climate change are uncertain, the cumulative impact sections below discuss how future climate change may affect environmental resource areas that could be impacted by the proposed NWMI facility.

### 4.14.1 Land Use and Visual Resources

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility on land use and visual resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The description of the affected environment in Section 3.1 (5-mi (8-km)) radius for land use and the viewshed for visual resources) serves as baseline conditions for the land use and visual resources cumulative impact assessment. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on land use and visual resources would be SMALL, as described in Section 4.1.

#### *4.14.1.1 Land Use*

The projects and activities described in Table 4–11 would result in minimal changes to existing land uses because new construction would occur either within or adjacent to existing facilities or within areas currently certified for industrial or commercial use. For example, most reasonably foreseeable projects would occur within the Discovery Ridge Research Park. In the most recent land use plan, the City of Columbia (2013) identifies the Discovery Ridge Research Park as “shovel ready” for future industrial development. The research park is also one of three sites that the City of Columbia (2013) designated as an industrial certified site. The future development goal for the Discovery Ridge Research Park is to increase the number of business and research facilities on site, especially for entities that would benefit from the close proximity to the resources available at the University of Missouri (City of Columbia 2013). In addition, one of the City of Columbia’s (2013) economic goals is to attract new businesses and increase the number of light industrial and high tech jobs within the Columbia Regional Airport-Discovery Ridge–U.S. Highway 63 Corridor, which would include the proposed Discovery Ridge site. Given that Discovery Ridge Research Park is currently certified for industrial use, any new development within this area would be compatible with current land use plans.

Future urbanization and global climate change could contribute to additional decreases in agricultural lands, forests, grasslands, and wetlands. Urbanization in the vicinity of the proposed site would alter important attributes of land use.

Urbanization would reduce natural vegetation and agricultural fields, resulting in an overall decline in the extent and connectivity of wetlands, forests, grasslands, and wildlife habitat. Global climate change could reduce crop yields and livestock productivity (USGCRP 2014), which may change portions of agricultural land uses. However, existing parks, reserves, and managed areas would help preserve wetlands and forested areas. In addition, zoning laws and comprehensive land use plans would help ensure a proper balance of development (City of Columbia 2013, 2016a).

Given that reasonably foreseeable new construction activities would occur within or adjacent to existing facilities or within areas certified for industrial use, cumulative land use impacts would be SMALL.

#### *4.14.1.2 Visual Resources*

The projects and activities described in Table 4–11 would result in minimal changes to the existing viewshed because most new construction would occur either within or adjacent to existing facilities or within areas that are currently certified for industrial use. Furthermore, the viewshed within the vicinity of the proposed site includes agricultural, light industrial, residential, and forested views. Within nondeveloped areas, where a new structure would change qualities of the existing landscape, the viewshed directly surrounding the proposed Discovery Ridge site is generally of low scenic quality because of a lack of notable features, uniform landform, low vegetation diversity, an absence of water, and mute colors.

Given that reasonably foreseeable new construction activities would occur within or adjacent to existing facilities or within areas certified for industrial use and of low scenic quality, cumulative visual impacts would be SMALL.

### **4.14.2 Air Quality and Noise**

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility on air quality and noise at the Discovery Ridge site when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The description of the affected environment in Section 3.2 provides baseline conditions for the assessment of cumulative impacts on air quality and noise. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on air quality and noise would be SMALL, as described in Section 4.2.

#### *4.14.2.1 Air Quality*

As described in Section 3.2.2, the ROI considered for the air quality analysis of the proposed NWMI facility is defined as Boone County. The ROI considered in the cumulative air quality analysis is also Boone County because air quality designations for criteria air pollutants are generally made at the county level.

Present-day activities in Boone County that could potentially result in cumulative impacts include seven major sources of air emissions identified on EPA's Enforcement and Compliance History Online (ECHO) air data search tool (EPA 2016c). Minor sources of air emissions are also present in Boone County; however, a minor source classification typically indicates that the facility has little to no potential for significantly affecting air quality or interfering with plans to achieve compliance with NAAQS (IEPA 2015). Sources of air pollutants classified as a major source require a permit that will include provisions on how much and what is allowed to be emitted, which serves to minimize cumulative impacts on air quality. Table 4–11, provides a list of current projects and reasonably foreseeable future actions that could contribute to cumulative impacts to air quality. Air emissions sources that contribute to air quality identified in Table 4–11 (e.g., fossil fuel projects and manufacturing facilities) that are currently operating have not contributed to a violation of the NAAQS given Boone County's designated attainment/unclassifiable status. These past and current emissions are included in the air quality baseline for Boone County. Therefore, cumulative impacts to air quality would be the result of changes to present-day emissions and future actions within Boone County.

Development and construction activities, as identified in Table 4–11, associated with regional growth in housing, business, and industry, as well as associated vehicular traffic, can increase air emissions. The population of Columbia, Missouri, is projected to increase between 22 and 35 percent by 2030 (relative to 2010), and construction of new housing and associated infrastructure will be needed to accommodate the increase in population (City of Columbia 2013). The population in Boone County is projected to increase by 51.6 percent by

2050 (relative to 2010), see Table 3-11. Annual job growth projection for Columbia is 1.3 to 1.4 percent (City of Columbia 2013). Regional air quality conditions could deteriorate from the effects of the growth in the County as growth gives rise to dust, exhaust from increased traffic, and other emissions. While air emissions from construction activities would be temporary and localized, the resulting regional growth in residential, commercial, and industrial uses across Boone County can result in overall long-term air emission sources. These new stationary and mobile (e.g., vehicle) emission sources could further overlap with operation and decommissioning of the proposed NWMI facility and could noticeably alter air quality conditions in Boone County. If degradation in air quality is observed, MDNR can develop air quality control programs to mitigate the effects of development. However, mitigation will depend on the control strategies implemented and adherence to these strategies.

Climate change can affect air quality as a result of changes in meteorological conditions. The formation, transport, dispersion, and deposition of air pollutants depend, in part, on weather conditions (IPCC 2007a). Air pollutant concentrations are sensitive to winds, temperature, humidity, and precipitation (EPA 2009a). Ozone levels have been found to be particularly sensitive to climate change influences (IPCC 2007a; EPA 2009b). Ozone is formed, in part, as a result of the chemical reaction of nitrogen oxides and volatile organic compounds (VOCs) in the presence of heat and sunlight. Nitrogen oxides and VOC sources include both natural emissions (e.g., biogenic emissions from vegetation or soils) and anthropogenic emissions (e.g., motor vehicles, power plants). Nitrogen oxide, biogenic VOCs, and ozone concentrations are expected to be higher in a warmer climate (EPA 2009b). Although surface temperatures are expected to increase in the Midwest, this may not necessarily result in an increase in ozone concentrations. The observed correlation between increased ozone concentrations and temperature has been found to occur in polluted and urban regions (those areas where ozone concentration are greater than 60 ppb). Additionally, increases in ozone concentrations correlated with temperature increases occur in combination with cloud-free regions and air stagnation episodes (Jacob and Winner 2009; IPCC 2013). Furthermore, climate model simulations do not agree on the ozone response to climate change. For instance, some models indicate increases in ozone concentrations with climate change for the Midwest (e.g., Wu et al. 2008), and others (e.g., Tagaris et al. 2007) project decreases in ozone concentrations with climate change for the Midwest.

Overall, the potential cumulative air quality impact associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL to MODERATE, primarily due to future economic and population growth in Boone County that can lead to long-term air emission sources and increases in air pollutants that can noticeably alter air quality.

*4.14.2.2 Noise*

The ROI considered for noise is a 1-mi (1.6-km) radius from the site boundary of the proposed NWMI facility. Noise levels attenuate rapidly with distance. When distance is doubled from a point source, noise levels decrease by 6 dBA (FHWA 2011). Generally, a 3-dBA change over existing noise levels is considered to be a “just noticeable” difference, a 5-dBA increase is readily perceptible, and a 10-dBA increase is subjectively perceived as a doubling in loudness (FHWA 2011).

Present-day activities within the ROI are identified in Table 4–11 and contribute to current background noise levels near the Discovery Ridge site. Potential cumulative noise impacts could occur during the construction, operations, and decommissioning phases in conjunction with other reasonably foreseeable activities occurring within the noise ROI of the proposed NWMI facility. Primarily, these would be construction-related activities from transportation projects as well as residential and commercial project construction identified in Table 4–11. Noise levels associated with construction equipment will be temporary and background levels would return once construction is completed. However, the potential expansion of the Discovery Ridge Research Park (MU 2009) and new roads adjacent to the proposed NWMI facility would result in an increase in noise levels from traffic and business growth after construction activities are complete. Given the potential for expansion at the Discovery Ridge Research Parkway and additional noise from vehicle traffic from new roads adjacent to the proposed facility, the NRC staff concludes that background noise levels could increase similar to that of a thriving commercial area with noise levels reaching 70 dBA, resulting in an increase of 5 dBA from estimated background levels. This increase in noise levels would be noticeable to noise-sensitive receptors in the vicinity of the Research Park and would overlap with operation and decommissioning of the proposed NWMI facility. Therefore, the NRC staff concludes that cumulative noise impacts would be SMALL to MODERATE.

### 4.14.3 Geologic Environment

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site on the geologic environment when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The cumulative impacts on the geologic environment primarily relate to land disturbance, the potential for soil erosion and loss, and the consumption of geologic resources. The descriptions of the affected environment in Sections 3.3.1 and 3.3.2 (Site Geology and Soils, respectively) of this EIS serve as the baseline for the geologic environment cumulative impacts assessment.

The ROI for evaluating cumulative impacts on soil resources encompasses the Discovery Ridge site and further encompassing a 5-mi (8-km) radius of the site. For geologic resources, the NRC staff further extended the ROI to include all of Boone County to encompass potential commercial sources of rock and mineral resources to support construction activities at the proposed site and vicinity. Because the aspects of land disturbance and conversion are addressed separately in Section 4.14.1.1, the cumulative impacts analysis here will focus on soil loss, including the loss of any prime farmland soils and other important farmland soils, and the consumption of geologic resources. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on the geologic environment, including geologic and soil resources, would be SMALL, as described in Section 4.3.

<u>Soil Resources</u>

New construction projects identified in Table 4–11 within the immediate 5-mi (8-km) radius of the Discovery Ridge site would result in the conversion and loss of soils. There would be no incremental loss of prime farmland or other important farmland soils because soils at the Discovery Ridge site do not meet the relevant criteria defined by the Natural Resources Conservation Service, as referenced in Section 3.3.2 of this EIS. Regardless, in accordance with local and State permits and approvals, as referenced in Sections 4.3 and 4.4 relative to the NWMI facility, all development activities in the ROI and beyond would be subject to BMPs for soil erosion and sediment control, which would serve to minimize soil erosion and loss. Developers would be likely to reclaim usable topsoil removed by ground-disturbing activities for use elsewhere within the impacted development sites. Alternatively, developers can stockpile usable topsoil or backfill and then sell or otherwise transfer it for reuse elsewhere at other development sites. Following the completion of construction activities, continued soil loss would be minimal as the remaining soils would lie beneath impervious surfaces such as buildings or the impacted area would have been revegetated or incorporated into facility landscaping or hardscaped areas. This would be the case, for example, at the NWMI facility site and at other pad sites within the Discovery Ridge Research Park. Although developed land areas could be reclaimed and sufficiently restored to support certain agricultural and nondeveloped uses at some point in the future, such lands and associated soils would not be restorable to their predeveloped state. Cumulative soil loss would largely occur in or adjacent to developed areas and soil loss would be mitigated by the use of BMPs. Based on these considerations, the NRC staff concludes that cumulative impacts on soil resources would be SMALL.

<u>Geologic Resources</u>

New facility construction and expansion (Table 4–11) would require the use and consumption of geologic resources, including rock and mineral assets such as construction aggregate materials (e.g., sand and gravel). Construction of the NWMI facility at the Discovery Ridge site would use many of the same materials, including concrete, gravel, and sand required for the other identified projects in Table 4–11. For example, construction of the NWMI facility would require about 1,700 $yd^3$ (1,300 $m^3$) of crushed aggregate (limestone) (see Sections 2.2 and 4.3.1). By comparison, the 11-county rock and mineral district of central Missouri that includes Boone County produces or uses approximately 5.95 million tons (5.4 million metric tons) of crushed stone annually. This is equivalent to 4.5 million $yd^3$ (3.4 million $m^3$) of material (USGS 2015c).

As noted in Section 3.3.1, rock and mineral products including construction aggregate are widely available throughout Boone County and the surrounding region. Likewise, products derived from geologic materials, including concrete and asphaltic materials used in construction, are widely available on a regional basis. It is not likely that the geologic resource requirements to construct the NWMI facility or the resource requirements of other identified projects are of such a volume as to affect local and regional sources and supplies of the identified resources. In addition, there are no developed geologic assets (mines or quarries) at or near the Discovery Ridge site that would be rendered inaccessible for future use. Therefore, the NRC staff concludes that cumulative impacts on geologic resources would be SMALL.

### 4.14.4 Water Resources

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site on water resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. This cumulative impacts analysis for surface water and groundwater resources considers such issues as water quality, water use, and potential climate change. It further considers relevant project actions, activities, and specific implications for surface water or groundwater withdrawal, effluent discharges, stormwater drainage and runoff, and accidental spills and releases. The description of the affected environment in Sections 3.4.1 and 3.4.2 (Surface Water Resources and Groundwater Resources, respectively) serves as the baseline for the water resources cumulative impacts assessment.

The ROI for the surface water resources component of the cumulative impacts analysis is comprised of the Discovery Ridge site and the Bonne Femme Creek watershed downstream of the site, as described in Section 3.4.1. For groundwater resources, the area of analysis includes the Discovery Ridge site and the local groundwater basin in which groundwater is recharged and flows to discharge points within the watershed. The area comprises those aquifers from which groundwater is withdrawn through wells to supply potable, industrial, agricultural, and other uses within a 5-mi (8-km) radius of the Discovery Ridge site. Thus, this analysis focuses on those projects that, when combined with those under the proposed action, would: (1) withdraw water from or discharge effluents to Gans Creek and other tributaries within the Bonne Femme Creek watershed downstream of the site, or (2) would use groundwater or could otherwise affect the same aquifers that would supply water to the Discovery Ridge site.

For surface water, the ROI further encompasses Perche Creek from its confluence with Hinkson Creek and including the segment of Perche Creek that receives effluent discharges from the Columbia Regional WWTP. The Columbia Regional WWTP would receive sanitary effluent from the proposed NWMI facility. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on surface water and groundwater resources would be SMALL, as described in Sections 4.4.1 and 4.4.2, respectively.

The proposed NWMI facility site is located within the Discovery Ridge Research Park. Site drainage flows generally south and southwest toward the southwesterly flowing Gans Creek, located approximately 0.35 mi (0.56 km) south of the site at is closest point. Gans Creek is located within the Bonne Femme Creek watershed that contributes drainage to the Missouri River, as described in Section 3.4.1. The State of Missouri has established water quality standards for Gans Creek and other tributaries within the Bonne Femme Creek watershed. Surface water is a minor source of water supply in Boone County. The predominant source of water for municipal water supply and for individual property owners in Boone County is groundwater pumped from deep bedrock aquifers, principally the Mississippian and the deeper, more extensive Cambrian-Ordovician aquifer system, described in Section 3.4.2.

*4.14.4.1 Surface Water*

Downstream of the Discovery Ridge site, the surface water hydrology is rather complex as the watershed is founded on karst terrane. Due to the occurrence of soluble carbonate bedrock, karst features include the presence of losing (sinking) and gaining sections of streams where surface water can easily enter the subsurface, providing flow to other streams. These features make surface waters and underlying groundwater particular vulnerable to contamination.

Gans Creek and other streams within the Bonne Femme Creek watershed have been designated by the State for the following beneficial uses: aquatic habitat protection; human health protection, whole body contact recreation, and secondary contact recreation; as well as livestock and wildlife protection and irrigation. In addition, the State of Missouri has classified a 3 mi (4.8 km) section of Gans Creek as an Outstanding State Resource Water. Boone County has also designated this section of stream and adjoining areas as an environmentally sensitive area and includes karst features such as Devil's Icebox Cave within Rock Bridge State Park (see Section 3.4.1.2).

An intensive study of the watershed conducted by Federal, State, and local stakeholder agencies (Frueh 2007) found water quality parameters to be typical for streams in carbonate bedrock areas and not seriously degraded from a hydrologic and water quality perspective. Nevertheless, Gans Creek as well as several of the stream segments within the Bonne Femme Creek watershed are included in the State's list of "impaired" waters, pursuant to Section 303(d) of the Federal Water Pollution Control Act (i.e., Clean Water Act (CWA)) of 1972. The pollutant of concern is water-borne *E. coli* bacteria stemming from rural nonpoint source runoff. As further described in Section 3.4.1.2, the State is required to evaluate pollutant loadings within such watersheds and implement a watershed-based program to assure future compliance with water quality standards. On an individual project or facility basis, the State typically addresses watershed improvement through existing and new NPDES permits. The Federal NPDES permit program, under CWA Section 402, addresses water pollution by regulating point sources (i.e., pipes, ditches) that discharge pollutants to waters of the United States. The State of Missouri has been delegated NPDES permitting authority by EPA.

Within the context of the local watersheds of the Missouri River, such as Bonne Femme Creek, climate change is an important consideration. Prospects for continued increases in temperature and changes in precipitation patterns, including longer periods of drought, would be likely to reduce the overall amount of water available for surface runoff. Over the period 1988 to 2010, a decrease in soil moisture has been documented during most seasons in the central Midwest (USGCRP 2014). As temperatures are projected to continue to increase across the Midwest, this trend would be expected to continue. Meanwhile, by mid-century, the scientific community projects increases in the frequency and intensity of extreme precipitation, while at same time the average maximum number of consecutive days with less than 0.01 in. of precipitation will increase (indicative of drought conditions) throughout the entire Midwest region (USGCRP 2014). An increased frequency of extreme rainfall events can cause erosion and lead to a decline in water quality (USGCRP 2014). This is particularly true where soils are dry and less able to retain precipitation that falls during heavier precipitation events. The implications are clear for a sensitive karst watershed, such as the Bonne Femme Creek watershed, where climatic changes can bring with them increases in runoff laden with nutrients, sediment, and other contaminants, and associated changes in near-surface groundwater. Increases in impervious surface due to development can further exacerbate these changes in water quality.

The proposed NWMI facility is part of a larger development, the Discovery Ridge Research Park (Table 4–11). As described in Sections 3.4.1, 4.4.1 and 4.4.2, the NWMI facility would have no direct impact on surface water features and no direct discharge of industrial wastewater to surface water bodies. No surface water would be used for the construction, operations, or decommissioning of the proposed NWMI facility; therefore, there would be no incremental contribution to cumulative impacts due to surface water use. Stormwater runoff would occur from the facility site during construction, operations, and decommissioning. Groundwater removed from excavations during facility construction may also be discharged from the site. During operations, NWMI would discharge sanitary wastewater to the City of Columbia sanitary sewer system. There would be no radioactive liquid effluents released from the facility during operations, as the RPF portion of the facility is designed to have zero liquid discharge.

Projects and activities occurring within the ROI would be subject to applicable local, State, and Federal regulatory requirements and associated permits and approvals. Accordingly, the University of Missouri will require that stormwater discharges from all tenants within the Discovery Ridge Research Park comply with the master stormwater management plan developed for the park. Construction projects are required to obtain a Land Disturbance Permit from the City of Columbia and submit related plans for city approval before any ground-disturbing activities or facility construction could begin on the site (Section 4.3.1). For projects outside the municipal boundary of the City, Boone County also requires a Land Disturbance Permit. These plans entail the implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development.

The MDNR has developed an NPDES general permit that must be obtained by owners and operators for the discharge of stormwater and certain non-stormwater discharges (e.g., dewatering) from land-disturbance sites that disturb 1 ac (0.4 ha) or more, or less than 1 ac (0.4) but part of a larger development. This State general permit requires permit holders to develop and implement an SWPP, the purpose of which is in part to ensure the proper design, implementation, management, and maintenance of BMPs in order to prevent the introduction of sediment and other pollutants in stormwater discharges. MDNR also requires certain industrial facilities to obtain an NPDES permit for stormwater discharges during facility operations.

The WWTP serves the whole City of Columbia. During the projected 30-year period of operations, the only liquid waste discharged from the NWMI facility would be sanitary in nature. This effluent would be discharged to the City of Columbia sanitary sewer system at an average rate of approximately 4,570 gpd (17,300 Lpd). This is equivalent to approximately 0.0046 mgd (17.4 $m^3$/day). The Columbia Regional WWTP would be the ultimate point of treatment. The

Columbia Regional WWTP has a design treatment capacity of 20 mgd (75,700 $m^3$/day) with average demand of 16 mgd (60,600 $m^3$/day). NWMI's additional wastewater volume would constitute a very small percentage (i.e., 0.12 percent) of the available treatment capacity of the WWTP. Sanitary wastewater discharges from the NWMI facility would be unlikely to have any impact on the facility or have any impact on ambient water quality downstream of the WWTP.

Nevertheless, the potential exists for substantial population growth in the County and City of about 40 percent between 2016 and 2050 (Section 3.7.1). The corresponding increase in sanitary effluent generated by the larger population would approach or exceed the capacity of the WWTP. This would necessitate that the City invest in additional wastewater treatment infrastructure. Given the planning timeframe, the NRC staff anticipates that the City of Columbia would be able to accommodate the increased treatment demand with timely expansions of treatment infrastructure, as it becomes needed.

In summary, construction, operations, and decommissioning of the proposed NWMI facility would have a minimal incremental contribution to cumulative impacts on surface water resources, including surface water and groundwater quality. Ongoing and future development projects within the Bonne Femme Creek watershed would be subject to County and City site development approvals, including Land Disturbance Permits. NPDES permits required for all new stormwater and industrial wastewater dischargers would include provisions to comply with applicable wasteload allocations established for downstream receiving waters. At present, there are few industrial facilities within the Bonne Femme Creek watershed or upstream of the watershed, as identified in Table 4–11. Within this context, however, climate change including changes in runoff rate and quality would be expected to have as big or a bigger role in affecting surface water hydrology and water quality as growth and development alone in the watershed, as described above. In consideration of this information, the NRC staff concludes that the cumulative impacts on surface water resources would be SMALL to MODERATE, primarily due to regional growth and climate change.

#### *4.14.4.2 Groundwater*

Groundwater is the source of water supply for municipal water suppliers and individual users in Boone County. Total groundwater use in Boone County is approximately 18.2 mgd (68,890 $m^3$/day). While groundwater is withdrawn from the more productive zones of the Mississippian aquifer and from the upper units of the Ordovician age units for agricultural and domestic uses in Boone County, public water supply utilities primarily rely upon deep wells completed in the Cambrian-Ordovician aquifer system. The shallow glacial drift that occurs primarily over the eastern part of the County including the Discovery Ridge site is not generally used as a source of water supply, as discussed in Section 3.4.2.

Public utilities, including water and sewer, already exist at the Discovery Ridge site. The Discovery Ridge site lies within the service area of Consolidated Public Water Supply District No. 1, and it would supply water to the proposed NWMI facility site. The district is one of five water districts that supply water to the majority of users across Boone County, in addition to the City of Columbia. The district relies on a system of deep wells and has a total groundwater production capacity of 11 mgd (49,200 $m^3$/day) with water supply demands of approximately 1.45 mgd (5,490 $m^3$/day) (Sections 3.4.2.2 and 4.4.2). In contrast, NWMI facility operations would require an average of 5,045 gpd (19,100 Lpd) of water, equivalent to 0.005 mgd (18.9 $m^3$/day).

The population of Boone County is projected to increase by about 40 percent by 2050, as referenced in Section 4.14.4.1. Assuming that this projected population growth has a direct and equal correlation on groundwater demand, total groundwater demand within the service area of

Consolidated Public Water Supply District No. 1 could grow to approximately 2 mgd (7,600 $m^3$/day).

Given the groundwater production capacity of the water supply district and the availability of groundwater within Boone County, the forecasted water demands alone would not be expected to affect the water district's ability to provide adequate water supplies over the next 30 years.

Nevertheless, based on the assessment presented below, the NRC staff assumes that climate change could have as great or a greater impact on surface water and groundwater resources, including overall water availability, as any other reasonably foreseeable future actions. Locally within the Bonne Femme Creek watershed, this is particularly relevant given the sensitivity of karst watersheds. The loss of moisture from soils because of higher temperatures, along with increased evapotranspiration from vegetation and the increased average number of days without precipitation is likely to intensify short-term (seasonal or shorter) droughts across the Midwest region into the future (USGCRP 2009, 2014). Such conditions can reduce the amount of water available for surface runoff, streamflow, and groundwater recharge. Specifically, climate change is projected to increase water demand across most of the United States. When accounting for regional changes in population coupled with predicted climate change impacts, current projections indicate that northeast Missouri (where the Discovery Ridge site is located) could experience climate-change induced increases in water demand of up to 10 to 25 percent (USGCRP 2014). This increase would still not challenge the current production capacity of Consolidated Public Water Supply District No. 1. In order to manage any increases in water demands across Boone County where the water supply is heavily reliant on deep groundwater, coupled with the potential for reduced groundwater recharge due to climate change, the County's water supply districts and other municipalities could take action to increase the efficiency and extent of their production and water distribution infrastructure. This could include redeveloping existing production wells or drilling new ones to manage water supply conflicts. Alternatively, public water suppliers could also seek out new water supply sources such as the abundant resources of the Missouri River, although this approach would entail investments in new infrastructure and increased operating costs. Suppliers could also pursue a combination of approaches such as conservation measures and new sources.

It remains that the projected average daily water needs for NWMI facility construction, operations, and decommissioning would be a very small percentage (less than 1 percent) of the public water district's total production and current available supply capacity. In total, the NRC staff concludes that the cumulative impacts on groundwater resources, including water availability, would be SMALL.

### 4.14.5 Ecological Resources

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility on ecological resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The description of the affected environment in Section 3.5 serves as a baseline for the ecological cumulative impact assessment. The ROI for evaluating cumulative impacts on ecological resources includes the Bonne Femme (Creek) watershed in the vicinity of the proposed site. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility would be SMALL, as described in Section 4.5.

Before European settlement, the main land cover types within the Bonne Femme watershed included prairies, forests, and wetlands. Since that time, these habitats have been greatly reduced and converted into agricultural fields, and residential and commercial areas, as described in Section 3.5. The remaining tracts of grasslands, forests, and wetlands tend to be relatively small and isolated, which provides lower quality habitats than large tracts of habitat because of the different biological and physical characteristics along the edge of a habitat patch.

Environmental management practices over the past few decades have slightly increased the quality and extent of terrestrial and aquatic habitats.  For example, the amount of forested habitats has increased because of changes in land management and forestry laws (Karstensen 2010).

Current threats to terrestrial and aquatic habitats include increased soil, nutrients, and other pollutants washing into streams and lakes from urban and agricultural stormwater runoff, continued conversion and fragmentation of wildlife habitat from development, and the introduction of invasive species (BFSC 2007; USGS 2009).  These activities will likely decrease the overall availability and quality of forested, grassland, and wetland habitats.  Species with threatened, endangered, or declining populations are likely to be more sensitive to declines in habitat availability and quality and the introduction of invasive species.

New development projects identified in Table 4–11 are likely to have minimal impacts on ecological resources because all the projects are sited within areas that are currently agricultural land, open space, or developed.  These types of land covers provide low-quality habitats for wildlife, birds, and aquatic resources.

State parks and wildlife refuges located near the proposed site, such as Rock Bridge State Park, Three River Conservation Area, and the northwest corner of the Mark Twain National Forest, provide valuable habitat to native wildlife and migratory birds.  For example, these parks contain complex, natural habitats that are relatively rare within the watershed, such as woodlands, oak forests, and tall grass prairies.  As agricultural activities, development, and urbanization increase habitat conversion and fragmentation, these protected areas will become ecologically more important because they provide continuous areas of minimally disturbed habitat.

Climate change in the midwestern United States is likely to include an increase in the annual mean temperature combined with an increase in the intensity of rainfall events (USGCRP 2014). As the climate changes, ecological resources will either need to be able to tolerate the new physical conditions, such as less water availability, or to shift their population range to new areas with a more suitable climate.  Some species may be more prone to changes in climate. For example, migratory birds that travel long distances may not be able to detect environmental clues that a warmer, earlier spring is occurring in the United States, while the birds are still overwintering in the tropics.  Fraser et al. (2013) found that songbirds overwintering in the Amazon basin did not leave their winter sites earlier, even when spring sites in the eastern United States experienced a warmer spring.  As a result, the song birds missed periods of “peak food” availability.  Climate changes could also favor non-native invasive species and promote population increases of insect pests and plant pathogens, which may be more tolerant to a wider range of climate conditions (USGCRP 2014).  Physiological stressors associated with climate change may also exacerbate the effects of existing stresses in the natural environment, such as those caused by habitat fragmentation, invasive species, nitrogen deposition and runoff from agriculture, and air emissions.

Section 4.5 of this EIS concludes that the impact from the proposed facility construction, operations, and decommissioning would not noticeably alter the terrestrial and aquatic environment and, thus, would be SMALL.  However, as environmental stressors, such as runoff from agricultural fields and urban areas and climate change, continue over the proposed construction, operational, and decommissioning periods, certain attributes of the terrestrial and aquatic environment (such as habitat quality) are likely to noticeably change.  The staff does not expect these impacts to destabilize any important attributes of the terrestrial and aquatic environment because such impacts will cause gradual change, which should allow many aspects of the terrestrial and aquatic environment to appropriately adapt. The NRC staff concludes that the cumulative impacts of the proposed construction, operations, and decommissioning of the NWMI facility plus other past, present, and reasonably foreseeable future projects or actions would result in MODERATE impacts to terrestrial and aquatic resources. This MODERATE impact is primarily driven by environmental stressors, such as runoff from agricultural fields and urban areas and climate change, which are likely to noticeably alter important attributes of the terrestrial and aquatic environments.

### 4.14.6 Historic and Cultural Resources

This section addresses the direct and indirect contributory effects from constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site when added to the aggregate effects of other past, present, and reasonably foreseeable future actions on historic and cultural resources. The ROI in this analysis is the Discovery Ridge site and its immediate vicinity. As discussed in Section 4.6, constructing, operating, and decommissioning the proposed NWMI facility would not impact any known historic and cultural resources at the Discovery Ridge site.

The archaeological record for the region indicates prehistoric and historic occupation; the APE appears to have been traditionally used as agricultural fields from the protohistoric period onward. Historic land development and prolonged agricultural use may have resulted in impacts on, and the loss of, cultural resources. As described in Section 3.6.2, no evidence of historic or cultural resources were found within the Lot 15 survey area, and the closest historic property is approximately 1 mi (1.6 km) to the northwest of the Discovery Ridge site. The only foreseeable project within the APE is the proposed NWMI facility. Therefore, historic and cultural resources are not likely to be affected by the cumulative effects of constructing, operating, and decommissioning the proposed NWMI facility combined with other past, present, and reasonable foreseeable future activities at the Discovery Ridge site.

### 4.14.7 Socioeconomics

This section addresses the direct and indirect contributory effects from constructing, operating, and decommissioning the proposed NWMI facility at Discovery Ridge when added to the effects from other past, present, and reasonably foreseeable future actions on current socioeconomic conditions within the ROI. The description of the affected environment in Section 3.7 serves as a baseline for the cumulative socioeconomic impact assessment. The socioeconomic ROI is Boone County. Section 4.7 found that socioeconomic impacts from the construction, operations, and decommissioning of the proposed NWMI facility would be SMALL.

Table 4–11 identifies past, present, and reasonably foreseeable future actions within the ROI that could contribute to cumulative socioeconomic impacts. Relevant “other actions” that are considered in this cumulative impacts analysis is the potential for future construction within the Discovery Ridge site and the construction and operation of the Discovery Park, involving residential and commercial development, on the west side of U.S. Highway 63 opposite the Discovery Ridge site.

The proposed NWMI facility is located in Lot 15 of the Discovery Ridge Research Park, an area designated for research, development, and office park and is currently zoned for commercial use. The Discovery Ridge Research Park is large enough for the construction and operation of several research laboratory and office facilities. Since no other research or office facilities are currently planned for the Discovery Ridge Research Park, there would be no labor shortages because the City of Columbia and Boone County have a sufficient workforce to meet the needs for new research facilities (Section 3.7.4).

The Discovery Park development is being constructed 0.4 mi (0.6 km) southwest of the proposed NWMI facility. Demand for labor would not create a shortage because the City of Columbia and Boone County have a sufficient workforce to meet the needs for both facilities. Construction of Discovery Park could increase the size of the local population as well as employment and tax revenue and an increased demand for public services in the ROI. However, the overall contributory socioeconomic effect of this construction project would be small. Therefore, with no other research or office facilities currently planned for the Discovery Ridge Research Park, the cumulative impact of the proposed NWMI facility, combined with the Discovery Park development, would be SMALL.

### 4.14.8 Human Health

The geographic ROI for the evaluation of cumulative effects on human health is a 5-mi (8-km) radius of the proposed NWMI facility. This evaluation will consider radiological and nonradiological impacts of other activities (in the recent past, present, and reasonably foreseeable future) within this ROI. Within this ROI, there are no nuclear power plants that would contribute to radioactive or nonradioactive exposure. However, the Callaway Energy Center nuclear power plant is located approximately 28 mi (45 km) away. Given that the proposed Discovery Ridge site is within the 50 mi (80 km) radiological emergency planning zone for the Callaway plant, radiological human health impacts associated with the Callaway plant will also be considered in this evaluation.

As discussed in Section 4.8.2, the NRC staff reviewed the information provided by NWMI regarding the proposed radiological and nonradiological safety programs that would be implemented to protect occupational workers and members of the public from any detrimental human health effects that could be associated with operation of the proposed NWMI facility. The NRC staff concluded that both radiological and nonradiological human health impacts to workers and members of the public from operation of the proposed facility would be SMALL.

#### *4.14.8.1 Radiological Impacts*

Projects and facilities considered for this evaluation that could have potential radiological human health impacts within the ROI include:

- MURR (currently operating);
- Callaway nuclear power plant (currently operating);
- two ABC Laboratories facilities (currently operating);
- University Hospital and Boone Hospital Center (two currently operating medical facilities that perform procedures using radiation); and
- two sites with legacy radioactive contamination: the site of one of the two ABC Laboratories facilities listed above, and the University of Missouri's Pickard Hall site.

As discussed in Section 3.10.1, MURR, which is located approximately 4 mi (6.4 km) from the proposed NWMI facility site, produces gaseous and liquid radiological effluents during routine operation. However, these effluents are monitored to ensure any public radiation dose that could result from the effluents is below NRC regulatory limits in 10 CFR Part 20. Additionally, environmental monitoring performed by MURR has shown minimal or no environmental impact from MURR operation. Given that MURR and the proposed NWMI facility would both be required to comply with NRC regulatory dose limits; current radiological environmental impacts from MURR are very low; and the distance between the two facilities (which would minimize potential cumulative radiation exposure), the NRC staff does not expect that the combined operation of these facilities would result in a cumulative radiological dose impact in excess of NRC regulatory limits.

The Callaway nuclear plant, which is discussed in Section 3.8.2, is located approximately 28 mi (45 km) from the proposed NWMI site. Environmental monitoring performed at the Callaway plant has shown minimal or no environmental impact from operation of the plant. Given that the Callaway plant and the proposed NWMI facility would both be required to comply with NRC regulatory dose limits; current radiological environmental impacts from the Callaway plant are very low; and the distance between the two facilities, the NRC staff does not expect that the combined operation of these facilities would result in a cumulative radiological dose impact in excess of NRC regulatory limits.

The two ABC Laboratories facilities, discussed in Section 3.8.2, are located approximately 0.3 mi (0.5 km) and 5 mi (8 km) from the proposed NWMI site. ABC Laboratories is licensed by NRC to use radioactive materials at these facilities (NWMI 2015a). Although worker doses are monitored at these facilities to ensure compliance with NRC occupational dose limits, no environmental monitoring is required because no radioactive material releases, and consequently no radiation dose to the public, is anticipated from the continued operation of these facilities. Given that ABC Laboratories and the proposed NWMI facility would both be required to comply with NRC dose limits, and also given that no radiological environmental impacts are anticipated from ABC Laboratories operation, the NRC staff does not expect that the combined operation of these facilities would result in a cumulative radiological dose impact in excess of NRC regulatory limits.

Two currently operating medical facilities, University Hospital and Boone Hospital Center, are each located approximately 4 mi (6.4 km) from the proposed NWMI site and each perform medical procedures using radiation. Although patients receiving these medical procedures are exposed to radiation, radiation doses to patients from medical procedures are not subject to NRC regulatory dose limits. The radiation exposure to members of the public outside of medical facilities is negligible; therefore, the NRC staff does not expect that the combined operation of University Hospital, Boone Hospital Center, and the proposed NWMI facility would result in a cumulative radiological dose impact in excess of NRC regulatory limits.

As discussed in Section 3.8.2, two sites in the ROI, an ABC Laboratories site and the University of Missouri’s Pickard Hall, which are located approximately 5 mi (8 km) and 1.2 mi (1.9 km) from the proposed NWMI facility site, respectively, contain legacy radiological contamination. The ABC Laboratories site contains three backfilled former liquid radiological waste disposal lagoons. However, surveys have shown the levels of residual radioactive contamination at this site to be very low. Since minimal or no continuing dose from radioactive material in these lagoons is expected, the NRC has approved the release of the land containing the backfilled lagoons for unrestricted use. The University of Missouri’s Pickard Hall, and some subsurface soil in the immediate vicinity of that building, contain legacy radioactive radium contamination from historical activities performed in the building. An internal standard operating procedure is used at Pickard Hall to help avoid any further spread of this contamination, minimizing any dose to the public. Since only minimal public radiation exposure occurs from either of these contaminated sites, and given the distance between these sites and the proposed NWMI facility, the NRC staff does not expect that the cumulative impacts of these sites and the proposed NWMI facility would result in a cumulative radiological dose impact in excess of NRC regulatory limits.

The NRC staff is currently conducting an independent safety evaluation to verify that the radiological exposure to occupational workers and members of the public from operation of the proposed NWMI facility would be below the regulatory limits in 10 CFR Part 20. If the NRC staff determines that the doses would be within the regulatory limits, the NRC staff concludes that the cumulative radiological human health impacts would be SMALL.

#### *4.14.8.2 Nonradiological Impacts*

Construction activities included in Table 4–11, as well as construction of the proposed NWMI facility, would involve potential hazards to workers typical of any construction site (NWMI 2015a). In addition, the proposed NWMI facility and some other facilities listed in Table 4–11 are industrial sites with many typical occupational hazards. These construction and industrial activities would be required to be performed subject to OSHA and State of Missouri safety regulations. Additionally, as the proposed NWMI facility would not be accessible to the general public during construction or operation (NWMI 2015a), and other construction and industrial sites are also generally not publicly accessible, these hazards are not anticipated to affect members of the public.

Hazardous chemical releases from the proposed NWMI facility, and from other activities or facilities within the ROI, would be required to be within EPA and State of Missouri regulatory limits. In addition, certain toxic chemical releases must be reported to the EPA as part of EPA's Toxics Release Inventory (TRI) program, as discussed in Section 3.8.3.

Other than the Discovery Ridge Research Park (which currently includes ABC Laboratories and IDEXX BioResearch as tenants), all other currently operating facilities in Table 4–11 for which possible chemical releases would be expected (Callaway nuclear power plant, MURR, Boone Quarries, University of Missouri's Combined Heat and Power Plant, Columbia Municipal Power Plant, and Columbia Energy Center) are approximately 4 mi (6.4 km) or more from the proposed NWMI facility site. ABC Laboratories and IDEXX BioResearch are 0.3 mi (0.5 km) and 0.1 mi (0.16 km) from the proposed site, respectively. Neither ABC Laboratories nor IDEXX BioResearch meet the thresholds that would make them subject to reporting for EPA's TRI program (EPA 2016d).

In summary, given the distances between the proposed NWMI facility site and other facilities listed in Table 4–11 and that ongoing and future facilities that would release chemicals would be subject to applicable regulations, the NRC staff does not expect that the cumulative impacts of other facilities in Table 4–11 and the proposed NWMI facility would result in a cumulative chemical exposure impact in excess of Federal or State regulatory limits. The NRC staff therefore concludes that the cumulative nonradiological human health impacts would be SMALL.

### 4.14.9 Waste Management

The ROI for the evaluation of cumulative impacts from the disposal of radioactive and nonradioactive waste is that area within a 5 mi (8 km) radius of the proposed NWMI facility. Table 4–11 lists the facilities and activities considered within this ROI.

This evaluation considers the cumulative impacts within the ROI associated with the waste management activities of other facilities using radioactive and nonradioactive material in the recent past, present, and reasonably foreseeable future.

In Section 4.9., the NRC staff reviewed the information provided by NWMI regarding its radioactive and nonradioactive waste management plans. The NRC staff found that the procedures, controls, and engineering design features that would be used at the proposed NWMI facility would minimize impacts to workers and the public from the handling, storage, transportation, and disposal of radioactive and nonradioactive wastes. The NRC staff therefore concludes that the human health impacts from both radioactive and nonradioactive wastes would be SMALL.

*4.14.9.1 Radioactive Waste*

Activities identified within the ROI that could generate radioactive waste include the operation of:

- MURR;
- ABC Laboratories; and,
- University Hospital and Boone Hospital Center, which use radiation for medical treatment.

Disposal of radioactive waste from any of these facilities would be required to be conducted in accordance with all Federal and State of Missouri regulations. Some or all radioactive wastes from these facilities would likely go to the same waste disposal sites. There are no radioactive waste disposal sites within the State of Missouri. Two facilities are available for the disposal of low-level radioactive waste produced within the State of Missouri: Energy Solutions Clive Operations in Clive, Utah, and WCS in Andrews, Texas. Energy Solutions accepts only Class A low-level radioactive waste, while WCS accepts Class A, B, and C low-level waste (NRC 2016e). As discussed in Section 4.9.1, NWMI plans to ship radioactive waste from the proposed facility to WCS (NWMI 2015a). WCS accepts mixed waste (i.e., waste that is both hazardous and radioactive), in addition to nonhazardous radioactive waste (WCS 2016).

As discussed in Section 4.9.1, if NWMI loses access to a low-level waste disposal facility, any low-level waste would have to be stored, either within the NWMI facility or in a new storage facility constructed either on site or at an offsite location, until a low-level waste facility is available. Low-level waste, regardless of its location, must be stored in accordance with Federal and state regulations to ensure the safety of workers and members of the public. As discussed in Sections 2.7.1, 2.8.1 and 4.9.1, NWMI would have controls and engineering design features at the proposed facility to ensure that handling and storage of radioactive waste would be conducted such that radiation doses to workers and members of the public are maintained ALARA. The NRC staff expects that similar facility design and management programs would be used to ensure safety during the temporary storage of low-level radioactive waste at other facilities within the ROI.

Based on the information on radioactive waste disposal for waste produced in Missouri and the United States, the NRC staff expects that there would be adequate disposal space for the cumulative quantities of radioactive waste that would be produced by the proposed NWMI facility and other facilities within the ROI. In addition, radioactive waste from all sources would be required to be handled, transported, and disposed of in accordance with Federal and state regulations. The NRC staff therefore concludes that the cumulative impact from radioactive waste disposal would be SMALL.

*4.14.9.2 Nonradioactive Waste*

Many activities within the ROI, including those listed in Table 4–11 and the proposed NWMI facility, could or would produce nonhazardous, nonradioactive wastes. Activities within the ROI that currently produce, or could produce, hazardous nonradioactive wastes include industrial, production, medical, and/or research facilities such as MURR, ABC Laboratories, IDEXX BioResearch, University of Missouri's Combined Heat and Power Plant, Columbia Municipal Power Plant, University Hospital, and Boone Hospital Center.

As discussed in Sections 2.7.3 and 4.9.2, NWMI would implement a waste minimization and pollution prevention program that would help to minimize the production of hazardous and nonhazardous wastes at the proposed facility. As discussed in Sections 2.7.2 and 4.9.2, the proposed NWMI facility would generate less than 1,000 kg (2,205 lb) of hazardous waste per month, and approximately 4,056 kg (8,942 lb) of nonradiological, nonhazardous waste (i.e., municipal waste) per year during operation (NWMI 2015c). NWMI expects that nonradiological hazardous wastes from construction or operation of the proposed facility would be collected by a hazardous waste disposal company such as Veolia or Clean Harbors for separation, processing, and disposal. Other solid waste (municipal waste or construction debris) generated by the construction or operation of the proposed facility would be picked up and disposed of at the City of Columbia sanitary landfill (NWMI 2015c).

The NRC staff expects that nonradiological hazardous or nonhazardous wastes produced by activities in the ROI other than NWMI would be disposed of similarly to the waste from the proposed NWMI facility. As discussed in Section 3.8.3 ABC Laboratories and IDEXX BioResearch are hazardous quantity generators that are periodically inspected to ensure and enforce compliance with applicable waste management regulations. All hazardous waste would be managed according to applicable regulations (e.g., RCRA and the Missouri Hazardous Waste Management Law (Missouri Revised Statutes 2015b)). Given the population density and level of activity in the ROI, and given that the ROI includes other large and small quantity hazardous waste generators as discussed in Section 3.8.3, the NRC staff also expects that the incremental quantity of waste produced by the proposed facility would be comparatively small and that there would be adequate infrastructure and capacity for disposal of the additional waste.

As discussed in Section 2.7.2, NWMI would release sanitary wastewater and nonradioactive liquid waste, meeting municipal treatment standards, to the Columbia sewer system. The NRC staff expects that wastewater from other activities within the ROI would be disposed of similarly to the wastewater from the proposed NWMI facility. The NRC staff also expects that the incremental quantity of wastewater produced by the proposed facility would be comparatively small, and that the Columbia sewer system would have adequate capacity to handle the additional wastewater.

Given that waste disposal infrastructure exists for nonradiological wastes generated within the ROI, that the incremental quantities of waste produced by the proposed NWMI facility would be comparatively small, and that all waste produced within the ROI would be handled and disposed of subject to Federal, State, and local regulations and standards, the NRC staff concludes that the cumulative impact from nonradiological waste disposal would be SMALL.

### 4.14.10 Accidents

The geographic ROI for the evaluation of cumulative effects of accidents is that within a 5 mi (8 km) radius of the proposed NWMI facility. This evaluation will consider cumulative impacts of radiological and chemical accidents that could occur within this ROI. Within this ROI, there are no nuclear power plants. However, the Callaway Energy Center nuclear power plant is located approximately 28 mi (45 km) away. Since the proposed site is within the 50 mi (80 km) radiological emergency planning zone for the Callaway plant, hypothetical radiological accidents associated with the Callaway plant will also be considered in this evaluation.

#### *4.14.10.1 Radiological Accidents*

As discussed in Section 4.11.1, the NRC staff reviewed the information provided by NWMI regarding radiological consequences of potential accidents at the proposed NWMI facility. The analyses provided by NWMI showed that hypothetical, unmitigated radiological accidents at the proposed facility could be intermediate-consequence for members of the public, and could be high- or intermediate-consequence for NWMI facility staff. However, NWMI stated that it would use engineered and administrative controls to reduce the likelihood and consequences of radiological accidents at the proposed facility, such that the proposed facility would comply with the performance requirements in 10 CFR 70.61. The NRC staff concluded that if the NRC safety review determined that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding radiological accident consequences, the impacts from potential radiological accidents would be SMALL.

Existing facilities included in this evaluation that could have potential radiological accidents are facilities that are nuclear reactors or that otherwise use radiation or radioactive materials, including Callaway nuclear power plant, MURR, ABC Laboratories, University Hospital, and Boone Medical Center. These facilities are licensed by NRC. To be licensed by NRC, facility licensees must show that the facilities are in compliance with NRC regulations, including dose limits for accidents. Therefore accidents at these facilities are expected to have minimal environmental impact. For example, the generic EIS for license renewal of nuclear power plants in the United States (NUREG-1437) determined that the environmental impacts of both design-basis accidents (i.e., credible accidents) and beyond design-basis accidents (i.e., severe, unlikely accidents) would be SMALL (NRC 2013b). The plant-specific supplement to the generic EIS for license renewal that was developed for the Callaway nuclear power plant found no accident-related impacts for the Callaway plant beyond those discussed in the generic EIS (NRC 2014).

The possible radiological accident impacts from other activities near the proposed NWMI facility would be minimal, and if the proposed NWMI facility were in compliance with NRC regulations regarding accident consequences, the incremental environmental effects of potential radiological accidents from the NWMI facility would also be minimal, as discussed in Section 4.11.1. Additionally, with the exception of the ABC Laboratories facility located approximately 0.3 mi (0.5 km) from the proposed facility site, for which no radiological releases are expected as discussed in Section 4.14.8.1, no other facilities currently licensed to use radiation or radioactive materials are located within approximately 4 mi (6.4 km) of the proposed facility site. Therefore, if the NRC safety review determines that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding radiological accident consequences, the NRC staff concludes that the cumulative impact from potential radiological accidents would be SMALL.

#### *4.14.10.2 Nonradiological Accidents*

As discussed in Section 4.11.2, the NRC staff reviewed the information provided by NWMI regarding chemical exposure consequences of potential accidents at the proposed NWMI facility. The analyses provided by NWMI showed that hypothetical, unmitigated chemical accidents at the proposed facility could be high- or intermediate-consequence for members of the public and NWMI facility staff. However, NWMI stated that it would use engineered and administrative controls to reduce the likelihood and consequences of hazardous chemical accidents at the proposed facility, such that the proposed facility would comply with the performance requirements in 10 CFR 70.61. The NRC staff concluded that if the NRC safety review determined that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding chemical accident consequences, the impacts from potential hazardous chemical accidents would be SMALL.

Existing facilities or activities included in this evaluation that could have potential chemical accidents include those listed in Table 4–11. These facilities or activities are required to comply with EPA and State of Missouri regulations to ensure the safe handling of chemicals and hazardous materials. The possible chemical accident impacts from other activities near the proposed NWMI facility would be minimal, and if the proposed NWMI facility were in compliance with NRC regulations regarding accident consequences, the incremental environmental effects of potential hazardous chemical accidents from the NWMI facility would also be minimal, as discussed in Section 4.11.2. Additionally, as discussed in Section 4.14.8.2, none of the facilities or activities listed in Table 4–11 that are located within approximately 4 mi (6.4 km) of the proposed NWMI facility site use hazardous chemicals in quantities that would make them subject to the EPA's TRI reporting requirements, further reducing the likelihood that any significant chemical release accident could occur in close proximity to the proposed NWMI facility site. Therefore, if the NRC safety review determines that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding hazardous chemical accident consequences, the NRC staff concludes that the cumulative impact from potential hazardous chemical accidents would be SMALL.

### 4.14.11 Transportation

This section addresses the direct and indirect contributory effects from constructing, operating, and decommissioning the proposed NWMI facility when added to the effects from other past, present, and reasonably foreseeable future actions on transportation infrastructure. The ROI is the 5-mi (8-km) region surrounding the proposed NWMI facility. However, the roads for routes that could be used for delivery of medical isotopes (if air transport is not possible) or disposal of wastes were also considered. Transportation infrastructure includes roadways, rail lines, airports, and traffic control devices. As discussed in Section 4.10, transportation impacts during construction, operations, and decommissioning would be SMALL.

Construction projects in Table 4–11 could produce an increase in vehicle traffic on roads within the 5-mi (8-km) radius of the proposed NWMI site. For example, Discovery Park, a residential and commercial development being constructed on the west side of U.S. Highway 63 opposite the Discovery Ridge Research Park, could add additional commuting vehicles and commercial trucks on local roads near the proposed NWMI facility. In addition, new construction projects could occur within the Discovery Ridge Research Park. However, existing roads are sufficient to handle the increased traffic. An increase in the number of commuter vehicles and commercial trucks on roads near the proposed NWMI site would not likely have a noticeable impact on overall traffic volumes. Therefore, the cumulative effect of traffic-related transportation impacts of the proposed action combined with the Discovery Ridge Research Park and Discovery Park development would be SMALL.

### 4.14.12 Environmental Justice

The environmental justice cumulative impact analysis evaluates the potential contributory human health and environmental effects from the construction, operations, and decommissioning of the proposed NWMI facility when added to the effects from other past, present, and reasonably foreseeable future actions on minority and low-income populations and whether these effects might be disproportionately high and adverse. Everyone living near Discovery Ridge Research Park and the proposed NWMI facility could be affected by construction, operations, and decommissioning activities, including minority and low-income populations.

The ROI is the 5-mi (8-km) region surrounding the proposed NWMI facility at the Discovery Ridge site. As discussed in Section 4.12, the proposed NWMI facility is not located in a minority population block group. Minority and low-income populations residing along site access roads could be affected by noise, dust, and increased commuter vehicle and truck traffic during construction, operations, and decommissioning. However, during construction and decommissioning, these would be short term and primarily limited to onsite activities. In addition, NWMI facility operations would not have high and adverse human health and environmental effects on minority and low-income populations. As a result, minority and low-income populations residing near the proposed NWMI facility at Discovery Ridge would not experience disproportionately high and adverse human health and environmental effects from the proposed action.

Table 4–11 identifies past, present, and reasonably foreseeable future actions within the ROI that could contribute cumulative human health and environmental effects. Potential impacts to minority and low-income populations from other past, present, and reasonably foreseeable future actions would mostly consist of environmental effects caused by construction and operation of new residential, commercial, and industrial developments (e.g., noise, dust, traffic, employment, and housing impacts). However, noise and dust impacts would be short term during construction and primarily limited to onsite activities. Minority and low-income populations residing along site access roads could be directly affected by commuter vehicle and truck traffic. However, these effects are not likely to be high and adverse and would be contained within a limited time period during certain hours of the day. Increased demand for housing could cause housing costs to rise. Increasing rental costs could disproportionately affect low-income populations who rely on inexpensive housing. However, given the availability of local labor and the likelihood that construction workers would commute to the work site, rental housing costs may be unaffected.

Emissions from new commercial or industrial facilities could also disproportionately affect minority and low-income populations. However, any impacts would depend on the magnitude of the change from current environmental conditions. Permitted air emissions from all commercial and industrial facilities, including the contributory effects from the proposed NWMI facility, would be expected to remain within regulatory standards.

Based on this information and the analysis of human health and other environmental impacts presented in this EIS, the contributory effects of constructing, operating, and decommissioning the proposed NWMI facility are not likely to create high and adverse cumulative human health and environmental effects on minority and low-income populations living near Discovery Ridge Research Park.

### 4.14.13 Summary

Table 4–12 summarizes the cumulative impacts for all resources areas.

**Table 4–12. Cumulative Impacts on Environmental Resources, Including the Impacts of the Proposed Project**

| Resource Category | Cumulative Impact Level | Description of Impacts |
|---|---|---|
| **Land Use and Visual Resources** | | |
| Land Use | SMALL | Cumulative land use impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. Discovery Ridge Research Park is currently certified for industrial use; any new development within this area would be compatible with current land use plans. |

| Resource Category | Cumulative Impact Level | Description of Impacts |
| --- | --- | --- |
| Visual Resources | SMALL | Cumulative visual impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. Reasonably foreseeable new construction activities would occur within or adjacent to existing facilities or within areas certified for industrial use and of low scenic quality. |
| **Air Quality and Noise** | | |
| Air Quality | SMALL to MODERATE | Cumulative air quality impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL to MODERATE primarily due to future economic and population growth in Boone County that can lead to long-term air emission sources and increases in air pollutants that can noticeably alter air quality. |
| Noise | SMALL to MODERATE | Cumulative noise impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL to MODERATE primarily due to the potential expansion of the Discovery Ridge Research Park and construction and operation of new roads adjacent to the proposed NWMI facility that would result in an increase in noise levels from traffic and business growth. |
| Geologic Environment | SMALL | Cumulative geologic resource impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. Following the completion of construction activities, continued soil loss would be minimal as the remaining soils would lie beneath impervious surfaces, such as buildings, or the impacted area would have been revegetated or incorporated into facility landscaping or hardscaped areas. Rock and mineral products including construction aggregate are widely available throughout Boone County and the surrounding region. |

| Resource Category | Cumulative Impact Level | Description of Impacts |
|---|---|---|
| Water Resources | SMALL to MODERATE | Cumulative surface water resource impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL to MODERATE, primarily due to regional growth and climate change. Cumulative groundwater resource impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. |
| Ecological Resources | MODERATE | Cumulative terrestrial and aquatic resource impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered MODERATE, primarily due to certain attributes of the terrestrial and aquatic environment (such as habitat quality) that are likely to noticeably change as a result of environmental stressors, such as runoff from agricultural fields and urban areas and climate change, and that will continue over the proposed construction, operational, and decommissioning periods. |
| Socioeconomics | SMALL | Cumulative socioeconomic impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. Demand for labor would not create a shortage because the City of Columbia and Boone County have a sufficient workforce to meet the needs of facilities. Construction of Discovery Park could increase the size of the local population as well as employment and tax revenue and an increased demand for public services in the ROI. However, the overall contributory socioeconomic effect of this construction project would be SMALL. |
| Historic and Cultural Resources | See next column | No evidence of historic or cultural resources were found within the Lot 15 (the proposed Discovery Ridge site) survey area, and the closest historic property is approximately 1 mi (1.6 km) to the northwest of the Discovery Ridge site. Historic and cultural resources are not likely to be affected by the cumulative effects of constructing, operating, and decommissioning the proposed NWMI facility combined with other past, present, and reasonable foreseeable future activities at the Discovery Ridge site. |

| Resource Category | Cumulative Impact Level | Description of Impacts |
|---|---|---|
| Human Health | SMALL | Cumulative human health impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. Radiological doses would be within NRC regulatory limits and nonradiological exposures would be within Federal and State regulatory limits. |
| Waste Management | SMALL | Cumulative waste management impacts associated with the construction, operations, and decommissioning of the NWMI facility in conjunction with other reasonably foreseeable projects is considered SMALL. Adequate disposal space for the cumulative quantities of radioactive and nonradioactive waste that would be produced by the proposed NWMI facility and other facilities within the ROI exists. Radioactive and nonradioactive waste from all sources would be required to be handled, transported, and disposed of in accordance with Federal and State regulations. |
| Accidents | SMALL | Given that other existing facilities within the ROI are required to comply with Federal and State regulations that limit the consequences of accidents at those facilities, and given the proximity of those facilities to the proposed NWMI facility, if the NRC safety review determines that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding radiological and chemical accident consequences, then the cumulative impacts from potential radiological and chemical accidents would be SMALL. |
| Transportation | SMALL | Cumulative traffic-related transportation impacts of the proposed action combined with the Discovery Ridge Research Park and Discovery Park development would be SMALL, an increase in the number of commuter vehicles and commercial trucks on roads near the proposed NWMI site would not likely have a noticeable impact on overall traffic volumes. |
| Environmental Justice | See next column | Cumulative human health and environmental effects on minority and low-income populations are not expected to be disproportionately high and adverse. |

# 5.0 ALTERNATIVES

This chapter describes alternatives to granting a construction permit for the proposed Northwest Medical Isotopes, LLC (NWMI), medical radioisotope production facility (NWMI facility) and the environmental impacts of those alternatives. The need to compare the proposed action with alternatives arises from the requirement in Section 102(2)(C)(iii) of the National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 et seq.). NEPA states that an environmental impact statement (EIS) shall include an analysis of alternatives to the proposed action. The U.S. Nuclear Regulatory Commission (NRC) implements this requirement through regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 51 and its Interim Staff Guidance in NUREG–1537 (NRC 2012), which state that the EIS will include an analysis that considers and weighs the environmental effects of the proposed action, the environmental impacts of alternatives to the proposed action, and alternatives available for reducing or avoiding adverse environmental effects.

The NRC standard of significance for impacts uses the Council on Environmental Quality (CEQ) terminology for “significantly” (40 CFR 1508.27). Since the significance and severity of an impact can vary with the setting of the proposed action, the NRC considered both “context” and “intensity,” as defined in the CEQ regulations in 40 CFR 1508.27. Context is the geographic, biophysical, and social context in which the effects would occur. Intensity is the severity of the impact. Based on this, the NRC established three levels of significance for potential impacts: SMALL, MODERATE, and LARGE. For this EIS, the NRC staff characterized impact levels for each resource area using the following three definitions of significance levels, which are presented in the Interim Staff Guidance to NUREG–1537 (NRC 2012):

> SMALL—environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. In assessing radiological impacts, the NRC has concluded that those impacts that do not exceed permissible levels in the NRC’s regulations are considered small.
>
> MODERATE—environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
>
> LARGE—environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

In this EIS, the NRC staff analyzed four alternatives to the proposed action. In Section 5.1, the NRC staff analyzed the no-action alternative or the environmental consequences if the NRC denies the construction permit. In Section 5.2, the NRC staff examined the environmental consequences if the NWMI facility were constructed, operated, and decommissioned at an alternative location. Based on an in-depth site selection process, the NRC staff examined in depth one alternative site, the University of Missouri Research Reactor (MURR). Section 5.3 examines the environmental impacts of construction, operating, and decommissioning a medical radioisotope production facility at the proposed Discovery Ridge site but using alternative technologies. The NRC initially considered a wide-range of potential alternative technologies and narrowed down the potential technologies to examine two alternative technologies in depth: uranium fission technology and linear accelerator-based technology. Section 5.4 describes the benefits and costs of the various alternatives.

## 5.1 No-Action Alternative

Under the no-action alternative, the NRC would deny the construction permit, and the NWMI facility would not be constructed. The no-action alternative does not involve the determination of whether radioisotopes are needed or should be generated. The decision to produce radioisotopes is at the discretion of applicants (NRC 2012).

Under the no-action alternative, no changes would occur to the proposed Discovery Ridge site from NRC-authorized construction. The site would remain designated as an industrial certified site. If the NRC denies the construction permit, a private entity could construct a facility on Lot 15. Given that such a facility would also need to construct and operate in compliance with applicable local, State, or Federal requirements, and that the facility would also likely be a light industrial facility because it would occur within the Discovery Ridge Research Park, the impacts would likely be similar to those described in Chapter 4. Therefore, impacts on all resource areas would be SMALL.

The no-action alternative is the only alternative considered by the NRC that does not satisfy the purpose and need for this EIS, because this alternative does not satisfy the need for a U.S. supplier of molybdenum-99 (Mo-99). Assuming that the need for a U.S. supplier of Mo-99 continues to exist, another private company would likely construct and operate a medical radioisotope production facility.

## 5.2 Alternative Sites

NWMI identified and selected reasonable alternative sites, using the site-selection process described in Section 5.2.1 (NWMI 2015a). The NRC staff reviewed NWMI's site selection process and considered the environmental impacts of locating the proposed NWMI facility at an alternative site. Unless indicated otherwise, the following discussion is a summary of information presented in NWMI's Environmental Report (ER) (NWMI 2015a) and responses to requests for additional information (RAI) (NWMI 2015c, 2016a).

### 5.2.1 Description of Alternative Site-Selection Process

#### *5.2.1.1 Initial Site Screening*

NWMI's site-selection process assessed a variety of economic and environmental factors to determine reasonable sites to construct and operate the proposed NWMI facility. NWMI determined that proximity to an existing university research reactor was the most important factor in determining site location because the production process relies upon one or more research reactors to irradiate targets (NWMI 2016a). From this broad list of potential locations, NWMI (2016a) further narrowed the range of reasonable alternatives to four potential sites based on the following requirements for the co-located university research reactor:

- experience supporting government and commercial industries,
- capability to support commercial irradiation on a regular basis,
- core configuration that could accept the NWMI targets, and
- sufficient power to meet NWMI's irradiation requirements.

Based on these criteria, NWMI identified four potential sites:

*Discovery Ridge Site*

The Discovery Ridge site is located in Columbia, Missouri, approximately 125 mi (201 km) west of St. Louis, Missouri. The site is located 3.7 miles (mi) (6 kilometers (km)) southeast of the University of Missouri Research Reactor. The 7.4-acre (ac) (3.0-hectare (ha)) site is located on a parcel of land that is part of a larger, developing technology research park (the Discovery Ridge Research Park). The site has been previously disturbed due to decades of agricultural activities. No utilities or roadways currently exist on site, but they could be made available.

*University of Missouri Research Reactor Site*

The University of Missouri Research Reactor (MURR) alternative site is located in Columbia, Missouri, approximately 125 mi (201 km) west of St. Louis, Missouri. The MURR alternative site is located within the MURR Center; the MURR Center occupies a 7.5-ac (3.0-ha) lot in a portion of the University Research Park, which is part of the University of Missouri (MU) campus and encompasses the existing research reactor. The production facility would be constructed immediately south of the MURR Center laboratory building, which houses the research reactor, on a partially paved parking lot. The paved parking lot within the MURR Center where the proposed NWMI facility would be constructed is 2.5 ac (1 ha) (NWMI 2016c). The land is currently zoned for industrial use and utilities are available. Under this alternative, NWMI would construct a below-ground direct connection between the existing MURR Center and the proposed NWMI facility (NWMI 2016c).

*Oregon State University Training, Research, Isotopes, General Atomics (TRIGA) Reactor Site*

The Oregon State University TRIGA Reactor (OSTR) alternative site is located in Corvallis, Oregon, approximately 80 mi (129 km) south of Portland, Oregon. The 3-ac (1.2-ha) site is located adjacent to the Oregon State University (OSU) Radiation Center, immediately to the east of the OSU TRIGA reactor (NWMI 2016c). Developing the site for the proposed facility would require relocation of two existing laboratory buildings and rerouting transportation access to the reactor bay. Utilities are currently available on site.

*McClellan Business Park Site*

The McClellan Business Park (McClellan) alternative site is located in McClellan, California, approximately 10 mi (16 km) north of Sacramento, California. The site includes an existing 45,000 square feet ($ft^2$) (4,181 square meters ($m^2$)) building approximately 61 m (200 ft) from the McClellan Nuclear Research Center, which houses a TRIGA reactor. The site is located within the McClellan Business Park. The land is currently zoned for industrial use and utilities are available.

*5.2.1.2 Secondary Screening*

To further narrow the range of possible alternatives, NWMI (2015a) conducted a decision analysis by using a Simple Multi-Attribute Rating Technique, which is based on the U.S. Department of Energy's (DOE's) Guidebook to Decision-Making Methods (DOE 2001). As part of this process, NWMI developed a set of 10 criteria to score the four potential sites and to ultimately identify the preferred site (Table 5–1). NWMI evaluated each site for each criteria and assigned it a score of 1 through 5 depending upon the site's ability to meet the criteria. NWMI also weighted each criteria based on its relative importance in terms of NWMI's business plan. As part of the business plan, NWMI assumed that no matter the alternative site, NWMI would transport targets to three RTRs for irradiation, and then transport the irradiated targets back to the production facility for processing. In addition, NWMI assumed that the majority of irradiation would occur at MURR (NWMI 2016a and 2016c).

*Political and Local Logistic Support*

NWMI determined that political and local logistical support are important factors in its site-selection process because local support depends on regional politics, and the importance to local economic development will likely play a large role in the financial success of the company. Therefore, NWMI assigned this criteria the highest weight of 10 points. NWMI assigned three sites, Discovery Ridge, MURR, and OSTR, a score of 4 (weighted score of 40), based on the high level of State, county, and local support for the proposed project and connections among NWMI and university reactor staff. McClellan scored the lowest (1, weighted score of 10) because of the limited State and local support for the proposed project.

*Facility Operations*

NWMI assigned facility operations the highest weight (10 points) based on the importance of NWMI having sole responsibility for operations and for the building design to prevent logistical complications. NWMI assigned Discovery Ridge a score of 4 (weighted score of 40) because NWMI would operate the proposed production facility. NWMI assigned MURR a score of 2 (weighted score of 20), based on logistical complications to operate within a smaller space and because the University of Missouri would require that MURR personnel, rather than NWMI personnel, manage the facility. NWMI assigned both OSTR and McClellan a score of 3 (weighted score of 30) because NWMI staff would solely manage the facility, although some land or building design constraints would make operations more constrained.

*Production Logistics*

NWMI assigned production logistics the highest weight (10 points) based on the critical role in minimizing transport time, and the associated (Mo-99) decay, to ensure NWMI delivers the maximum amount of product to the distributor. NWMI assigned Discovery Ridge and MURR a score of 4 (weighted score of 40), because target irradiation would primarily occur at MURR, which would be adjacent to or less than 20 mi (32 km) from the production facility. Thus, for these two sites, travel time would be minimized between the irradiation facility and the production facility. For OSTR and McClellan, NWMI assigned a score of 3 (weighted score of 30) given the longer distance between these two sites and MURR. NWMI assumed that all sites would have similar processing and product conditioning timeframes.

*Transportation*

NWMI assigned transportation a high weight (8 points) because longer transportation routes would likely be more costly because of the longer transportation time, especially with inclement weather delays. NWMI assigned MURR and Discovery Ridge a score of 4 (weighted score of 32), because target irradiation would primarily occur at MURR, which would be adjacent to or less than 20 mi (32 km) from either site. NWMI assigned OSTR and McClellan a score of 2 (weighted score of 16) and 3 (weighted score of 24), respectively, based on the additional distance from these two sites to MURR, in which NWMI assumed the majority of irradiation would occur. Transportation to and from MURR from these sites would also require crossing significant mountain ranges, which may increase the probability of delays. OSTR is an additional 200 mi (322 km), or 5 hours of travel time, from MURR than McClellan, which influenced the lower score for OSTR.

*Radioactive, Hazardous, and Mixed Secondary Waste Generation*

NWMI assigned radioactive, hazardous, and mixed secondary waste generation a high weight (8 points) because the proposed facility must comply with Federal, State, and local radioactive and hazardous waste requirements, which may vary by State and/or locality. NWMI assigned McClellan a score of 3 (weighted score of 24) based on the additional State regulatory requirements in California for the storage, transportation, and disposal of generated waste. Disposal costs may also be greater in California. Given the fewer regulatory requirements and lower disposal costs at the other three sites, NWMI assigned Discovery Ridge, MURR, and OSTR a score of 4 (weighted score of 32).

*Federal, State, County, and Local Requirements*

NWMI assigned Federal, State, county, and local requirements a weight of 5 because NWMI determined that differences in State, county, and local environmental permitting requirements could influence the initial start date for operations. NWMI assigned McClellan a score of 3 (weighted score of 15) based on the additional State and local regulatory requirements in California, such as a State environmental analysis required under the California Environmental Quality Act. Given the fewer regulatory requirements at the other three sites, NWMI assigned Discovery Ridge, MURR, and OSTR a score of 4 (weighted score of 20).

*Federal and State Taxes and Incentives*

NWMI assigned Federal and State tax and incentives a low weight (3 points) because State and local taxes, employment hiring credits, and incentives may slightly differ among locations, which could affect the cost of construction, equipment, and operations. NWMI assigned Discovery Ridge and MURR a score of 5 (weighted score of 15), based on the low sales and corporate income taxes (4.225 and 6.25 percent, respectively) and the number of financial incentives offered in Missouri, such as State-wide programs to reduce taxes for companies creating new jobs and purchases of new equipment within certain manufacturing facilities, training programs for new employees, and recruitment assistance. NWMI assigned OSTR a score of 3 (weighted score of 9) based on the lack of sales tax, moderate corporate income tax (7.6 percent), and reduced property taxes for the proposed project. NWMI assigned McClellan a score of 1 (weighted score of 3) based on the high sales and corporate income tax (7.75 and 8.84 percent, respectively), and the lack of reduced property taxes.

*Available Space*

NWMI assigned available space a low weight (3 points) because all four sites have the minimum amount of space required for the production facility, but differences in the available space could influence NWMI's ability for future expansion and the complexity of construction activities. NWMI assigned Discovery Ridge a score of 5 (weighted score of 15) because no buildings currently occur on the site and space is available for future expansion. NWMI assigned MURR a score of 3 (weighted score of 9) because future expansion would be limited. NWMI assigned OSTR a score of 1 (weighted score of 3) because the site is less than 1.0 ha (2.5 ac) and no future expansion would be available. NWMI assigned McClellan a score of 2 (weighted score of 6) because of limited construction possibilities within the existing building, although future expansion could occur.

*Construction Costs*

NWMI assigned construction costs a low weight (2 points) because local labor rates, materials costs, and the current site condition could have a small influence on the total construction cost. NWMI assigned Discovery Ridge a score of 4 (weighted score of 8) because few restrictions would impede building design and construction. NWMI assigned MURR a score of 3 (weighted score of 6), based on the higher costs to conduct construction activities within a limited space and to construct a below-grade connection to the MURR reactor. NWMI assigned OSTR and McClelland a score of 3 (weighted score of 6) because OSTR has few construction restrictions, but it may require demolition and reconstruction of existing buildings and also because McClellan would require structural and mechanical modifications to meet the code within the existing building.

*Natural or Human-Made Disaster Potential*

NWMI assessed the natural or human-made disaster potential based on Federal Emergency Management Agency (FEMA) disaster declarations and U.S. Geological Survey (USGS) seismic activity predictions. NWMI assigned this criterion a low weight (1 point) because each site is adjacent or close to an existing reactor, which was likely sited in an area with low potential for natural or human-made disasters. NWMI assigned Discovery Ridge and MURR a score of 3 (weighted score of 3) because both sites have the most storm, flooding, and tornado declarations but low-to-no earthquake risk. OSTR received a score of 4 (weighted score of 4) because the associated county (Benton) had the fewest disaster declarations and moderate-to-low earthquake risk. McClellan received a score of 2 (weighted score of 2) because the associated county (Sacramento) had more disaster declarations than OSTR, but less than Discovery Ridge and MURR, and a higher earthquake risk.

Summary

NWMI (2015a, 2015c, 2016a) developed 10 site-selection criteria and weighted each criteria 1 through 10, depending upon the relative importance to NWMI's business plan. Next, NWMI assigned each site a score of 1 to 5, based on the criteria discussed above. Table 5–1 summarizes these scores.

**Table 5–1. NWMI Site-Selection Scoring Criteria**

| | (Weight) | Discovery Ridge | MURR | OSTR | McClellan |
|---|---|---|---|---|---|
| Political and local logistics support | (10) | 4 | 4 | 4 | 1 |
| Facility operations | (10) | 4 | 2 | 3 | 3 |
| Production logistics | (10) | 4 | 4 | 3 | 3 |
| Transportation | (8) | 4 | 4 | 2 | 3 |
| Radioactive, hazardous, and mixed secondary waste generation | (8) | 4 | 4 | 4 | 3 |
| Federal, State, county, and local requirements to construct and operate facility | (5) | 4 | 4 | 4 | 2 |
| Federal and State tax incentives | (3) | 5 | 5 | 3 | 1 |
| Available space | (3) | 5 | 3 | 1 | 2 |
| Construction costs | (2) | 4 | 3 | 3 | 3 |
| Natural or human-made disaster potential | (1) | 3 | 3 | 4 | 2 |
| Weighted Total Score[1] | | 245 | 217 | 190 | 145 |
| Weighted Percentage[2] | | 82% | 72% | 63% | 48% |

Notes:

[1]The weighted total score is the sum of each criteria weight multiplied by each site-specific criteria score.

[2]The weighted percentage is the site-specific weighted total score divided by the total possible weighted score (300).

Source: NWMI 2016a

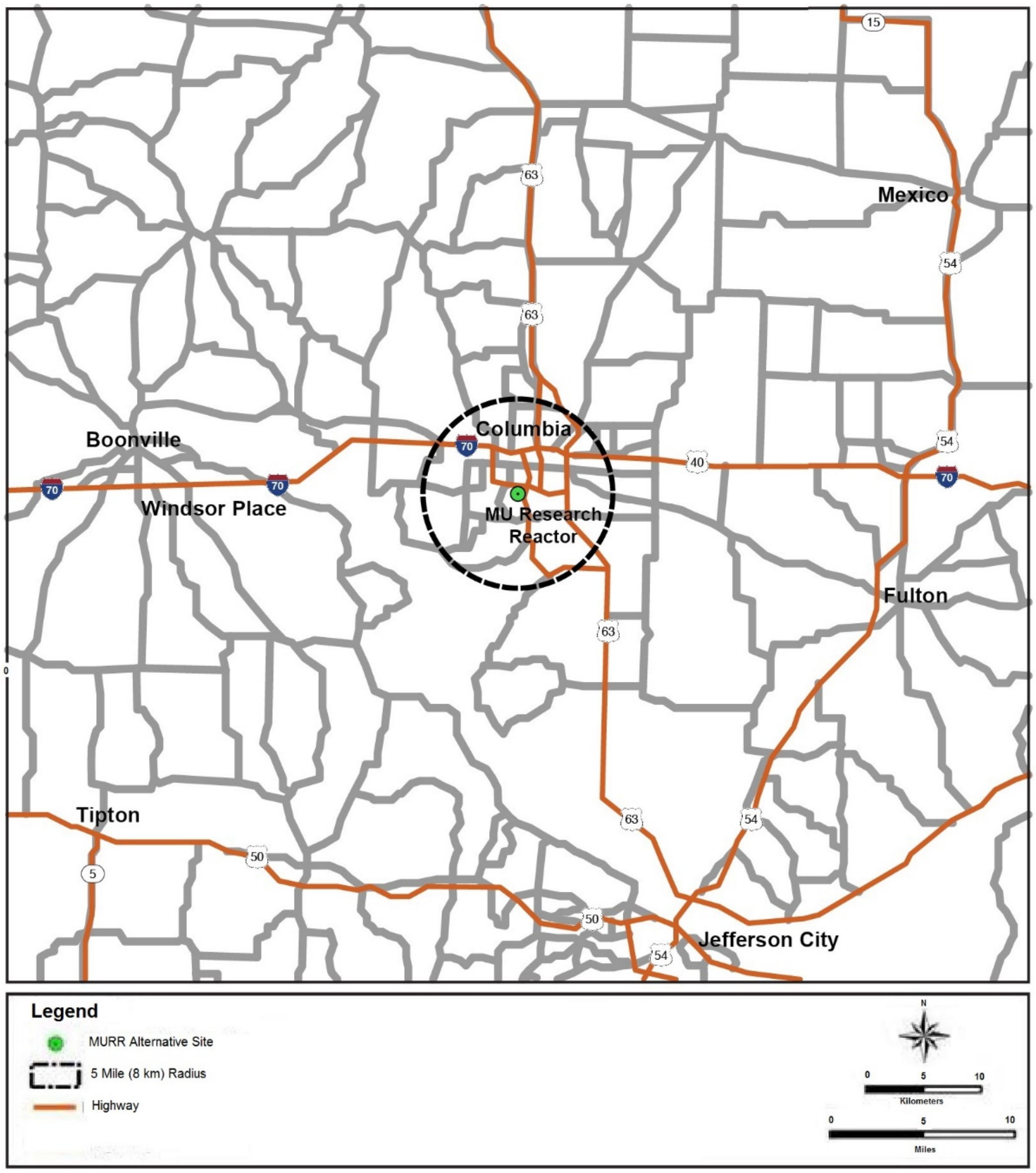
Based on these scores, NWMI selected the Discovery Ridge site, with a total weighted score of 245 out of 300 (82 percent), as the proposed location for the NWMI facility. The three alternative sites scored lower: MURR (217 total weighted score; 72 percent), OSTR (190 total weighted score; 63 percent), and McClellan (145 total weighted score, 48 percent) (NWMI 2016a). OSTR and McClellan scored lower than Discovery Ridge and MURR primarily based on the longer transportation routes and more complex production logistics, the lower State tax and financial incentives and the lack of available space for future expansion. The NRC staff evaluated the site-selection methodology described above and concluded that the process for selecting and evaluating alternative sites, including the proposed site at Discovery Ridge, is reasonable and consistent with guidelines presented in NUREG–1537 and the associated Interim Staff Guidance (NRC 2012).

NEPA requires that an agency analyze a reasonable number of examples, covering the full spectrum of alternatives, in the EIS (46 FR 18026). Further, Appendix A to 10 CFR Part 51 states that the level of information for each alternative considered will reflect the depth of analysis required for sound decisionmaking. The NRC staff analyzed one alternative site in detail given that the proposed site and alternative site likely cover the full spectrum of alternatives and provide sufficient information for sound decisionmaking based on the relatively small size of the proposed facility, the limited footprint and excavation required, the use of county water rather than surface or groundwater for withdrawal or discharge, and the ability to site the facility within a previously disturbed area. Thus, the NRC staff analyzed the MURR alternative site in detail below.

### 5.2.2 University of Missouri Research Reactor Alternative Site

The NRC staff evaluated the MURR site in detail as a reasonable alternative. The MURR site is a 3.0 ha (7.5 ac) lot located in Columbia, Missouri, within Boone County, approximately 125 mi (201 km) west of St. Louis, Missouri (Figure 5–1; NWMI 2016c). Specifically, the site is located on the University of Missouri Campus, within the MURR Center. NWMI would construct a new production facility immediately south of the existing research reactor on a partially paved parking lot. An external waste management building, a diesel generator building, and the Radioisotope Production Facility (RPF) building would be constructed on the 2.5-ac (1-ha) paved parking lot within the MURR Center (NWMI 2016c) and would collectively cover approximately 66,150 $ft^2$ (6,145 $m^2$). There would be one offsite location at an existing building (the University of Missouri Life Science Incubator Building) across the street from the MURR Center that would house the administrative building, including offices and conference rooms, but no new construction would be required (NWMI 2016c). Research Park Drive and South Providence Road provide access to the site. Irradiation of low-enriched uranium (LEU) targets would be carried out at MURR, OSTR, and a third reactor. The impacts as a result of irradiation of LEU targets at these three research reactors is discussed in Section 4.13 of the EIS.

**Figure 5–1. Cities and Major Roadways Transportation near the University of Missouri Research Reactor Alternative Site**




### *5.2.2.1 Land Use and Visual Resources*

<u>Land Use</u>

The MURR site includes 7.5 ac (3.0 ha) of land within the southwestern portion of the City of Columbia (Figure 5–1; NWMI 2016c). The site is currently zoned for light industrial use and is part of the University Research Park (City of Columbia 2012, 2016i; NWMI 2015c). The University Research Park includes several industrial buildings used for research or commercial purposes (NWMI 2015a). A few deciduous trees occur on site, although most appear to have been planted for ornamental purposes (NRC 2015c). No prime farmland or farmland of Statewide importance, active mines or quarries, military reservations, Federally designated wild and scenic rivers, national parks, national forests, Federally designated coastal zone areas, or Federal lands held in trust for an American Indian tribe occur on the MURR site (NWMI 2015a; Find the Data 2016; NRCS 2016a, 2016b; NOAA 2016).

Immediately surrounding the MURR site (within a 0.6-mi (1-km) radius), the majority of the land is owned by the University of Missouri, including three sporting venues: Memorial Stadium/Faurot Field (62,000 seats), Mizzou Arena (15,061 seats), and Hearnes Center (13,300 seats). The A.L. Gustin Golf Course is west of the MURR site and Epple Field, which includes the University of Missouri tennis facilities, is south of the MURR site.

Within a 5-mi (8-km) radius of the MURR site, a variety of land uses occur, including residential, light industrial, commercial, and forested areas. Several City and State parks occur within the vicinity, including multiple recreational trails (NWMI 2015a; NRC 2015b).

*Construction*

Construction at the MURR site would occur within an existing parking lot (NWMI 2015a, 2015c). Because the site is already zoned for industrial use and existing building have supported research for several decades, no change in zoning or land use would occur.

Impacts on land use from construction would be SMALL, given that no change in land use or zoning would occur, and no special land uses or mineral resources occur within the MURR site.

*Operations*

Operation of the NWMI facility would not require any new land or require land use changes beyond those required for construction. Therefore, impacts on land use during operations would be SMALL.

*Decommissioning*

Decommissioning activities would be similar to construction activities because they would involve heavy equipment to dismantle buildings and remove roadway and parking facilities. Land requirements to perform these activities would be similar to those required during construction. After decommissioning activities are complete, the MURR site would likely remain industrial because it is part of the University Research Park. Given that land requirements would be similar to those described during construction, and that after decommissioning is complete the land would likely remain industrial, the NRC staff determined that the impacts on land use during decommissioning would be SMALL.

<u>Visual Resources</u>

The visual setting of the area that would be affected by the proposed NWMI facility at the MURR site is primarily a light industrial viewshed (NWMI 2015a; NRC 2015b). In addition, trees are visible in many directions (NWMI 2015a; NRC 2015b).

*Construction*

The activities associated with constructing the proposed NWMI facility (e.g., excavation, earthmoving, pile driving, and erecting the facility) would require large pieces of construction equipment, which may alter the appearance of the existing landscape because construction equipment is not typically visible on the MURR site. However, the MURR site has low scenic quality caused by a lack of notable features, uniform landform, low vegetation diversity, an absence of water, mute colors, cultural modifications to adjacent scenery, and a commonality within the physiographic province. The MURR site also has a low-to-moderate sensitivity rating because it is in an area with low scenic values and a lack of special natural and wilderness areas. In addition, the viewshed surrounding the MURR site is aesthetically altered by light industrial buildings, such as research facilities. In addition, NWMI (2015a) stated that the RPF building would be designed to blend in with the architecture of the existing facilities on the MURR site. Based on the light industrial viewshed, the low scenic quality and sensitivity ratings, construction-related aesthetic impacts of the proposed NWMI facility at the MURR site would be SMALL during construction.

*Operations*

After the facility is constructed, the appearance of the NWMI facility at the MURR site would not change during operations, other than a small steam plume that may be visible from the exhaust stack. The steam plume from the exhaust stack is expected to be minimal, because opacity associated with the natural-gas-fired boiler tends to be low, as a result of emissions described in Section 4.2.1.1. The steam plume would be more visible during periods of cold weather, although the size of the steam plume would still be relatively small. Therefore, visual impacts during operations of the proposed NWMI facility at the MURR site would be SMALL.

*Decommissioning*

Decommissioning activities would be similar to construction activities because they would require heavy equipment to dismantle buildings and remove roadway and parking facilities. After decommissioning activities are complete, the MURR site would likely remain industrial because it is part of the University Research Park. Given that the facility would be located in a district zoned for light industrial use and the viewshed surrounding the MURR site is aesthetically altered by light industrial buildings, the NRC staff would not expect any changes to the landscape during decommissioning to significantly affect any viewsheds. Therefore, visual impacts during decommissioning of the proposed NWMI facility at the MURR site would be SMALL.

#### *5.2.2.2 Air Quality and Noise*

<u>Air Quality</u>

The MURR site is located in Boone County, Missouri. The climate at this MURR site is similar to what was described in Section 3.2.1 for the Discovery Ridge site. Boone County is part of the Northern Missouri Intrastate Air Quality Control Region (40 CFR 81.116). With regard to the National Ambient Air Quality Standards (NAAQS) criteria pollutants, Boone County is designated unclassifiable/attainment for all criteria pollutants (40 CFR 81.326). Therefore, criteria air pollutant concentrations in the County are lower than NAAQS or there is insufficient data to determine if the NAAQS are met. The nearest Class I Federal area to the proposed site is the Hercules-Glades Wilderness Area in Bradleyville, Missouri, approximately 140 mi (225 km) away. The region of influence (ROI) for the air quality analysis discussed below is Boone County, because air quality designations are made at the county level.

*Construction*

Sources of air pollutant emissions during construction at the MURR site would include fugitive dust from earth-moving equipment, non-road vehicles, and worker and delivery vehicles. Earth-moving activities, including excavation, clearing, and compacting, will generate fugitive dust on site. Operation of construction equipment will emit criteria pollutants (particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides) on site from the combustion of fuels in equipment. Employee and delivery and shipment vehicular exhaust will emit criteria air pollutants (particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides). Air emissions would be similar to those estimated and presented in Table 4–3 for the Discovery Ridge site, because construction activities and parameters would be similar (i.e., construction duration, and number of worker vehicles, land disturbance and excavation, and building footprint). Since the MURR site is centered on an existing paved parking lot, additional equipment (e.g., track drill, cold planer) to remove existing paved surfaces may be needed to prepare the site for construction. However, use of this equipment will be short term during the beginning of site preparation. Therefore, construction air emissions at the MURR site would be similar to estimated emissions presented in Table 4–3. Overall construction-related emissions for criteria pollutants are well below the significant de minimis levels discussed under the New Source Review program and major source threshold emissions (see Section 3.2.2). Total greenhouse gas emissions (GHGs) (approximately 27,000 tons of carbon dioxide equivalent ($CO_2$eq) per year) would be well below the 75,000 tons/year (TPY) of $CO_2$eq (68,000 metric TPY) threshold for prevention of significant deterioration (PSD) and Title V permits set in the Greenhouse Gas (GHG) Tailoring Rule and EPA's mandatory GHG Tailoring Rule (74 FR 56260). Therefore, the NRC staff does not expect increases in air emissions from construction activities at the MURR site to contribute to concentrations that would exceed NAAQS in Boone County. Given that air emissions during construction would be local and temporary (17 months), that Boone County is designated as an attainment/unclassifiable area, that construction emissions are well below the significant de minimis levels, and that construction emissions are not expected to contribute to concentrations that would exceed the NAAQS, the NRC staff concludes that air quality impacts during construction at the MURR site would be SMALL.

*Operations*

Air emissions sources from operation of the proposed NWMI facility would be predominantly from: (1) target preparation and irradiated target processing, (2) fuel combustion associated with processing and facility heating, and (3) vehicular traffic from commuting workers and from transportation of shipments and deliveries during operations. Air emissions would be similar to those estimated for the proposed Discovery Ridge site, because the operational activities and the number and type of sources would be similar (number of worker vehicles, fuel combustion sources, and target preparation and processing activities). Therefore, air emissions would include nitrogen oxides, sulfur dioxide, particulate matter, carbon monoxide, and carbon dioxide and would be similar to what is presented in Table 4–4. Based on these estimated emissions, the NRC staff does not expect emissions from operation of the NWMI facility at the MURR site to contribute to concentrations that would exceed NAAQS or that would deteriorate Boone County's unclassifiable/attainment designation. Given that NAAQS are not expected to be exceeded and that Boone County is designated unclassifiable/attainment, the NRC staff concludes that air quality impacts during operation at the MURR site would be SMALL.

*Decommissioning*

Decommissioning activities would include earth-moving equipment, demolition of structures, and dismantlement and decontamination of systems over a period of up to 24 months (NWMI 2015a, 2016a). Equipment, worker vehicles, and truck shipments will emit criteria air pollutants (particulate matter, carbon monoxide, sulfur dioxide, and nitrogen oxides) and GHGs. Demolition and dismantlement of structures will emit fugitive dust. Air emissions would be similar to those estimated for the proposed Discovery Ridge site, because the decommissioning activities would be similar. Therefore, air emissions would include nitrogen oxides, sulfur dioxide, particulate matter, carbon monoxide, and carbon dioxide and would be similar to what is presented in Table 4–5. Projected emissions are well below the significant de minimis levels discussed under the New Source Review program in Section 3.2.2 of this EIS. Therefore, the NRC staff does not expect increases in air emissions from decommissioning activities to contribute to concentrations that would exceed NAAQS or prevent Boone County from maintaining attainment designation. The NRC staff concludes that air quality impacts from decommissioning at the MURR site would be SMALL.

Noise

Existing noise sources near the MURR site include vehicular traffic along South Providence Road (Route 63), cooling towers associated with MURR, and sports venues (within 0.3 mi (0.48 km) of MURR). Noise-sensitive receptors within 1 mi (1.6 km) of the MURR site include:

- residence, approximately 0.47 mi (0.76 km) north of the MURR site;
- golf course, approximately 0.09 mi (0.14 km) west of the MURR site;
- hospital, approximately 0.80 mi (1.3 km ) northeast of the MURR site;
- University of Missouri research buildings, 0.1 mi (0.16 km ) northeast of MURR site; and
- MURR, immediately adjacent to MURR site.

The NRC staff did not identify the existence of any ambient noise surveys for the MURR site and vicinity. At 5-ft (1.5-m) distance from MURR's cooling towers noise levels can reach 71 A-weighted decibels (dBA) (Lenntech undated). Typical noise levels at 15 m (50 ft) from a highway such as Route 63 can reach 70 dBA (FHWA 2003). The MURR site is located within the University Research Park; therefore, the NRC staff estimates background noise levels of 65 to 70 dBA, which are typical of commercial areas. The ROI for the noise analysis discussed below is 1 mi (1.6 km) from the MURR site.

*Construction*

Noise sources associated with building the proposed NWMI facility will include construction equipment on site and workforce and shipment/delivery vehicles. Increased traffic volumes because of 82 workers and 21 deliveries per week can increase noise emissions along nearby access roads to the MURR site and will depend on the increase in traffic from current conditions. Access to the MURR site is from South Providence Road (Route 63) and Research Park Drive. In 2013, the annual average daily traffic volume traffic count along South Providence Road (at the Stadium Boulevard intersection) was 29,940 (1,247 vehicles per hour) (MODOT 2013). Sound levels increase at a rate of 3 dBA per doubling of traffic volumes and an increase of 3 dBA is barely noticeable. Conservatively assuming that all worker vehicles and deliveries travel on South Providence Road at the same time, a traffic volume of 1,350 vehicles/hr will result. This increase in traffic will not result in any noticeable increased noise levels.

The types of equipment that would be used on the MURR site during construction would include those listed in Table 4–2 and additional equipment (e.g., track drill) to remove the existing paved surfaces. Noise emissions from equipment that will be used during construction are predicted to be in the 80- to 85-dBA range at a 50 ft (80 km) distance (FHWA 2006). At 0.14 km (0.09 mi), noise will attenuate to 61 to 65 dBA and at 0.76 km (0.47 mi), distance to the nearest residence, noise will attenuate to 46 to 51 dBA. However, because of the proximity to the existing MURR building from the construction site, noise levels at MURR can reach 80-85 dBA, which would be noticeable. Background noise levels are assumed to be 65 to 70 dBA. A 10-dBA increase is subjectively perceived as a doubling in loudness and almost always causes an adverse community response (FHWA 2011). Although building walls of the MURR laboratory building may dampen the construction equipment noise levels, the increase in noise levels would be noticeable. Given noise levels from construction equipment and distance to noise-sensitive receptors, the NRC staff estimate that noise impacts from construction at the MURR site would be SMALL to MODERATE.

*Operations*

Noise sources during operation would be primarily from workforce and shipment vehicles. Noise from operating equipment would be contained inside buildings and is not anticipated to be audible outside the proposed NWMI building at the MURR site. Increased traffic volumes because of a daily workforce of 98 and 16 deliveries per week can increase noise emissions along South Providence Road and will depend on the relative increase in traffic volume. Conservatively assuming that all worker vehicles and deliveries travel on South Providence Road at the same time, this will result in a traffic volume of 1,361 vehicles/hr. Sound levels increase at a rate of 3 dBA per doubling of traffic volumes and an increase of 3 dBA is barely noticeable. This increase in traffic from 1,246 vehicles per hour to 1,361 vehicles/hr will not result in noticeable noise levels.

Given that noise levels from operating equipment are not expected to be audible beyond the building facility and additional noise levels from worker and shipment vehicles are not anticipated to be noticeable, the NRC staff concludes that noise impacts during operation would be SMALL.

*Decommissioning*

Noise emissions during decommissioning would be similar to those generated during construction. Increased noise levels would occur from increased traffic volumes and from the use of equipment on site. A daily peak workforce of 81 and a total of 21 deliveries and shipments per week are anticipated during decommissioning. Sound levels increase at a rate of 3 dBA per doubling of traffic volumes and an increase of 3 dBA is barely noticeable. Conservatively assuming that all worker vehicles and deliveries travel on South Providence Road at the same time, the additional traffic along South Providence Road should not be noticeable.

As discussed above, under construction, noise levels from construction equipment at MURR can reach 80 to 85 dBA, which would be noticeable. During decommissioning, equipment similar to construction activities would be used and similar noise levels are assumed during decommissioning activities. Therefore, given the expected noise levels during decommissioning and the distance to noise sensitive receptors, the NRC staff estimate that noise impacts from decommissioning at the MURR site would be SMALL to MODERATE.

#### *5.2.2.3 Geologic Environment*

<u>Site Geology, Soils, and Seismic Setting</u>

The alternative site for the proposed NWMI facility is in the University Research Park within the existing MURR Center (NWMI 2016c). The MURR Center, and alternate site, are located within the Dissected Till Plains section of the Central Lowland province (MDNR 2002a). Landforms within this physiographic section are the product of glacial action as modified by post-glacial geomorphological processes, as further described in Section 3.3.1 of this EIS.

MURR and the University of Missouri campus are located in an area known locally as the Columbia dissected uplands (MU 2006). The MURR site is located on a relatively flat plain adjacent to a stream valley that was incised into the glacial strata. The MURR site lies at an elevation of approximately 615 ft (187 m) above mean sea level (MSL) (Figure 5–2).

While glacial drift deposits are prevalent in the eastern half of Boone County, residuum (weathered bedrock material) is the predominant bedrock cover over the western half of the County. The MURR site is mapped as residuum (unit J). This unit is a tan to reddish-brown gravelly clay and silty clay, which developed from limestone and shale bedrock. The total thickness of this bedrock cover normally ranges from 1 to 20 ft (0.3 to 6 m) thick and is typically covered by a layer of loess and/or glacial drift. Across the University Research Park, mapping shows that the total depth of this cover is as much as 25 ft (7.6 m) deep (MGS 2016). Specific to the MURR site, these surficial deposits also likely include alluvium of Holocene age associated with Hinkson Creek (MU 2006).

The uppermost bedrock units underlying the site belong to the Osagean series of Mississippian age (345 to 359 million years ago). These rocks are characterized as very cherty, crystalline, and fossiliferous limestones (MU 2006). Geologic mapping shows that the specific bedrock unit beneath the site is Burlington-Keokuk limestone (MGS 2016). The Burlington Limestone is as much as 160 ft (49 m) thick in the Columbia area. This bedrock unit is relatively soluble and, where it outcrops at the surface, it is susceptible to karst development, as further described in Section 3.3.1 for the Discovery Ridge site (MU 2006). However, geologic mapping shows that the nearest karst features are approximately 3.5 mi (5.6 km) south of the MURR site (MGS 2016).

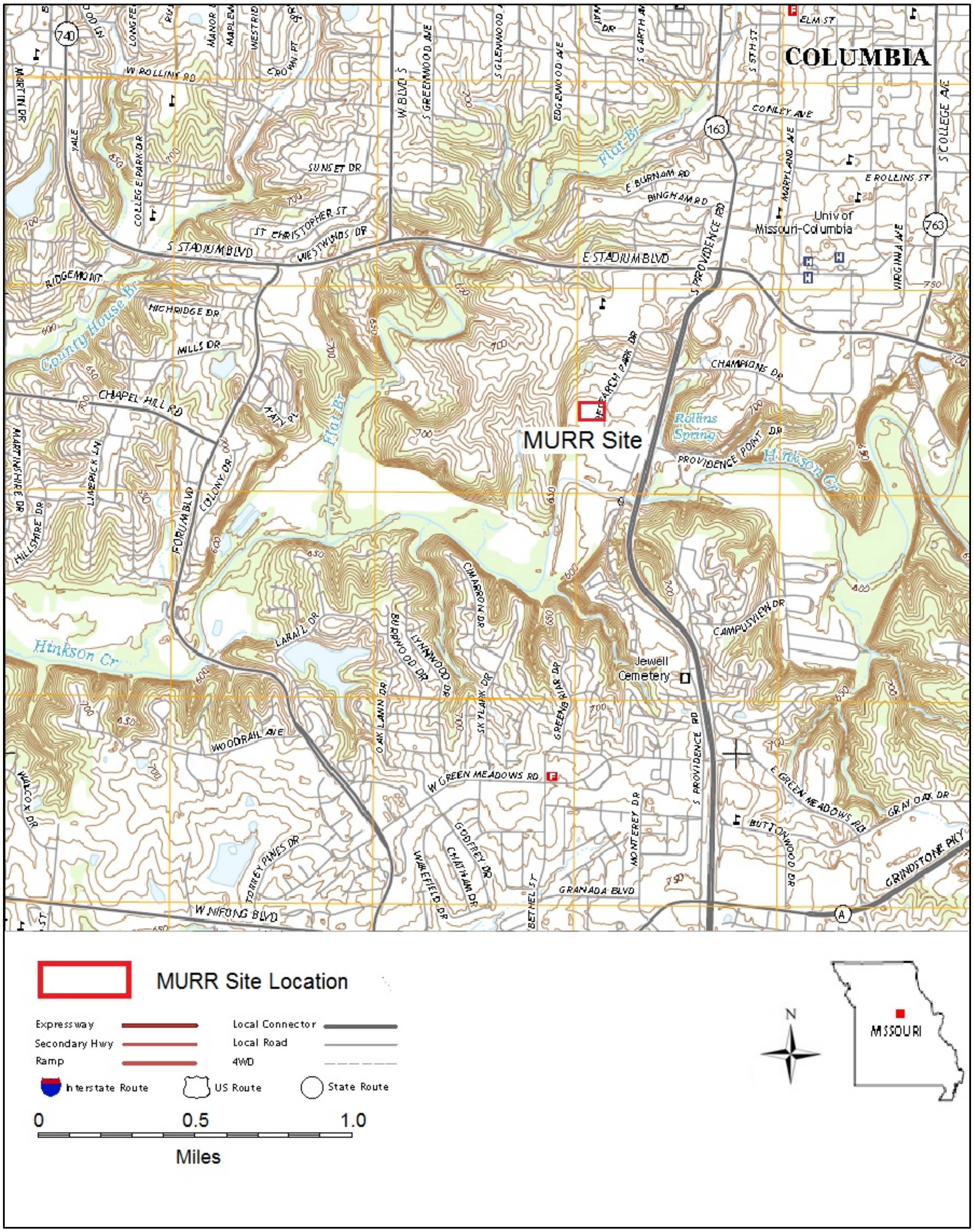
Older Devonian age limestones and sandstones are relatively thin or absent in the Columbia area; nevertheless, Ordovician age carbonate strata are well represented, including the Jefferson City Dolomite and the Rubidoux Formation. Cambrian age carbonates underlie the Ordovician strata and include the Eminence and Potosi Dolomites (MU 2006; Miller and Appel 1997).

The horizontal sedimentary strata underlying the MURR site exhibit little deformation, and the Columbia area is relatively free of faults, folds, and other major structural features (MU 2006). There are no mapped geologic faults or other significant geologic features within 5 mi (8 km) of the site. The closest geologic fault structure is the Fox Hollow fault, as further described in Section 3.3.1. The northern end of this fault is located approximately 6.5 mi (10.5 km) southeast of the MURR site. There has been no movement on this fault since the Paleozoic Era and it does not constitute an earthquake hazard. Evidence for active and recurrent faulting, along with associated seismic activity, can be found in eastern and southeastern Missouri and in southern Illinois, as further described in Section 3.3.1 of this EIS and referenced below. The most significant seismologic features are associated with the New Madrid Seismic Zone (MU 2006).

Geologic resources, encompassing rock and mineral (fuel and nonfuel) resources, from geologic strata in the Columbia area have historically included limestone and coal, as well as sand and gravel deposits, which are widely available, from glacial and floodplain materials throughout Boone County (MDNR 2001; USGS 2015c). A former limestone quarry is located about 0.4 mi (6 km) south of the MURR site and a former coal mining operation is located approximately 0.6 mi (1 km) southwest of the site (MGS 2016).

Soil unit mapping by the Natural Resources Conservation Service (NRCS) identifies the natural soils across the MURR site as predominantly Weller silt loam, bench, 2 to 5 slopes (NRCS 2016c). Where not otherwise mixed or replaced with fill material that may have been placed in conjunction with the construction of MURR, soils in this mapping unit are mainly silt loams occupying stream terraces. They are moderately well-drained, deep soils that developed from parent materials consisting of loess deposits over stream alluvium. The depth to the water table in these soils generally ranges from 24 to 48 in. (61 to 122 cm) (NRCS 2016c).

**Figure 5–2. Topographic Map of the MURR Site and Vicinity**




Source: Modified from USGS 2015a

Natural soils across the MURR site are rated as somewhat limited for building site development and excavation work primarily due to the depth to the saturated zone and clay shrink/swell potential. The soils have slight limitations due to instability of excavation walls (caving). The soils meet the classification criteria of prime farmland soils as defined in the Farmland

Protection Policy Act of 1981 (7 U.S.C. 4201 et seq.) and implementing regulations (7 CFR Parts 657, 658). However, because the site and vicinity is developed and otherwise committed to urban development, the site is exempt from Farmland Protection Policy Act provisions (7 CFR 658.2 and 658.3).

Northeast Missouri and the MURR site are located within a relatively stable region of the continent, as further described in Section 3.3.3. While the area is not immune to seismic activity, the intensities of Midcontinent earthquakes are generally mild, although they are usually felt over wide areas (MU 2006). Earthquake sources in southeast Missouri, associated with the New Madrid Seismic Zone, are the primary driver of earthquake hazard in northeast Missouri. The New Madrid Seismic Zone and the earthquake history for northeast Missouri, representative of the MURR site, are described in Section 3.3.3 of this EIS.

Over the last 40 years, a total of 99 earthquakes with a magnitude equal to or greater than 2.5 have occurred within a radius of 200 mi (322 km) of the MURR site. The vast majority of these earthquakes had epicenters more than 90 mi (140 km) to the east and south in association with the Wabash Valley and New Madrid seismic zones, respectively. The closest of these events occurred on July 31, 2005 near Tipton, Missouri, approximately 25 mi (40 km) southwest of the MURR site. The earthquake had a magnitude of 3.3 and produced MMI III to IV (weak to light) shaking near the epicenter, but it was not generally felt north of the Missouri River into Boone County (USGS 2016c).

Section 3.3.3 of this EIS presents information on predicted earthquake ground motions across central Boone County based on the USGS's latest seismic hazard mapping data. NWMI performed a preliminary seismic design analysis to assess the potential maximum earthquake ground motions in consideration of site-specific soil conditions (i.e., for a stiff soil profile (Site Class D)) (see Section 3.3.3). The NRC staff will further evaluate the potential maximum earthquake and other seismic design considerations in the safety evaluation report (SER) related to the NWMI construction permit application.

*Construction*

Ground-disturbing activities associated with facility construction would have impacts on geologic and soil resources similar to those discussed for the Discovery Ridge site (Section 4.3.1). Earthwork requirements and the ease of excavation would generally be similar, with a few exceptions. To prepare the site for facility construction, NWMI would first need to remove existing hardscape including asphalt and concrete associated with a parking lot, walkways, and curb and gutter. It is also likely that some existing utilities lines would need to be relocated. These activities would entail additional earthwork and could possibly lengthen the construction timeframe at this site. The site's loamy, alluvial soils are typically suitable to build on and engineer (e.g., grade and compact). The shrink/swell potential of site soils is moderately favorable for site development purposes with only slight limitations and risk for impacting building foundations and concrete surfaces.

Excavations at the site could be prone to slumping because of the potential for saturated soils and seasonally high water table conditions, as similarly discussed for the Discovery Ridge site. These conditions could require the use of bracing in trenches and other measures (e.g., cofferdams) during construction of the below-grade portion of the facility. The potential for soil erosion and loss would be similar to the Discovery Ridge site. However, as described in Section 4.3.1, adherence to standard best management practices (BMPs) for soil erosion and sediment control and stormwater runoff management, and compliance with the provisions of a Land Disturbance Permit from the City of Columbia, would serve to minimize soil erosion and loss. In consideration of these points, the NRC staff finds that the impacts on the geologic environment from the construction of the NWMI facility at the MURR site would be SMALL.

*Operations*

There would be no incremental impact on the geologic environment from facility operations at the MURR site. Following construction, exposed soils would no longer be subject to erosion because they would lie beneath buildings or other impervious surfaces, with areas outside those areas restored to a vegetated or landscaped condition.

Regardless of the site location, the final design and construction of the NWMI facility would have to comply with all applicable building codes and standards, which provide for the evaluation of site geologic and soil conditions, including potential seismic hazards. Thus, the NRC staff concludes that the operational impacts associated with the geologic environment at the MURR site would be SMALL.

*Decommissioning*

Facility demolition and other ground-disturbing activities associated with decommissioning would have impacts on soils and underlying sediments and geologic strata similar to those described in Section 4.3.3 for the Discovery Ridge site. Site decommissioning activities would be conducted in accordance with a decommissioning plan submitted to the NRC and in compliance with applicable local, State, and Federal regulations and permits. Therefore, the NRC staff finds that the impacts on the geologic environment from facility decommissioning at the MURR site would be SMALL.

#### *5.2.2.4 Water Resources*

Surface Water Hydrology, Quality, and Use

The MURR site is located within the Hinkson Creek watershed. Hinkson Creek is a major tributary to Perche Creek, which flows to the Missouri River. The MURR site is located slightly less than 8 mi (13 km) northeast of the Missouri River at its closest point. In total, the Hinkson Creek watershed drains 81 $mi^2$ (210 $km^2$) and roughly bisects the City of Columbia in a northeast to southwest direction, and it serves as the major stormwater drainage basin for the City of Columbia. Together with the MURR site, all the properties belonging to the University of Missouri drain either directly or indirectly to Hinkson Creek and ultimately to the Missouri River (MU 2006).

While no natural surface water drainages exist on the MURR site, a stormwater drainage system serves the MURR site and adjoining university properties. This system generally consists of an open system of swales and culverts (MU 2006). The MURR property drains generally south toward Hinkson Creek, which is located approximately 0.2 mi (0.3 km) south of the site.

From just south of the site (Figure 5–2), Hinkson Creek flows generally in a west to southwest direction over a sinuous course for approximately 7.6 stream mi (12.1 km) (4 linear mi (6.4 km)) from the MURR site to its confluence with the southward-flowing Perche Creek near the Columbia Regional Wastewater Treatment Plant (WWTP). Perche Creek continues flowing southwest before turning south and then southeast, paralleling the Missouri River, for a total of about 11 stream mi (17.7 km) before entering the river at a point approximately 8 mi (12.9 km) southwest of the MURR site.

The USGS maintains a gaging station on Hinkson Creek just downstream from the Highway 163 bridge (Station 06910230) at South Providence Road, approximately 0.25 mi (0.4 km) southeast of the MURR site. The mean annual discharge measured at this site for the period of record (water years 1967 through 2015) is 62.3 cubic feet per second (cfs) (1.76 cubic meters per second ($m^3$/s)). The highest peak flow was 14,200 cfs (401 $m^3$/s) on April 30, 2009. For water year 2015, the mean discharge was 112.7 cfs (3.18 $m^3$/s). The mean 90-percent exceedance flow is 0.4 cfs (0.011 $m^3/s$) for the period of record. The 90 percent exceedance flow is an indicator value of hydrologic drought. It signifies a rate of streamflow that is equaled or exceeded 90 percent of the time, as compared to the average flow for the period of record. Based on average monthly flow over the period of record at the station, August is the low-flow month, and April is the high-flow month for Hinkson Creek (USGS 2016d).

The Federal Emergency Management Agency has delineated the floodplain boundary for Hinkson Creek, which runs south of the site. The MURR site is mapped as outside the 500-year flood elevation. However, the location of the proposed NWMI facility site on the MURR site is located less than 500 ft (152 m) north of the delineated 100-year floodplain (base flood elevation 605 ft (184 m)) (FEMA 2011b). The University of Missouri (MU 2006) states that the existing MURR laboratory building is about 200 ft north of the 100-year floodplain at its closest point.

In accordance with Section 303(c) of the Federal Water Pollution Control Act (i.e., Clean Water Act (CWA)) of 1972, as amended), states have the primary responsibility for establishing, reviewing, and revising water quality standards for the Nation's navigable waters. As further discussed in Section 3.4.1.2, the State of Missouri, like other states, has established water quality standards, numeric criteria, and associated designated use categories for all waters of the State, including jurisdictional wetlands. In summary, all perennial rivers and streams, streams with permanent pools, and lakes and reservoirs that intersect the flow lines of perennial rivers and streams are designated for the following beneficial uses: aquatic habitat protection, human health protection, whole body contact recreation, and secondary contact and livestock and wildlife protection and irrigation (10 CSR 20-7.031). These uses apply to Hinkson Creek and other major streams within a 5-mi (8-km) radius of the MURR site, including Perche Creek.

CWA Section 303(d) requires states to identify all "impaired" waters for which effluent limitations and pollution control activities are not sufficient to attain water quality standards in such waters. As more fully described in Section 3.4.1.2 of this EIS, states prepare a 303(d) "list" that comprises those water quality limited stream segments that require the development of total maximum daily loads (TMDLs) to assure future compliance with water quality standards. Once established, states implement TMDLs through watershed-based programs, primarily through the National Pollutant Discharge Elimination System (NPDES permit program in accordance with CWA Section 402.

The lower reaches of Hinkson Creek downstream of the MURR site are included in the State of Missouri's 303(d) list (MDNR 2014a, 2015a). The Missouri Department of Natural Resources (MDNR) continues to list Hinkson Creek as impaired for whole body contact recreation due to water-borne *E. coli* bacteria. The reason for listing is impairment of the beneficial use due to nonpoint source runoff.

<u>Groundwater Hydrology, Quality, and Use</u>

Groundwater beneath the MURR site and the south Columbia area of Boone County occurs in unconsolidated and consolidated water-bearing deposits (aquifers). USGS broadly recognizes a surficial aquifer system and two bedrock aquifer systems in northeast Missouri, as described in Section 3.4.2.1. In general, the hydrogeology of the south Columbia area and the MURR site is similar to the Discovery Ridge site.

The overlying glacial drift, where present, produces only limited quantities of water in the Columbia area. Still, both the Mississippian and the underlying Cambrian-Ordovician aquifer systems are present beneath the site. Within the Mississippian system, the Burlington Limestone yields mainly hard water through shallow wells that is adequate to support rural domestic uses. Within the upper Ordovician age strata, the Jefferson City Formation is the principal water-bearing unit in the Columbia area. This formation averages 400 ft (122 m) thick and produces moderate quantities of water. It has been the most widely used unit for rural domestic supply (MU 2006).

Most notably, the Ordovician and Cambrian bedrock units, particularly the sandstone and dolomitic units, yield considerable water to deep wells in the Columbia area. These units are part of the Cambrian-Ordovician aquifer system (see Section 3.4.2.1). This system is about 1,300 ft (400 m) thick in the Columbia area, at depths ranging from approximately 150 to 400 ft (46 to 122 m) below ground surface (bgs). Two of the deepest formations of significance are the Eminence and Potosi Dolomites, which can produce well yields ranging from 400 to 1,100 gallons per minute (gpm) (1.5 to 4.2 cubic meters per minute ($m^3$/min)) (MU 2006). The NRC staff's review of available MDNR well logs for the area within a 2-mi (3.2-km) radius of the MURR site indicate that the depth to the Ordovician strata is marked by the Cotter Dolomite at depths of approximately 200 to 300 ft (60 to 90 m) bgs (MGS 2016; MDNR 2016e).

The MDNR maintains extensive geospatial data, including data extracted from well driller logs submitted to the State. Available MDNR data indicate that the static water level in the uppermost aquifer across the south Columbia area ranges between 600 and 625 ft (183 and 190 m) MSL. The approximate depth to groundwater (as measured from the land surface) in the area ranges between 90 and 100 ft (27 to 30 m) bgs (MGS 2016). Depth to groundwater would be less within the incised stream valleys, such as Hinkson Creek. In addition, the NRC staff expects that shallow groundwater also occurs within the stream alluvium and other unconsolidated sediments in proximity to Hinkson Creek, which runs just to the south and southwest of the site.

Groundwater is used extensively and almost exclusively across Boone County, as summarized in Section 3.4.2.2. Historically, the City of Columbia relied on a system of deep wells for public water supply. Declines in well production and other factors prompted the City to install a new well field in 1972 within the alluvial aquifer of the Missouri River floodplain (known as the McBaine Bottoms) (MU 2006; City of Columbia and MDNR 2013). The well field is located approximately 7 mi (11 km) southwest of the MURR site (MGS 2016). This production system consists of 15 alluvial wells installed to a depth of about 110 ft (33 m) in the bottom alluvium. The system has a total groundwater production capacity of 30 million gallons per day (mgd) (113,560 cubic meters per day ($m^3$/day)). Groundwater is pumped to the City's nearby McBaine water plant, where it is treated by aeration, softening, filtration, and finally by disinfection before distribution. The City of Columbia's average groundwater use is 12.6 mgd (47,700 $m^3$/day) (City of Columbia 2016c).

The City maintains four deep wells as emergency backup water sources (MU 2006; City of Columbia and MDNR 2013). These wells average 1,320 ft (402 m) in depth. They have produced groundwater yields ranging from 700 to 1,200 gpm (2.6 to 4.5 $m^3$/min) from the Eminence and Potosi Dolomites. The closest of these wells is approximately 2.3 mi (3.7 km) northwest of the existing MURR laboratory building (MU 2006).

The University of Missouri, through its Campus Facilities Department, maintains its own system of deep wells to supply potable water across the university, including providing water supply to the existing MURR Center. Five supply wells comprise the production system. These wells have depths ranging from 1,200 to 1,415 ft (366 to 431 m). The combined rated production capacity of the wells is 4,700 gpm (17.8 $m^3$/min) (MU 2006, 2016a). This is equivalent to 6.77 mgd (25,630 $m^3$/day). In 2014, university water use averaged 1.74 mgd (6,590 $m^3$/day) (MU 2015).

*Construction*

Facility construction activities at the MURR site would not have any direct impact on surface water resources because no natural watercourses originate within the boundaries of the site. Stormwater drainage ditches deliver stormwater from the site south toward Hinkson Creek, which is located approximately 0.2 mi (0.3 km) south of the site. As at the Discovery Ridge site, the potential does exist for shallow groundwater to occur south of the existing MURR main building and beneath the proposed NWMI facility site. This would require groundwater dewatering during construction, as further described and evaluated in Section 4.4.2.1. If NWMI were to select this alternative site, it would commission site-specific geotechnical and hydrologic studies to assess shallow groundwater conditions and to guide any necessary construction accommodations and final facility design.

As discussed above in Section 5.2.2.3 for construction and detailed in Section 4.3.1.1 for the Discovery Ridge site, ground-disturbing activities would be subject to a Land Disturbance Permit from the City of Columbia as well as a State of Missouri NPDES general permit (i.e., Missouri State Operating Permit MO-RA) for the discharge of stormwater from land-disturbance sites. The development application package for the Land Disturbance Permit would require NWMI to develop and implement a soil erosion and sediment control plan and a stormwater management plan. These plans entail the implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development. Further, the NPDES general permit similarly requires the development and implementation of a stormwater pollution prevention plan (SWPP) to prevent the introduction of sediment and other pollutants in stormwater discharges.

Under CWA Section 401, an applicant for a Federal license or permit to conduct any activities, including facility construction or operation, that may cause a discharge into navigable waters is required to provide the Federal licensing agency with a certification from the state or agency having jurisdiction in which the discharge would originate. This water quality certification signifies that discharges from the project or facility to be licensed by the Federal agency will comply with CWA requirements and will not cause or contribute to a violation of state water quality standards. A Federal agency cannot issue a license or permit to an applicant until the required certification is provided, or the responsible state or agency has waived the requirement. The NRC recognizes that some NPDES-delegated states explicitly integrate their 401 certification process with NPDES permit issuance. The State of Missouri regulations for administering its water quality certification process are at 10 CSR 20-6.060.

The only regulated direct discharges from the proposed facility involve stormwater associated with construction activity. As referenced above, NWMI would obtain coverage under a State-issued NPDES general permit for such discharges. Permit provisions are intended to ensure that the State’s water quality standards are met. NWMI has stated that no State certification is required under CWA Section 401 (NWMI 2015a). NWMI also has stated that it would seek a waiver from the State (NWMI 2015c). However, because the NRC cannot issue a construction permit without the required certification, NWMI must provide the NRC with either a 401 certification from the State of Missouri, a waiver, or other State documentation that a Section 401 certification is not necessary. During construction, water would be required for such uses as dust control, soil compaction, as well as to meet the drinking and sanitary needs of the construction workforce during the construction period. NWMI would not use surface water or onsite groundwater to support facility construction at the site. Instead, the NRC staff expects that the University of Missouri campus water utility (Campus Facilities Department) that currently provides water to the existing MURR Center would supply water to the NWMI facility site. Water could be supplied during construction by trucking it to the point of use or through a portable water tap from a nearby service line or hydrant, until a permanent water service line is constructed. Construction activities would require an average of 6,140 gallons per day (gpd) (23,200 liters per day (Lpd)) of water, equivalent to 0.006 mgd (23 $m^3$/day). This projected daily demand is a very small percentage (i.e., about 0.34 and 0.12 percent) of the University's existing demand and available production capacity, respectively. Wastewater generation would be limited to sanitary waste from the construction workforce and would likely be accommodated using portable restroom facilities.

No natural surface water features occur on the site, and NWMI would not divert or withdraw surface water or onsite groundwater during construction. NWMI would also be subject to compliance with City and State permits, including an NPDES general permit for the discharge of stormwater from a land-disturbance site. Therefore, the NRC staff concludes that the impacts on surface water and groundwater hydrology, water quality, and water use from the construction of the NWMI facility at the MURR site would be SMALL.

*Operations*

Normal facility operations would not have any direct impact on surface water or groundwater hydrology or quality. Stormwater runoff from the proposed NWMI facility at the MURR site would also be managed by an engineered stormwater management system, including necessary detention/retention structures, constructed and operated in compliance with applicable local, State, and Federal stormwater management permits, plans, procedures, and practices, as discussed in Sections 4.4.1.2 and 4.4.2.2 for the Discovery Ridge site.

There would be no radioactive liquid effluents released from the facility because the RPF portion of the facility is designed to have zero liquid discharge. NWMI would conduct all material, chemical, and waste handling activities within the confines of the NWMI facility, precluding any releases to the environment, including soils and groundwater. The only liquid waste stream discharged from the facility would be sanitary wastewater at an average rate of approximately 4,570 gpd (17,300 Lpd). NWMI would discharge this wastewater to the City of Columbia Sanitary Sewer Utility, which also receives effluent from the existing MURR Center (MU 2006). The Columbia Regional WWTP provides treatment of the sanitary wastewater discharged into the sewer system, and the WWTP has excess treatment capacity available. The effluent would be required to meet the system's influent acceptance and treatment criteria, as well as NRC's regulations at 10 CFR 20.2003 (see Section 4.4.1.2).

Water use for facility operations would require an average of 5,045 gpd (19,100 Lpd) of water, equivalent to 0.005 mgd (18.9 $m^3$/day), as previously described in Section 4.4.2.2 for the Discovery Ridge site. A service connection from the University of Missouri campus water utility would provide water to the NWMI facility. Similar to the projected water needs for construction, the NWMI facility's projected operational water needs are a small percentage (i.e., about 0.29 and 0.1 percent) of the University's existing water supply demand and available production capacity, respectively.

The proposed NWMI facility would not divert or withdraw surface water or onsite groundwater to support facility operation at the MURR site because the University of Missouri's campus utility would provide water supply. There would be no discharge of industrial or radiological effluents to surface water or groundwater, and the NWMI facility operations would need to comply with local, State, and Federal stormwater management permits, plans, procedures, and practices. Accordingly, the NRC staff concludes that the impacts on surface and groundwater hydrology, water quality, and water use from the operation of the NWMI facility at the MURR site would be SMALL.

*Decommissioning*

Facility decontamination, demolition, and site-restoration activities would be similar, regardless of the site, with the potential magnitude of the impacts on surface water and groundwater similar to those discussed for construction. The NRC staff expects that a State-issued NPDES general permit would be required for the discharge of stormwater from land-disturbance sites. NWMI would conduct site activities in accordance with appropriate BMPs and would observe waste handling and pollution prevention practices and response procedures during decommissioning, such that no materials or contaminants are released to soils, surface water, or underlying groundwater.

As previously referenced for the Discovery Ridge site (see Section 4.4.2.3), NWMI would conduct decommissioning work and activities in accordance with a decommissioning plan submitted to the NRC. NWMI would be required to conduct necessary surveys of the soils and subsurface to comply with the NRC's radiological criteria for license termination in 10 CFR Part 20, Subpart E. The NRC staff also expects that NWMI would sample soils and other media as necessary in accordance with other required local and State permits and approvals to ensure that no nonradiological contamination remains in excess of action levels.

Some water would be required for dust control and soil compaction during decommissioning (Section 4.4.2.3). NWMI estimates that decommissioning activities would require an average of 2,000 gpd (7,600 Lpd) of water, equivalent to 0.002 mgd (7.6 $m^3$/day) during the 24-month decommissioning period. The NRC staff assumes that the University of Missouri campus water utility would also supply water for decommissioning. The projected water volume is less than the volume required for facility construction, as discussed above, and the impacts on supply capacity would similarly be negligible.

Given that no natural surface water features occur on the MURR site, that water requirements would be minimal, and that NWMI would develop and implement stormwater pollution prevention and spill response procedures as part of local and State permit requirements for ground-disturbing activities, the NRC staff concludes that the impacts on water resources from facility decommissioning would be SMALL.

#### *5.2.2.5 Ecological Resources*

The MURR facility complex consists of 7.5 ac (3.0 ha) of existing buildings, parking lots, a few deciduous trees, and some ornamental grasses and shrubs (NWMI 2015a and NWMI 2016c; NRC 2015b). The MURR site provides habitat for birds, mammals, amphibians, reptiles, and other wildlife tolerant of human-modified landscapes, and frequent disturbances from human activity. Birds and wildlife may use the MURR site to feed on vegetation, as a temporary resting location, or while traveling among other habitats. Therefore, species would likely be similar to those described in Section 3.5.3 for the proposed Discovery Ridge site. Wildlife that require dense stands of trees, native plants, shrubs, or uncultivated grasses would not use the proposed site because of the lack of forested areas, wetlands, and native grasslands.

No water bodies or aquatic habitats exist within the boundaries of the MURR site. The MURR site drains generally south toward Hinkson Creek, which is located approximately 0.2 mi (0.3 km) south of the site.

The NRC staff determined that the Federal and State-listed species that have the potential to exist within the MURR site are the same as those that have the potential to occur on the proposed Discovery Ridge site. The NRC staff made this determination based on FWS's online database (FWS 2016), the Missouri Department of Conservation's (MDC's) description of State-listed species (MDC 2000a, 2000b, 2016b), and the NWMI ER (NWMI 2015a). The NRC staff reviewed the habitat requirements for these species and determined that no suitable habitat for any of the State endangered or Federally listed species occur on the MURR site (see Table 3–11). The NRC staff did not observe any Federally listed or State-endangered species on the MURR site during the site audit (NRC 2015b).

The FWS also administers the Migratory Bird Treaty Act (16 U.S.C. 703–712), which prohibits anyone from taking native migratory birds or their eggs, feathers, or nests. FWS (2015a, 2016) determined that the same migratory birds likely use the proposed Discovery Ridge site and the MURR site given their proximity to one another and because both sites have been heavily modified by human activities. In the vicinity of the site, migratory birds rely on riparian, forested, grassland, and wetland habitats as important areas for foraging, resting, avoiding predators, and, for some species, breeding. On the MURR site, migratory birds likely use trees for resting and possibly for limited foraging.

<u>Construction</u>

Construction of the NWMI facility would occur within a paved parking lot that provides minimal, if any, habitat to species highly tolerant of human activity (NWMI 2015a). Noise from construction activities could disturb birds and wildlife. In response to such disturbances, birds and wildlife could move out of the immediate area and find adequate, similar habitat within the vicinity.

During construction, bird collisions with construction equipment and the new facility could result in mortality from the presence of tall structures (e.g., stacks or cranes) and artificial night lighting during nighttime construction. The size of structures and the likelihood of mortality from bird collisions would be similar to that described in Section 4.5 for the proposed Discovery Ridge site. In that analysis, the NRC staff determined that impacts from bird collisions would be negligible and unlikely to affect local or migratory populations, based on previous reviews of bird collisions at nuclear power plants that are similar or larger in height and size than the proposed NWMI facility.

Construction at the MURR site is not expected to result in any direct impacts on aquatic resources, such as habitat loss, because no aquatic resources would be within the footprint of the proposed facility or the construction laydown areas. Runoff from the site could affect offsite aquatic resources by increasing turbidity or introducing various chemicals or other pollutants. However, impacts on aquatic resources are expected to be minimal because of the distance to Hinkson Creek, and NWMI would be required, in its stormwater permit, to use appropriate soil erosion and sediment control BMPs.

Given that construction would not permanently or temporarily affect any high-quality habitats, such as grasslands, undisturbed forests, or wetlands; that permanently and temporarily affected habitats are abundant within the region; that mortality from bird collisions is expected to be negligible; and that no State-endangered or Federally listed species are likely to occur on the site, the NRC staff concludes that impacts on ecological resources during construction of the proposed NWMI facility at the MURR site would be SMALL.

<u>Operations</u>

During operations, impacts on ecological resources could result from bird collisions, herbicide applications for landscape maintenance activities, elevated noise levels, and increased turbidity or introduction of pollutants from runoff. As described in Section 4.5, mortality from bird collisions is expected to be negligible, given that the tallest structure would be a stack approximately 75 ft (23 m) tall. Disturbance from daily activities, herbicide applications, or elevated noise levels is likely to have minimal impacts on wildlife and plant species, given that the species identified at the MURR site are tolerant of disturbance, because of current operations at the existing research reactor and other nearby educational facilities. In response to any disturbances during operations, birds and wildlife could move out of the immediate area and find adequate, similar habitat within the vicinity.

Operation of the facility is not expected to result in any direct impacts on aquatic resources, because wastewater would be not be discharged to any waterbody (NWMI 2015a). Indirect impacts during operations could include runoff that may contain sediments, contaminants from road and parking surfaces, or herbicides. However, as described above, impacts on aquatic resources are expected to be minimal because of the distance to Hinkson Creek, and NWMI would be required, in its stormwater permit, to use appropriate soil erosion and sediment control BMPs.

Given that mortality from bird collisions is expected to be negligible, that habitat disturbances during operations would be minimal, that any disturbed wildlife could find similar habitat in the vicinity, that BMPs would be required in the NWMI stormwater permit, and that no Federally or State-listed species occur on the MURR site, impacts on ecological resources during operations of the proposed NWMI facility at the MURR site would be SMALL.

Decommissioning

Decommissioning activities would have similar impacts on those that occur during construction. For example, NWMI would use construction equipment to dismantle large buildings, which could result in disturbances to wildlife and birds and potential runoff to nearby water bodies. In addition, some land on the site could be used as staging areas for the equipment and to conduct certain dismantling activities. As described above, if noise or other activities disturb birds or wildlife, similar habitat is available in nearby offsite areas. No surface water would be used during decommissioning, and NWMI would develop and implement spill prevention and response procedures as part of State permit requirements for ground-disturbing activities. Therefore, impacts during decommissioning of the proposed NWMI facility at the MURR site are expected to be SMALL.

#### *5.2.2.6 Historic and Cultural Resources*

The general cultural background and chronological sequence of human occupation at the MURR site and vicinity would be the same as that described for the Discovery Ridge Research Park site in Section 3.6.1. The NWMI facility would be located on previously disturbed land adjacent to the south side of the existing University of Missouri Laboratory and Reactor Containment Buildings, colloquially known as the “Laboratory Building” (MU 2010; NWMI 2015c). The Laboratory Building was originally constructed in 1964 and is located on a 7.5 ac (3 ha) plot of land within the larger University Research Park, an 84 ac (34 ha) tract approximately 1 mi (1.6 km) southwest of the main campus. During MURR Center’s original construction, trees were removed from the site and approximately 15,000 $yd^3$ (11,500 $m^3$) of fill was deposited on the south and central portions of the site. Several additions and a new building have subsequently been constructed at this location (MU 2006, 2010).

A review of databases maintained by the National Park Service indicates that there are 50 properties listed in the National Register of Historic Places (NHRP) in Boone County, with the vast majority of them located in and around Columbia. However, no historic properties are located on the 7.5 ac (3 ha) MURR Center (NWMI 2015a). The nearest property on the NRHP list is the Sanford F. Conley House, which is located on the University of Missouri main campus about 1 mi (1.6 km) north-northeast of the existing MURR Center (MU 2006, 2010). The view from the Sanford F. Conley House of the MURR site is obstructed by trees and campus properties.

No archeological survey was commissioned by NWMI for the MURR site. However, a review of state archaeological records conducted by the University of Missouri in 2010 found no evidence of archaeological sites on the 7.5 ac (3 ha) MURR site. The nearest recorded archaeological site was identified approximately 1,000 ft (300 m) northeast of the existing MURR Center (MU 2010).

*Construction*

Construction would maintain previously disturbed paved and open space in industrial use. Since no historic properties (36 CFR 800.4(d)(1)) would be affected and no archaeological sites or evidence of cultural resources have been identified during previous archaeological reviews, historic and cultural resources are not likely to be impacted by the construction of the proposed NWMI facility at the MURR site. Construction of the NWMI facility would also have little or no visual impact as discussed in Section 5.2.2.1. The nearest NRHP site, the Sanford F. Conley House, is about 1 mi (1.6 km) away to the north-northeast, and its view is obstructed by trees and campus properties. Based on these factors, construction of the NWMI facility would not impact any known historic and cultural resources at the MURR site.

*Operations*

Because no historic properties (as defined by 36 CFR 800.4(d)(1)) would be affected and no archaeological sites or evidence of cultural resources have been identified during previous archaeological reviews, historic and cultural resources would not likely be impacted during NWMI facility operations at the MURR site. The completed NWMI facility would also have little or no visual impact. The nearest NRHP site, the Sanford F. Conley House, is about 1 mi (1.6 km) away to the north-northeast, and its view is obstructed by trees and campus properties. Based on these factors, operation of the NWMI facility would not impact any known historic and cultural resources at the MURR site.

*Decommissioning*

Because no historic properties (as defined by 36 CFR 800.4(d)(1)) would be affected and no archaeological sites or evidence of cultural resources have been identified during previous archaeological reviews, historic and cultural resources would not likely be impacted during the decommissioning of the NWMI facility operations at the MURR site. Decommissioning of the NWMI facility would also have little or no visual impact. The nearest NRHP site, the Sanford F. Conley House, is about 1 mi (1.6 km) away to the north-northeast, and its view is obstructed by trees and campus properties. Based on these factors, decommissioning of the NWMI facility would not impact any known historic and cultural resources at the MURR site.

#### *5.2.2.7 Socioeconomics*

The MURR site and the Discovery Ridge site share the same socioeconomic ROI. Both are located in the City of Columbia, Boone County, Missouri. The number of workers needed to construct, operate, and decommission the proposed NWMI facility at the MURR site would be the same or similar. The description of the affected environment and the socioeconomic impacts of constructing, operating, and decommissioning the proposed NWMI facility at the MURR site would be the same as described for the Discovery Ridge site in Sections 3.7 and 4.7. Therefore, the socioeconomic impacts from constructing, operating, and decommissioning the proposed NWMI facility at the MURR site would be SMALL.

#### *5.2.2.8 Human Health*

*Construction*

Construction of the proposed NWMI facility at the MURR site would be essentially the same as construction at the Discovery Ridge site. There would be no significant differences in the design of the RPF building of the facility, with the exception of a below-grade corridor constructed between the RPF building of the facility and the existing MURR basement (NWMI 2015a, 2016c). The MURR basement is an area is which construction workers could potentially be exposed to radiation. Construction workers working in this area would be considered occupational radiation workers, and radiological controls and monitoring would be put into place to protect construction workers and to ensure that construction workers' occupational worker dose would be maintained within 10 CFR Part 20 limits; however, NWMI expects that, due to the controls used, no measureable radiation dose would be received by the construction workers (NWMI 2016c). Construction workers for a facility at the MURR site would be exposed to similar physical occupational hazards as construction workers at the Discovery Ridge site, and any chemical exposure to workers or members of the public would also be similar. All occupational or material hazards would be controlled to ensure compliance with all applicable Federal and State regulations (NWMI 2015a). In Section 4.8.1 of this EIS, the NRC staff concluded that the radiological and nonradiological human health impacts from construction of the proposed NWMI facility at the Discovery Ridge site would be SMALL. Because there are no significant differences in construction or facility design except for the below-grade corridor, and because any potential hazards associated with construction would continue to be subject to Federal and State of Missouri regulations, the NRC staff concludes that the human health impacts from construction of the proposed NWMI facility at the MURR site would also be SMALL.

*Operations*

The operation of the proposed NWMI facility at the MURR site would also be essentially the same as operation at the Discovery Ridge site.

Radiological human health factors associated with an NWMI facility at the MURR site, including radiation sources, radioactive effluents, worker doses, and dose mitigation measures, would be the same as they would be for an NWMI facility at the Discovery Ridge site (NWMI 2015a). As stated in Section 4.8.2.1, NWMI estimated that the dose to the maximally exposed offsite member of the public from radioactive effluents emitted during operation of the proposed facility at the Discovery Ridge site would be 3.6 millirem (mrem) per year. This dose would be received by an individual located at the site boundary, 30 ft (9.1 m) from the facility stack at the Discovery Ridge site (NWMI 2016a). NWMI expects that the nearest distance to the site boundary from the facility stack would not vary by more than a few meters compared with the Discovery Ridge site, and that the dose to a member of the public at the site boundary for routine radioactive effluent releases would not change significantly for the MURR alternative site relative to the Discovery Ridge site (NWMI 2016c). A facility at the MURR site would continue to be subject to the NRC's dose limits in 10 CFR Part 20.

Due to the proximity of an NWMI facility at the MURR site to MURR, the NRC staff assumes that no public highway transportation of unirradiated or irradiated LEU targets between the NWMI facility and MURR would be needed. However, the NRC staff assumes that doses from transportation of targets between the NWMI facility and the other two research reactors (OSTR and a third reactor) would be very similar for an NWMI facility located at either site due to the proximity of the MURR site and Discovery Ridge site.

Nonradiological human health factors associated with an NWMI facility at the MURR site, including chemicals and hazardous materials present at the site, nonradioactive effluents, potential chemical exposures to workers and/or the public, physical occupational hazards, and mitigation measures for nonradiological human health impacts, would also essentially be the same as they would be for an NWMI facility at the Discovery Ridge site. All occupational or material hazards would be controlled to ensure compliance with all applicable Federal and State regulations (NWMI 2015a).

In Section 4.8.2 of this EIS, the NRC staff concluded that the radiological and nonradiological human health impacts from operation of the proposed NWMI facility at the Discovery Ridge site would be SMALL. Because there are no significant differences in facility design or operation, and because any potential radiological or nonradiological hazards associated with operation would continue to be subject to Federal and State of Missouri regulations, the NRC staff concludes that the human health impacts from operation of the proposed NWMI facility at the MURR site would also be SMALL.

*Decommissioning*

Since the design and operation of the proposed NWMI facility at the MURR site would be similar to that at the Discovery Ridge site, and the general characteristics of the two sites are also similar, the NRC staff expects that the decommissioning of the proposed facility at the MURR site would also be similar to that at the Discovery Ridge site. Any occupational, chemical, or radiological hazards to workers and/or the public would be similar, and would be required to be in compliance with all applicable Federal and State of Missouri regulations. In Section 4.8.3 of this EIS, the NRC staff concluded that the radiological and nonradiological human health impacts from decommissioning of the proposed NWMI facility at the Discovery Ridge site would be SMALL. Because there would be no significant differences in facility decommissioning, and because any potential radiological or nonradiological hazards associated with decommissioning would continue to be subject to Federal and State of Missouri regulations, the NRC staff concludes that the human health impacts from decommissioning of the proposed NWMI facility at the MURR site would also be SMALL.

#### *5.2.2.9 Waste Management*

Construction, operations, and decommissioning of the proposed NWMI facility at the MURR site would be essentially the same as at the Discovery Ridge site. The NRC staff expects that there would be no physical differences between the design of the facilities that would change the types or volumes of radiological or nonradiological wastes generated during construction, operations, or decommissioning of the proposed facility at the MURR site. The disposal pathways for radioactive waste produced by an NWMI facility at the MURR site would be the same as for a facility at the Discovery Ridge site (NWMI 2016a). The distance that radioactive waste produced during operations or decommissioning would need to be transported to reach a disposal site would be effectively the same for either site. In addition, because of the proximity of the MURR site to the Discovery Ridge site and the similar waste disposal infrastructure, the NRC staff expects disposal pathways for nonradioactive waste (including hazardous waste) at the MURR site to be similar to the Discovery Ridge site. All waste management activities at an NWMI facility at the MURR site would be required to comply with all applicable Federal, State, and local regulations.

In Section 4.9 of this EIS, the NRC staff concluded that impacts from radioactive and nonradioactive waste management during construction, operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site would be SMALL. Because there would be no significant differences in waste management, and because waste management would continue to be subject to Federal, State, and local regulations, the NRC staff concludes that the impacts from waste management of the proposed NWMI facility at the MURR site during construction, operations, and decommissioning would also be SMALL.

*5.2.2.10 Transportation*

Affected Environment

Figure 5–1 shows major roads and transportation features in the vicinity of the MURR site. The MURR site is located within the City of Columbia limits. Research Park Drive provides direct access to the site.

Research Park Drive intersects with old Route K and South Providence Road (Missouri Route 163), a four-lane roadway in Boone County, about 0.15 mi (0.25 km) to the east. The MURR site has direct easy access to Route 163. Route 163's northern terminus is at U.S. Interstate 70/U.S. Route 40 (I-70/US 40) in Columbia; its southern terminus is at U.S. Highway 63 south of Columbia. Route 163 also intersects with Stadium Boulevard (Missouri Route 740) approximately 0.6 mi (1 km) to the north. Route 740 intersects with U.S. Highway 63, 2.3 mi (3.7 km), to the east. U.S. Highway 63 continues to Jefferson City, Missouri, 31 mi (50 km) to the south. U.S. Interstate 70 proceeds approximately 125 mi (201 km) east to St. Louis, Missouri, and 125 mi (201 km) west to Kansas City, Missouri. Current average daily traffic volumes for nearby roads is listed in Table 5–2.

**Table 5–2. Average Daily Traffic Counts in the Vicinity of the MURR Site 2013**

| Road | Section | Average Daily Traffic |
|---|---|---|
| Route 163 | South of I-70 | 21,114 |
| I-70 | East of Route 163 | 66,297 |
| I-70 | West of Route 163 | 73,758 |
| Route 163 | South of Route 740 | 29,802 |
| Route 740 | East of Route 163 | 31,151 |
| Route 740 | At U.S. Highway 63 | 21,965 |
| U.S. Highway 63 | North of Route 740 | 47,234 |
| U.S. Highway 63 | South of Route 740 | 45,006 |
| Route 163 | North of Grindstone Parkway | 26,900 |
| Grindstone Parkway | East of Route 163 to U.S. Highway 63 | 35,142 |

Source: MODOT 2013

Impact Analysis

This section describes potential transportation impacts during the construction, operations, and decommissioning of the proposed NWMI facility at the MURR site. The impact analysis considers changes in traffic volumes on the existing roadway network. The number of workers and truck deliveries and shipments needed to construct, operate, and decommission the NWMI facility at the MURR site would be the same or similar as the Discovery Ridge site.

*Construction*

Similar to construction at Discovery Ridge, transportation impacts would be caused by an increase in commuter vehicles and construction trucks on local roads. Construction workers would arrive via site access roads and traffic volumes on these roads would increase during shift changes. In addition, trucks would deliver construction equipment and material to the work site and remove construction waste material, thus adding to traffic volumes on site access roads. The increase in vehicular traffic would peak during certain hours of the day (e.g., shift changes), resulting in temporary levels of service impacts and possible delays at intersections.

During construction, an average daily workforce of 38 workers would be commuting to and from the work site for 17 months. During peak construction, up to 82 workers could be commuting daily to the construction site. In addition, an average of 20 trucks per week (4 trucks per day) would deliver construction equipment and material to the work site. An additional 1 truck per week would remove construction waste (NWMI 2015a, 2015c).

Due to the small size of the average daily workforce, the low number of daily truck deliveries and shipments combined with the short duration of construction (17 months) and easy access to Route 163, there would be little if any noticeable traffic volume-related level of service impacts. Therefore, transportation impacts during the construction of the proposed NWMI facility at the MURR site would be SMALL.

*Operations*

Transportation impacts occurring during operation of the proposed NWMI facility would be caused by an increase in commuter vehicles and delivery trucks on local roads. Operations workers would arrive via site access roads and traffic volumes on these roads would increase during shift changes. In addition, trucks would deliver production material, ship products, and remove waste material, thus adding to the traffic volumes on site access roads. The increase in vehicular traffic would peak during certain hours of the day (e.g., shift changes), resulting in temporary levels of service impacts and possible delays at intersections.

During operations, 98 workers would be commuting to and from the MURR site (NWMI 2015a). In addition, an average of 2 to 4 trucks per week would deliver nonradioactive material; an average of 2 to 3 trucks per week would deliver irradiated LEU targets; and another two trucks per year would deliver fresh LEU (NWMI 2015a, 2016a).

In addition, outbound truck traffic would include the following:

(1) an average of 1 truck shipment per week of LEU targets to irradiation facilities,

(2) an average of 2 shipments per week of medical isotope product through the Columbia Regional Airport,

(3) an average of 3 to 4 shipments per week of waste, and

(4) an average of 2 truck shipments per year of take back LEU (NWMI 2015c, 2016a).

Medical isotope product shipments to customers would be transported from the NWMI facility by truck to the Columbia Regional Airport, over 13 mi (21 km) away. Radioactive and nonradioactive waste would also be transported by common truck carrier from the NWMI facility to an offsite storage, treatment, or disposal facility.

The relatively small size of the workforce and low number of daily truck deliveries and shipments would generate little if any noticeable traffic volume-related level of service impacts. Therefore, given the size of the operations workforce, the number of trucks, and easy access to Route 163, transportation impacts during NWMI facility operations at the MURR site would be SMALL.

*Decommissioning*

Transportation impacts occurring during decommissioning would be caused by an increase in commuter vehicles and trucks on local roads. Decommissioning workers commuting to the work site would arrive via site access roads and traffic volumes on these roads could increase during shift changes. In addition, trucks would deliver equipment and material to the work site and remove waste material, thus adding to traffic volumes on site access roads. The increase in vehicular traffic would peak during certain hours of the day (e.g., shift changes), resulting in temporary levels of service impacts and possible delays at intersections.

During construction, an average daily workforce of 38 workers would be commuting to and from the work site for 18 to 24 months. During peak decommissioning activities, up to 81 workers could be commuting daily. In addition, an average of 1 truck per week would deliver equipment and material to the work site. An additional 20 trucks per week would remove construction waste (NWMI 2015a).

The small size of the average daily workforce, the low number of daily truck deliveries and shipments combined with the short duration of decommissioning (18 to 24 months) and easy access to Route 163, there would be little if any noticeable traffic volume-related level of service impacts. Therefore, transportation impacts during the decommissioning of the proposed NWMI facility at the MURR site would be SMALL.

#### *5.2.2.11 Accidents*

The design and operation of the proposed NWMI facility constructed at the MURR site would be essentially the same as it would be for a facility constructed at the Discovery Ridge site (NWMI 2015a). Therefore the NRC staff expects that the quantities of radionuclides and hazardous chemicals that could be released during a possible radiological or chemical accident, as well as any safety features to prevent or mitigate chemical or radioactive material releases during any accident, would also be the same. The distances from the nearest publicly accessible locations (along the facility fence line) to the radiological and chemical accident release points would also be similar for the MURR alternative site and the Discovery Ridge site (NWMI 2016c). For a proposed NWMI facility at the Discovery Ridge site, the nearest permanent residence would be approximately 430 m (0.27 mi) away; for a facility constructed at the MURR site, the nearest resident would be approximately 762 m (0.47 mi) away (NWMI 2015a).

In Section 4.11.1 of this EIS, the NRC staff concluded that the impacts from potential radiological accidents for the proposed NWMI facility constructed at the Discovery Ridge site would be SMALL. For a proposed NWMI facility at the MURR site, the location of the nearest resident would change, but the NRC staff expects that the maximum offsite accident dose to any member of the public, and the point where the maximum offsite dose would be received relative to the location of the facility, would not change significantly (as the quantity of radiological material released would be the same, and weather or other factors that could affect dispersion of radioactive materials would be very similar). The population density of individuals living and working around both sites would also be similar (NWMI 2015a). Therefore the unmitigated consequences of radiological accidents for members of the public would be very similar for a proposed NWMI facility at either site. The unmitigated consequences for NWMI facility staff would also be very similar or identical. The NRC staff expects that a proposed NWMI facility at the MURR site would use similar engineering and administrative controls to reduce the consequences and likelihood of accidents that an NWMI facility at the Discovery Ridge site would. Given the similarity of potential radiological accidents for a proposed NWMI facility at the MURR site to radiological accidents for a facility at Discovery Ridge, and given the similar number and distribution of members of the public near either site, if the NRC staff determines in its SER that the proposed NWMI facility at Discovery Ridge would comply with 10 CFR 70.61 and any other NRC regulations applicable to radiological accident consequences, then the NRC staff concludes that the impacts from potential radiological accidents for a proposed NWMI facility located at the MURR site would also be SMALL.

In Section 4.11.2 of this EIS, the NRC staff concluded that the impacts from potential hazardous chemical accidents for the proposed NWMI facility constructed at the Discovery Ridge site would be SMALL. For potential chemical accidents at the proposed NWMI facility at Discovery Ridge, NWMI determined that the highest chemical exposures would occur along the facility fence line, which is the nearest location to the facility accessible by members of the public. Given that the nearest location accessible to the public would be similar for a facility at the MURR site, and that the quantity of hazardous chemicals released would be the same, the unmitigated consequences of chemical accidents for members of the public would be very similar for an NWMI facility at either site. The unmitigated consequences for NWMI facility staff would also be very similar or identical. The NRC staff expects that a proposed NWMI facility at the MURR site would use similar engineering and administrative controls to reduce the consequences and likelihood of accidents compared to an NWMI facility at the Discovery Ridge site. Given the similarity of potential hazardous chemical accidents for a proposed NWMI facility at the MURR site to hazardous chemical accidents for a facility at Discovery Ridge, if the NRC staff determines in its SER that the proposed NWMI facility at Discovery Ridge would comply with 10 CFR 70.61 and any other NRC regulations applicable to chemical accident consequences, then the NRC staff concludes that the impacts from potential hazardous chemical accidents for a proposed NWMI facility located at the MURR site would also be SMALL.

##### *5.2.2.12 Environmental Justice*

This section describes the potential human health and environmental effects from the construction, operations, and decommissioning of the proposed NWMI facility on minority and low-income populations living near the MURR site. As previously discussed in Section 4.12, the NRC addresses environmental justice issues and concerns by first identifying potentially affected minority and low-income populations and then determining whether there would be any potential human health or environmental effects and whether any of these effects would be disproportionately high and adverse.

Minority population data are available for Census block groups within a 5-mi (8-km) radius of the MURR site. Low-income population data are only available at the Census tract level because of the limited availability of poverty and income data at the block group level. To protect confidentiality, the United States Census Bureau (USCB) does not publish information about small geographic areas if the population size is too small. Race and ethnicity, and poverty and income data were used to determine the presence of minority and low-income populations. If the center point of the Census tract and block group is within the 5-mi (8-km) radius boundary, data from the entire Census tract or Census block group was used.

<u>Minority Population</u>

According to the 2010 Census, approximately 23 percent of the City of Columbia population (which includes more than one Census tract and block group) identified themselves as minority. According to the USCB’s 2014 American Community Survey 1-Year Estimates, since 2010 minority population in the City of Columbia was estimated to have increased by approximately 3,000 persons and now comprise 24 percent of the population (see Table 3–15). (UCSB 2016c)

Approximately 23 percent of the population identified themselves as minority individuals (Table 5–3) within the 5-mi (8-km) radius of the MURR site and the existing industrial park (MCDC 2016b). The largest minority group was Black or African American at 10.8 percent, followed by Asian at 5.2 percent (MCDC 2016b).

Census block groups were considered minority population block groups if the percentage of the minority population within any block group exceeded 23 percent. Twenty-five of the 58 Census block groups were found to have meaningfully greater minority populations. These block groups are concentrated predominantly north and east of the MURR site within the City of Columbia. The MURR site is located in Census Tract 11.03, Block Group 4, with a minority population of 18.5 percent.

**Table 5–3. Minority Populations in Census Block Groups Within 5 mi (8 km) of the MURR Site**

| Census Tract | Block Group | Total Population | Minority Population[(a)] | Percent Minority |
|---|---|---|---|---|
| 2 | 1 | 665 | 139 | 20.9 |
| 2 | 2 | 1,065 | 171 | 16.1 |
| 3 | 1 | 641 | 66 | 10.3 |
| 3 | 2 | 1,151 | 81 | 7.0 |
| 3 | 3 | 1,218 | 229 | 18.8 |
| **5** | **1** | **1,441** | **536** | **37.2** |
| 5 | 2 | 1,353 | 258 | 19.1 |
| 6 | 1 | 1,151 | 82 | 7.1 |
| 6 | 2 | 930 | 53 | 5.7 |
| 6 | 3 | 1,237 | 98 | 7.9 |
| 6 | 4 | 1,284 | 193 | 15.0 |
| **7** | **1** | **734** | **263** | **35.8** |
| **7** | **2** | **1,543** | **433** | **28.1** |
| **7** | **3** | **1,265** | **309** | **24.4** |
| **9** | **1** | **798** | **263** | **33.0** |
| **9** | **2** | **713** | **390** | **54.7** |
| **10.01** | **1** | **1,316** | **373** | **28.3** |
| **10.01** | **2** | **864** | **222** | **25.7** |
| 10.01 | 3 | 2,476 | 446 | 18.0 |
| 10.02 | 1 | 2,979 | 462 | 15.5 |
| **10.02** | **2** | **2,194** | **529** | **24.1** |
| 10.02 | 3 | 777 | 97 | 12.5 |
| 11.01 | 1 | 2,815 | 522 | 18.5 |
| 11.01 | 2 | 3,304 | 666 | 20.2 |
| 11.01 | 3 | 2,509 | 501 | 20.0 |
| 11.03 | 1 | 1,421 | 136 | 9.6 |
| 11.03 | 2 | 2,475 | 286 | 11.6 |
| **11.03** | **3** | **1,281** | **312** | **24.4** |
| 11.03 | 4 | 1,537 | 284 | 18.5 |
| 11.04 | 1 | 3,444 | 508 | 14.8 |
| 11.04 | 2 | 3,920 | 491 | 12.5 |
| **11.04** | **3** | **3,265** | **796** | **24.4** |
| 12.01 | 1 | 1,079 | 155 | 14.4 |

| Census Tract | Block Group | Total Population | Minority Population[(a)] | Percent Minority |
|---|---|---|---|---|
| 12.01 | 2 | 1,042 | 114 | 10.9 |
| 12.01 | 3 | 3,055 | 571 | 18.7 |
| 12.01 | 4 | 644 | 65 | 10.1 |
| 12.02 | 1 | 2,341 | 369 | 15.8 |
| 12.02 | 2 | 2,882 | 418 | 14.5 |
| **13** | **1** | **1,218** | **622** | **51.1** |
| **13** | **2** | **2,618** | **728** | **27.8** |
| 14 | 1 | 5,724 | 1,299 | 22.7 |
| 14 | 2 | 1,807 | 389 | 21.5 |
| **14** | **3** | **1,191** | **295** | **24.8** |
| **14** | **4** | **2,711** | **729** | **26.9** |
| **15.02** | **2** | **2,172** | **822** | **37.8** |
| **15.02** | **3** | **712** | **396** | **55.6** |
| **15.04** | **1** | **1,959** | **550** | **28.1** |
| **15.04** | **2** | **2,077** | **721** | **34.7** |
| **15.04** | **3** | **3,975** | **1,130** | **28.4** |
| **15.04** | **4** | **1,095** | **642** | **58.6** |
| **18.05** | **1** | **4,628** | **1,154** | **24.9** |
| 18.05 | 2 | 3,264 | 643 | 19.7 |
| **21** | **1** | **816** | **492** | **60.3** |
| **21** | **2** | **1,472** | **858** | **58.3** |
| **21** | **3** | **832** | **264** | **31.7** |
| 22 | 1 | 3,230 | 674 | 20.9 |
| 22 | 2 | 2,203 | 389 | 17.7 |
| 22 | 3 | 1,320 | 62 | 4.7 |

[(a)] Includes people of Hispanic, Latino, or Spanish ethnicity.
Census block groups with minority population percentages greater than 23 percent are in **bold**.

Sources: USCB 2010 Census Summary File 1, Table P9, Hispanic or Latino or Not Hispanic or Latino by Race (USCB 2016b)

Low-Income Population

According to 2010–2014 American Community Survey estimates, an average of 11.3 percent of families and 20.7 percent of all people residing in Boone County were identified as living below the Federal poverty threshold. In addition, the City of Columbia had an average of 13.2 percent of families and 24.9 percent of all people identified as living below the Federal poverty level. The Federal poverty threshold for a family of four was $22,314 in 2010 and $24,230 in 2014 (USCB 2016d).

Table 5–4 lists low-income population Census tracts within a 5-mi (8-km) radius of the MURR site and the estimated average number of people living below the poverty level. According to the USCB's American Community Survey 5-Year Estimates for 2010–2014, 25.9 percent of the total population within that radius was identified as living below the Federal poverty level (MCDC 2016b).

Census tracts were considered low-income population Census tracts if the percentage of individuals living below the Federal poverty threshold exceeded 25.9 percent. Ten of the 18 Census tracts were found to have meaningfully greater low-income populations. These Census tracts are concentrated mainly northeast of the MURR site within the City of Columbia. The MURR site is located in Census Tract 11.03 with an estimated 16.5 percent of its population living below the poverty level (USCB 2016d).

**Table 5–4. Percentage of People and Families in Census Tracts Within 5 mi (8 km) of the MURR Site Whose Income is Below the Poverty Level**

| Census Tract | Total Population | Percentage of People Below Poverty Level | Percentage of Families Below Poverty Level |
|---|---|---|---|
| **2** | **1,749** | **29.5** | **25.9** |
| **3** | **3,097** | **66.8** | **10.3** |
| **5** | **2,760** | **70.5** | **77.1** |
| 6 | 4,917 | 7.2 | 0.7 |
| **7** | **3,877** | **29.1** | **20.8** |
| **9** | **1,618** | **29.0** | **15.3** |
| **10.01** | **4,644** | **40.2** | **11.7** |
| 10.02 | 6,052 | 16.7 | 15.8 |
| **11.01** | **8,824** | **56.2** | **14.6** |
| 11.03 | 6,989 | 16.5 | 4.4 |
| 11.04 | 10,778 | 17.7 | 5.1 |
| 12.01 | 6,169 | 8.2 | 6.8 |
| 12.02 | 5,620 | 8.2 | 5.2 |
| **13** | **3,603** | **27.8** | **17.9** |
| 14 | 11,394 | 12.1 | 7.8 |
| 15.04 | 9,161 | 23.8 | 15.8 |
| **21** | **3,649** | **49.4** | **45.8** |
| **22** | **7,223** | **72.8** | **67.3** |

Census tracts with percentages of people below the poverty level is greater than 25.9 percent are in bold.

Source: USCB American Community Survey 5-Year Estimates, 2010–2014, Table DP03, Selected Economic Characteristics (USCB 2016c)

Impact Analysis

Section 5.2 of this EIS presents an assessment of the environmental effects from constructing, operating, and decommissioning the proposed NWMI facility at MURR for all affected resource areas. The NRC uses this information to determine if there would be any human health or environmental effects that could disproportionately affect minority and low-income populations and whether any of these effects would be high and adverse.

The following subsections of Section 5.2 describe the potential human health and environmental effects from constructing, operating, and decommissioning the proposed NWMI facility that could impact minority and low-income populations:

- radiological and nonradiological human health impacts (Section 5.2.2.8),
- noise impacts (Section 5.2.2.2), and
- traffic impacts (Section 5.2.2.10).

The NRC also considered whether there would be any environmental impacts that would affect a specific minority and low-income population and whether there would be any unique effects that could appreciably exceed or (are) likely to appreciably exceed those for the general population.

<u>Subsistence Consumption of Fish and Wildlife</u>

The special pathway receptors analysis is an important part of the environmental justice analysis because consumption patterns may reflect the traditional or cultural practices of minority and low-income populations in the area, such as migrant workers or Native Americans.

Section 4–4 of Executive Order 12898 (1994) directs Federal agencies, whenever practical and appropriate, to collect and analyze information about the consumption patterns of populations that rely principally on fish and/or wildlife for subsistence and to communicate the risks of these consumption patterns to the public. In this EIS, the NRC staff considered whether there were any means for minority or low-income populations to be disproportionately affected by examining impacts on American Indians, Hispanics, migrant workers, and other traditional lifestyle special pathway receptors.

Based on the description of air and water quality impacts and the discussion of human health effects in this EIS, human health impacts in special pathway receptor populations in the region as a result of subsistence consumption of water, local food, fish, and wildlife are not likely to be high or adverse. Thus, constructing, operating, and decommissioning the proposed NWMI facility at the MURR site would not have disproportionately high and adverse human health and environmental effects on these populations.

*Construction*

Similar to construction at Discovery Ridge, potential impacts to minority and low-income populations from the construction of the proposed NWMI facility at the MURR site would mostly consist of environmental effects (e.g., noise, dust, and traffic). Noise and dust impacts during construction would be short term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads could be affected by an increase in the number of commuter vehicles and truck traffic traveling to and from the proposed work site. However, given the short duration of construction, the small size of the average daily workforce, and the small number of trucks, construction of the proposed NWMI facility would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near MURR.

*Operations*

Potential impacts to minority and low-income populations during NWMI facility operations would mostly consist of radiological and nonradiological human health and environmental (e.g., noise and traffic) effects. Everyone living near MURR and the proposed NWMI facility could be affected by operations activities, including minority and low-income populations. Any human health and environmental effect would depend on the magnitude of the change from current environmental conditions. Minority and low-income populations residing along site access roads could be affected by the increased commuter vehicle and truck traffic during certain hours of the day.

As discussed in Section 5.2.2.8 of this EIS, the potential radiological dose to the public from NWMI facility operations would be well within NRC and applicable Federal, State, and local regulatory limits. As a result, everyone living near the proposed NWMI facility site, including minority and low-income populations, would not be adversely affected by radiation exposure during facility operations. Permitted nonradiological air emissions would also be required to remain within regulatory standards.

As discussed in Section 5.2.2.2 of this EIS, noise levels may increase along site access roads due to increased commuter vehicle and truck traffic during NWMI facility operations. This may not be noticeable, however, given the relatively small size of the workforce and the limited number of daily truck deliveries and shipments. Based on this information, operation of the proposed NWMI facility would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near MURR.

*Decommissioning*

Similar to construction impacts, potential impacts to minority and low-income populations during the decommissioning of the proposed NWMI facility at the MURR site would mostly consist of environmental and socioeconomic effects (e.g., noise, dust, and traffic). Noise and dust impacts during decommissioning would be short term and primarily limited to onsite activities. Minority and low-income populations residing along site access roads could be affected by an increase in the number of commuter vehicles and truck traffic travelling to and from the proposed work site. However, because of the temporary nature of decommissioning, these effects are not likely to be high and adverse and would be contained within a limited time period during certain hours of the day. Given the short duration, the small size of the average daily workforce, and the small number of trucks, decommissioning the proposed NWMI facility would not have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near MURR.

#### *5.2.2.13 Cumulative Impacts*

Available information about the past, present, and reasonably foreseeable projects and other activities near the MURR site is provided in Table 5–5.

**Table 5–5. Past, Present, and Reasonably Foreseeable Projects and Other Actions Considered for the Cumulative Impacts Analysis – MURR**

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| **Nuclear Projects** | | | |
| Callaway Plant | Nuclear power plant, one 1,236 MWe Westinghouse 4-loop pressurized water reactor | 32 mi (51 km) southeast of site | Operational (NRC 2015j) |
| **Research and Manufacturing Facilities** | | | |
| Boone Quarries | Crushed Limestone Quarry | 3.3 mi (5.3 km) north of site | Operational (Con-Agg undated) |

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| Discovery Ridge Research Park | Research Park being developed on University of Missouri lands with potential expansion to 550 ac (220 ha) | 3.7 mi (6 km) southeast of site | Research park currently has two tenants (ABC Laboratories and IDEXX BioResearch) occupying two of 14 lots comprising Phase I (139 ac (56 ha)) of the park's development. Potential total future build out would be 550 ac (220 ha). No other proposed tenants were identified at this time. (MU 2009, 2016g) |
| University of Missouri Research Reactor | 10 MWt research reactor | Immediately adjacent to the site | Operational |
| ABC Laboratories | Analytical biochemical testing serves | 3.8 mi (6.1 km) southeast of site | Operational (ABC 2016) |
| IDEXX BioResearch | Animal bioresearch health monitoring and diagnostic testing laboratory | 4 mi (6.5 km) southeast of site | Operational (IDEXX 2015, MU 2016g) |
| **Fossil Fuel Projects** | | | |
| University of Missouri Combined Heat and Power Plant | Conventional Steam Coal (50.7 MW); Natural Gas-Fired Combustion Turbine (22.8 MW); Petroleum 3.5 MW) | 1.1 mi (1.8 km) north-northeast of site | Operational (EIA 2015a) |
| Columbia Municipal Power Plant | Natural Gas-Fired Combustion Turbine 47.5 MW; Conventional Steam Coal (38.5 MW); Petroleum (12.6 MW); Landfill Gas (3 MW) | 2.6 mi (4.2 km) north-northeast of site | Operational (EIA 2015b) |
| Columbia Energy Center | Natural Gas Fired Combustion Turbine (140 MW) | 7.4 mi (12 km) northeast of site | Operational (EIA 2015c) |
| **Transportation Projects** | | | |
| Columbia Regional Airport | Public airport | 10 mi (16 km) southeast of site | Operational. Proposed runway expansion and improvements under consideration. (CRA 2012) |
| **Medical Facilities** | | | |
| University Hospital | Hospital that performs radiological procedures | 0.9 mi (1.5 km) northeast of site | Operational (MU 2016h) |
| Boone Hospital Center | Hospital that performs radiological procedures | 1.9 mi (3.1 km) northeast of site | Operational (Boone County 2016c) |

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| **Parks/Recreation Sites** | | | |
| Nifong Park | 58 ac (23 ha) park offering picnicking, fishing, and hiking. Other amenities include Walters-Boone County Historical Museum, historic Maplewood home and grounds, and Boone Junction Historical Village | 3 mi (4.8 km) southeast of site | Operational. Minor park improvements planned though 2017. Managed by the City of Columbia. (City of Columbia 2016f; NWMI 2015a) |
| A. Perry Phillips Park | 140 ac (57 ha) park offering picnicking, fishing, boating, and hiking. | 5.3 mi (5.3 km) southeast of site | Operational. Park dedicated in 2011 and being developed over several years in conjunction with adjacent Gans Creek Recreational Area. Planned improvements through 2018 include an ice skating center and an indoor sports center. Managed by the City of Columbia. (City of Columbia 2016g; NWMI 2015a) |
| Gans Creek Recreational Area | 320 ac (130 ha) park offering five multipurpose athletic fields | 4 mi (6.4 km) southeast of site | Operational. Two additional athletic fields under construction, with planned future construction of playground, restroom, and concession facilities. Managed by the City of Columbia. (City of Columbia 2016h) |
| Rock Bridge State Park | 2,273 ac (920 ha) park containing unique geological features and offering picnicking, hiking, cycling, and horseback riding. | 3.3 mi (5.3 km) south of site | Operational. Managed by Missouri Department of Natural Resources (MDNR undated; USA Parks 2015) |
| Other Recreational Areas | Various parks, campgrounds, and natural areas | Within 10 mi (16 km) | Operational |
| **Other Projects/Actions** | | | |
| Discovery Park | 105 ac (42 ha) residential and commercial development center | 3.5 mi (5.6 km) southeast of site | Under construction. (Columbia Daily Tribune 2015b) |

| Project Name | Summary of Project | Location | Status |
|---|---|---|---|
| A.L. Gustin Golf Course | 6,500-yd (5,944-m) university-owned public golf course | 0.1 mi (0.2 km) west of site | Operational (MU 2016i) |
| Other Future Development | Construction of housing units and associated commercial buildings; roads, bridges, and rail; water and/or wastewater treatment and distribution facilities, and associated pipelines as described in local land use planning documents. | Throughout region | Construction would occur in the future as described in State and local land use planning documents. |

Land Use and Visual Resources

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the NWMI facility at the MURR site on land use and visual resources, when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The description of the affected environment in Section 5.2.2.1 serves as baseline conditions for the cumulative impact assessment of land use and visual resources. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on land use and visual resources would be SMALL, as described in Section 5.2.2.1.

*Land Use*

The projects and activities described in Table 5–5 would result in minimal changes to existing land uses, because new construction would occur either within or adjacent to existing facilities, or within areas currently zoned for industrial or residential use. Future urbanization and global climate change could contribute to additional decreases in agricultural lands, forests, grasslands, and wetlands. Urbanization in the vicinity of the MURR site would alter important attributes of land use. Urbanization would reduce natural vegetation and agricultural fields, resulting in an overall decline in the extent and connectivity of wetlands, forests, grasslands, and wildlife habitat. Global climate change could reduce crop yields and livestock productivity (USGCRP 2014), which may change portions of agricultural land uses. However, existing parks, reserves, and managed areas would help preserve wetlands and forested areas. In addition, zoning laws and comprehensive land use plans would help ensure a proper balance of development (City of Columbia 2013).

Given that reasonably foreseeable new construction activities would occur within or adjacent to existing facilities or within areas zoned for industrial or residential use, cumulative impacts of the proposed NWMI facility on land use resources would be SMALL.

*Visual Resources*

The projects and activities described in Table 5–5 would result in minimal changes to the existing viewshed, because new construction would occur either within or adjacent to existing facilities, or within areas currently zoned for industrial or residential use. Furthermore, the viewshed within the vicinity of the MURR site is agricultural, light industrial, forested or residential. Within undeveloped areas, where a new structure would change qualities of the existing landscape, the viewshed is generally of low scenic quality because of a lack of notable features, uniform landform, low vegetation diversity, an absence of water, mute colors, and a commonality within the physiographic province.

Given that reasonably foreseeable new construction activities would occur within or adjacent to existing facilities or within areas zoned for industrial or residential use and of low scenic quality, the NRC staff determined that cumulative impacts of the proposed NWMI facility on visual resources would be SMALL.

<u>Air Quality and Noise</u>

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the NWMI facility at the MURR site on air quality and noise, when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on air quality would be SMALL, as described in Section 5.2.2.2. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on noise would be SMALL to MODERATE.

*Air Quality*

The ROI considered for the air quality analysis for the NWMI facility located at the MURR site is Boone County, because air quality designations for criteria air pollutants are generally made at the county level (Section 5.2.2.2). Table 5–5, provides a list of current projects and reasonably foreseeable future actions that could contribute to cumulative impacts to air quality. Air emissions sources that contribute to air quality identified in Table 5–5 (e.g., fossil fuel projects and manufacturing facilities) that are currently operating have not contributed to a violation of the NAAQS given Boone County's designated attainment/unclassifiable status. Consequently, cumulative impacts to air quality would be the result of changes to present-day emissions and future actions within Boone County.

Development and construction activities, as identified in Table 5–5, associated with regional growth in housing, business, and industry, as well as associated vehicular traffic can increase air emissions. The population for the City of Columbia is projected to increase between 22 and 35 percent by 2030 (related to 2010) and construction of new housing and associated infrastructure will be needed to accommodate the increase in population (City of Columbia 2013). Annual job growth projection for the City of Columbia is 1.3 to 1.4 percent (City of Columbia 2013). Regional air quality conditions could deteriorate from the effects of growth in Boone County, because growth gives rise to dust, vehicle exhaust from increased traffic, and other emissions. Although air emissions from construction activities would be temporary and localized, the resulting regional growth in residential, commercial, and industrial uses across Boone County could result in overall long-term air emission sources. These new stationary and mobile (e.g., vehicle) emission sources could further overlap with operations and decommissioning of the proposed NWMI facility and could noticeably alter air quality conditions in Boone County. If degradation in air quality is observed, MDNR can develop air quality control programs to mitigate the effects of development. However, mitigation will depend on the control strategies implemented and adherence to these strategies. Climate change impacts, as discussed in Section 4.14, can affect air quality as a result of changes in meteorological conditions. However, the combination of conditions that can change air pollutant concentrations are still being investigated by the scientific community.

The NRC staff determined that the potential cumulative air quality impact associated with construction, operations, and decommissioning of the NWMI facility, in conjunction with other reasonably foreseeable projects, would be SMALL to MODERATE, because future economic and population growth in Boone County could lead to long-term air emission sources and increases in air pollutants that can noticeably alter air quality.

*Noise*

The ROI considered for the noise impact analysis is a 1-mi (1.6-km) radius from the proposed NWMI facility at the MURR site. Noise levels attenuate rapidly with distance. When distance is doubled from a point source, noise levels decrease by 6 dBA (FHWA 2011). Generally, a 3-dBA change over existing noise levels is considered to be a “just noticeable” difference, a 5-dBA increase is readily perceptible, and a 10-dBA increase is subjectively perceived as a doubling in loudness (FHWA 2011). As discussed in Section 5.2.2.2, the impact to noise would be SMALL to MODERATE during construction and decommissioning.

Those projects identified in Table 5–5 that involve construction activities could result in increases in noise levels. Because these projects are beyond the noise analysis ROI for the MURR site, these projects would not be expected to have significant noise impacts or increase ambient noise levels within the ROI. Therefore, the NRC staff determined that the potential cumulative noise impact associated with construction, operations, and decommissioning of the NWMI facility, in conjunction with other reasonably foreseeable projects, would remain SMALL to MODERATE.

Geologic Environment

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility at the MURR site on the geologic environment when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The cumulative impacts on the geologic environment primarily relate to land disturbance, the potential for soil erosion and loss, and the consumption of geologic resources. The description of the affected environment in Section 5.2.2.3 of this EIS serves as the baseline for the geologic environment cumulative impacts assessment.

The ROI for evaluating cumulative impacts on soil resources encompasses the MURR site and further encompassing a 5-mi (8-km) radius of the site. For geologic resources, the NRC staff further extended the ROI to include all of Boone County to encompass potential commercial sources of rock and mineral resources to support construction activities at the proposed site and vicinity. Because the aspects of land disturbance and conversion are addressed separately under Land Use and Visual Resources above, the cumulative impacts analysis here will focus on soil loss, including the loss of any prime farmland soils and other important farmland soils, and the consumption of geologic resources. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on the geologic environment, including geologic and soil resources, would be SMALL, as described in Section 5.2.2.3.

*Soil Resources*

New construction projects identified in Table 5–5 within the immediate 5-mi (8-km) radius of the MURR site would result in the conversion and loss of soils. There would be no incremental loss of prime farmland or other important farmland soils because although soils at the MURR site do meet the relevant criteria as prime farmland soils, they are already in and otherwise committed to development uses. Regardless, in accordance with local and State permits and approvals, as referenced in Section 5.2.2.3 relative to the NWMI facility, all development activities in the ROI would be subject to BMPs for soil erosion and sediment control, which would serve to minimize soil erosion and loss. Developers would be likely to reclaim usable topsoil removed by ground-disturbing activities for use elsewhere at the impacted development sites. Alternatively, developers can stockpile usable topsoil or backfill and then sell or otherwise transfer it for reuse elsewhere at other development sites. Following the completion of construction activities, continued soil loss would be minimal as the remaining soils would lie beneath impervious surfaces, such as buildings, or the impacted area would have been revegetated or incorporated into facility landscaping or hardscaped areas. This would be the case, for example, at the NWMI facility site and at other sites across the University of Missouri campus and across south Columbia. Although developed land areas could be reclaimed and sufficiently restored to support certain agricultural and non-developed uses at some point in the future, such lands and associated soils would not be restorable to prime or other important farmland status. Cumulative soil loss would largely occur in or adjacent to developed areas and soil loss would be mitigated by the use of BMPs. As a result, the NRC staff concludes that cumulative impacts on soil resources would be SMALL.

*Geologic Resources*

New facility construction and expansion (Table 5–5) would require the use and consumption of geologic resources, including rock and mineral assets such as construction aggregate materials (e.g., sand and gravel). Construction of the NWMI facility at the MURR site would use many of the same materials, including concrete, gravel, and sand required for the other identified projects. For example, construction of the NWMI facility would require about 1,700 cubic yards ($yd^3$) (1,300 cubic meters ($m^3$)) of crushed aggregate (limestone) (see Section 2.2). By comparison, the 11-county rock and mineral district of central Missouri that includes Boone County produces or uses approximately 5.95 million tons (5.4 million metric tons) of crushed stone annually. This is equivalent to 4.5 million $yd^3$ (3.4 million $m^3$) of material (USGS 2015c).

As noted in Section 5.2.2.3, rock and mineral products, including construction aggregate, are widely available throughout Boone County and the surrounding region. Likewise, products derived from geologic materials, including concrete and asphaltic materials used in construction, are widely available on a regional basis. It is not likely that the geologic resource requirements to construct the NWMI facility or the resource requirements of other identified projects are of such a volume as to affect local and regional sources and supplies of the identified resources. In addition, there are no active geologic assets (mines or quarries) at or near the MURR site that would be rendered inaccessible for future use. Therefore, the NRC staff concludes that cumulative impacts on geologic resources would be SMALL.

Water Resources

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the proposed NWMI facility on water resources when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. This cumulative impacts analysis for surface water and groundwater resources considers such issues as water quality, water use, and potential climate change. It further considers relevant project actions, activities, and specific implications for surface water or groundwater withdrawal, effluent discharges, stormwater drainage and runoff, and accidental spills and releases. The description of the affected environment in Section 5.2.2.4 serves as the baseline for the water resources cumulative impacts assessment.

The ROI for the surface water resources component of the cumulative impacts analysis is comprised of the MURR site and the Hinkson Creek watershed downstream of the site and including Perche Creek, as described in Section 5.2.2.4, Surface Water Hydrology, Quality, and Use. For groundwater resources, the ROI includes the MURR site and the local groundwater basin in which groundwater is recharged and flows to discharge points within the watershed. The area further comprises those aquifers from which groundwater is withdrawn through wells to supply potable, industrial, agricultural, and other uses within a 5-mi (8-km) radius of the site. Thus, this analysis focuses on those projects that, when combined with those under the proposed action, would: (1) withdraw water from or discharge effluents to Hinkson Creek and other tributaries within the watershed downstream of the site, or (2) would use groundwater or could otherwise affect the same aquifers that would supply water to the MURR site. For surface water, the ROI further encompasses Perche Creek from its confluence with Hinkson Creek and including the segment of Perche Creek that receives effluent discharges from the Columbia Regional WWTP. The Columbia Regional WWTP would also receive sanitary effluent from the proposed NWMI facility. The incremental impacts from construction, operations, and decommissioning of the proposed NWMI facility on surface water and groundwater resources would be SMALL, as described in Sections 5.2.2.4.

The MURR site is located adjacent to the existing MURR laboratory building, within the University of Missouri campus. Site drainage flows generally south through stormwater drainage channels toward Hinkson Creek, which located approximately 0.2 mi (0.3 km) south of the site. Hinkson Creek is a tributary to Perche Creek and, ultimately, to the Missouri River, as further discussed in Section 5.2.2.4.

The State of Missouri has established water quality standards for Hinkson Creek and other tributaries within the watershed that ultimately flow to the Missouri River. Surface water is a minor source of water supply in Boone County. The predominant source of water for municipal water supply and for individual property owners in Boone County, and particularly within the City of Columbia, is groundwater pumped from deep bedrock aquifers (Section 5.2.2.4, Groundwater Hydrology, Quality, and Use).

*Surface Water Resources*

Hinkson Creek, which passes south of the MURR site, bisects the City of Columbia and it serves as the major stormwater drainage basin for the City of Columbia. Like other perennial rivers and streams of the State, Hinkson Creek is designated for the following beneficial uses: aquatic habitat protection, human health protection, whole body contact recreation, and secondary contact as well as livestock and wildlife protection and irrigation. These uses apply to Hinkson Creek and other major streams within a 5-mi (8-km) radius of the MURR site, including Perche Creek. Hinkson Creek is included in the State's list of "impaired" waters, pursuant to Section 303(d) of the Federal Water Pollution Control Act (i.e., Clean Water Act (CWA)) of 1972. Hinkson Creek is impaired for whole body contact recreation because of water-borne *E. coli* bacteria. The reason for listing is impairment of the beneficial use due to nonpoint source runoff.

As further described in Section 5.2.2.4, the State is required to evaluate pollutant loadings within such watersheds and implement a watershed-based program to assure future compliance with water quality standards. On an individual project or facility basis, the State typically addresses watershed improvement through existing and new permits. The NPDES permit program, under CWA Section 402, addresses water pollution by regulating point sources (i.e., pipes and ditches) that discharge pollutants to waters of the United States. The State of Missouri has been delegated NPDES permitting authority by EPA.

Within the context of the local watersheds of the Missouri River, such as Hinkson Creek, climate change is an important consideration. Projections for continued increases in temperature and changes in precipitation patterns, including longer periods of drought, would be likely to reduce the overall amount of water available for surface runoff, with an effect on the beneficial uses of affected surface waters. Over the period 1988 to 2010, a decrease in soil moisture has been documented during most seasons in the central Midwest (USGCRP 2014). As temperatures are projected to continue to increase across the Midwest, this trend would be expected to continue. Meanwhile, by mid-century, the scientific community projects increases in the frequency and intensity of extreme precipitation, while at same time, an increase in the average maximum number of consecutive days with less than 0.01 in (0.025 cm) of precipitation (indicative of drought conditions) throughout the entire Midwest region (USGCRP 2014). An increased frequency of extreme rainfall events can cause erosion and lead to a decline in water quality (USGCRP 2014). This is particularly true where soils are dry and less able to retain precipitation that falls during heavier precipitation events. The implications are clear for an urbanized watershed, such as Hinkson Creek, where climatic changes can bring with them increases in runoff laden with nutrients, sediment, and other contaminants. Increases in impervious surface due to existing and future development can further exacerbate these changes in water quality.

Current and proposed future projects and facilities that adjoin the MURR site include institutional, residential, commercial, and industrial uses (Table 5–5) within the urbanized University of Missouri campus. Projects and activities occurring within the ROI would be subject to applicable local, State, and Federal regulatory requirements and associated permits and approvals. Construction projects must obtain a Land Disturbance Permit from the City of Columbia and submit related plans for city approval before any ground-disturbing activities or facility construction could begin on the site (Section 4.3.1). For projects outside the municipal boundary of the City of Columbia, Boone County also requires a Land Disturbance Permit, including the development and implementation of a soil erosion and sediment control plan and a stormwater management plan. These plans entail the implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development.

The MDNR has developed an NPDES general permit that must be obtained by owners and operators for the discharge of stormwater and certain non-stormwater discharges (e.g., dewatering) from land-disturbance sites that disturb 1 ac (0.4 ha) or more, or less than 1 ac (0.4) but part of a larger development. This State general permit requires permit holders to develop and implement an SWPP, the purpose of which is in part to ensure the proper design, implementation, management, and maintenance of BMPs to prevent the introduction of sediment and other pollutants in stormwater discharges. MDNR also requires certain industrial facilities to obtain an NPDES permit for stormwater discharges during facility operations.

The Columbia Regional WWTP serves all of the City of Columbia. During the projected 30-year period of operations, the only liquid waste discharged from the NWMI facility would be sanitary in nature. This effluent would be discharged to the City of Columbia sanitary sewer system at an average rate of approximately 4,570 gpd (17,300 Lpd). This is equivalent to approximately 0.0046 mgd (17.4 $m^3$/day). The Columbia Regional WWTP would be the ultimate point of treatment. The Columbia Regional WWTP has a design treatment capacity of 20 mgd (75,700 $m^3$/day) with average demand of 16 mgd (60,600 $m^3$/day). NWMI's additional wastewater volume would constitute a very small percentage (i.e., 0.12 percent) of the available treatment capacity of the WWTP. Sanitary wastewater discharges from the NWMI facility would be unlikely to have any impact on the facility or have any impact on ambient water quality downstream of the WWTP.

Nevertheless, the potential exists for substantial population growth in the County and City of Columbia of about 40 percent between 2016 and 2050 (Section 3.7.1). The corresponding increase in sanitary effluent generated by the larger population would approach or exceed the capacity of the WWTP. This would require the City of Columbia to invest in additional wastewater treatment infrastructure. Given the planning timeframe, the NRC staff expects that the City of Columbia would be able to accommodate the increased treatment demand with timely expansions of treatment infrastructure, as it becomes needed.

In summary, construction, operations, and decommissioning of the proposed NWMI facility would have a minimal incremental contribution to cumulative impacts on surface water resources, including surface water and groundwater quality. Ongoing and future development projects within the Hinkson Creek watershed would be subject to City and Boone County site development approvals, including Land Disturbance Permits. NPDES permits required for all new stormwater and industrial wastewater dischargers would include provisions to comply with applicable wasteload allocations established for downstream receiving waters. Within this context, climate change including changes in runoff rate and quality would be expected to have as big or a bigger role in affecting surface hydrology and water quality as growth and development alone in the watershed, as described above. In consideration of this information, the NRC staff concludes that the cumulative impacts on surface water resources would be SMALL to MODERATE overall, primarily because of urbanization, regional growth, and climate change.

*Groundwater Resources*

The City of Columbia's water supply primarily comes from a well field withdrawing from the alluvial aquifer adjacent to the Missouri River floodplain and located about 7 mi (11 km) southwest of the MURR site. This well field has a total groundwater production capacity of 30 mgd (113,560 $m^3$/day). The City of Columbia's average groundwater use is 12.6 mgd (47,700 $m^3$/day) (City of Columbia 2016j). Meanwhile, the University of Missouri maintains its own system of five deep wells to supply potable water across the university, including providing water supply to the existing MURR Center. The combined rated production capacity of the wells is 4,700 gpm (17.8 $m^3$/min) (MU 2006, 2016j). This is equivalent to 6.77 mgd (25,630 $m^3$/day). In 2014, university water use averaged 1.74 mgd (6,590 $m^3$/day) (MU 2015b). In contrast, NWMI facility operations would require an average of 5,045 gpd (19,100 Lpd) of water, equivalent to 0.005 mgd (18.9 $m^3$/day).

The population of Boone County is projected to increase by about 40 percent by 2050. Assuming that this projected population growth has a direct and equal correlation on groundwater demand, total groundwater demand within the water supply service areas of the City of Columbia and the University of Missouri could grow to approximately 17.6 mgd (66,600 $m^3$/day) and 2.4 mgd (9,100 $m^3$/day), respectively. In reality, population growth in the student body, faculty, and other tenant entities located on the university campus would not be expected to grow proportionally. Given the groundwater production capacity of the two systems, the forecasted water demands alone would not be expected to affect the ability of the City of Columbia and University of Missouri water systems to meet the water supply demands of expected growth over the next 30 years.

However, the NRC staff assumes that climate change could have as great or a greater impact on surface water and groundwater resources, including overall water availability, as any other reasonably foreseeable future actions. The loss of moisture from soils because of higher temperatures, as discussed in Section 4.14, along with increased evapotranspiration from vegetation and the increased average number of days without precipitation is likely to intensify short-term (seasonal or shorter) droughts across the Midwest region into the future (USGCRP 2009, 2014). Such conditions can reduce the amount of water available for surface runoff, streamflow, and groundwater recharge. Specifically, climate change is projected to increase water demand across most of the United States. When accounting for regional changes in population coupled with predicted climate change impacts, current projections indicate that northeast Missouri (where the MURR site is located) could experience climate-change induced increases in water demand of up to 10 to 25 percent (USGCRP 2014). This increase would not seriously challenge the current production capacity of either the City of Columbia or the University of Missouri as the respective supply systems have large excess capacity margins. In order to manage any increases in water demands across Boone County where the water supply is heavily reliant on deep groundwater coupled with reduced groundwater recharge due to climate change, the County's water supply districts, municipalities, and other interests that rely upon deep groundwater could take action to increase the efficiency and extent of their production and water distribution infrastructure. This could include redeveloping existing production wells or drilling new wells to better manage water supply conflicts. However, it is noteworthy that the City of Columbia's well field would be well insulated from any drawdown in the region's bedrock aquifers due to any increased production, owing to the presence of the Missouri River that can serve as a source of induced recharge to the alluvial aquifer.

Alternatively, public water suppliers could seek out new water supply sources, such as the Missouri River, although this approach would entail investments in new infrastructure and increased operating costs. Suppliers could also pursue a combination of approaches such as conservation measures and new sources.

It remains that the projected average daily water needs for NWMI facility construction, operations, and decommissioning would be a very small percentage (less than 0.3 percent) of the University of Missouri's total production and current available supply capacity. In total, the NRC staff concludes that the cumulative impacts on groundwater resources, including water availability, would be SMALL.

Ecological Resources

This section addresses the direct and indirect effects of the construction, operations, and decommissioning of the NWMI facility at the MURR site on ecological resources, when added to the aggregate effects of other past, present, and reasonably foreseeable future actions. The description of the affected environment in Section 5.2.2.5 serves as a baseline for the cumulative impact assessment of ecological resources. The ROI for evaluating cumulative impacts on ecological resources includes the area surrounding the MURR site that is ecological, connected to the onsite ecological resources (e.g., the watershed surrounding the MURR site). The incremental impacts from construction, operations, and decommissioning the proposed NWMI facility would be SMALL, as described in Section 5.2.2.5.

Since European settlement, prairies, forests, and wetlands have been greatly reduced and converted into agricultural fields, industrial uses, and residential and commercial areas. Remaining tracts of grasslands, forests, and wetlands tend to be relatively small and isolated, which results in lower quality habitat than large tracts of habitat, because of the different biological and physical characteristics along the edge of a habitat patch.

Current threats to terrestrial and aquatic habitats include increased soil, nutrients, and other pollutants washing into streams and lakes from urban and agricultural stormwater runoff; continued conversion and fragmentation of wildlife habitat from development; introduction of invasive species; and climate change (BFSC 2007; USGCRP 2014). These activities will likely decrease the overall availability and quality of forested, grassland, and wetland habitats. Species with threatened, endangered, or declining populations are likely to be more sensitive to declines in habitat availability and quality and the introduction of invasive species.

New development projects identified in Table 5–5 are likely to have minimal impacts on ecological resources because all the projects are sited within areas that are currently agricultural land, open space, or developed. These types of land covers provide low-quality habitat for wildlife, birds, and aquatic resources. However, as environmental stressors, such as runoff from agricultural fields and urban areas and climate change, continue over the next few decades, certain attributes of the terrestrial and aquatic environment (e.g., habitat quality) are likely to noticeably change. The NRC staff does not expect these impacts to destabilize any important attributes of the terrestrial and aquatic environment, because such impacts will cause gradual change, which should allow some aspects of the terrestrial and aquatic environment to appropriately adapt. The NRC staff concludes that the cumulative impacts of the proposed construction and operation of the NWMI facility, plus other past, present, and reasonably foreseeable future projects or actions would result in MODERATE impacts on terrestrial and aquatic resources.

Historic and Cultural Resources

This section addresses the direct and indirect contributory effects from constructing, operating, and decommissioning the proposed NWMI facility at the MURR site when added to the aggregate effects of other past, present, and reasonably foreseeable future actions on historic and cultural resources. The geographic area considered in this analysis is the area of potential effect (APE) associated with the proposed MURR facility, the MURR site, and its immediate vicinity. As discussed in Section 5.2.2.6, constructing, operating, and decommissioning the proposed NWMI facility would not impact any known historic and cultural resources at the MURR site.

The archaeological record for the region indicates prehistoric and historic occupation; the APE appears to have been traditionally used as agricultural fields from the protohistoric period onward. Historic land development may have resulted in impacts on, and the loss of, cultural resources. As described in Section 5.2.2.6, no evidence of historic or cultural resources were found within the area, and the closest historic property is approximately 1 mi (1.6 km) to the north-northeast of the MURR site. The only foreseeable project within the APE is the proposed NWMI facility at the MURR site. Therefore, historic and cultural resources are not likely to be affected by the cumulative effects of constructing, operating, and decommissioning the proposed NWMI facility combined with other past, present, and reasonably foreseeable future activities at the MURR site.

Socioeconomics

This section addresses the direct and indirect contributory effects from the construction, operations, and decommissioning of the proposed NWMI facility at the MURR site when added to the effects from other past, present, and reasonably foreseeable future actions on current socioeconomic conditions within the ROI. Since the MURR site and the Discovery Ridge site share the same socioeconomic ROI, the description of the affected environment in Section 3.7 serves as a baseline for the cumulative socioeconomic impact assessment. The geographic area of analysis is the ROI, the City of Columbia and Boone County. In either location, the socioeconomic impacts from constructing, operating, and decommissioning the proposed NWMI facility in the ROI would be SMALL. Since no other research or office facilities are currently planned for the Discovery Ridge Research Park, there would be no labor shortages because the City of Columbia and Boone County have a sufficient workforce to meet the needs for new research facilities (Section 3.7.4).

Table 5–5 identifies past, present, and reasonably foreseeable future actions within the ROI that could contribute to cumulative socioeconomic impacts. Relevant “other actions” considered in this cumulative impacts analysis is Discovery Park, a residential and commercial development being constructed 3.5 mi (5.6 km) southeast of the MURR site. Construction of Discovery Park could increase the size of the local population as well as employment and tax revenue and increase the demand for public services in the ROI. However, the overall socioeconomic effect of this construction project would be small. Therefore, the cumulative socioeconomic impact of the proposed action combined with the Discovery Park development would be SMALL.

Human Health

This section addresses the cumulative radiological and nonradiological effects on human health for a proposed NWMI facility located at the MURR site. The geographic ROI for this evaluation of cumulative effects on human health is that area within a 5-mi (8-km) radius of the proposed NWMI facility at the MURR site. This evaluation will consider radiological and nonradiological impacts of other activities (in the recent past, present, and reasonably foreseeable future) within this ROI. Within this ROI, there are no nuclear power plants that would contribute to radioactive or nonradioactive exposure. However, the Callaway Energy Center nuclear power plant is located approximately 32 mi (51 km) away. Since the MURR site is within the 50 mi (80 km) radiological emergency planning zone for the Callaway plant, radiological human health impacts associated with the Callaway plant will also be considered in this evaluation.

As discussed in Section 5.2.2.8, the NRC staff reviewed the possible human health effects that could be associated with construction, operations, and decommissioning of the proposed NWMI facility at the MURR site. The NRC staff concludes that both radiological and nonradiological human health impacts to workers and members of the public from construction, operations, and decommissioning of the proposed facility at the MURR site would be SMALL.

Items considered for this evaluation that could have potential radiological health impacts within the ROI include the Callaway nuclear power plant, ABC Laboratories, University Hospital, and Boone Hospital Center, and the existing MURR Center (all listed in Table 5–5). As discussed in Section 4.14.8.1, these facilities are all required to comply with NRC regulations, including limits on doses to members of the public. Therefore the NRC staff expects minimal or no environmental impacts for each of these facilities considered individually. For Callaway, ABC Laboratories, University Hospital and Boone Hospital Center, given the distances between those facilities and the MURR site (see Table 5–5) and the very limited individual impacts from each of those facilities, the NRC staff does not expect that the cumulative impacts of those facilities and the proposed NWMI facility at the MURR site would result in a cumulative radiological dose impact in excess of NRC regulatory limits. The existing MURR laboratory building, however, as stated above, would be located immediately adjacent to a proposed NWMI facility at the MURR site. As discussed in Section 3.10.1, the existing MURR Center has a technical specification (TS) that requires airborne radiological effluents be limited to levels that ensure that the NRC dose limits in 10 CFR Part 20 will not be exceeded. MURR's annual reports for 2013, 2014, and 2015, show that MURR's airborne Ar-41 effluents ranged from 48.9 to 78.1 percent of the TS limit when averaged on an annualized basis, and that no other radionuclides were released at average concentrations greater than 1 percent of the TS limits (MU 2014, 2015a, 2016d). Also as discussed in Section 3.10.1, the MURR Center is required to comply with 10 CFR 20.1101(d), which requires licensees to maintain public doses ALARA by establishing a 10 mrem constraint on public dose from airborne radioactive material released into the environment. Although MURR remained within TS limits and in compliance with 10 CFR Part 20 during the years 2013 through 2015, a proposed NWMI facility constructed at the MURR site would release additional airborne radiological effluents, as discussed in Sections 2.7.1.1 and 4.8.2.1. For a proposed NWMI facility at the MURR site, these releases would occur in very close proximity to the existing MURR Center. As discussed in Sections 4.8.2 and 5.2.2.8, NWMI estimated that the maximum public dose from routine airborne effluents from the proposed NWMI facility at the Discovery Ridge site would be approximately 3.6 mrem per year, below both the 100 mrem annual limit in 10 CFR 20.1301 and the 10 mrem ALARA constraint of 10 CFR 20.1101(d), and this dose would not change significantly for a proposed NWMI facility at the MURR site. Although cumulative effluents from a proposed NWMI facility at the MURR site and the existing MURR Center could, potentially, result in cumulative public doses that are greater than doses from either facility individually, both facilities would be required to comply with 10 CFR 20.1101(d) by implementing the 10 mrem ALARA constraint. The NRC staff expects that since the public dose from airborne radioactive effluents from each facility individually would be maintained within this constraint, the cumulative dose from effluents from both facilities would remain well below the 100 mrem annual regulatory public dose limit in 10 CFR 20.1301. Therefore, if the NRC staff determines in its SER that the doses for the proposed NWMI facility located at Discovery Ridge would be in compliance with 10 CFR Part 20, the NRC staff concludes that the cumulative radiological human health impacts for a proposed NWMI facility at the MURR site would be SMALL.

Activities considered for this evaluation that could have potential nonradiological human health impacts within the ROI include all items listed in Table 5–5 as well as the existing MURR Center. Construction activities included in Table 5–5, as well as construction of the proposed NWMI facility at the MURR site (which would be very similar to construction at the Discovery Ridge site), would involve potential hazards to workers typical of any construction site (NWMI 2015a). In addition, the proposed NWMI facility at the MURR site and some other facilities listed in Table 5–5 are industrial sites with many typical occupational hazards. These construction and industrial activities would be required to be performed subject to Occupational Safety and Health Administration (OSHA) and State of Missouri safety regulations.

As discussed in Section 4.14.8.2, hazardous chemical releases from the proposed NWMI facility and from other activities or facilities within the ROI, would be required to be within EPA and State of Missouri regulatory limits. All currently operating facilities in Table 5–5 for which possible chemical releases could be expected, except for the existing MURR facility, would be approximately 1.1 mi (1.8 km) or more from the proposed NWMI facility at the MURR site. The existing MURR could also generate possible chemical releases, and the existing MURR laboratory building would be located adjacent to a proposed NWMI facility at the MURR site. However, the existing MURR Center is below chemical emissions thresholds that would make it subject to reporting for EPA's Toxics Release Inventory (TRI) program (see Section 4.14.8.2) (EPA 2016g).

All construction, industrial, and other work activities at a proposed NWMI facility at the MURR site, and elsewhere in the ROI, would be conducted in accordance with Federal and State regulations. In addition, since chemical releases from a proposed NWMI facility at the MURR site and other facilities in the ROI would be within EPA and State regulatory limits, and also given the distances between the MURR site and facilities listed in Table 5–5 that may have significant chemical emissions and be subject to TRI reporting, the NRC staff does not expect that the cumulative impacts of other facilities in the ROI and the proposed NWMI facility would result in a cumulative chemical exposure impact in excess of Federal or State regulatory limits. The NRC staff therefore concludes that the cumulative nonradiological human health impacts of the proposed NWMI facility located at the MURR site would be SMALL.

Waste Management

This section addresses the cumulative impacts within the ROI associated with the waste management activities of other facilities using radioactive and nonradioactive material in the recent past, present, and reasonably foreseeable future. The geographic ROI for the evaluation of cumulative impacts from the disposal of radioactive and nonradioactive waste is that area within a 5 mi (8 km) radius of the proposed NWMI facility at the MURR site. Table 5–5 lists facilities and activities considered within this ROI (Table 5–5 also lists some facilities outside the 5 mi (8 km) radius, which are not considered in this evaluation).

As stated in Section 5.2.2.9, the types and quantities of radiological and nonradiological waste generated, and the disposal pathways for that waste, for a proposed NWMI facility at the MURR site would be essentially identical to those for the proposed NWMI facility at the Discovery

Ridge site. The NRC staff therefore concludes that the human health impacts from both radioactive and nonradioactive wastes for a proposed NWMI facility at the MURR site would be SMALL.

The ROI for a proposed NWMI facility at the MURR site (which includes activities listed in Table 5–5) is within the general City of Columbia, Boone County, Missouri area. As discussed in Section 4.14.9, the NRC staff assumes that sufficient infrastructure currently exists for proper disposal of all radioactive waste generated within the State of Missouri, and all nonradioactive waste generated in the Columbia, Missouri area, including radioactive and nonradioactive wastes that would be generated by a proposed NWMI facility at the Discovery Ridge site. Therefore, given the similar ROIs for a proposed NWMI facility at either site, and given that all radioactive or nonradioactive waste generated at a proposed NWMI facility at either site or by any other activity within either ROI would be required to be handled in accordance with Federal, State, and local regulations, the NRC staff concludes that the cumulative impacts from radiological and nonradiological waste management for a proposed NWMI facility at the MURR site would be SMALL.

<u>Transportation</u>

This section addresses the direct and indirect contributory effects from constructing, operating, and decommissioning the proposed NWMI facility when added to the effects from other past, present, and reasonably foreseeable future actions on transportation infrastructure. The ROI is the 5-mi (8-km) region surrounding the proposed NWMI facility at the MURR site. However, the roads for routes that could be used for delivery of medical isotopes (if air transport is not possible) or disposal of wastes were also considered. Transportation infrastructure includes roadways, rail lines, airports, and traffic control devices. As discussed in Section 5.2.2.10, transportation impacts during construction, operations, and decommissioning would be SMALL.

Construction projects in Table 5–5 could produce an increase in vehicle traffic on roads within the 5-mi (8-km) radius of the proposed NWMI site. For example, Discovery Park, a residential and commercial development being constructed 3.5 mi (5.6 km) southeast of the MURR site, could add additional commuting vehicles and commercial trucks on local roads near the proposed NWMI facility. In addition, new construction could occur within the Discovery Ridge Research Park. However, existing roads are sufficient to handle the increased traffic. An increase in the number of commuter vehicles and commercial trucks on roads near the MURR site would not likely have a noticeable impact on overall traffic volumes. Therefore, the cumulative effect of traffic-related transportation impacts of the proposed action combined with the Discovery Ridge Research Park and Discovery Park development would be SMALL.

<u>Accidents</u>

This section addresses the cumulative impacts within the ROI associated with possible accidents at other facilities using radioactive and/or non-radioactive hazardous chemicals. The ROI for the evaluation of cumulative effects of accidents is that within a 5-mi (8-km) radius of a proposed NWMI facility at the MURR site. Within this ROI, there are no nuclear power plants. However, the Callaway nuclear power plant is located approximately 32 mi (51 km) away. Since the proposed site is within the 50 mi (80 km) radiological emergency planning zone for the Callaway plant, hypothetical radiological accidents associated with the Callaway plant are also considered in this evaluation.

In Section 5.2.2.11, the NRC staff concluded that the impacts from both possible radiological accidents and possible non-radiological (hazardous chemical) accidents for a proposed NWMI facility at the MURR site would be SMALL.

As discussed in Section 4.14.10.1, nuclear reactors and nuclear materials facilities in the United States must comply with NRC regulations, including accident dose limits. The nuclear reactors and other facilities within the ROI that use radiation or radioactive materials are Callaway, ABC Laboratories, University Hospital, Boone Hospital Center, and the existing MURR center. These facilities are licensed by the NRC and have demonstrated compliance with NRC's dose limits for accident conditions, as applicable. Therefore, the NRC staff expects possible radiological accidents at these facilities to have minimal environmental impact. With the exception of the existing MURR center, the facilities within 5 mi (8 km) of the MURR site (ABC Laboratories, University Hospital, and Boone Hospital Center) are facilities for which no radiological material releases are expected (see Section 4.14.8.1). The existing MURR center would be located adjacent to a proposed NWMI facility at the MURR site. Accidents at the existing MURR center and a proposed NWMI facility at the MURR site would individually be expected to have minimal environmental impact because NRC-licensed facilities must comply with NRC regulations related to radiological accident consequences. However, due to the very close proximity of these two facilities, there is increased likelihood of a single scenario (such as an external event) that could cause accidents to occur at both facilities, creating the possibility for cumulative dose impacts greater than those for an accident at either facility individually. Therefore, if the NRC staff determines in its SER that the proposed NWMI facility at the Discovery Ridge site would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding radiological accident consequences, the NRC staff concludes that the cumulative impact from potential radiological accidents for a proposed NWMI facility at the MURR site would be SMALL to MODERATE.

As discussed in Section 4.14.10.2, industrial, production, or other facilities in Missouri (including those in the ROIs for a proposed NWMI facility located at either the MURR or Discovery Ridge sites) are required to comply with EPA and State of Missouri regulations to ensure the safe handling of chemicals and hazardous materials. With the exception of the existing MURR center, all facilities or activities in Table 5–5 for which hazardous chemical releases could be expected would be located approximately 1.1 mi (1.8 km) or more from a proposed NWMI facility at the MURR site. The existing MURR center would be located adjacent to a proposed NWMI facility at the MURR site; however, as discussed previously in this section, the existing MURR center does not use hazardous chemicals in quantities that would make it subject to the EPA's TRI reporting requirements, reducing the likelihood that any significant chemical release accident could occur in close proximity to a proposed NWMI facility at the MURR site. Therefore, if the NRC staff determines in its SER that the proposed NWMI facility would comply with 10 CFR 70.61 and any other applicable NRC regulations regarding hazardous chemical accident consequences, the NRC staff concludes that the cumulative impact from potential hazardous chemical accidents for a proposed NWMI facility at the MURR site would be SMALL.

Environmental Justice

The environmental justice cumulative impact analysis evaluates the potential contributory human health and environmental effects from the construction, operations, and decommissioning of the proposed NWMI facility when added to the effects from other past, present, and reasonably foreseeable future actions on minority and low-income populations and whether these effects might be disproportionately high and adverse. Everyone living near the proposed NWMI facility at the MURR site could be affected by construction, operations, and decommissioning activities, including minority and low-income populations.

The ROI is the 5-mi (8-km) region surrounding the proposed NWMI facility at the MURR site. As discussed in Section 5.2.2.12, the proposed NWMI facility is not located in a minority population block group. Minority and low-income populations residing along site access roads could be affected by noise, dust, and increased commuter vehicle and truck traffic during construction, operations, and decommissioning. However, during construction and decommissioning, these would be short term and primarily limited to onsite activities. In addition, NWMI facility operations would not have high and adverse human health and environmental effects on minority and low-income populations. As a result, minority and low-income populations residing near the proposed NWMI facility at MURR would not experience disproportionately high and adverse human health and environmental effects from the proposed action.

Table 5–5 identifies past, present, and reasonably foreseeable future actions within the geographic area of analysis that could contribute cumulative human health and environmental effects. Potential impacts to minority and low-income populations from other past, present, and reasonably foreseeable future actions would mostly consist of environmental effects caused by construction and operation of new residential, commercial, and industrial developments (e.g., noise, dust, traffic, employment, and housing impacts). However, noise and dust impacts would be short term during construction and primarily limited to onsite activities. Minority and low-income populations residing along site access roads could be directly affected by an increase in commuter vehicle and truck traffic. However, these effects are not likely to be high and adverse and would be intermittent, only occurring when construction trucks and other vehicles pass by during certain hours of the day. Increased demand for housing could cause housing costs to rise. Increasing rental costs could disproportionately affect low-income populations that rely on inexpensive housing. However, given the availability of local labor and the likelihood that construction workers would commute to the work site, rental housing costs may be unaffected.

Emissions from new commercial or industrial facilities could also disproportionately affect minority and low-income populations. However, any impacts would depend on the magnitude of the change from current environmental conditions. Permitted air emissions from all commercial and industrial facilities, including the contributory effects from the proposed NWMI facility, would be expected to remain within regulatory standards.

Based on this information and the analysis of human health and other environmental impacts presented in this EIS, the contributory effects of constructing, operating, and decommissioning the proposed NWMI facility would not create disproportionately high and adverse cumulative human health and environmental effects on minority and low-income populations living near MURR.

## 5.3 Alternative Technologies

The purpose of the NWMI facility is to use LEU to domestically produce molybdenum-99 (Mo-99) (Section 2.0). Other alternative medical radioisotope production technologies currently exist and have been proposed that could be used to create these isotopes (e.g., “Making Medical Isotopes: Report of the Task Force on Alternatives for Medical-Isotope Production (TRIUMF 2008) and Homogeneous Aqueous Solution Nuclear Reactors for the Production of Mo-99 [molybdenum-99] and other Short Lived Radioisotopes” (IAEA 2008)).

In this analysis of the alternative technologies, the NRC staff evaluated the potential environmental impacts if a commercial entity were to construct and operate a facility on the proposed Discovery Ridge site using an alternative technology. The NRC staff notes that no commercial entity (other than NWMI) has proposed building or operating a facility at the proposed Discovery Ridge site.

### 5.3.1 Description of Alternative Technology Screening Process

#### *5.3.1.1 Initial Screening*

To begin the alternative technology evaluation, the NRC staff initially considered the range of possible alternatives, or various methods to produce Mo-99, including international commercial entities currently producing Mo-99 and several commercial entities proposing new methods to produce Mo-99 within the United States. The Council on Environmental Quality's regulations implementing NEPA provide guidance when a large number of potential alternatives exist. In such situations, NEPA only requires that an agency analyze a reasonable number of examples, covering the full spectrum of alternatives, in the EIS (46 FR 18026).

For the purposes of this EIS, the NRC staff initially limited the alternative technologies analysis to the five technologies that the DOE's National Nuclear Security Administration (NNSA), through the Office of Nuclear Nonproliferation's Global Threat Reduction Initiative, awarded cooperative agreements (as of July 2016) for three main reasons. First of all, these technologies appear to be technically feasible. In awarding the cooperative agreements, NNSA based its decision, in part, on an evaluation of the technical feasibility. Secondly, the NRC is not aware of entities proposing to construct a new facility in the United States using technology currently being used in other countries. Therefore, based on the technology that has been proposed to create a domestic source of Mo-99, as of July 2016, the alternative technologies examined in the EIS include the type of technologies most likely to be constructed and operated within the United States. Lastly, the NRC staff concluded that the five entities awarded cooperative agreements used technologies that covered the spectrum of potential alternatives based on the general land use requirements, power levels, and other environmental and engineering parameters.

The five alternative technologies include the following:

(1) neutron capture technology,

(2) aqueous homogenous reactor technology,

(3) selective gas extraction technology,

(4) uranium fission technology, and

(5) linear accelerator-based technology.

*Neutron Capture Technology*

The neutron capture technology produces Mo-99 by neutron irradiation of natural molybdenum in a boiling water reactor (GE-Hitachi 2011). Given that the proposed Discovery Ridge site does not contain a boiling water reactor, the NRC staff does not consider construction of a new power reactor to be reasonable, because the currently proposed site has insufficient space and other resources to support a power reactor. Alternatively, a research reactor could be used to produce Mo-99 using neutron capture technology. Sufficient space likely occurs on the proposed Discovery Ridge site to construct a new research reactor as part of the neutron capture alternative.

*Aqueous Homogenous Reactor Technology*

The LEU aqueous homogenous reactor technology produces Mo-99 using an aqueous homogenous reactor fueled by a uranium salt solution, followed by a series of chemical processes to extract the Mo-99 (IAEA 2008; B&W 2012). The size of each reactor would be approximately 200 to 240 kilowatts, and it would be capable of producing about 1,100 6-day Ci on a weekly basis (IAEA 2008). The reactor fuel solution would contain LEU salt dissolved in water and acid. This solution would also be the target material for Mo-99 production, as fissioning the uranium-235 would produce Mo-99 and other isotopes. The reactor would be operated until a sufficient amount of Mo-99 occurred in the fuel solution. The fuel solution would be removed and processed using chemical purification to extract the Mo-99 (IAEA 2013b).

*Selective Gas Extraction Technology*

The selective gas extraction technology produces Mo-99 by irradiating porous uranium oxide targets and then using a selective gas extraction process to extract the Mo-99 (Bertch 2014; Grozelle 2016). For this technology, uranium targets would initially be placed within a tube and then irradiated within a research reactor. After irradiation, the target tube would be heated and gas would flow through the porous target to extract the Mo-99 in hot cells (Bertch 2014; Grozelle 2016). The target tube includes separate areas for gas delivery and collection. The target would be re-irradiated following the selective gas extraction process.

*Uranium Fission Technology*

The uranium fission technology would produce Mo-99 using a subcritical fission process followed by chemical extraction of Mo-99 (SHINE 2015). The process would use an accelerator and neutron multiplier to produce neutrons that would enter a tank containing a target solution with the fissile uranium-235 isotope. As neutrons collide with the uranium-235, the uranium would split and form other radioisotopes, including Mo-99, xenon-133, and iodine-131. Extraction and purification would occur within hot cells. During this process, Mo-99 extraction would occur as a batch process in which the irradiated uranyl sulfate target solution would be passed through an adsorption column to extract the isotopes. The extracted isotopes would then undergo dissolution and evaporation processes to yield a crude Mo-99 product. The purification process would remove impurities through small-scale additions of reagents and through precipitation, filtration, and boiling. LEU remaining in the target solution would be reused and would undergo cleanup for use as the target solution for subsequent cycles because only a small amount of uranium-235 is used up during each production run.

*Linear Accelerator-Based Technology*

The linear accelerator-based technology produces Mo-99 by utilizing an accelerator to irradiate natural molybdenum that has been enriched in the radioisotope molybdenum-100 (Mo-100) (DOE 2012). Targets made of molybdenum would be enriched in the radioisotope Mo-100 and would be irradiated (or bombarded) using a pair of accelerators. After bombardment, the targets would be removed and be shipped from the facility to an end user medical facility (NorthStar 2015). After further processing at the end user medical facility, the spent or unusable portion of the radiochemical from the end user facility would be returned and reused.

*5.3.1.2 Secondary Screening*

(1) For the next level of screening, the NRC staff searched for engineering and environmental data to describe the impacts from construction and operations for alternative technology within topical papers, white papers, environmental assessments, environmental reports, and other sources of information. Based on this review, the NRC staff did not find sufficient data to describe the potential environmental impacts from construction and operations of the neutron capture technology, aqueous homogenous reactor technology, nor the selective gas extraction technology due to the lack of environmental documents describing potential environmental impacts to the natural and human environmental from these technologies. Therefore, the NRC staff determined that insufficient environmental information exists to meaningfully analyze the environmental impacts of these technologies in detail. For these reasons, the NRC staff does not consider these

technologies reasonable alternatives and has excluded them from further consideration.

(2) The NRC staff determined that sufficient environmental data exist regarding the potential impacts of construction, operations, and decommissioning for the uranium fission alternative (SHINE 2015; NRC 2015c) and the linear accelerator-based alternative (DOE 2012). Therefore, in the following sections, the NRC staff evaluated in depth the potential environmental impacts if a commercial entity were to construct, operate, and decommission a uranium fission facility or a linear accelerator-based facility on the proposed Discovery Ridge site.

### 5.3.2 Linear Accelerator-Based Technology

The linear accelerator-based technology produces Mo-99 by using an accelerator to irradiate natural molybdenum that has been enriched in the radioisotope Mo-100. For the purpose of this analysis, the NRC staff assumed the facility would be similar to the facility described in NNSA's "Environmental Assessment for NorthStar Medical Technologies LLC Commercial Domestic Production of the Medical Isotope Molybdenum-99" (DOE 2012). The NRC staff acknowledges that other commercial entities have proposed methods of producing Mo-99 using linear accelerator-based technology, such as Niowave, Inc. (Niowave 2015). However, for the purpose of this analysis, the NRC staff used the environmental parameters included in NNSA's environmental assessment for the NorthStar Medical Radioisotope facility because this commercial entity was awarded a cooperative agreement by NNSA and sufficient environmental data exist regarding this proposed technology to conduct a meaningful analysis.

The facility for the linear accelerator-based alternative would have the capacity to produce approximately 3,000 6-day Ci per week. To produce Mo-99, the operator would use a target made of molybdenum enriched in the radioisotope Mo-100 and would irradiate (or bombard) the targets using a pair of accelerators. Up to 16 accelerators would be constructed and used during operations (DOE 2012). After bombardment, the operator would then ship Mo-99 from the facility to an end user medical facility (NorthStar 2015). After further processing at the end user medical facility, the spent or unusable portion of the radiochemical from the end user facility would be returned.

During operations, the facility would produce radiolytic and other offgases such as nitrogen oxides (DOE 2012). The production process would also generate radioactive and nonradioactive liquid waste (DOE 2012).

The NRC staff assumed that the operator would construct a containment building for the accelerators and radioactive waste facility (DOE 2012). In addition, a separate building or parts of the building would contain the processing facility (e.g., hot cells and chemical laboratories), areas for shipping and receiving, and a waste management center. Support facilities, such as administration buildings, parking lots, and access roads, would be similar to those for the NWMI facility. Construction of a linear accelerator-based facility would take up to 18 months and require up to 50 workers (DOE 2012). The linear accelerator-based facility would have a combined building footprint of 77,000 $ft^2$ (7,200 $m^2$) and excavate 21,000 $m^3$ (28,000 $yd^3$) of soil and rock material (DOE 2012). Operation of a linear accelerator-based facility would require up to 150 workers (DOE 2012).

A description of the affected environment for the Discovery Ridge site is provided in Chapter 3 of the EIS. The following sections describe the impacts of constructing, operating, and decommissioning the proposed NWMI facility utilizing the linear accelerator-based technology.

#### *5.3.2.1 Land Use and Visual Resources*

Land use impacts of a linear accelerator-based alternative at the Discovery Ridge site would be confined to the 7.4 ac (3.0 ha) site. The linear accelerator-based alternative would disturb a similar amount of land as the proposed NWMI facility (DOE 2012). The highest structure would be the emissions stack for chemical processing, which would extend approximately 18 m (60 ft) in height, with a diameter of 0.6 m (2 ft) (DOE 2012). Therefore, the height of the buildings for the accelerator-based alternative would be bounded by the parameters analyzed for the NWMI facility in Section 4.1. As described in Section 4.1, land use impacts during construction, operations, and decommissioning would be SMALL, because the entire site is currently certified for industrial use, and the permanently converted agricultural land would be a small portion of available agricultural land within the vicinity. As described in Section 4.1, aesthetic impacts during construction, operations, and decommissioning would be SMALL at the proposed Discovery Ridge site, given that a light industrial development landscape surrounds part of the site and the visual setting is generally flat and has a uniform landform with low vegetation diversity and a low visual-quality rating. Based on a similar land disturbance and building height for the linear accelerator-based alternative, land use and visual impacts would be SMALL during construction, operations, and decommissioning of a linear accelerator-based facility on the Discovery Ridge site.

#### *5.3.2.2 Air Quality and Noise*

Air Quality

*Construction*

Construction activities associated with building a linear accelerator-based facility would generate air pollutant emissions from site-disturbing activities (e.g., grading, compacting), operation of construction equipment, and worker and shipment vehicles. Emissions from construction are presented in Table 5–6.

**Table 5–6. Estimated Air Emissions Resulting from Construction of a Linear Accelerator-Based Facility**

| | **Total Emissions (ton/year)[(a)]** |
|---|---|
| Nitrogen Oxides ($NO_x$) | 8 |
| Carbon Monoxide (CO) | 6 |
| Sulfur Dioxide ($SO_2$) | 0.5 |
| Particulate Matter less than 10 microns (μm) ($PM_{10}$) | 17 |
| Particulate Matter less than 2.5 μm ($PM_{2.5}$) | 3 |
| Carbon Dioxide ($CO_2$) | 1,500 |

[(a)] Accounts for emission from construction equipment, fugitive dust, and worker and delivery vehicle emissions. Estimates obtained from DOE 2012.

While emissions would be greater than construction of the proposed NWMI facility, emissions would be below the significant de minimis levels under the New Source Review program discussed in Section 3.2.2 of this EIS. Therefore, the NRC staff does not expect increases in air emissions from construction activities of a linear accelerator-based technology at the Discovery Ridge site to contribute to concentrations that would exceed NAAQS in Boone County. The

NRC staff concludes that air quality impacts during construction of a linear accelerator-based technology at the Discovery Ridge site would be SMALL.

*Operations*

Operation of a linear accelerator-based facility would produce air emissions from operation of the building heating system, emergency generator, chemical processing, and worker vehicles. Total emissions from operations of a linear accelerator-based facility are presented in Table 5–7.

**Table 5–7. Estimated Air Emissions Resulting from Operation of a Linear Accelerator-Based Facility**

| | **Total Emissions (ton/year)[(a)]** |
|---|---|
| Nitrogen Oxides ($NO_x$) | 9 |
| Carbon Monoxide (CO) | 6.5 |
| Sulfur Dioxide ($SO_2$) | 0.01 |
| Particulate Matter less than 10 microns (μm) ($PM_{10}$) | 0.3 |
| Particulate Matter less than 2.5 μm ($PM_{2.5}$) | 0.03 |
| Carbon Dioxide ($CO_2$) | 40,000 |

[(a)] Accounts for emission from emergency generators, building heating system, process operations, and worker vehicles. Estimates obtained from DOE 2012 and rounded up.

Total operation-related emissions for criteria pollutants are well below the significant de minimis levels under the New Source Review program and major source under Title V operating source threshold (100 TPY) discussed Section 3.2.2 of this EIS. Therefore, the NRC staff does not expect increases in air emissions from operation activities of a linear facility at the Discovery Ridge site to contribute to concentrations that would interfere with the maintenance NAAQS or degrade Boone County's attainment/unclassifiable designation.

*Decommissioning*

Decommissioning activities would be similar to construction activities. The decommissioning activities would include, for example, vehicular traffic, earth-moving equipment, demolition of structures, and dismantlement and decontamination of systems. Emissions would be similar to what is presented in Table 5–6, above. Similarly, the NRC staff concludes that air quality impacts during decommissioning of a linear accelerator-based technology at the Discovery Ridge site would be SMALL.

Noise

*Construction*

Noise emissions during construction would occur because of increased traffic volumes from worker vehicles and because of the use of construction equipment on site. Noise from construction equipment would be localized, short term, and intermittent during machinery operations. Noise levels from construction equipment is predicted to be 65 dBA at 210 m (0.13 mi) distance from the equipment (DOE 2012). Noise levels from construction equipment therefore would not exceed existing noise levels at the sensitive receptors to the Discovery Ridge Site. The number of worker vehicles expected during construction is 50 (DOE 2012), all of which, for purposes of this analysis, are assumed to travel along U.S. Highway 63 during hours when work starts and stops. Sound levels increase at a rate of 3 dBA per doubling of traffic volumes. Conservatively assuming that all worker vehicles and deliveries travel on U.S. Highway 63 at the same time, this will result in a traffic volume of 868 vehicles/hr. This increase in traffic will not result in noise levels that will be noticeable from a traffic volume of 818 vehicles/hr.

Given that increases in noise levels as a result of additional vehicle traffic will not be noticeable and noise levels from construction equipment are not anticipated to exceed existing ambient noise levels, the NRC staff concludes that offsite noise impacts from construction would be SMALL.

*Operations*

Noise emissions during operation would occur because of increased traffic and the cooling tower. Noise from most operating equipment would be contained inside buildings and are not anticipated to be audible outside the linear accelerator-based facility (DOE 2012). Cooling tower noise levels are estimated to reach 60 dBA at a distance of 9 m (30 ft) from the cooling towers, which would not be noticeable given existing ambient noise levels at the Discovery Ridge site. The number of worker vehicles expected during operation is 150 (DOE 2012). Adding this traffic volume to existing traffic levels along U.S. Highway 63 will not result in noise levels that would be noticeable (less than 3 dBA increase). Therefore, the NRC staff concludes that noise impacts from operation of a linear accelerator-based facility at the Discovery Ridge site would be SMALL.

*Decommissioning*

Noise emissions during decommissioning would occur because of increased traffic volumes from worker vehicles and the use of equipment on site. Equipment during decommissioning would be similar to that used during the construction phase. As discussed above, noise levels from construction equipment for a linear accelerator-based facility are not expected to exceed existing noise levels. Similarly, noise levels from additional worker vehicles are not anticipated to be noticeable. Therefore, given that increases in noise levels as a result of additional vehicle traffic will not be noticeable and noise levels from equipment are not anticipated to exceed existing ambient noise levels, the NRC staff concludes that noise impacts from decommissioning a linear accelerator-based facility at the Discovery Ridge site would be SMALL.

#### *5.3.2.3 Geologic Environment*

Geology and Soils

*Construction*

Impacts on geology and soils associated with construction of a linear accelerator-based facility at the Discovery Ridge site would likely be similar to but somewhat greater than the impacts described for the proposed technology alternative, as presented in Section 4.3.1. The potential for greater impacts under this technology alternative is attributable to the larger footprint of the linear accelerator-based facility (77,000 $ft^2$ (7,200 $m^2$)) and the greater depth of excavation required (i.e., up to 30 ft (9 m)) in order to construct the below-grade portions of the facility (DOE 2012). As the depth to bedrock beneath the site is on the order of 25 ft (7.6 m) or less (Section 3.3.1), it is possible that blasting and other construction methods may be required during foundation excavation, depending on such factors as the depth of bedrock weathering. As for the proposed technology, the NRC staff assumes that the entire 7.4 ac (3.0 ha) site would be disturbed during construction of the linear accelerator-based facility.

The larger footprint that would be cleared, graded, and compacted along with the greater excavation depth would increase the potential for soil erosion and loss. Nevertheless, construction activities would be subject to the same site development permitting and associated regulatory requirements previously described in Section 4.3.1. For instance, NWMI would need to conduct site work in accordance with a Land Disturbance Permit from the City of Columbia in accordance with Chapter 12A, Article II (Land Preservation) of the City's Code of Ordinances (City of Columbia 2015). NWMI would need to prepare a soil erosion and sediment control plan and a stormwater management plan. These plans entail the implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development.

As described in Sections 3.3.1 and 3.3.2 and evaluated as for potential impacts in Section 4.3.1 for the proposed alternative, the site presents construction challenges that will need to be addressed during facility construction, along with possible mitigative features incorporated into the facility design. These challenges include the depth to bedrock, the potential for a seasonally high water table or perched groundwater, and the occurrence of soils with construction limitations (e.g., fat clays with a high shrink/swell potential). NWMI will conduct a site-specific geotechnical and hydrological studies of the Discovery Ridge site to characterize site conditions in support of final facility design.

As summarized in Section 2.2, Table 2–1 for the proposed alternative, geologic resources would also be required to support construction of a linear accelerator-based facility; these resources include granular stone (e.g., typically crushed aggregate (sand and gravel)) and aggregate to produce ready-mix concrete. Nevertheless, as noted in Section 3.3.1, construction aggregate is widely available throughout Boone County and northeast Missouri; therefore, their consumption to support facility construction under this alternative would not likely deplete local or regional stockpiles of such geologic resources.

Excavation of the below-grade portion of a linear accelerator-based facility to a depth of up to 30 ft (9.1 m) would result in the removal of up to approximately 28,000 $yd^3$ (21,000 $m^3$) of soil, sediments, and rock material, as compared to 9,000 $yd^3$ (6,900 $m^3$) for the proposed alternative. DOE (2012) indicates that the excavated material would be used on site for grading purposes, and presumably for backfill, or transported off site for disposal or reuse. Soils at the Discovery Ridge site, particularly the fat clays, have poor shear strength when wetted and have generally poor workability as a construction material, including for use as structural (engineered) backfill (Section 3.3.1). Consequently, the NRC staff expects that at least some proportion of this excavated material may need to be replaced with engineered backfill from offsite sources, thus adding to the volume of onsite earthwork required and geologic materials consumed. Still, the NRC staff expects that soils and other materials with the necessary engineering properties are readily obtainable from sources throughout the City of Columbia area and across Boone County.

Potential impacts on the geologic environment from construction of a linear accelerator-based facility at the Discovery Ridge site, to include soil loss and geologic resource consumption, would be similar to but somewhat greater than those associated with the proposed technology alternative. Site conditions also present somewhat greater constraints on site development and linear accelerator-based facility construction because of the larger facility footprint and greater excavation depth required. However, as for the proposed technology, the completion of detailed site-specific geotechnical studies would serve to reduce the cited uncertainties with respect to site geologic and soil conditions. Overall, the NRC staff concludes that the impacts on the geologic environment from the construction of a linear accelerator-based facility would also be SMALL.

*Operations*

Operational impacts on the geologic environment would be negligible under this technology alternative. During facility operations, previously disturbed areas would not be subject to long-term soil erosion. Areas disturbed during construction would be within the footprint of the completed facility or overlain by other impervious surfaces (such as roadways and parking lots), or revegetated.

Regardless of the technology, final facility design and construction would comply with applicable building codes and standards, which provide for the evaluation of site geologic and soil conditions, including potential seismic hazards. Completion of site-specific geotechnical and hydrological studies, as discussed in Section 4.3.1, would inform final facility design for the linear accelerator-based technology and construction considerations. The NRC staff concludes that linear accelerator-based facility operational impacts associated with the geologic environment at the proposed site would be SMALL.

*Decommissioning*

Compacted site soils and underlying sediments would be disturbed by facility demolition and decontamination work. The impacts on site geology and soils would be similar in scope to those described for construction. For the linear accelerator-based facility, the potential for soil erosion and loss would be somewhat greater than for the proposed NWMI technology primarily because of the larger facility footprint. Regardless, all site clearing to restore the proposed site to a reusable condition would be subject to applicable permits and approvals (e.g., demolition or clearance permit) and the applicable provisions, including Chapter 6, Article II (Building Code) of the City of Columbia's Code of Ordinances (City of Columbia 2015).

Before beginning to dismantle onsite structures, NWMI would remove waste materials and contaminated media from the structures. Materials would be packaged and properly disposed of as discussed in Section 5.3.2.9. Thus, these materials would not pose a contamination threat to site soils or water resources. NWMI would be required to conduct all decommissioning activities in accordance with a decommissioning plan submitted to the NRC and applicable regulations, as described in Section 2.9. As a result, the NRC staff concludes that impacts on the geologic environment from facility decommissioning would be SMALL.

#### *5.3.2.4 Water Resources*

Surface Water and Groundwater Resources

*Construction*

Impacts on surface water and groundwater resources from construction activities associated with the linear accelerator-based technology alternative would be similar to but somewhat greater than those under the proposed technology alternative (see Sections 4.4.1.1 and 4.4.2.1). The potential for greater impacts is attributable to the additional land affected because of the larger footprint of the facility and the greater depth of excavation, as referenced in Section 5.3.2.3. Otherwise, the same general assumptions, impact considerations, and regulatory parameters discussed for the proposed alternative apply to this alternative.

Site construction activities would have no direct impact on surface water resources. No natural surface water features occur on the Discovery Ridge site, and the site is not located in an area susceptible to flooding or in a delineated floodplain, as discussed in Section 3.4.1. During construction, however, stormwater runoff from construction areas could potentially affect downstream surface water quality if not properly managed. NWMI would be required to obtain a Land Disturbance Permit from the City of Columbia and submit related plans for City approval before any ground-disturbing activities or facility construction could begin on the site, as referenced in Section 5.3.2.3. The City would require that appropriate soil erosion and sediment control BMPs be used to minimize soil erosion and the stormwater transport of suspended sediment and other pollutants.

Construction stormwater runoff from the site would also be subject to regulation in accordance with CWA Section 402. Under the State of Missouri's delegated authority for administering the NPDES permit program pursuant to Section 402, the State has developed an NPDES general permit for construction stormwater. Permit coverage must be obtained by facility owners and operators for the discharge of stormwater and certain non-stormwater discharges (e.g., dewatering flows) from land-disturbance sites that disturb 1 ac (0.4 ha) or more, as further described in Section 4.4.1.1. NWMI's construction activities would be subject to NPDES permit and other local regulations for soil erosion and sediment control and construction stormwater management.

In addition, under CWA Section 401, an applicant for a Federal license or permit to conduct any activities, including facility construction or operation, that may cause a discharge into navigable waters is required to provide the Federal licensing agency with a certification from the state or agency having jurisdiction in which the discharge would originate. As discussed in Section 4.4.1.1 for the Discovery Ridge site, NWMI has stated that no State certification is required under CWA Section 401 (NWMI 2015a). NWMI also has stated that it would seek a waiver from the State (NWMI 2015c). However, because the NRC cannot issue a license or permit until the required certification is submitted, NWMI must provide the NRC with either a 401 certification from the State of Missouri, a waiver, or other State documentation that a Section 401 certification is not necessary.

The need for groundwater dewatering would be more likely under this alternative. This is due to the greater depth of excavation (i.e., up to 30 ft (7 m)) expected for the below-grade portion of the linear accelerator-based facility. The volume of groundwater requiring removal could be greater than the maximum volume projected by NWMI for the proposed technology, as described in Section 4.4.2.1.

As such, the NRC staff expects that dewatering could have minor effects on the vertical and horizontal extent of shallow groundwater, if present, and on groundwater flow direction, but any effects would be localized and temporary. Notwithstanding, NWMI would conduct site-specific geotechnical and hydrologic studies of the Discovery Ridge site that would characterize groundwater conditions beneath the site (NWMI 2015c). These results would guide any necessary construction accommodations and final facility design.

Other than the need for construction dewatering, no surface water or onsite groundwater would be withdrawn to support construction for this technology alternative. Water would be required during facility construction for such uses as dust control and soil compaction as well as to meet the drinking and sanitary needs of the construction workforce during the construction period.

Water lines and other utilities are already in place at the southwest corner of the Discovery Ridge site, with public water provided by Consolidated Public Water Supply District No. 1 (Section 4.4.2.1). The district uses groundwater as its supply source, and it has a total groundwater production capacity of 11 mgd (49,200 $m^3$/day) and currently supplies approximately 1.45 mgd (5,490 $m^3$/day) to customers.

The NRC staff estimates that onsite water needs to support linear accelerator-based facility construction would be similar to but greater than those for the proposed technology alternative, with the difference attributable primarily to the larger footprint of the facility. The NRC staff estimates that construction activities would require an average of 7,200 gpd (27,300 Lpd) of water. This is equivalent to 0.0072 mgd (27.2 $m^3$/day). Total projected water use for the slightly longer construction period (18 months) as compared to the NWMI proposed technology alternative would be about 2.6 million gal (9.8 million L). The projected average daily water needs for facility construction under this alternative is a very small percentage (i.e., about 0.50 and 0.07 percent) of the public water district's existing demand and available production capacity, respectively.

As stated in Section 4.4.1.1, the construction contractor would provide portable restroom facilities for the construction workforce. This measure would reduce the quantity of water required for potable and sanitary uses. These facilities would be serviced off site by a commercial vendor, alleviating any potential surface water or groundwater quality concerns.

Construction activities would not disturb any surface water features under this technology alternative, and NWMI would be required to prepare site-specific plans and implement BMPs in accordance with local and MDNR requirements to mitigate the potential impacts on surface water quality associated with construction activities. No surface water or onsite groundwater would be used to support facility construction. Construction dewatering would be likely during construction, but site-specific geotechnical and hydrologic studies will further characterize subsurface conditions, and dewatering activities would be conducted in accordance with regulatory requirements. The volume of water required to support onsite construction activities would be a very small percentage of the public utility's existing demand and available production capacity. The NRC staff concludes that the impacts on surface water and groundwater hydrology, quality, and use from the construction of a linear accelerator-based facility would be SMALL.

*Operations*

Under the linear accelerator-based technology alternative, normal facility operations would not have any direct impact on surface water or groundwater hydrology or quality. As described in Sections 4.4.1.2 and 4.4.2.2 for the proposed alternative at the Discovery Ridge site, stormwater runoff from the facility site would also be managed by an engineered stormwater management system, including necessary detention/retention structures, constructed and operated in compliance with applicable local, State, and Federal stormwater management permits, plans, procedures, and practices.

The NRC staff estimates that operation of the linear accelerator-based technology facility would normally require less water than the proposed technology alternative. This is because the volume of water necessary to meet workforce potable and sanitary needs is the primary component of total facility use. A closed-loop cooling system would normally operate to service the accelerators. Initial cooling system makeup requirements would total about 3,000 gal (11,400 L). This water would circulate internally and would need to be replenished only periodically. However, the use of a hybrid, evaporative cooling system may be necessary during the summer. This would require additional makeup water totaling 2,800 gpd (11,000 Lpd) during the summer months (DOE 2012).

The NRC staff estimates that an average of 4,000 gpd (15,100 Lpd) of water, equivalent to 0.004 mgd (15.1 $m^3$/day), would be required to support facility operations under this alternative. Consolidated Public Water Supply District No. 1 would also provide water service to the site and facility under this alternative. The projected average daily water use for this technology alternative is a negligible percentage of the production capacity of the water district and represents a very small increase (about 0.3 percent) in the volume of water that the district supplies to its customers.

There would be no radioactive liquid effluents released from the facility. Liquid waste generated during operations would be collected and stored by NWMI, and there would be no release of radioactive material through wastewater. All facility operations would be contained inside properly constructed buildings with proper material- and waste-handling facilities and spill prevention/cleanup capabilities (DOE 2012). As designed, only sanitary wastewater would be discharged to the sanitary sewer system serving the site (DOE 2012). The NRC staff estimates that sanitary effluent flow would average 3,300 gpd (12,500 Lpd). This is equivalent to approximately 0.0033 mgd (12.5 $m^3$/day). This effluent would be treated at the Columbia Regional WWTP. The Columbia Regional WWTP has a design treatment capacity of 20 mgd (75,700 $m^3$/day) with average demand of 16 mgd (60,600 $m^3$/day). The sanitary effluent flow under this technology alternative would be a very small percentage (i.e., 0.08 percent) of the available treatment capacity of the WWTP. The effluent would be required to meet the sewer system's influent acceptance and treatment criteria, as well as NRC's regulations at 10 CFR 20.2003.

Under this technology alternative, there would be no radiological or nonradiological impacts on surface water or groundwater during normal operations. Facility operations would need to comply with local, State, and Federal stormwater management permits, plans, procedures, and practices. Water requirements and sanitary effluent treatment needs would be met by public facilities, which have adequate capacity. As a result, the NRC staff concludes that the impacts on surface and groundwater hydrology, water quality, and water use from the operation of a linear accelerator-based facility would be SMALL.

*Decommissioning*

Facility decontamination, demolition, and site-restoration activities would be similar to those under the proposed technology alternative, with the potential magnitude of the impacts on surface water and groundwater similar to those discussed above for construction. NWMI would perform demolition and site-restoration activities in accordance with applicable local and State permits and approvals, including a State-issued NPDES general permit for the discharge of stormwater from land-disturbance sites, as described in Section 4.4.1.1 for construction. NWMI would use appropriate construction BMPs, including waste handling and pollution prevention practices and response procedures during decommissioning, so that no materials or contaminants are released to soils, surface water, or underlying groundwater.

NWMI would conduct work in accordance with a decommissioning plan submitted to the NRC. NWMI would be required to conduct necessary surveys of the soils and subsurface to comply with the NRC's radiological criteria for license termination in 10 CFR Part 20, Subpart E. The NRC staff also expects that NWMI would sample soils and other media as necessary in accordance with other required local and State permits and approvals to ensure that no nonradiological contamination remains in excess of action levels.

Water would be required for dust control and soil compaction during decommissioning. Based on facility size and dimensions as compared to the proposed technology alternative, the NRC staff estimates that decommissioning activities would require an average of 2,300 gpd (8,700 Lpd) of water, equivalent to 0.0023 mgd (8.7 $m^3$/day) during the decommissioning period. The NRC staff assumes that Consolidated Public Water Supply District No. 1 would also supply water needed for decommissioning. The projected water volume needed is less than the volume required for facility construction, as discussed above, and the impacts on supply capacity would similarly be negligible.

Since decommissioning activities would be conducted in accordance with pollution prevention and spill response procedures as part of local and State permit requirements for ground-disturbing activities and water needs would be minimal, the NRC staff concludes that the impacts on surface water and groundwater resources from facility decommissioning would be SMALL.

#### *5.3.2.5 Ecological Resources*

The linear accelerator-based alternative would disturb a similar amount of land as the proposed NWMI facility. Directly affected vegetation would be limited to non-native, common, or weedy species, which are abundant within the region and provide relatively low-quality habitat for birds and wildlife in comparison to forests, grasslands, and wetland habitats. In addition to a loss of habitat, noise from construction activities could disturb birds and wildlife. In response to such disturbances and loss of habitat, birds and wildlife could move out of the immediate area and find adequate, similar habitat (agricultural fields) within the vicinity. All other impacts on ecological resources, such as bird collisions, disturbance during maintenance activities, and potential runoff to offsite aquatic resources, are expected to be similar to those described for the proposed NWMI facility in Section 4.5 because of similar construction methods, similar amount of land disturbed, and similar operating and decommissioning activities. Therefore, the NRC staff concludes that the impacts on ecological resources from a linear accelerator-based facility at the Discovery Ridge site would be SMALL during construction, operations, and decommissioning.

#### *5.3.2.6 Historic and Cultural Resources*

Impacts to historic and cultural resources from the linear accelerator-based alternative would be similar to those described for the proposed NWMI facility in Section 4.6. With no historic properties affected, no archaeological sites or evidence of cultural resources identified during the Phase I survey (NWMI 2015a), tribal input, and the cultural resource assessment and consultations performed by the NRC staff, constructing, operating, and decommissioning the NWMI facility using this alternative technology would not impact any known historic and cultural resources at the Discovery Ridge site.

#### *5.3.2.7 Socioeconomics*

Socioeconomic impacts from the linear accelerator-based alternative would be similar to those described for the proposed NWMI facility in Section 4.7. This technology alternative would require up to 50 construction workers and up to 150 workers during facility operations. The number of construction workers for the linear accelerator-based alternative would be fewer than the subcritical fission process alternative and the proposed NWMI facility. The number of operation workers for the linear accelerator-based alternative and the subcritical fission process alternative would be the same but higher than the proposed NWMI facility. These are peak estimates of workers, and the average daily number of operations workers would be much less. Most, if not all, workers would likely reside within the ROI or adjacent counties and communities and commute to the work site. Even if the estimated number of operations workers (150) were to generate two to three times additional employment in the ROI, the combined total number of workers would represent less than three-quarters of a percent of the current civilian labor force in Boone County. This would have little to no noticeable effect on employment levels or public services demands in the ROI. Given the size of the workforce, socioeconomic impacts for constructing, operating, and decommissioning the linear accelerator-based technology alternative at the Discovery Ridge site would be SMALL.

#### *5.3.2.8 Human Health*

The NRC staff expects human health impacts from the linear accelerator-based alternative to be similar to those described in Section 4.8 for the proposed NWMI facility. Like the proposed NWMI facility, the linear accelerator-based facility would be required to comply with all Federal and State regulations, protecting workers and members of the public during construction, operations, and decommissioning. For example, OSHA regulations would protect workers from physical occupational hazards; OSHA and EPA regulations would protect workers and the public from hazardous material and chemical hazards; and NRC regulations would protect workers and the public from radiological hazards. Additionally, the NRC staff expects that for both radiological and nonradiological hazards, the linear accelerator-based alternative would incorporate engineered design features and procedural controls to minimize any impacts to workers or the public (DOE 2012).

Operation of the linear accelerator-based facility would require transportation of nonradioactive natural molybdenum target material to the facility. Radioactive materials transportation associated with the linear accelerator-based facility would include transportation of Mo-99 product from the facility to an end user medical facility, and transportation of the spent or unusable portion of Mo-99 product back to the linear accelerator-based facility for reuse. However, since the linear accelerator-based facility would not use or handle LEU, no transportation of irradiated or unirradiated LEU targets would occur in conjunction with operation of the facility (DOE 2012). All transportation would be in compliance with NRC and DOT regulations.

Given the safety-oriented design and procedures at a facility using the linear accelerator-based alternative, and given that this facility would be required to comply with all Federal and State of Missouri regulations, ensuring that public health and safety are protected, the NRC staff concludes that the human health impacts from construction, operations, and decommissioning of the linear accelerator-based alternative would be SMALL.

#### *5.3.2.9 Waste Management*

The NRC staff assumes that waste management impacts from the linear accelerator-based alternative would be similar to those described in Section 4.9 for the proposed NWMI facility. Based on comparisons with similar proposed linear accelerator-based facilities, the NRC staff expects that the linear accelerator-based alternative would generate approximately 160 metric tons (175 tons) of solid waste (construction debris) during construction, and operation of the linear accelerator-based alternative would generate about 10.4 $m^3$ (14 $yd^3$) of low-level radioactive waste, 2.4 $m^3$ (3.1 $yd^3$) of hazardous waste, and 45 $m^3$ (59 $yd^3$) of nonradioactive, nonhazardous waste annually (DOE 2012). Compared to the volumes of waste that would be produced by the proposed NWMI facility (NWMI 2015c), these volumes of hazardous and nonradioactive, nonhazardous waste generated by the linear accelerator-based alternative would be similar, and the volume of radioactive waste would be significantly smaller. As discussed in Section 4.14.9, the NRC staff assumes that sufficient infrastructure exists in the City of Columbia, Missouri, area for proper management of wastes from the proposed NWMI facility; therefore, the infrastructure would also be sufficient to handle waste from the linear accelerator-based alternative. In addition, the operator of the linear accelerator-based alternative would be required to comply with NRC, DOT, State of Missouri, and local requirements, as applicable, regarding disposal, handling, and transportation of waste. Since adequate infrastructure exists for waste disposal in the City of Columbia, Missouri, area, and since waste disposal would be required to be conducted in accordance with all applicable regulations, the NRC staff concludes that the impacts from waste management during construction, operations, and decommissioning of the linear accelerator-based alternative would be SMALL.

#### *5.3.2.10 Transportation*

Transportation impacts from the linear accelerator-based alternative would be similar to those described for the proposed NWMI facility in Section 4.10. Construction, operations, and decommissioning activities would be very similar and over same time span. Transportation impacts would consist of commuting workers and truck deliveries and shipments of equipment and materials. During periods of peak construction up to 50 workers and operations up to

150 workers could be commuting daily to the work site. Workers would arrive via site access roads and the volume of traffic on nearby roads could increase during shift changes. In addition to commuting workers, trucks would be transporting equipment and materials to and from the work site, thus increasing the amount of traffic on local roads. Up to 10 to 20 truck shipments per day would occur during operations (DOE 2012). The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. However, given the size of the average daily workforce, the number of daily truck deliveries and shipments combined with the easy access to U.S. Highway 63, there would be little if any noticeable traffic volume-related level of service impacts. Therefore, transportation impacts during the construction, operations, and decommissioning of the NWMI facility using the linear accelerator-based technology at the Discovery Ridge site would be SMALL.

#### *5.3.2.11 Accidents*

DOE previously assessed a range of accidents involving either radioactive Mo-99, or chemicals that would be used during Mo-99 production, for a potential linear accelerator-based facility (DOE 2012). The accident scenarios were chosen such that the accidents considered would represent the range of possible accident consequences given the design, operating parameters, and types of materials that would be present at the facility. Possible internal accidents (e.g., fire), external accidents (e.g., tornado), and sabotage events were all considered. For evaluation of impacts of accidents to members of the public, DOE's assessment considered the nearest member of the public to the facility to be located at a site boundary 20 m (65.6 ft) from the facility (DOE 2012).

This assessment determined that, for an extremely unlikely severe chemical accident involving an explosion-, fire-, earthquake-, or tornado-induced release of helium from the facility (the highest-consequence chemical accident considered), assuming average meteorological conditions, PAC-1, PAC-2, and PAC-3 limits would not be exceeded at the location of the maximally exposed member of the public. This means that no significant health effects would be expected for members of the public as a result of this accident for average meteorological conditions (PAC-1, PAC-2, and PAC-3 limits are defined in Section 4.11.2). However, DOE's assessment also determined that, for 95th percentile meteorological conditions (i.e., meteorological conditions that would result in greater exposure than the conditions that occur 95 percent of the time), the helium concentration at the location of the maximally exposed member of the public would exceed the PAC-3 limits; concentrations above PAC-3 limits could result in life-threatening health effects or death. (DOE 2012).

DOE's assessment considered two broad types of radiological accidents: accidents or events that could result in an airborne release of radioactive material, and accidents that could result in direct radiation exposure. The assessment determined that, for a sabotage event (i.e., an intentional action by a person inside or outside of the facility intending to cause harm to workers or members of the public) resulting in an airborne release of Mo-99, the dose to a maximally exposed member of the public would be 130 mrem for average meteorological conditions, and 560 mrem for 95th percentile meteorological conditions. This was the highest consequence airborne release of radioactive material accident or event considered. The assessment also determined that, for an earthquake-, tornado-, or aircraft impact-induced accident that damages the facility, exposing an irradiated target and causing direct radiation exposure (the highest consequence direct radiation exposure accident considered), the dose to a maximally exposed member of the public from 1 hour of exposure would be 1,100 mrem (DOE 2012).

For the bounding chemical and radiological accidents discussed above, PAC-1/2/3 limits, and 10 CFR Part 20 public dose limits, respectively, would be exceeded. However, the NRC staff expects that a linear accelerator-based facility would include additional engineered designed features and procedural controls that would mitigate the consequences of these accidents. Before construction or operation of a linear accelerator-based facility, the NRC staff would perform a safety review of the proposed facility that would include a thorough evaluation of possible radiological or chemical accidents at the facility, including the consequences of those accidents and any features or controls that would mitigate those consequences. To receive a construction permit or operating license from the NRC, the applicant would have to demonstrate that the facility would be in compliance with all NRC regulations, including 10 CFR Part 20 dose limits and accident performance requirements in 10 CFR 70.61, as applicable. If the NRC staff determines in its SER for the linear accelerator-based facility that the facility would be operated in compliance with all applicable regulations governing the consequences of accidents, then the NRC staff concludes that the impacts from accidents at the linear accelerator-based facility would be SMALL.

##### *5.3.2.12 Environmental Justice*

The environmental justice impacts from a linear accelerator-based alternative would be similar as those discussed for the proposed NWMI facility in Section 4.12. Minority and low-income populations residing along site access roads could be affected by noise and dust and increased commuter vehicle and truck traffic during construction, operations, and decommissioning. However, these effects are not likely to be high and adverse and would be short term and within a limited time period during certain hours of the day. Noise and dust impacts from onsite activities during construction and decommissioning would similarly be short term. Everyone living near Discovery Ridge could be affected by operation activities, including minority and low-income populations. Any human health and environmental effect would depend on the magnitude of the change from current environmental conditions.

As discussed in Section 5.3.2.8 of this EIS, the potential radiological dose to the public from facility operations would be well within NRC and applicable Federal, State, and local regulatory limits. As a result, everyone living near the Discovery Ridge site, including minority and low-income populations, would not be adversely affected by radiation exposure during facility operations. Permitted nonradiological air emissions would also be required to remain within regulatory standards. Noise levels may increase along U.S. Highway 63 because of increased commuter vehicle and truck traffic during NWMI facility operations. This may not be noticeable, however, given the relatively small size of the workforce and the limited number of daily truck deliveries and shipments. Based on this information, construction, operations, and decommissioning of the proposed NWMI facility using the linear accelerator-based technology would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near Discovery Ridge.

##### *5.3.2.13 Cumulative Impacts*

Cumulative impacts for the linear accelerator-based alternative would be similar to those described in Chapter 4 for the NWMI RPF facility at the Discovery Ridge site, because direct contributory effects from construction, operations, and decommissioning for this technology would be similar.

### 5.3.3 Subcritical Fission Technology

The uranium fission technology would produce Mo-99 using a subcritical fission process followed by chemical extraction of Mo-99. For the purpose of this analysis, the NRC staff assumed the facility would be similar to the facility described in NRC's *Environmental Impact Statement for the Construction Permit for the SHINE Medical Radioisotope Production Facility, Final Report,* NUREG–2183 (NRC 2015c), which considered the environment impacts of the facility proposed in the SHINE Medical Technologies, Inc.'s Construction Permit Application (SHINE 2015).

The first stage in the radioisotope production process for this alternative is the production of neutrons, which induce the fission of uranium, resulting in the formation of radioisotopes. During the irradiation stage, a neutron driver (accelerator) affixed above a subcritical operating assembly would accelerate deuterium ions into a chamber filled with tritium gas. This chamber would be centered within the subcritical operating assembly which contains a vessel containing LEU target solution in the form of uranyl sulfate. The resulting ion beam would strike the tritium gas and produce helium nuclei and neutrons. These additional neutrons would pass through a neutron multiplier, which would produce additional neutrons (SHINE 2015).

The neutrons would then pass into the LEU target solution within one of several irradiation units, causing the uranium-235 in the solution to fission (split) and produce byproduct materials, including Mo-99. The target solution in each irradiation unit would be maintained at a subcritical level (i.e., a level at which the uranium-235 fission and the consequent neutron production in the target solution vessel would not be self-sustaining). Mo-99, xenon-133, and iodine-131 production would occur within the target solution from fission during the irradiation cycle. An offgas system would be used during this stage to handle and contain radiolytic and fission product gases released from the target solution. The target solution vessel would be surrounded by a light-water pool. This pool would be used to control the temperature of the target solution vessel, reflect neutrons back into the vessel, shield radiation, and absorb heat resulting from the fission process (SHINE 2015).

At the end of the irradiation cycle in each irradiation unit, the target solution would be removed from the target solution vessel and transferred through piping to one of three hot cells (shielded nuclear radiation confinement chambers) where the Mo-99 would be selectively extracted and purified using a chemical process (SHINE 2015; NRC 2015c). Following extraction and purification, the separated radioisotopes would be packaged and distributed.

At full operational capacity, the facility could produce up to 8,200 6-day curies (Ci 6-day) per week of the medical radioisotope Mo-99 (SHINE 2015). To meet this production schedule, each irradiation unit would need to operate continuously for about 5.5 days. Radioisotope production functions would operate close to 7 days per week (SHINE 2015).

A description of the affected environment for the Discovery Ridge site is provided in Chapter 3 of the EIS. Construction of a subcritical fission-based facility will include five main buildings that would cover 91,000 $ft^2$ (8,500 $m^2$) and total excavated material would be 278,000 $yd^3$ (213,000 $m^3$) (SHINE 2015; NRC 2015c). Construction of a subcritical fission-based alternative would take 18 months and require a peak workforce of 451 workers (SHINE 2015; NRC 2015c). Operation of a subcritical fission-based alternative would require a peak workforce of 150 workers for 30 years (SHINE 2015; NRC 2015c). The decommissioning phase would be 6 months and require a peak workforce of 261 workers (SHINE 2015; NRC 2015c). The following sections describe the impacts of constructing, operating, and decommissioning the proposed NWMI facility using the subcritical fission-based technology.

#### *5.3.3.1 Land Use and Visual Resources*

Land use impacts of a subcritical fission-based alternative at the Discovery Ridge site would be confined to the 7.4 ac (3.0 ha) site. The fission-based alternative would disturb a similar amount of land as the proposed NWMI facility (SHINE 2015; NRC 2015c). The highest structure would be the emissions stack, which would extend approximately 66 ft (20 m) in height (SHINE 2015; NRC 2015c). Therefore, the height of the buildings for the fission-based alternative would be bounded by the parameters analyzed for the NWMI facility in Section 4.1. As described in

Section 4.1, land use impacts during construction, operations, and decommissioning would be SMALL, because the entire site is currently certified for industrial use, and the permanently converted agricultural land would be a small portion of available agricultural land within the vicinity. As described in Section 4.1, aesthetic impacts during construction, operations, and decommissioning would be SMALL at the proposed Discovery Ridge site, given that a light industrial development landscape surrounds part of the site and the visual setting is generally flat and has a uniform landform with low vegetation diversity and a low visual-quality rating. Based on a similar amount of land disturbed and building height for the subcritical fission facility alternative, land use and visual impacts would be SMALL during construction, operations, and decommissioning of a subcritical fission facility on the Discovery Ridge site.

#### *5.3.3.2 Air Quality and Noise*

A description of the air quality and noise affected environment for the Discovery Ridge site is provided in Section 3.2 of the EIS.

<u>Air Quality</u>

*Construction*

Construction activities associated with building a subcritical fission facility would generate air pollutant emissions from site-disturbing activities (e.g., grading, compacting), operation of construction equipment, and worker and shipment vehicles. Construction-related emissions are presented in Table 5–8.

**Table 5–8. Estimated Air Emissions Resulting from Construction of a Subcritical Fission Facility**

| | Total Emissions (tons/year)[(a)] |
|---|---|
| Nitrogen Oxides ($NO_x$) | 278 |
| Carbon Monoxide (CO) | 184 |
| Sulfur Dioxide ($SO_2$) | 18 |
| Particulate Matter less than 10 microns (μm) ($PM_{10}$) | 26 |
| Particulate Matter less than 2.5 μm ($PM_{2.5}$) | 20 |
| Carbon Dioxide ($CO_2$) | 14,920 |

(a) Accounts for emission from construction equipment, fugitive dust, and worker and delivery vehicle emissions. Construction phase would be 18 months. Emissions based on NRC 2015c.

Emissions would be greater than construction of the proposed NWMI facility because the subcritical fission facility would be a larger facility that would require a larger workforce and additional equipment. Emissions would exceed the significant de minimis levels under the New Source Review program discussed in Section 3.2.2. However, total construction emissions would be 4 percent or less of the Boone County annual emissions for each criteria pollutant and carbon dioxide. Further, these emissions are bounding conditions that assume conservative equipment activities and conservative workforce commute distances (NRC 2015c). Additionally, the facility may be required to obtain and abide by applicable construction air permits to prevent degradation of air quality in Boone County. Therefore, the NRC staff concludes that the air quality impacts during construction would be SMALL.

*Operations*

Operation of a subcritical fission facility would produce air emissions from fuel combustion associated with processing and facility heating purposes (boilers and heaters), an emergency generator, target solution preparation, and worker vehicles. Total emissions from these sources are presented in Table 5–9.

**Table 5–9. Estimated Air Emissions Resulting from Operation of a Subcritical Fission Facility**

| | Total Emissions (tons/year)[(a)] |
|---|---|
| Nitrogen Oxides ($NO_x$) | 13 |
| Carbon Monoxide (CO) | 53 |
| Sulfur Dioxide ($SO_2$) | 0.2 |
| Particulate Matter less than 10 µm ($PM_{10}$) | 1.0 |
| Particulate Matter less than 2.5 µm ($PM_{2.5}$) | 1.0 |
| Carbon Dioxide ($CO_2$) | 17,250 |

(a) Accounts for emissions from construction equipment, fugitive dust, and worker and delivery vehicle emissions. Emissions based on NRC 2015c.

Total operation-related emissions for criteria pollutants are well below the significant de minimis levels under the New Source Review program and major sources under Title V operating sources threshold (100 TPY) discussed in Section 3.2.2 of this EIS. Therefore, the NRC staff does not expect increases in air emissions from construction activities to contribute to concentrations that would interfere with the maintenance of NAAQS or degrade Boone County's attainment/unclassifiable designation. Therefore, the NRC staff concludes that the air quality impacts during operation of a subcritical fission facility would be SMALL.

*Decommissioning*

Activities associated with decommissioning of a subcritical fission facility would generate air pollutant emissions from site-disturbing activities, operation of equipment, worker vehicles, and demolition of structures, and dismantlement and decontamination of systems. Total emissions from these sources are presented in Table 5–10.

**Table 5–10. Estimated Air Emissions Resulting from Decommissioning of a Subcritical Fission Facility**

| | Total Emissions (ton/year)[(a)] |
|---|---|
| Nitrogen Oxides ($NO_x$) | 173 |
| Carbon Monoxide (CO) | 89 |
| Sulfur Dioxide ($SO_2$) | 11 |
| Particulate Matter less than 10 µm ($PM_{10}$) | 14 |
| Particulate Matter less than 2.5 µm ($PM_{2.5}$) | 12 |
| Carbon Dioxide ($CO_2$) | 8,000 |

(a) Accounts for emission from construction equipment, fugitive dust, and worker and delivery vehicle emissions. Total emissions during 6-month decommissioning phase. Emissions based on NRC 2015.

Emissions would be greater than decommissioning of the proposed NWMI facility as a result of the subcritical fission facility being a larger facility that would require a larger workforce and additional equipment. Emissions would exceed the significant de minimis levels under the New Source Review program discussed in Section 3.2.2. However, decommissioning emissions would be 2 percent or less of the Boone County annual emissions for each criteria pollutant and carbon dioxide. Further, these emissions are based upon bounding conditions. For instance, a 100-mi (160-km) roundtrip worker commute for each employee and simultaneous continuous use of construction equipment were assumed (NRC 2015c). Additionally, the facility may be required to obtain and abide by applicable air permits to prevent degradation of air quality in Boone County. Therefore, the NRC staff concludes that the air quality impacts during decommissioning would be SMALL.

<u>Noise</u>

*Construction*

Noise emissions during construction would occur because of increased traffic volumes from worker vehicles and because of the use of construction equipment on site. The maximum number of worker vehicles expected on site during construction is 451, all of which, for purposes of this analysis, are assumed to travel along U.S. Highway 63 during hours when work starts and stops. Sound levels increase at a rate of 3 dBA per doubling of traffic volumes. Traffic volume along U.S. Highway 63 is 818 vehicles/hr (NWMI 2016a; NWMI 2016c). Conservatively assuming that all worker vehicles and deliveries travel on U.S. Highway 63 at the same time, this will result in a traffic volume of 1,259 vehicles/hr. This increase in traffic will not result in noise levels that will be noticeable.

Construction equipment for a subcritical fission facility would be similar to construction equipment of the proposed NWMI facility. However, because the subcritical fission facility would be a larger facility, multiple numbers of similar equipment are assumed to be used simultaneously (NRC 2015c). Simultaneous use of multiple equipment may result in greater noise levels than single-use equipment. For example, simultaneous use of three pieces of equipment, each with noise levels of 85 dBA, results in a combined noise level of 90 dBA. However, accounting for attenuation of noise levels from construction equipment to nearby noise sensitive receptors at the Discovery Ridge, site noise emissions from construction equipment are not expected to noticeable or exceed existing noise levels at the sensitive receptors. Further, noise from construction equipment would be localized, short term, and intermittent during machinery operations.

Given that increases in noise levels as a result of additional vehicle traffic will not be noticeable and noise levels from construction equipment are not anticipated to exceed existing ambient noise levels, the NRC staff concludes that offsite noise impacts from construction would be SMALL.

*Operations*

Noise emissions during operation would occur because of increased traffic. Noise from operating equipment would be contained inside buildings and are not anticipated to be audible outside the subcritical fission facility (NRC 2015c). The number of worker vehicles expected during operation is 150. Adding this traffic volume to existing traffic levels along U.S. Highway 63 will not result in noise levels that would be noticeable (less than 3-dBA increase). Therefore, the NRC staff concludes that noise impacts from operation of a subcritical fission facility at the Discovery Ridge site would be SMALL.

*Decommissioning*

Noise emissions during decommissioning would occur because of increased traffic volumes from worker vehicles and the use of equipment on site. The maximum number of worker vehicles expected on site during decommissioning is 261, all of which, for purposes of this analysis, are assumed to travel along U.S. Highway 63 during hours when work starts and stops. Sound levels increase at a rate of 3 dBA per doubling of traffic volumes. Conservatively assuming that all worker vehicles and deliveries travel on U.S. Highway 63 at the same time, this will result in a traffic volume of 1,079 vehicles/hr. This increase in traffic will not result in noise levels that will be noticeable from a traffic volume of 818 vehicles/hr.

Equipment during decommissioning would be similar to that used during the construction phase. As discussed above, noise levels from construction equipment for a subcritical fission facility are not expected to exceed existing noise levels. Therefore, given that increases in noise levels as a result of additional vehicle traffic will not be noticeable and that noise levels from equipment are not anticipated to exceed existing ambient noise levels, the NRC staff concludes that noise impacts from decommissioning a subcritical fission facility at the Discovery Ridge site would be SMALL.

#### *5.3.3.3 Geologic Environment*

Geology and Soils

*Construction*

Impacts on geology and soils associated with construction of a subcritical fission process facility at the Discovery Ridge site would be similar to but somewhat greater than the impacts described for the proposed technology, as presented in Section 4.3.1. The potential for greater impacts under this technology alternative is attributable to the larger footprint of the subcritical fission process facility (91,000 $ft^2$ (8,500 $m^2$)) and the greater depth of excavation required (i.e., up to 39 ft (12 m)) to construct the below-grade portions of the facility (NRC 2015c). Because the depth to bedrock beneath the site is on the order of 25 ft (7.6 m) or less (Section 3.3.1), it is probable that blasting and other construction methods may be required during foundation excavation. The NRC staff further assumes that the entire 7.4 ac (3.0 ha) site would be disturbed during construction of the subcritical fission process facility.

The larger footprint that would be cleared, graded, and compacted along with the greater excavation depth would increase the potential for soil erosion and loss. Nevertheless, construction activities would be subject to the same site development permitting and associated regulatory requirements previously described in Section 4.3.1. For instance, NWMI would need to conduct site work in accordance with a Land Disturbance Permit from the City of Columbia in accordance with Chapter 12A, Article II (Land Preservation) of the City's Code of Ordinances (City of Columbia 2015). NWMI would need to prepare a soil erosion and sediment control plan and a stormwater management plan. These plans entail the implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development.

As described in Sections 3.3.1 and 3.3.2 and evaluated for potential impacts in Sections 4.3.1 and 5.3.2.3, the Discovery Ridge site presents construction challenges that will need to be addressed during facility construction, along with mitigative features incorporated into the facility. These challenges include the depth to bedrock, the potential for a seasonally high water table or perched groundwater, and the occurrence of soils with construction limitations (e.g., fat clays with a high shrink/swell potential). NWMI would conduct site-specific geotechnical and hydrological studies of the Discovery Ridge site to characterize site conditions in support of final subcritical fission facility design.

As summarized in Section 2.2, Table 2–1, for the proposed alternative, geologic resources would also be required to support construction of a subcritical fission process facility; these resources include granular stone (e.g., typically crushed aggregate (sand and gravel)) and aggregates to produce ready-mix concrete. The volumes required would be proportionally greater for this technology alternative as compared to either the proposed technology or the linear accelerator-based facility alternatives. Specifically, projected geologic resource requirements to construct the subcritical fission process facility include, but are not limited to, 16,000 $yd^3$ (12,233 $m^3$) of crushed stone material (NRC 2015c). Nevertheless, as noted in Section 3.3.1, construction aggregate is widely available throughout Boone County and northeast Missouri and so their consumption to support facility construction under this alternative would not likely deplete local or regional stockpiles of such geologic resources.

Because of the larger facility footprint and, especially, the greater depth of excavation required to construct the below-grade portion of the facility, excavation activities under this technology alternative would result in removal of up to 278,000 $yd^3$ (213,000 $m^3$) of soil, sediments, and rock material. This is considerable in comparison to the excavation volumes of 28,000 $yd^3$ (21,000 $m^3$) and 9,000 $yd^3$ (6,900 $m^3$) associated with the linear accelerator-based facility and proposed technology alternative, respectively. For construction of a subcritical fission process facility, NRC (2015) indicated that materials needed for backfill around structures and topsoil for use in miscellaneous earthwork and final surface preparation would be reclaimed from onsite, excavated material and prepared as necessary to meet structural requirements. Nonetheless, soils at the Discovery Ridge site, particularly the fat clays, have poor shear strength when wetted and have generally poor workability as a construction material, including for use as structural (engineered) backfill (Section 3.3.1). Thus, the NRC staff assumes that at least some proportion of this excavated material would need to be replaced with engineered backfill from offsite sources, thus adding to the volume of onsite earthwork required and geologic materials consumed. Due to the diversity of soil types in the region, the NRC staff concludes that soils with the necessary engineering properties are readily obtainable from sources throughout the City of Columbia area and across Boone County or from sources elsewhere in central and eastern Missouri.

Under this alternative, the potential impact on the geologic environment from deep excavation work, potential soil loss, and geologic resource consumption would be greater than under both the linear accelerator-based facility and proposed technology alternatives. Because of the larger facility size and the need for deep excavation, site conditions would present greater constraints on site development and facility construction. Completion of detailed site-specific geotechnical studies would serve to inform construction planning and final facility design. In consideration of the above factors, the NRC staff concludes that the impacts on the geologic environment from the construction of a subcritical fission process facility at the Discovery Ridge site would also be SMALL.

*Operations*

Operational impacts on the geologic environment would be negligible under this technology alternative. During facility operations, previously disturbed areas would not be subject to long-term soil erosion. Areas disturbed during construction would be within the footprint of the completed facility or overlain by other impervious surfaces (such as roadways and parking lots), or revegetated.

Regardless of the technology, final facility design and construction would comply with applicable building codes and standards, which provide for the evaluation of site geologic and soil conditions, including potential seismic hazards. Completion of site-specific geotechnical and hydrological studies, as discussed in Section 4.3.1, would inform final facility design and construction considerations. The NRC staff concludes that subcritical fission process facility operational impacts associated with the geologic environment at the proposed site would be SMALL.

*Decommissioning*

Compacted site soils and underlying sediments would be disturbed by facility demolition and decontamination work. The impacts on site geology and soils would be similar in scope to those described for construction. For the subcritical fission process facility, the potential for soil erosion and loss during decommissioning would be greater than for either the linear accelerator-based facility or proposed technology primarily because of the larger facility footprint and extensive below-grade portions of the facility. Nonetheless, all site clearing to restore the proposed site to a reusable condition would be subject to applicable permits and approvals (e.g., demolition or clearance permit), and the applicable provisions including Chapter 6, Article II (Building Code) of the City of Columbia's Code of Ordinances (City of Columbia 2015).

Before beginning to dismantle onsite structures, NWMI would remove waste materials and contaminated media from the structures. Materials would be packaged and properly disposed of as discussed in Section 5.3.3.9. Thus, these materials would not pose a contamination threat to site soils or water resources. NWMI would be required to conduct all decommissioning activities in accordance with a decommissioning plan submitted to the NRC and applicable regulations, as described in Section 2.9. The NRC staff concludes that impacts on the geologic environment from facility decommissioning under this technology alternative would be SMALL.

#### *5.3.3.4 Water Resources*

Surface Water and Groundwater Resources

*Construction*

Impacts on surface water and groundwater resources from construction activities associated with the subcritical fission process alternative would be similar to but greater than those under both the linear accelerator-based and proposed technology alternatives (see Sections 4.4.1.1, 4.4.2.1, and 5.3.2.4). The potential for greater impacts is attributable to the additional land affected because of the larger footprint of the facility and the greater depth of excavation, as referenced in Section 5.3.3.3. Otherwise, the same general assumptions, impact considerations, and regulatory parameters discussed for the linear accelerator-based and proposed technology alternatives apply to this alternative discussion.

During construction, stormwater runoff from construction areas could potentially affect downstream surface water quality if not properly managed. NWMI would be required to obtain a Land Disturbance Permit from the City of Columbia and submit related plans for city approval before any ground-disturbing activities or facility construction could commence on the site, as referenced in Section 5.3.3.3. The City would require that appropriate soil erosion and sediment control BMPs be used to minimize soil erosion and the stormwater transport of suspended sediment and other pollutants.

Construction stormwater runoff from the construction would also be subject to regulations in accordance with CWA Section 402. Under the State of Missouri's delegated authority for administering the NPDES permit program pursuant to Section 402, the State has developed an NPDES general permit for construction stormwater. Permit coverage must be obtained by owners and operators for the discharge of stormwater and certain non-stormwater discharges (e.g., dewatering flows) from land-disturbance sites that disturb 1 ac (0.4 ha) or more, as further described in Section 4.4.1.1. NWMI's construction activities would be subject to NPDES permit and other local regulations for soil erosion and sediment control and construction stormwater management.

In addition, under CWA Section 401, an applicant for a Federal license or permit to conduct any activities, including facility construction or operation, that may cause a discharge of regulated pollutants into navigable waters is required to provide the Federal licensing agency with a certification from the state or agency having jurisdiction in which the discharge would originate. As discussed in Section 4.4.1.1 for the Discovery Ridge site, NWMI has stated that no State certification is required under CWA Section 401 (NWMI 2015a). NWMI also has stated that it would seek a waiver from the State (NWMI 2015c). However, because the NRC cannot issue a construction permit until the required certification is submitted, NWMI must provide the NRC with either a 401 certification from the State of Missouri, a waiver, or State documentation that a Section 401 certification is not necessary.

The need for groundwater dewatering would be very likely under this alternative. This is because of the greater depth of excavation (i.e., up to 39 ft (12 m)) expected for the below-grade portion of the subcritical fission process facility. The volume of groundwater requiring removal could be much greater, depending on the depth and extent of groundwater, than the maximum volume projected by NWMI for the proposed technology, as described in Section 4.4.2.1. Consequently, the NRC staff expects that dewatering could have localized effects on the vertical and horizontal extent of shallow groundwater and on groundwater flow direction, although the impacts would likely be temporary. NWMI has committed to commissioning site-specific geotechnical and hydrologic studies of the Discovery Ridge site. These studies would characterize groundwater conditions beneath the site and would guide any necessary construction accommodations and final facility design.

As previously discussed, the Discovery Ridge site is served by public water, with service provided by Consolidated Public Water Supply District No. 1 (Section 4.4.2.1). The district uses groundwater as its supply source, and it has a total groundwater production capacity of 11 mgd (49,200 $m^3$/day) and currently supplies approximately 1.45 mgd (5,490 $m^3$/day) to customers.

Under this technology alternative, onsite water needs to support facility construction would be greater than under both the linear accelerator-based and proposed technology alternatives. The NRC staff estimates that construction activities would require an average of 12,000 gpd (45,400 Lpd) of water. This is equivalent to 0.012 mgd (45.4 $m^3$/day). Total projected water use for the construction period (18 months) is about 4.3 million gal (16.3 million L), excluding water required for concrete production and preoperational testing (NRC 2015c). The projected average daily water needs for construction under this technology alternative would still be a small percentage (i.e., about 0.8 and 0.11 percent) of the public water district's existing demand and available production capacity, respectively.

For construction under this technology alternative, NWMI would be required to prepare site-specific plans and implement BMPs in accordance with local and MDNR requirements to mitigate the potential impacts on surface water quality. No surface water features would be disturbed and no surface water or onsite groundwater would be used to support facility construction. Construction dewatering would be very likely during construction, but site-specific geotechnical and hydrologic studies will further characterize subsurface conditions, and dewatering activities would be conducted in accordance with regulatory requirements. The volume of water required to support onsite construction activities would be a small percentage of the public utility's existing demand and available production capacity. The NRC staff concludes that the impacts on surface water and groundwater hydrology, quality, and use from the construction of a subcritical fission process facility would be SMALL.

*Operations*

Normal facility operations would not have any direct impact on surface water or groundwater hydrology or quality under this technology alternative. Consistent with the previously described alternatives, stormwater runoff from the facility site would be managed by an engineered stormwater management system, constructed and operated in compliance with applicable local, State, and Federal stormwater management permits, plans, procedures, and practices.

Projected water demands for operation of a subcritical fission process facility under this alternative are higher than for either the linear accelerator-based technology or proposed technology alternatives. Water would be required for potable and sanitary uses, fire protection, heating and cooling system makeup, and makeup for the radioisotope production process, with the largest use attributable to potable and sanitary water use by the facility workforce (NRC 2015c).

Total water use is projected to be 6,073 gpd (22,990 Lpd), equivalent to 0.0061 mgd (23 $m^3$/day), to support facility operations under this alternative (NRC 2015). Consolidated Public Water Supply District No. 1 would also provide water service under this alternative. While higher when compared to the other technology alternatives, the projected average daily water use is a negligible percentage of the production capacity of the water district and represents a very small increase (about 0.4 percent) in the volume of water the district supplies to its customers.

Consistent with the other technologies, no radiological liquid effluents would be discharged to the environment under this technology alternative. All facility operations would be contained inside properly constructed buildings with waste management systems and programs in place to control, handle, process, store, and transport the types and quantities generated by the medical radioisotope production process (NRC 2015c).

Facility wastewater would normally consist of sanitary wastewater and boiler blowdown from the facility's heated water system. In addition, facility personnel may periodically convey small quantities of maintenance and laboratory chemicals to the facility's sanitary sewer drains. As for water use, wastewater generation would be higher under this technology alternative when compared to the other technology alternatives. Wastewater flow would average 5,850 gpd (22,145 Lpd), equivalent to about 0.0059 mgd (22.3 $m^3$/day) (NRC 2015c). This effluent would be discharged to the City of Columbia sanitary sewer system for treatment at the Columbia Regional WWTP. The Columbia Regional WWTP has a design treatment capacity of 20 mgd (75,700 $m^3$/day) with an average demand of 16 mgd (60,600 $m^3$/day). The effluent flow under this technology alternative would be a very small percentage (i.e., 0.15 percent) of the available treatment capacity of the WWTP. The effluent would be required to meet the sewer system's influent acceptance and treatment criteria, as well as NRC's regulations at 10 CFR 20.2003.

There would be no radiological or nonradiological impacts on surface water or groundwater during normal operations under this technology alternative. Facility operations would need to comply with applicable regulatory requirements and would be conducted in accordance with appropriate practices. Water requirements and sanitary effluent treatment needs would be met by public facilities, which have adequate capacity. Therefore, the NRC staff concludes that the impacts on surface and groundwater hydrology, water quality, and water use from the operation of a subcritical fission process facility would be SMALL.

*Decommissioning*

Facility decontamination, demolition, and site-restoration activities would be similar to those under the other technology alternatives, with the potential magnitude of the impacts on surface water and groundwater similar to those discussed above for construction. NWMI would perform demolition and site-restoration activities in accordance with applicable local and State permits and approvals, including a State-issued NPDES general permit for the discharge of stormwater from land-disturbance sites. NWMI would use appropriate construction BMPs, including waste handling and pollution prevention practices and response procedures during decommissioning, so that no materials or contaminants are released to soils, surface water, or underlying groundwater.

NWMI would conduct work in accordance with a decommissioning plan submitted to the NRC. NWMI would be required to conduct necessary surveys of the soils and subsurface to comply with the NRC's radiological criteria for license termination in 10 CFR Part 20, Subpart E. The NRC staff also expects that NWMI would sample soils and other media as necessary in accordance with other required local and State permits and approvals to ensure that no nonradiological contamination remains in excess of action levels.

Water would be required for dust control and soil compaction during decommissioning. Based on relative facility size and dimensions as compared to the other technology alternatives, the NRC staff estimates that decommissioning activities would require up to about 4,000 gpd (15,100 Lpd) of water, equivalent to 0.004 mgd (15.1 $m^3$/day) during the decommissioning period. The NRC staff assumes that Consolidated Public Water Supply District No. 1 would supply water needed for decommissioning. The projected water volume needed is less than the volume required for facility construction, as discussed above, and the impacts on supply capacity would similarly be very small.

Considering the above, the NRC staff concludes that the impacts on surface water and groundwater resources from decommissioning of a subcritical fission process facility under this alternative would be SMALL.

#### *5.3.3.5 Ecological Resources*

The subcritical fission-based alternative would disturb a similar amount of land as the proposed NWMI facility. Directly affected vegetation would be limited to non-native, common, or weedy species, which are abundant within the region and provide relatively low-quality habitat for birds and wildlife in comparison to forests, grasslands, and wetland habitats. In addition to a loss of habitat, noise from construction activities could disturb birds and wildlife. In response to such disturbances and loss of habitat, birds and wildlife could move out of the immediate area and find adequate, similar habitat (agricultural fields) within the vicinity. All other impacts on ecological resources, such as bird collisions, disturbance during maintenance activities, and potential runoff to offsite aquatic resources, are expected to be similar to those described for the proposed NWMI facility in Section 4.5 because of similar construction methods, similar or smaller building size and footprint, and similar operating and decommissioning activities. Therefore, the NRC staff concludes that the impacts on ecological resources would be SMALL during construction, operations, and decommissioning of a subcritical fission facility on the Discovery Ridge site.

#### *5.3.3.6 Historic and Cultural Resources*

Impacts to historic and cultural resources from the subcritical fission process alternative would be similar to those described for the proposed NWMI facility in Section 4.6. With no historic properties affected, no archaeological sites or evidence of cultural resources identified during the Phase I survey (NWMI 2015a), tribal input, and the cultural resource assessment and consultations performed by the NRC staff, constructing, operating, and decommissioning the NWMI facility using the subcritical fission technology would not impact any known historic and cultural resources at the Discovery Ridge site.

#### 5.3.3.7 Socioeconomics

Socioeconomic impacts from the subcritical fission process alternative would be similar to those described for the proposed NWMI facility in Section 4.7. Although this technology alternative would require a higher number of workers to construct (up to 450), operate (up to 150), and decommission (up to 260) than for the proposed NWMI facility, these are peak estimates of workers, and the average daily number of construction and decommissioning workers would be much less. Most, if not all, workers would likely reside within the ROI or adjacent counties and communities and commute to the work site. Even if the estimated number of operations workers (150) were to generate two to three times additional employment in the ROI, the combined total number of workers would represent less than three-quarters of a percent of the current civilian labor force in Boone County. This would have little to no noticeable effect on employment levels or public service demand in the ROI. Given the size of the workforce, socioeconomic impacts from the construction, operations, and decommissioning of the proposed NWMI facility using the subcritical fission process technology at the Discovery Ridge site would be SMALL.

#### 5.3.3.8 Human Health

The NRC staff expects that human health impacts from the subcritical fission process alternative would be similar to those described in Section 4.8 for the proposed NWMI facility. Like the proposed NWMI facility, the subcritical fission process alternative facility would be required to comply with all Federal, State of Missouri, and local regulations, protecting workers and members of the public during construction, operations, and decommissioning. For example, OSHA regulations would protect workers from physical occupational hazards; OSHA and EPA regulations would protect workers and the public from hazardous material and chemical hazards; and NRC regulations would protect workers and the public from radiological hazards.

The NRC evaluated the human health impacts of a subcritical fission technology facility. A subcritical fission technology facility would have incorporated engineered design features and procedural controls to minimize any impacts to workers or the public from both radiological and nonradiological hazards. The maximum dose to a member of the public from radioactive gaseous emissions would be approximately 9.0 mrem, which is within 10 CFR Part 20 dose limits (SHINE 2015; NRC 2015c). Operation of the subcritical fission technology facility would require transportation of fresh LEU to the facility and Mo-99 product from the facility to an end user medical facility. However, no transportation of irradiated LEU would occur in conjunction with operation of the facility. All transportation would be in compliance with NRC and DOT regulations.

The NRC staff concluded that, if the facility was constructed, operated, and decommissioned in compliance with all applicable regulations, the radiological and nonradiological human health impacts from construction, operations, and decommissioning of the subcritical fission process alternative facility would be SMALL (NRC 2015c; SHINE 2015). The NRC staff expects that similar features and controls to minimize impacts to workers and the public would be used at other facilities using the subcritical fission process. Given the safety-oriented design and procedures at a facility using the subcritical fission process alternative, and given that this facility would be required to comply with all Federal and State of Missouri regulations, ensuring that public health and safety are protected, the NRC staff concludes that the human health impacts from construction, operations, and decommissioning of the subcritical fission process alternative would be SMALL.

#### 5.3.3.9 Waste Management

The NRC staff assumes that waste management impacts from the subcritical fission process alternative would be similar to those described in Section 4.9 for the proposed NWMI facility. Like the proposed NWMI facility, the subcritical fission process alternative facility would be required to comply with all applicable Federal, State of Missouri, and local regulations regarding waste handling, transportation, and disposal.

The NRC staff evaluated the waste management impacts of a subcritical fission technology facility. The facility would produce low-level radioactive waste ranging from Class A through greater than Class C (GTCC). The facility would also produce hazardous and nonhazardous nonradioactive wastes. The facility would use waste minimization practices, and handling, storage, and disposal of all wastes would be conducted in compliance with all applicable regulations. The NRC staff concluded that, since waste management must be performed in compliance with regulations, and since disposal pathways would exist for the types and quantities of wastes generated, the impacts from waste management during construction, operations, and decommissioning at the subcritical fission process facility would be SMALL (NRC 2015c; SHINE 2015).

The NRC staff expects that similar waste minimization practices would be used at the subcritical fission process alternative facility, and that the types and quantities of waste generated would also be similar. As discussed in Section 4.14.9, the NRC staff assumes that sufficient infrastructure and disposal pathways exist in the Columbia, Missouri, area for proper management of wastes from the proposed NWMI facility therefore, the infrastructure would also be sufficient to handle waste from the subcritical fission process alternative. For GTCC waste that would be generated at the subcritical fission process facility, a provision of the American Medical Isotopes Production Act of 2012 (42 U.S.C. 2065(c)(3)(A)(ii)) states that DOE would take title to, and be responsible for, the final disposition of radioactive waste created by the irradiation, processing, or purification of uranium leased from DOE if it determines that the producer does not have access to a disposal path. Therefore, if a disposal pathway for GTCC waste did not exist, DOE would be responsible for its disposal.

Because disposal pathways exist for waste that would be generated by the subcritical fission process facility, and because all handling, storage, transportation, and disposal of wastes would be conducted in accordance with all applicable regulations, the NRC staff concludes that the impacts from waste management during construction, operations, and decommissioning of the subcritical fission process alternative would be SMALL.

#### 5.3.3.10 Transportation

Transportation impacts from the subcritical fission process alternative would be similar to those described for the NWMI facility in Section 4.10. Construction, operations, and decommissioning activities would be very similar and over the same time span. Transportation impacts would consist of commuting workers and truck deliveries and shipments of equipment and materials. During periods of peak construction up to 451 workers, operations up to 150 workers, and decommissioning up to 261 workers could be commuting daily to the work site. These are peak estimates of workers, and the average daily number of construction and decommissioning workers would be much less. Workers would arrive via site access roads and the volume of traffic on nearby roads could increase during shift changes. In addition to commuting workers, trucks would be transporting equipment and materials to and from the work site, thus increasing the amount of traffic on local roads. During construction up to 14 trucks, during operations an average of 3 trucks, and during decommissioning up to 9 trucks would travel to and from the site (NRC 2015c). The increase in vehicular traffic would peak during shift changes, resulting in temporary levels of service impacts and delays at intersections. However, given the small size of the average daily workforce and the number of daily truck deliveries and shipments combined with the easy access to U.S. Highway 63, there would be little if any noticeable traffic volume-related level of service impacts. Therefore, transportation impacts during the construction, operations, and decommissioning of the proposed NWMI facility using the subcritical fission process technology at the Discovery Ridge site would be SMALL.

#### *5.3.3.11 Accidents*

The NRC staff previously evaluated the environmental impacts from radiological and chemical accidents at a proposed facility based on the subcritical fission process. This facility would use engineered design features and controls to mitigate the consequences of accidents. The evaluation showed that public doses from possible radiological accidents would be within 10 CFR Part 20 limits. The evaluation also showed that, for possible chemical accidents, chemical concentrations at the location of the maximally exposed member of the public would either be below PAC-1 limits, or above PAC-1 limits but below PAC-2 limits (PAC-1, PAC-2, and PAC-3 limits are defined in Section 4.11.2), meaning that chemical accidents could cause mild transient adverse health effects but would not cause serious irreversible health effects. The NRC staff's environmental evaluation stated that if the subsequent NRC staff safety evaluation determined that radiological and chemical accident exposures would be in compliance with NRC regulatory limits (10 CFR Part 20 dose limits and chemical accident performance requirements in 10 CFR 70.61), then the impacts from accidents at the subcritical fission process facility would be SMALL (NRC 2015c; SHINE 2015).

The NRC staff expects that other subcritical fission process facilities would have similar engineered design features and controls to mitigate the consequences of accidents, and it also expects that the consequences of accidents at other subcritical fission process facilities would be similar. Before construction or operation of a subcritical fission process facility, the NRC staff would perform a safety review of the proposed facility that would include a thorough evaluation of possible radiological or chemical accidents at the facility, including the consequences of those accidents and any features or controls that would mitigate those consequences. To receive a construction permit or operating license from the NRC, the applicant would have to demonstrate that the facility would be in compliance with all NRC regulations, including 10 CFR Part 20 dose limits and the accident performance requirements in 10 CFR 70.61, as applicable. If the NRC staff determines in its SER that the subcritical fission process facility would be operated in compliance with all applicable regulations governing the consequences of accidents, then the NRC staff concludes that the impacts from accidents at the subcritical fission process facility would be SMALL.

#### *5.3.3.12 Environmental Justice*

The environmental justice impacts from a subcritical fission process alternative would be the similar as those discussed for the NWMI facility in Section 4.12. Minority and low-income populations residing along site access roads could be affected by noise and dust and increased commuter vehicle and truck traffic during construction, operations, and decommissioning. However, these effects are not likely to be high and adverse and would be short term and within a limited time period during certain hours of the day. Noise and dust impacts from onsite activities during construction and decommissioning would similarly be short term. Everyone living near Discovery Ridge could be affected by operation activities, including minority and low-income populations. Any human health and environmental effects would depend on the magnitude of the change from current environmental conditions.

As discussed in Section 5.3.3.8 of this EIS, the potential radiological dose to the public from facility operations would be well within NRC and applicable Federal, State, and local regulatory limits. As a result, everyone living near the Discovery Ridge site, including minority and low-income populations, would not be adversely affected by radiation exposure during facility operations. Permitted nonradiological air emissions would also be required to remain within regulatory standards. Noise levels may increase along U.S. Highway 63 because of increased commuter vehicle and truck traffic during NWMI facility operations. This may not be noticeable, however, given the relatively small size of the workforce and the limited number of daily truck deliveries and shipments. Based on this information, construction, operations, and decommissioning of the proposed NWMI facility using the subcritical fission process technology would not likely have disproportionately high and adverse human health and environmental effects on minority and low-income populations living near the Discovery Ridge site.

#### *5.3.3.13 Cumulative Impacts*

Cumulative impacts for the subcritical fission-based alternative would be similar to those described in Chapter 4 for the NWMI RPF facility at the Discovery Ridge site, because direct contributory effects from construction, operations, and decommissioning for this technology would be similar.

## 5.4 Cost-Benefit Comparison

NEPA and CEQ require that all agencies of the Federal government prepare detailed environmental statements on proposed major Federal actions significantly affecting the quality of the human environment. One of NEPA's principal objectives is to require each Federal agency to consider, in its decisionmaking process, the environmental impacts of each proposed major action. In particular, as stated below, Section 102 of NEPA requires all Federal agencies to the fullest extent possible to:

> (B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by Title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations. (42 U.S.C. 4321).

However, neither NEPA nor CEQ requires the benefits and costs of a proposed action to be quantified in dollars or any other common metric. The intent of this section is not to identify and quantify all potential societal benefits of the proposed action and compare them to potential costs. Instead, it focuses only on those benefits and costs of such magnitude or importance that including them in this analysis can inform the decisionmaking process.

This section compiles the expected impacts from operations of the proposed NWMI facility and aggregates them into two final categories: (1) the expected costs and (2) the expected benefits derived from approving the proposed action. Table 5–11 describes the following information on major environmental costs and benefits, including:

- average annual production of commercial products;
- expected increase in tax payments to State and local tax jurisdictions during construction and operations;
- other benefits;
- environmental degradation, which includes impacts on: land use and visual resources, air quality, noise, geologic environment, water resources, ecological resources, historic and cultural resources, socioeconomics, human health, waste management, transportation, environmental justice, and increased demand for public services;

- effects on human health; and
- other costs, which include lost tax revenues, decreased recreational value, and transportation (as appropriate).

**Table 5–11. Costs and Benefits of Constructing, Operating, and Decommissioning the Proposed NWMI Facility at the Discovery Ridge Site**

| Cost-Benefit Category | Description | Impact Assessment |
|---|---|---|
| **Benefits** | | |
| Domestic Production of Mo-99 | NWMI would produce a domestic supply of Mo-99; no domestic producers of this widely used medical radioisotope currently exist in the United States and the United States currently imports all of its supply. | _ |
| Use of LEU Targets | NWMI would use LEU targets for production of medical radioisotopes, contributing to the Federal nonproliferation objective to phase out U.S. exports of highly enriched uranium, as identified in the Energy Policy Act of 1992. | _ |
| Tax Revenues | Construction of the proposed NWMI facility would result in estimated total additional tax revenues of approximately $2.5 million for the City of Columbia, Boone County, and the State of Missouri. During the 30-year operational period, NWMI would annually pay estimated property taxes of approximately $1.2 million, sale taxes of $830,000, and income taxes of $465,000 (NWMI 2015a). | _ |
| Local Economy | Increased jobs would benefit the area economically. (Section 4.7) | _ |
| **Costs** | | |
| Land Use | Land use impacts would be confined to agricultural land comprising the proposed 7.4 ac (3.0 ha) site, and 0.26 ac. (0.1 ha) of offsite agricultural lands immediately adjacent to the proposed site, which is a small portion of the agricultural land within a 5-mi (8-km) radius of the site (Section 4.1.1). The location of the proposed facility is within an area designated as an industrial certified site. No additional land would be disturbed during operations or decommissioning. | SMALL |
| Visual Resources | The proposed NWMI facility would not noticeably alter visual resources, based on the low scenic quality and light industrial viewshed within the vicinity of the proposed site. (Section 4.1.2) | SMALL |
| Air Quality | Air quality impacts during construction, operations, and decommissioning, would be negligible, given the relatively low emissions and the unlikelihood that they would contribute to concentrations that would interfere with the maintenance NAAQS or degrade Boone County's attainment/unclassifiable designation. (Section 4.2) | SMALL |

| Cost-Benefit Category | Description | Impact Assessment |
|---|---|---|
| Noise | During construction, operations, and decommissioning, noise would be minimal, given the minor (1 dBA) expected increases in noise levels. (Section 4.2) | SMALL |
| Geologic Environment | Construction of the proposed NWMI facility would consume geologic resources and have the potential to increase soil erosion, but the overall impact would be minor, given that the geologic resources are widely available within the region and erosion would be managed with the implementation of BMPs. (Section 4.3) | SMALL |
| Water Resources | Water resource impacts during construction, operations, and decommissioning would be negligible, because of the lack of natural surface water features on site, implementation of appropriate stormwater management practices, and the use of municipal water. (Section 4.4) | SMALL |
| Ecological Resources | Terrestrial and aquatic ecology impacts are expected to be SMALL, because the proposed action would not affect any high quality habitats; the entire site has been previously disturbed; and because no aquatic features or Federally or State-listed species occur on the site. (Section 4.5) | SMALL |
| Historic and Cultural Resources | Because no historic properties would be affected and no archaeological sites or evidence of cultural resources were identified during the Phase I survey, historic and cultural resources are not likely to be impacted by the construction, operations, or decommissioning of the proposed NWMI facility at the Discovery Ridge site. The NWMI facility would also have little or no visual impact. Based on these factors, as well as tribal input and the cultural resource assessments and consultations performed by the NRC staff, the proposed facility would not impact any known historic and cultural resources at the Discovery Ridge site. (Section 4.6) | No historic properties affected |
| Socioeconomics | Socioeconomic impacts are expected to be SMALL, based on the size of the workforce required to construct, operate, and decommission the NWMI facility. (Section 4.7) | SMALL |
| Human Health | Human health impacts would be minimized because access to the site would be restricted, NWMI would implement normal safety practices contained in OSHA regulations, and NWMI would operate the proposed NWMI facility in accordance with all applicable Federal and State of Missouri regulatory requirements. (Section 4.8) | SMALL |

| Cost-Benefit Category | Description | Impact Assessment |
|---|---|---|
| Waste Management | Based on the availability of waste disposal pathways for radiological and nonradiological waste; NWMI's proposed waste management systems; engineered design features to minimize radioactive and nonradioactive contamination; and NRC, DOT, and State of Missouri radiation protection requirements, the NRC staff concludes that radioactive and nonradioactive waste is expected to be managed in accordance with applicable regulatory requirements. (Section 4.9) | SMALL |
| Transportation | Due to the small size of the average daily workforce, the low number of daily truck deliveries and shipments, and easy access to U.S. Highway 63, there would be little if any noticeable traffic volume-related level of service impacts. (Section 4.10) | SMALL |
| Accidents | The NRC staff is conducting an independent review of the potential dose to the public from chemical and radiological accidents in the NRC staff's SER. If the NRC staff determines in its SER that the proposed NWMI facility would comply with NRC regulations applicable to chemical and radiological accident consequences, the NRC staff concludes that the impacts from potential chemical and radiological accidents would be SMALL. | SMALL |
| Environmental Justice | Minority and low-income populations residing along site access roads or near the proposed site could be affected by noise and dust and increased commuter and other vehicular traffic during construction and decommissioning. However, these would be short term and primarily limited to onsite activities. Operation of the proposed NWMI facility is not expected to disproportionately affect minority and low-income populations, as everyone living near the proposed NWMI facility and the existing research park would be exposed to the same potential effects from operations, and any impacts would depend on the magnitude of the change in ambient conditions. Permitted nonradiological air emissions are expected to remain within regulatory limits. (Section 4.12) | Minority and low-income populations would not be expected to experience any disproportionately high and adverse effects |

The financial costs related to the construction, operations, and decommissioning of the proposed NWMI facility are described below. Regulations at 10 CFR 50.33(f)(1) state that an applicant for a construction permit shall demonstrate that it possesses or has reasonable assurance of obtaining the necessary funding needed to cover estimated construction and related fuel cycle costs. Further, the applicant shall indicate the source(s) of funds to cover these costs. In Chapter 15 of the preliminary safety analysis report (PSAR), NWMI stated that it has obtained financing for its development and construction project using various sources of financing, including equity and debt, and listed financial commitments. These specific financial commitments are considered business sensitive and proprietary, and as such have been withheld from public disclosure per 10 CFR 2.390.

NWMI's operational cost estimates provided in Chapter 15 of the PSAR include the total annual operating costs for the first 5 years (NWMI 2015j). NWMI expects that revenue from the sale of Mo-99 and other radioisotopes will exceed operating costs, and provided a preliminary cost estimate (NWMI 2015j).

### 5.4.1 Benefit and Costs of Alternatives

This section compares the environmental impacts of the proposed NWMI facility with those that would be associated with using an alternative site or alternative technologies. Table 5–12 provides a tabular comparison of the potential environmental impacts of constructing, operating, and decommissioning the proposed NWMI facility at Discovery Ridge with the alternative site (MURR) and the no-action alternative. In nearly all cases, impacts associated with using the alternative site would be similar to the impacts associated with the proposed action, and remain SMALL. The only exception would be noise associated with the MURR site, which would result in SMALL to MODERATE impacts. The financial costs of construction, operations, and decommissioning of the proposed NWMI facility at the alternative site would likely be similar to the financial costs at the proposed NWMI site because of the facility's design and operational plan. The no-action alternative would have SMALL impacts for every resource area.

Table 5–13 provides a tabular comparison of the potential environmental impacts of constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site with the potential environmental impacts of using an alternative technology (linear accelerator-based or subcritical fission). The NRC staff determined that impacts across all resources and areas of evaluation would be SMALL, regardless of which radioisotope production technology is employed.

Construction and operation of the proposed facility at an alternative site or using an alternative technology would not reduce or avoid adverse effects, compared with constructing and operating the proposed NWMI facility at the Discovery Ridge site. The adverse environmental impacts from the no-action alternative would be SMALL. However, the no-action alternative would not fulfill the purpose and need for the proposed action.

**Table 5–12. Comparison of Impacts for the Proposed NWMI Facility, Proposed Alternative Site, and No-Action**

| Impacts on Resource or Other Area Evaluation | Proposed Discovery Ridge Site | MURR Alternative Site | No-Action |
|---|---|---|---|
| Land Use | SMALL | SMALL | SMALL |
| Visual Resources | SMALL | SMALL | SMALL |
| Air Quality | SMALL | SMALL | SMALL |
| Noise | SMALL | SMALL to MODERATE | SMALL |
| Geologic Environment | SMALL | SMALL | SMALL |
| Water Resources | SMALL | SMALL | SMALL |
| Ecological Resources | SMALL | SMALL | SMALL |
| Historic and Cultural Resources | No historic properties affected | | |

| Impacts on Resource or Other Area Evaluation | Proposed Discovery Ridge Site | MURR Alternative Site | No-Action |
|---|---|---|---|
| Socioeconomics | SMALL | SMALL | SMALL |
| Human Health | SMALL | SMALL | SMALL |
| Waste Management | SMALL | SMALL | SMALL |
| Transportation | SMALL | SMALL | SMALL |
| Accidents | SMALL | SMALL | SMALL |
| Environmental Justice | No disproportionately high and adverse human health and environmental effects on minority and low-income populations | | |

**Table 5–13. Comparison of Technologies at the Proposed NWMI Facility in Discovery Ridge**

| Impacts on Resource or Other Area Evaluation | Proposed NWMI Technology | Linear Accelerator-Based Technology | Subcritical Fission Technology |
|---|---|---|---|
| Land Use | SMALL | SMALL | SMALL |
| Visual Resources | SMALL | SMALL | SMALL |
| Air Quality | SMALL | SMALL | SMALL |
| Noise | SMALL | SMALL | SMALL |
| Geologic Environment | SMALL | SMALL | SMALL |
| Water Resources | SMALL | SMALL | SMALL |
| Ecological Resources | SMALL | SMALL | SMALL |
| Historic and Cultural Resources | No historic properties affected | | |
| Socioeconomics | SMALL | SMALL | SMALL |
| Human Health | SMALL | SMALL | SMALL |
| Waste Management | SMALL | SMALL | SMALL |
| Transportation | SMALL | SMALL | SMALL |
| Accidents | SMALL | SMALL | SMALL |
| Environmental Justice | No disproportionately high and adverse human health and environmental effects on minority and low-Income populations | | |

### 5.4.2 Cost-Benefit Conclusions

In Chapter 4 and the preceding sections of Chapter 5, the NRC staff described the costs and benefits of the proposed action as well as alternatives to the proposed action. In weighing the costs and benefits, the NRC staff concludes that the overall benefits of constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site outweigh the environmental and other costs based upon the following considerations:

- U.S. policy is to ensure a reliable supply of medical radioisotopes while minimizing the use of highly enriched uranium for civilian purposes (NNSA 2011; White House 2012);

- the small environmental impact, including radiological impacts and risk to human health, which would be caused by constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site;
- the economic benefit of constructing and operating the proposed NWMI facility to communities located near the Discovery Ridge site; and
- the increased availability of medical isotopes for U.S. public health needs.

Constructing, operating, and decommissioning the NWMI facility at the Discovery Ridge site would have slightly less environmental costs than at the alternative site because impacts from noise would be SMALL to MODERATE at the MURR site, due to the close proximity of the exiting MURR workforce to heavy equipment noise that would be associated with construction and decommissioning an NWMI facility within the MURR Center. However, the overall benefits of constructing and operating the proposed NWMI facility at either site would outweigh the environmental or other costs for the reasons outlined above.

Installation of alternative technologies (e.g., linear accelerator-based or subcritical fission-based) would not result in any greater economic advantages or disadvantages over the proposed NWMI technology, and the environmental costs and benefits would be similar to those described for the proposed NWMI facility at the Discovery Ridge site. Therefore, the overall benefits and costs of utilizing an alternative technology at the Discovery Ridge site would be the same and would outweigh the environmental and other costs for the reasons outlined above.

## 5.5 Alternatives Summary

In this Chapter the NRC staff considered the following alternatives to constructing, operating, and decommissioning of the NWMI facility at the proposed Discovery Ridge site in Columbia, Missouri:

- the no-action alternative;
- construction, operations, and decommissioning of the NWMI facility at the MURR site (alternative site);
- construction, operations, and decommissioning of a linear accelerator-based facility at the Discovery Ridge site (Alternative Technology No. 1); and
- construction, operations, and decommissioning of a subcritical fission-based facility at the Discovery Ridge site (Alternative Technology No. 2).

The impacts for the proposed action, the no-action alternative, alternative site, and alternative technologies are summarized in Tables 5–12 and 5–13.

In conclusion, the NRC staff notes that the no-action alternative would result in SMALL impacts to all resource areas. The no-action alternative, however, does not fulfill the purpose and need of the project. The environmentally preferred alternatives are the construction, operations, and decommissioning of the NWMI facility at the Discovery Ridge site (proposed action), the linear accelerator-based facility at the Discovery Ridge site (Alternative Technology No. 1), and the subcritical fission-based facility at the Discovery Ridge site (Alternative Technology No. 2). The impacts associated with the proposed action and the two alternative technologies would be SMALL for all resource areas. The other alternative capable of meeting the purpose and need of the project is locating the NWMI facility at the MURR site. However, this alternative would entail potentially greater impacts than the proposed action of constructing the NWMI facility at the Discovery Ridge site (i.e., impacts from noise for constructing the NWMI facility at the MURR site would be SMALL to MODERATE).

# 6.0 CONCLUSIONS

This environmental impact statement (EIS) contains the environmental review of the Northwest Medical Isotopes, LLC (NWMI), application for a construction permit under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50 that would allow construction of the NWMI medical radioisotope production facility (NWMI facility) at the Discovery Ridge site in Columbia, Missouri. This EIS follows the requirements in 10 CFR Part 51, which are the U.S. Nuclear Regulatory Commission's (NRC's) regulations that implement the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.). This chapter presents preliminary conclusions and recommendations from the environmental review of the NWMI facility. Section 6.1 summarizes the environmental impacts of construction, operations, and decommissioning. Section 6.2 compares the environmental impacts of the proposed action, the construction of the NWMI facility at one alternative site, and the construction of two alternative technologies at the Discovery Ridge site in Columbia, Missouri. Section 6.3 discusses unavoidable impacts of the proposed action and alternatives to the proposed action and identifies resource commitments. Section 6.4 presents the NRC staff's preliminary conclusions and recommendations.

## 6.1 Environmental Impacts of the Proposed Action

The NRC staff concludes that issuing a construction permit for the NWMI facility would have SMALL impacts for all resource areas. Table 6–1 summarizes the environmental impacts from construction, operations, and decommissioning of the proposed NWMI facility.

The NRC staff also considered cumulative impacts of past, present, and reasonably foreseeable future actions regardless of which agency (Federal or non-Federal) or person undertakes them. In Section 4.14, the NRC staff concluded that the cumulative impacts would be SMALL for all resource areas with the exception of air quality, noise, water resources, and ecological resources. For air quality, noise and water resources, the NRC staff concluded that the cumulative impacts would be SMALL to MODERATE. For ecological resources, the NRC staff concluded that the cumulative impacts would be MODERATE.

**Table 6–1. Summary of the Environmental Impacts from Construction, Operations, and Decommissioning of the Proposed NWMI Facility at the Discovery Ridge site**

| Resource Area | Summary of Impact | Impact Level |
|---|---|---|
| Land Use | Land use impacts would be confined to agricultural land comprising the proposed 7.4 ac (3.0 ha) site, and 0.26 ac. (0.1 ha) of offsite agricultural lands immediately adjacent to the proposed site, which is a small portion of the agricultural land within a 5-mi (8-km) radius of the site. The location of the proposed facility is within an area designated as an industrial-certified site (Section 4.1.1). | SMALL |
| Visual Resources | The proposed NWMI facility would not noticeably alter visual resources, based on the low scenic quality and light industrial viewshed within the vicinity of the proposed site (Section 4.1.2). | SMALL |

| Resource Area | Summary of Impact | Impact Level |
|---|---|---|
| Air Quality | Air quality impacts during construction, operations, and decommissioning, would be negligible, given the relatively low emissions and the unlikelihood that they would contribute to concentrations that would interfere with NAAQS or degrade Boone County's attainment/unclassifiable designation (Section 4.2.1). | SMALL |
| Noise | During construction, operations, and decommissioning, an increase in noise levels beyond 1 dBA is not expected and therefore would not be noticeable (Section 4.2.2). | SMALL |
| Geologic Environment | Construction and decommissioning of the proposed NWMI facility would consume geologic resources and have the potential to increase soil erosion, but the overall impact would be minor, given that the geologic resources are widely available within the region and erosion would be managed with the implementation of best management practices (BMPs) (Section 4.3). During facility operations, previously disturbed areas would not be subject to long-term soil erosion. Areas disturbed during construction would be within the footprint of the completed facility or overlain by other impervious surfaces (e.g., roadways and parking lots), or revegetated. As a result, incremental impacts on geology and soils would be negligible during operations. | SMALL |
| Water Resources | Water resource impacts during construction, operations, and decommissioning would be negligible, because of the lack of natural surface water features on site, implementation of appropriate stormwater management practices, and the use of municipal water (Section 4.4). | SMALL |
| Ecological Resources | No aquatic features or Federally or State-listed species occur on the Discovery Ridge site; the site is a previously disturbed habitat; construction, operations, and decommissioning would not permanently or temporarily affect any high-quality habitats, such as grasslands, forests, or wetlands. Operations could result in bird collisions with the facility; however, mortality from bird collisions is expected to be negligible (Section 4.5). | SMALL |

| Resource Area | Summary of Impact | Impact Level |
|---|---|---|
| Historic and Cultural Resources | No historic properties would be affected and no archaeological sites or evidence of cultural resources were identified during the Phase I survey. Therefore, historic and cultural resources are not likely to be impacted by the construction, operations, or decommissioning of the proposed NWMI facility at the Discovery Ridge site. The NWMI facility would also have little or no visual impact. Based on these factors, as well as tribal input and a cultural resource assessment and consultations, the proposed facility would not affect any historic and cultural resources at the Discovery Ridge site (Section 4.6). | No historic properties affected |
| Socioeconomics | Given the small number of workers during construction, operations, and decommissioning, the overall socioeconomic impacts would be SMALL (Section 4.7). | SMALL |
| Human Health | NWMI would implement normal safety practices contained in OSHA regulations, and NWMI would operate the proposed NWMI facility in accordance with all applicable Federal and State of Missouri regulatory requirements. The maximum dose to a member of the public would be well within the annual dose limit of 100 mrem in 10 CFR 20.1301. Access to the site would be restricted and NWMI would administratively control doses to occupational workers, such that these doses would be well below the limits in 10 CFR 20.1201 (Section 4.8). | SMALL |
| Waste Management | Based on the availability of waste disposal pathways for radiological and nonradiological waste; NWMI's proposed waste management systems; engineered design features to minimize radioactive and nonradioactive contamination; and NRC, DOT, and State of Missouri radiation protection requirements, radioactive and nonradioactive waste can be managed in accordance with applicable regulatory requirements (Section 4.9). | SMALL |
| Transportation | Due to the small size of the average daily workforce, the low number of daily truck deliveries and shipments, and easy access to U.S. Highway 63, there would be little if any noticeable traffic volume-related level of service impacts during construction, operations, and decommissioning (Section 4.10). | SMALL |

| Resource Area | Summary of Impact | Impact Level |
|---|---|---|
| Accidents | The NRC staff is conducting an independent review of the consequences of accidents, and will document this review in its SER. If the NRC staff determines in its SER that the proposed NWMI facility would comply with 10 CFR 70.61 and any other NRC regulations applicable to radiological accident consequences and hazardous chemical accident consequences, the impacts from these accidents at the proposed facility would be SMALL. | SMALL |
| Environmental Justice | Minority and low-income populations residing along site access roads or near the proposed site could be affected by noise and dust and increased commuter and other vehicular traffic during construction and decommissioning. However, these would be short term and primarily limited to onsite activities. Operation of the proposed NWMI facility is not expected to disproportionately affect minority and low-income populations because everyone living near the proposed NWMI facility and the existing research park would be exposed to the same potential effects from operations, and any impacts would depend on the magnitude of the change in ambient conditions. Permitted nonradiological air emissions are expected to remain within regulatory limits (Section 4.12). | Minority and low-income populations would not be expected to experience any disproportionately high and adverse effects |

## 6.2 Comparison of Alternatives

In Chapter 5, the NRC staff considered the following alternatives to construction, operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site in Columbia, Missouri:

- the no action-alternative;
- construction, operations, and decommissioning of the NWMI facility at the University of Missouri Research Reactor (MURR) site in Columbia, Missouri;
- construction, operations, and decommissioning of a linear accelerator-based facility at the proposed Discovery Ridge site (Alternative Technology No. 1)
- construction, operations, and decommissioning of a subcritical fission-based facility at the proposed Discovery Ridge site (Alternative Technology No. 2).

Tables 5–12 and 5–13 summarize the impacts for the proposed action, the no-action alternative, alternative site, and two alternative technologies. In conclusion, the NRC staff notes that the no-action alternative would result in SMALL impacts to all resource areas. However, the no-action alternative does not fulfill the purpose and need of the project. The environmentally preferred alternatives are the construction, operations, and decommissioning of the NWMI facility at the Discovery Ridge site (proposed action), the linear accelerator-based facility at the Discovery Ridge site (Alternative Technology No. 1), and the subcritical fission-based facility at the Discovery Ridge site (Alternative Technology No. 2). Like the impacts associated with the proposed action, the impacts associated with the two alternative technologies would be SMALL for all resource areas. The other alternative capable of meeting the purpose and need of the project is locating the NWMI facility at the MURR site. However, this alternative would entail potentially greater impacts than the proposed action of constructing the NWMI facility at the Discovery Ridge site (i.e., impacts from noise for constructing the NWMI facility at the MURR site would be SMALL to MODERATE).

## 6.3 Resource Commitments

### 6.3.1 Unavoidable Adverse Impacts

Section 102(2)(C)(ii) of the National Environmental Policy Act of 1969 requires that an EIS include information on any adverse environmental effect that cannot be avoided should the proposal be implemented. Unavoidable adverse impacts are predicted adverse environmental impacts that cannot be avoided.

As described in this EIS and summarized above, the impacts to all resource areas from the proposed action would be SMALL: the environmental effects would not be detectable or would be so minor that they would neither destabilize nor noticeably alter any important attribute of the resource. However, even though SMALL, there may be unavoidable adverse impacts from construction, operations, and decommissioning of the proposed NWMI facility. Table 6–2 presents the unavoidable adverse impacts from construction, operations, and decommissioning of the proposed NWMI facility and presents mitigations and controls intended to lessen the adverse impact. Unless noted otherwise, mitigation measures were taken from NWMI's Environmental Report (NWMI 2015a, 2015d) or from responses to requests for additional information (NWMI 2015c, 2016a, 2016b).

**Table 6–2. Unavoidable Adverse Environmental Impacts**

| Resource Area | Unavoidable Adverse Impact | Mitigation Measures |
|---|---|---|
| Land Use | 7.4 ac (3.0 ha) of agricultural land would be disturbed and converted into an industrial area. An additional 0.26 ac (0.1 ha) would be temporarily converted from agricultural land to a construction material staging area. | NWMI would restore temporarily affected areas with vegetation that is common to the Discovery Ridge Research Park. Ground vegetation would include grasses, shrubs, trees and/or ornamental flowers including native species. The facility would be built and operated with all local zoning requirements. |
| Visual Resources | Partial obstruction of views of the existing landscape as a result of the new facility and a small steam plume from exhaust stack. | NWMI would revegetate open areas with grasses, shrubs, trees and/or ornamental flowers including native species. |

| Resource Area | Unavoidable Adverse Impact | Mitigation Measures |
|---|---|---|
| Air Quality | During construction and decommissioning, increases in fugitive dust and air emissions would result from earth-moving activities, construction equipment, worker vehicle commuting, delivery and shipment vehicles. During facility operations, air emissions would result from worker vehicle commuting, delivery and shipment vehicles. | NWMI would control fugitive dust by watering unpaved and disturbed areas, stabilizing spoil piles, revegetating slopes, and minimizing soil disturbance through phased grading. NWMI would reduce equipment idle times, use ultra-low sulfur diesel fuel, and install pollution control devices on construction equipment to minimize construction equipment related emissions. NWMI would develop a comprehensive program for controlling GHG emissions associated with operation of the NWMI facility. This will include developing a GHG emission inventory, implementing methods for avoiding or minimizing GHG emissions identified in the inventory, and encouraging carpooling and other measures to minimize GHG emissions due to vehicle traffic during operation. |
| Noise | Short-term localized noise from construction equipment and workforce and shipment/delivery vehicles. | Distance to sensitive receptors would limit offsite noise levels. Facility design (e.g., wall thickness and physical barriers) would limit noise of operating equipment inside buildings. |
| Geologic Resources | Construction would consume geologic resources and have the potential to increase soil erosion. | NWMI would conduct construction activities in accordance with the provisions of a Land Disturbance Permit and City of Columbia approved site development plan, which would require implementation of construction-related BMPs for soil erosion and sediment control and stormwater pollution prevention during site development, facility construction, and for post development. |

| Resource Area | Unavoidable Adverse Impact | Mitigation Measures |
|---|---|---|
| Water Resources | Stormwater runoff could potentially affect downstream surface water quality. Fuels and chemicals stored on the NWMI facility site could have substantial, localized water quality impacts if such materials were to be released to the environment. | Stormwater runoff from the NWMI facility site would be managed by an engineered stormwater management system, including necessary detention/retention structures, constructed and operated in compliance with State and municipal stormwater management plans, procedures, and practices. NWMI would be required to obtain a Land Disturbance Permit from the City of Columbia, which would require appropriate soil erosion and sediment control BMPs to be used to minimize soil erosion and the stormwater transport of suspended sediment and other pollutants.<br><br>NWMI would be required to adhere to a City-approved stormwater management plan to control the peak flow rates of stormwater discharge associated with specified design storms. Wastewater must meet the acceptance criteria of the Columbia Regional Wastewater Treatment Plan. Waste handling and pollution prevention practices and spill prevention and response procedures would be observed so that no materials or contaminants would be released to soils or exposed to stormwater, where they could contaminate underlying groundwater. |
| Ecological Resources | Construction could result in a loss of low-quality habitat, the potential for wildlife avoidance and displacement caused by noise or herbicide applications, and increased risk of bird collisions with construction equipment and artificially lighted structures. Operations could result in bird collisions with the facility. Decommissioning could result in the potential for wildlife avoidance and displacement caused by noise or herbicide applications and increased risk of bird collisions with construction equipment and artificially lighted structures. | NWMI would mitigate impacts from herbicide applications by implementing BMP requirements that would limit their use and contain the broad application throughout the site. During construction at night, NWMI would use BMPs, such as light source shielding and appropriate directional lighting, to mitigate impacts associated with artificial nighttime illumination. |
| Historic and Cultural Resources | Construction could result in inadvertent discovery of historic or cultural resources. | If cultural or historical resources are identified during construction, NWMI will contact the SHPO immediately. |

| Resource Area | Unavoidable Adverse Impact | Mitigation Measures |
|---|---|---|
| **Socioeconomics** | | |
| Human Health | Radiological: Workers and members of the public could be exposed to radiation, such as gaseous radioactive effluents that contain krypton, xenon, and tritium.<br>Nonradiological: Potential for chemical exposures and hazards to workers typical of any industrial facility. | NWMI would have facility design features and use procedures to minimize radiation exposure to occupational workers and members of the public. NWMI would maintain radiation exposure to facility workers to within the occupational dose limits in 10 CFR 20.1201. Radiation exposure within the proposed facility would be minimized using shielding, optimized process designs, radiological work planning, protective equipment and materials, access controls, and contamination control measures that will all be used to keep doses to personnel as low as is reasonably achievable (ALARA). NWMI would have a radiological effluent monitoring program to ensure that the types and quantities of radioactive material released from the proposed facility are within expected parameters, such that the limits in 10 CFR 20.1301 and 10 CFR 20.1101(d) would not be exceeded.<br><br>Transportation of radioactive materials, both on public highways and by air, must comply with the applicable DOT regulations in 49 CFR Parts 172, 173, 175, 177, and 397, as well as the NRC packaging requirements for radioactive material in 10 CFR Part 71.<br><br>NWMI would employ normal construction safety practices contained in Occupational Safety and Health Administration (OSHA) regulations, such as safety training, safety equipment, and supervision of the work force to promote worker safety and reduce the likelihood of worker injury during construction. Use of access controls, proper personal protective equipment, and safety practices would reduce instances of accidents or exposure to hazardous materials. An emergency response plan would be used to reduce the impact to human health and the environment. |

| Resource Area | Unavoidable Adverse Impact | Mitigation Measures |
|---|---|---|
| Waste Management | Radioactive Waste: Generation of radiological waste and mixed waste, including 525,000 kg (1,157,427 lbs) of solidified liquid low-level radioactive waste annually; 15,000 kg (33,069 lbs) encapsulated solid low-level radioactive waste annually; and 7,000 kg (15,432 lbs) of unencapsulated solid low-level radioactive waste annually; and 760 kg (1,676 lbs) of mixed waste annually.<br>Nonradioactive Waste: Generation of nonradiological hazardous (up to 1,000 kg (2,205 lbs) per month) and nonhazardous waste. | NWMI would implement a waste minimization and pollution prevention program that would include a recycling and reclamation program, and require employees to consider waste minimization and pollution prevention during performance of their jobs. |
| Transportation | Increase in vehicular traffic would peak during shift changes or during peak construction and decommissioning activities, resulting in temporary levels of service impacts and possible delays at intersections. | NWMI would encourage carpooling. |
| Accidents | If the NRC staff determines that the consequences and/or likelihood of possible accidents at the proposed NWMI facility would be low, such that the facility would be in compliance with the performance requirements in 10 CFR 70.61 and any other applicable NRC regulations, then only minor environmental impacts are anticipated. | The potential radiological and chemical accident consequences must comply with applicable NRC regulations. NWMI would incorporate engineering design features and administrative controls to ensure that exposure from accidents would be within regulatory limits. |
| Environmental Justice | Construction and decommissioning noise and dust impacts are expected to be short term and limited to onsite activities; minority and low-income populations residing along site access roads could be affected by an increase in the number of commuter vehicles and truck traffic traveling to and from the proposed work site; human health and environmental impacts would not be high or adverse. | See discussions above on mitigation measures for human health and environmental effects, such as noise, traffic, and air quality |

In addition, the Missouri Department of Conservation (MDC) submitted a letter to the NRC dated June 2, 2016 (ADAMS No. ML16155A148), in which MDC recommended certain mitigation measures be considered to avoid, minimize, and where necessary mitigate impacts to fish, forest, and wildlife resources (MDC 2016f). The NRC staff provided a copy of these recommended mitigation measures to NWMI for its consideration (NRC 2016f). These mitigation measures are summarized below:

- If site development or construction will result in tree removal, the applicant is encouraged to coordinate with the U.S. Fish and Wildlife Service.
- Regionally native plants should be used to revegetate areas where soils are disturbed for the project. Exercise caution to avoid introduction of non-native plants to the watershed, such as through a Hazard Analysis Critical Control Plan described by the American Society for Testing and Materials (ASTM E2592-80).

The NRC staff did not consider these mitigation measures when determining the potential impacts from the proposed action because NWMI has not committed to incorporating the suggested mitigation measures. NWMI is not required to implement the suggested mitigation measures because they are recommendations, and not requirements, from MDC.

### 6.3.2 Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The construction, operations, and decommissioning of the NWMI facility and alternatives to the proposed actions would result in short-term uses of the environment, as described in Chapters 4 and 5. “Short-term” is the period of time during which construction, operations, and decommissioning activities would take place.

The construction, operations, and decommissioning of the NWMI facility would require short-term use of the environment and commitment of resources and would commit certain resources (e.g., land and energy), indefinitely or permanently. Short-term resource commitments would be similar at the alternative site and for the two alternative technologies if they were to be developed at the proposed Discovery Ridge site. These alternatives and the proposed action would result in similar relationships between local short-term uses of the environment and the maintenance and enhancement of long-term productivity.

Construction, operations, and decommissioning would require up to 7.4 ac (3.0 ha) of agricultural land that would be committed to industrial land use during the short term. In addition, during construction 0.26 ac (0.1 ha) of agricultural land would temporarily be used as a construction material staging area. The facility would partially obstruct views of the existing landscape. Construction, operations, and decommissioning could also displace wildlife through destruction of habitat or noise. Wildlife may return to the site once construction or decommissioning is completed if it is restored to suitable habitat. Mineral and other geologic resources would be consumed for facility construction. Water would be required for various purposes during NWMI facility construction, operations, and decommissioning as identified in Table 2–3.

Air emissions from construction, operations, and decommissioning would introduce small amounts of radiological and nonradiological constituents at the facility site. However, such emissions are not expected to affect air quality or radiation exposure to the extent that they would impair public health and long-term productivity of the environment. Noise emitted by construction, operations, and decommissioning activities would increase the ambient noise levels on site and in adjacent offsite areas. However, increases in noise levels are not expected to be noticeable, and noise levels would return to background levels once construction and decommissioning activities are complete.

Increased employment, expenditures, and tax revenues generated during construction, operations, and decommissioning activities directly benefit local, regional, and State economies over the short term. Worker vehicles and the delivery and shipment of materials would increase the volume of traffic on local roads. Worker and delivery vehicles-related traffic would be short term during peak construction and decommissioning activities and work shifts and, therefore, would not affect long-term productivity.

The management and disposal of low-level radioactive waste, hazardous waste, and nonhazardous waste requires an increase in energy and consumes space at treatment, storage, or disposal facilities. Regardless of the location, the use of land to meet waste disposal needs would reduce the long-term productivity of the land.

Extension installation of service lines (e.g., electric power, water) during construction of the proposed NWMI facility would connect the facility to utility providers. This additional infrastructure would be available and beneficial for any future use of the proposed NWMI facility after its decommissioning.

### 6.3.3 Irreversible and Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitment of resources that have been noted in this EIS. Resources are irreversible when primary or secondary impacts limit future options for a resource. An irretrievable commitment refers to the use or consumption of resources that are neither renewable nor recoverable for future use. Irreversible and irretrievable commitments of resources for construction, operations, and decommissioning of a medical isotope facility include the commitment of water, energy, raw materials, and other natural and man-made resources. In general, the commitment of capital, energy, labor, and material resources are also irreversible.

The implementation of the proposed site, alternative site, or the alternative technology considered in this EIS would entail the irreversible and irretrievable commitment of energy, water, chemicals, fossil fuels, and other natural and man-made resources. These resources would be unrecoverable. For example, NWMI would consume materials during construction, as described in Chapter 2. These materials would be irretrievable unless NWMI recycles them during decommissioning (e.g., finds another facility to use such materials). During operations, uranium used as the source for the molybdenum isotope would be the main resource that would be irreversibly and irretrievably committed.

Mineral and other geologic resources, such as concrete, granular material, steel, and asphalt necessary for construction of the facility, would be irreversibly committed for construction of the NWMI facility. In addition, a small amount of soils and sediments would be lost to wind and water erosion during construction, operations, and decommissioning.

A negligible increase in the mortality of birds could occur because of their collisions with facility structures. The loss of these birds would be irreversible and irretrievable.

Nonradiological irreversible commitments to occupational human health resources may occur. Such impacts would be similar to potential hazards that occur at any industrial construction site.

Energy expended would be in the form of fuel for equipment, vehicles, and facility operations and electricity for equipment and facility operations. Electricity and fuel would be acquired from offsite commercial sources. Water would be obtained from existing water supply systems. These resources are readily available, and the amounts required are not expected to deplete available supplies or exceed available system capacities.

### 6.3.4 Unresolved Conflicts

Section 102(2)(E) of the National Environmental Policy Act of 1969 requires that the NRC staff study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources. In reviewing the potential impacts associated with the proposed action, the NRC staff did not identify any unresolved conflicts.

## 6.4 Preliminary Recommendation

After weighing the environmental, economic, technical, and other benefits against environmental and other costs, and considering reasonable alternatives, the NRC staff's preliminary recommendation, unless safety issues mandate otherwise, is the issuance of the construction permit to NWMI.  The NRC staff based its preliminary recommendation on the following factors:

- NWMI's Environmental Report;
- the NRC staff's consultation with Federal, State, and local agencies, as well as Tribal officials;
- the NRC staff's independent environmental review; and
- the NRC staff's consideration of public comments received during the scoping process.

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# APPENDIX A
# COMMENTS RECEIVED ON THE NORTHWEST MEDICAL ISOTOPES, LLC, RADIOISOTOPE PRODUCTION FACILITY ENVIRONMENTAL REVIEW

# A. COMMENTS RECEIVED ON THE NORTHWEST MEDICAL ISOTOPES, LLC, RADIOISOTOPE PRODUCTION FACILITY ENVIRONMENTAL REVIEW

## A.1 Comments Received During the Scoping Period

The scoping process for the environmental review of the construction permit application for the Northwest Medical Isotopes, LLC (NWMI), radioisotope production facility (NWMI facility) began on November 18, 2015, with the publication of the U.S. Nuclear Regulatory Commission's (NRC's) Notice of Intent to conduct scoping in the *Federal Register* (80 FR 72115). The scoping process included a public meeting held in Columbia, Missouri, on December 8, 2015. Approximately 43 people attended the meeting. After the NRC presented its prepared statements on the construction permit review process, the meeting was open for public comments. Attendees provided oral statements that were recorded and transcribed by a certified court reporter. A summary and transcript of the scoping meeting are available through the NRC's Agencywide Documents Access and Management System (ADAMS). The ADAMS Public Electronic Reading Room is accessible at http://www.nrc.gov/reading-rm/adams.html. The scoping meeting summary and meeting transcript (NRC 2016a) can be found at ADAMS No. ML15356A096. In addition to comments that the NRC received during the public meeting, the agency also received comments electronically and through the mail.

Each commenter was given a unique identifier to allow every comment to be traced back to its author. Table A–1 identifies the individuals who provided comments and an ADAMS No. to identify the source document of the comments.

Specific comments were categorized and consolidated by topic. Comments with similar specific objectives were combined to capture the common essential issues raised by commenters. Comments have been grouped into the following general categories:

- Specific comments that address environmental issues within the purview of the NRC environmental regulations related to a construction permit. These comments address issues related to the construction, operations, and decommissioning of the NWMI facility. The comments also address alternatives to the proposed action and related Federal actions.
- General comments in support of, or opposed to, the NWMI facility or comments regarding the construction permit process, the NRC's regulations, and the regulatory process.
- Comments that address issues that do not fall within, or are specifically excluded from, the purview of NRC environmental regulations related to the construction permit process. These comments may address issues, such as emergency preparedness, security, and safety.

**Table A–1. Individuals Providing Comments During the Scoping Comment Period**

*Each commenter is identified, along with an affiliation, if any, and the source of the comment.*

| Commenter | Affiliation (if stated) | ID | Comment Source | ADAMS No. |
|---|---|---|---|---|
| Lisa C. Baker | United Keetoowah Band of Cherokee Indians in Oklahoma | 01 | E-mail | ML16049A297 |
| Everett Bandy | Quapaw Tribe of Oklahoma | 02 | Letter | ML16020A339 |
| Dan Brague | Mallinckrodt Pharmaceuticals | 03 | Transcript | ML15356A133 |
| Jerry Dowell | Columbia Chamber of Commerce | 04 | Transcript | ML15356A133 |
| David Griggs | Regional Economic Development | 05 | Transcript | ML15356A133 |
| Diane Hunter | Miami Tribe of Oklahoma | 06 | E-mail | ML16056A421 |
| Andrew Knife Chief | Pawnee Nation of Oklahoma | 07 | Letter | ML16020A338 |
| Terry Maglich | Missouri Department of Economic Development | 08 | Transcript | ML15356A133 |
| Bob McDavid | Mayor, City of Columbia | 09 | Transcript | ML15356A133 |
| Karen Miller | Boone County Commission, Commissioner | 10 | Transcript | ML15356A133 |
| Toni M. Prawl | Missouri Department of Natural Resources | 11 | Letter | ML16020A340 |
| Joshua Tapp | U.S. Environmental Protection Agency | 12 | Letter | ML16007A004 |

Comments that are outside the scope of the NWMI facility environmental review are not included here but appear in and are responded to in the Scoping Summary Report (ADAMS No. ML16056A628). To maintain consistency with the Scoping Summary Report, Appendix A retains the unique identifiers used in that report for each comment.

The NRC staff placed comments received during the scoping comment period applicable to this environmental review into categories based on topics in the environmental impact statement (EIS). These categories are listed in Table A–2.

**Table A–2. Issue Categories**

| Technical Issues |
|---|
| Accidents |
| Air Quality |
| Alternatives |
| Coordination |
| Cost-Benefit Comparison |
| Cumulative Impacts |
| Ecological Resources |
| Environmental Justice |

| Technical Issues |
|---|
| Historic and Cultural Resources |
| Human Health |
| Land Use |
| Purpose and Need |
| Water Resources |
| Support for the NWMI Facility |

The following pages contain the comments, identified by the commenter's identification and comment number, and the NRC staff's response. Comments are presented in the same order as listed in Table A–2.

### A.1.2 Accidents

Comments:

**12-03:** The increased likelihood of a transportation accident involving molybdenum- 99 […] can increase the risk of harm to sensitive populations.

Response:

*This comment recommends that the NRC consider the increased likelihood of transportation accidents. Section 4.8.2.1 of the EIS discusses the impacts to the public from highway transportation of radioactive material associated with the proposed NWMI facility. As discussed in Section 4.8.2.1, when transporting radioactive material, both NWMI and commercial carriers used by NWMI must comply with applicable U.S. Department of Transportation (DOT) regulations and NRC packaging requirements for radioactive material in 10 CFR Part 71. The annual dose to a maximally exposed individual from highway transportation of radioactive material associated with the proposed NWMI facility is small relative to the NRC's 100 mrem annual public dose limit in 10 CFR 20.1301. The NRC's public dose limit is set at a level that helps to ensure that any risk to members of the public, including sensitive populations, from radiation exposure that occurs due to the operation of a nuclear facility is no greater than the risk from any other hazard to which individuals are routinely exposed (ICRP 1987; 56 FR 23360). In addition, as noted in Section 4.8.2.1, the Commission has determined that the radiological and nonradiological environmental impacts of normal (incident-free) transportation of radioactive materials done in accordance with NRC and DOT regulations, and the risks and consequences of accidents involving radioactive material shipments in packages for which the NRC has issued design approvals meeting the performance standards of 10 CFR Part 71, are small (49 FR 9375).*

### A.1.3 Air Quality

Comment:

**12-20:** The document should also consider greenhouse gas emissions and how the preferred alternative might improve or degrade air quality based on the construction of the facility and how this facility could improve transportation GHG emissions based on reduction of imports from Canada or overseas. Information on how to comply with the President and CEQ can be found here: https://www.whitehouse.gov/administration/eop/ceq/initiatives/nepa/ghgguidance.

Response:

*This comment recommends that the EIS assess the greenhouse gas emission (GHG) and air quality impacts of the proposed NWMI facility. Section 4.2 of the EIS addresses the impacts on* *air quality that results from construction, operations, and decommissioning of the proposed NWMI facility. Section 4.2 quantifies annual GHG emissions resulting from construction, operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site. Section 5.4.1 of the EIS compares the environmental impacts of the proposed NWMI facility with the environmental impacts associated with using an alternative site or alternative technologies.*

### A.1.4 Alternatives

<u>Comments:</u>

**12-01:** Although the proposed action is only the licensing of a new low enriched uranium Medical Isotope [facility], EPA strongly encourages NRC to consider all the significant environmental impacts that would be caused by licensing this facility, both the beneficial and harmful, to human health and the environment. For example, alternatives one might consider are: 1) no-action, 2) licensing of this facility, or 3) denial of this facility to license with approval for licensing a different facility at another location.

<u>Response:</u>

*This comment suggests that the NRC consider all the significant environmental impacts as a result of the no-action alternative (e.g., denial of the construction permit application), the proposed action, and an alternative site and facility. Chapter 4 of the EIS evaluates the potential environmental impacts from the proposed action. Chapter 5 of the EIS evaluates the potential impacts from the no-action alternative, an alternative site, and two alternative technologies. Section 5.4.1 of the EIS compares the environmental impacts of the proposed NWMI facility with those that would be associated with using an alternative site or alternative technologies. Specifically, Table 5–12 provides a tabular comparison of the potential environmental impacts of constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site with the alternative site and the no-action alternative. Table 5–13 provides a tabular comparison of the potential environmental impacts of constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site with the potential environmental impacts of using alternative technologies.*

### A.1.5 Coordination

<u>Comment:</u>

**12-12:** Has coordination between Missouri Department of Natural Resources and NRC occurred?

<u>Response:</u>

*This comment asks whether coordination has occurred between the NRC and the Missouri Department of Natural Resources. In a letter dated November 19, 2015, the NRC invited the Missouri Department of Natural Resources' (MDNR) Division of Environmental Quality, Chief of Policy, and State Historic Preservation Office to participate in the scoping process for the environmental review related to the proposed NWMI facility (NRC 2015b). On December 9, 2015, MDNR's State Historic Preservation Officer responded to the NRC (see response to Comment 12-15 below). However, MDNR's Division of Environmental Quality and Chief of Policy did not submit comments to the NRC during the scoping period. Section 1.7 of the EIS identifies agencies contacted during the formal consultation processes and Appendix D discusses agencies with which the NRC consulted. The MDNR will be on distribution for the NRC's draft EIS and will be invited to the NRC's public meeting discussing the draft EIS.*

<u>Comment:</u>

**12-14:** Will there need to be coordination for farmland conversion?

Response:

*This comment asks whether the NRC will need to coordinate with the U.S. Department of Agricultural regarding the conversion of prime farmland to nonagricultural uses. As discussed in Section 3.1.1.1 of the EIS, the proposed site (Discovery Ridge) and alternative site (University of Missouri Research Reactor) do not contain prime farmland or other important farmland soils as defined in the Farmland Protection Policy Act of 1981 (7 U.S.C. 4201 et seq.) and implementing regulations (7 CFR Parts 657 and 658). Given that the Discovery Ridge site is already committed to use as a research, development, and office park, the site is not subject to the Farmland Protection Policy Act (7 CFR 658.2). Section 3.1.1 of the EIS describes land use on and around the proposed site in Columbia, Missouri, and Section 4.1.1 addresses the impacts to land use from construction, operations, and decommissioning of the proposed NWMI facility. Section 5.2.2.1 of the EIS describes land use on and around the alternative site in Columbia, Missouri and the impacts to land use from construction, operations, and decommissioning of the proposed NWMI facility.*

**12-15:** Has coordination occurred with the Missouri State Historic Preservation Officer?

Response:

*This comment asks whether coordination has occurred between the NRC and the Missouri State Historic Preservation Officer (SHPO). Section 4.6.3 of the EIS explains that the NRC initiated NHPA Section 106 consultation with the Missouri SHPO on November 19, 2015. A Cultural Resource Assessment, Section 106 Review, was conducted by the SHPO for the proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility, in Columbia, Missouri (Lot 15 at Discovery Ridge). The assessment signed by Toni M. Prawl, Ph.D., Deputy State Historic Preservation Officer, on December 9, 2015, states that, "Adequate documentation has been provided (26 CFR Section 800.11). There will be 'no historic properties affected' by the current project." The assessment also states, the Missouri SHPO has "no objection to the initiation of project activities." The Missouri SHPO will be on distribution for the NRC's draft EIS and will be invited to the NRC's public meeting discussing the draft EIS.*

### A.1.6 Cost Benefit Analysis

Comment:

**12-02:** Although the proposed action is only the licensing of a new low enriched uranium Medical Isotope [facility], EPA strongly encourages NRC to consider all the significant environmental impacts that would be caused by licensing this facility, both the beneficial and harmful, to human health and the environment. […] The direct effects of such facilities can be both beneficial and harmful and we encourage NRC to expand the discussion in this area.

Comment:

**12-05:** In contrast, if such medical supplies have a pronounced effect on human health and are in short supply or are not otherwise readily available, then such considerations should also be taken into account. EPA recommends objectively analyzing both positive and negative aspects so that the decision maker can easily choose the preferred alternative.

Response:

*The above comments suggest that the NRC staff consider the costs and benefits of the proposed action and alternatives. Section 5.4 of the EIS evaluates the costs and benefits for the proposed action and compares the environmental impacts of the proposed action, no-action alternative, alternative sites, and two alternative technologies. Specifically, Table 5–12 provides a tabular comparison of the potential environmental impacts of constructing, operating, and* *decommissioning the proposed NWMI facility at the Discovery Ridge site with the alternative site and the no-action alternative. Table 5–13 provides a tabular comparison of the potential environmental impacts of constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site with the potential environmental impacts of using alternative technologies.*

### A.1.7 Cumulative Impacts

Comment:

**12-06:** Cumulative impact discussions may also include transport of hazardous materials, storage of materials, national health benefits, induced development due to job creation, and reduction of GHGs due to proximity of the new facility.

Response:

*The comment recommends that the EIS include a cumulative impact discussion that considers transportation, waste management, human health, socioeconomics, and GHG emissions. Section 4.14 of the EIS considers the potential cumulative impacts of the construction, operations, and decommissioning of the proposed NWMI facility when overlaid or added to temporary or permanent effects associated with other past, present, and reasonably foreseeable actions on the affected resource areas. Table 4–12 of the EIS summarizes the cumulative impacts for all resource areas. The cumulative impacts for (1) socioeconomics are SMALL; (2) air quality are SMALL to MODERATE; and (3) waste management are SMALL.*

### A.1.8 Ecological Resources

Comment:

**12-07:** When developing Threatened and Endangered species, one might consider not only animal species, but also plant species if construction will occur on undisturbed land.

Response:

*This comment recommends that the NRC consider the potential impacts to threatened and endangered animal and plant species from construction of the proposed NWMI facility. Section 3.5.4 of the EIS describes the Federally listed species (both plants and animals) that have the potential to exist within the action area. As discussed in Section 3.5.4, the NRC staff concludes that Federally listed, proposed, or candidate species are unlikely to occur within the action area. In Section 4.5.4 of the EIS, the NRC staff concludes that there would be no effect on Federally listed species or habitats under FWS's jurisdiction.*

### A.1.9 Environmental Justice

Comments:

**12-11:** Would EJ communities be disproportionately affected by the proposed locations?

Response:

*The comment asks whether the proposed action would disproportionately affect Environmental Justice (EJ) communities. In the EIS, the NRC staff concludes that it is not likely that the construction, operations, and decommissioning of the proposed NWMI facility would have disproportionately high and adverse human health and environmental effects on minority and low-income populations if located at the Discovery Ridge site (Section 4.12) or at the University of Missouri Research Reactor location (Section 5.2.2.12).*

### A.1.10 Historical and Cultural Resources

Comments:

**06-01:** In reference to the above-mentioned project, the Miami Tribe is not currently aware of existing documentation directly linking a specific Miami cultural or historic site to the project site. However, as this site is within the extended homelands of the Miami Tribe, should any human remains or Native American cultural items falling under the Native American Graves Protection and Repatriation Act (NAGPRA) or archaeological evidence be discovered during any phase of this project, the Miami Tribe requests immediate consultation with the entity of jurisdiction for the location of discovery. The Miami Tribe offers no objection to the proposed project at this time. However, should human remains and/or cultural objects be discovered, regardless of initial determination as to site dating or cultural affiliation, please contact me […] to initiate consultation.

**01-01:** Thank you for contacting us as a potential consulting party on this project. The UKB [United Keetoowah Band] defers consultation on this project to federally recognized tribes with more of a historic interest in this site.

**02-01**: This project is outside of the current area of interest for the Quapaw Tribe [of Oklahoma], therefore, the Quapaw Tribe does not desire to comment on this project at this time.

**07-01**: The Pawnee Nation Office of Historic Preservation has received the information and materials requested for our Section 106 Review and Consultation. Consultation with the Pawnee Nation is required by Section 106 of the National Historic Preservation Act of 1966 (NHPA), and 36 CFR Part 800. Given the information provided, you are hereby notified that the proposal project location should have no potential to adversely affect any known Archaeological, Historical, or Sacred Pawnee sites. Therefore, in accordance with 36 CFR 800.4(d)(1), you may proceed with the proposed project. However, please be advised that undiscovered properties may be encountered and must be immediately reported to us under both the NHPA and NAGPRA regulations.

**11-01**: The [Missouri] State Historic Preservation Office has reviewed the information submitted on the above referenced project. Based on this review, we have made the following determination: Adequate documentation has been provided (36 CFR Section 800.11). There will be "no historic properties affected" by the current project. For the above checked reason, the State Historic Preservation Office has no objection to the initiation of project activities. PLEASE BE ADVISED THAT, IF THE CURRENT PROJECT AREA OR SCOPE OF WORK ARE CHANGED, A BORROW AREA IS INCLUDED IN THE PROJECT, OR CULTURAL MATERIALS ARE ENCOUNTERED DURING CONSTRUCTION, APPROPRIATE INFORMATION MUST BE PROVIDED TO THIS OFFICE FOR FURTHER REVIEW AND COMMENT. Please retain this documentation as evidence of compliance with Section 106 of the National Historic Preservation Act, as amended.

Response:

*The above commenters generally indicate there are no known cultural or historic resources that could be affected by the proposed action, but express concerns that they be contacted consistent with the Section 106 process if such resources are identified in the future. Section 3.6 of the EIS describes the archaeological history of Columbia, Missouri, and Boone County and identifies historic and cultural resources that could potentially be found in the vicinity of the proposed NWMI facility at the Discovery Ridge Research Park. Section 4.6 of the EIS concludes that construction, operations and decommissioning of the proposed NWMI facility would not impact any known historic and cultural resources at the Discovery Ridge Research Park site.*

### A.1.11 Human Health

<u>Comments:</u>

**12-09:** What is the safe distance to the nearest residence?

<u>Response:</u>

*The above comment recommends that the NRC consider impacts to an offsite member of the public. Section 3.8.1 identifies the location of the nearest residence, as well as the locations of sensitive receptors (schools, medical facilities, parks, recreational areas, religious institutions, and retirement communities within the 5-mi (8-km) region of influence) relative to the proposed Discovery Ridge site. The nearest residence is located 0.27 mi (435 m) from the proposed Discovery Ridge site. Section 4.8 addresses the human health impacts to members of the public from construction, operations, and decommissioning of the proposed NWMI facility. Section 4.11 addresses the impacts to members of the public, including individuals located at the nearest residence, from potential accidents at the proposed NWMI facility. In Sections 4.8 and 4.11, the NRC staff concluded that if the proposed facility is constructed, operated, and decommissioned in compliance with all applicable regulations, then the impacts to offsite members of the public (including those at the nearest residence) from both routine operation of the proposed facility and potential accidents at the proposed facility would be small.*

<u>Comment:</u>

**12-18:** Will the facility be required to conduct an annual environmental and public health radiation dose assessment similar to commercial nuclear reactors?

<u>Response:</u>

*The comment recommends that the EIS consider annual environmental monitoring requirements and public dose assessment for the proposed facility. Section 3.8.2 of the EIS discusses NRC's radiation protection dose limits contained in 10 CFR Part 20. If licensed to operate, the licensee for the radioisotope production facility would need to perform environmental and public radiation dose assessments to show compliance with the annual radiation dose limits for individual members of the public. The NRC regulations at 10 CFR 20.1301 specify an annual maximum allowable dose of 100 mrem to a member of the public from exposure to radiation and radioactive material at a licensed facility. In addition, 10 CFR 20.1302 requires licensees to make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas (both within and outside the site boundary), and to measure annual average concentrations of radionuclides in effluent releases from the facility, as needed to demonstrate compliance with the annual dose limits for individual members of the public. The NRC regulations at 10 CFR 20.2203 require licensees to submit reports of incidents and occurrences involving radiation exposures to members of the public that exceed regulatory limits. Section 4.8.2.1 of the EIS discusses the applicant's proposed radiological effluent and environmental monitoring programs. The applicant's proposed radiological effluent and environmental monitoring programs will be evaluated in a separate safety evaluation report related to the construction permit application based on the information in the NWMI preliminary safety analysis report.*

### A.1.12 Purpose and Need

<u>Comment:</u>

**12-08:** In reviewing the background on these type of facilities, it appears that ten letters of intent have been made recently, with one construction application already submitted in Wisconsin. If the facility in Wisconsin were to be built, would this facility and the others be necessary and viable?

Response:

*This comment recommends that the environmental review consider whether construction of the proposed NWMI facility is necessary if another radioisotope production facility is constructed. Section 1.3 of the EIS describes the purpose and need for the proposed action. The purpose of the NRC's Federal action is to evaluate NWMI's proposal to construct a facility that would ultimately produce medical radioisotopes. This definition of purpose and need reflects the NRC's recognition that, unless there are findings in the safety review required by the Atomic Energy Act of 1954, as amended, or findings in the environmental analysis under NEPA that would lead the NRC to reject a construction permit application, the agency does not have a role in decisions as to whether a particular medical radioisotope production facility should be constructed and operated. Section 1.3 of the SEIS identifies the demand in the United States for molybdenum-99 (Mo-99) and production capacity of the proposed NWMI facility.*

### A.1.13 Water Resources

Comment:

**12-04:** […]the possibility of groundwater contamination near private wells can increase the risk of harm to sensitive populations.

Response:

*The comment recommends that the EIS assess the groundwater impacts from the proposed facility and consider the effects on sensitive populations. Section 3.4.2 of the EIS describes the groundwater resources at and around the proposed Discovery Ridge site. Section 3.4.2.2 of the EIS discusses water supply wells and other wells within a 1-mi (1.6-km) radius of the proposed Discovery Ridge site. Sections 4.4.1 and 4.4.2 of the EIS evaluate the impacts from construction, operations, and decommissioning of the proposed NWMI facility on surface water and groundwater quality and use, respectively. As discussed in Sections 4.4.1.2 and 4.4.2.2, the proposed facility is designed to have zero liquid discharge of radioactive or hazardous liquids; therefore, there would be no such liquid effluents released from the facility to the environment during operation. Facility discharges would be limited to sanitary effluent, which would be conveyed to the City of Columbia Sanitary Sewer Utility as discussed in Section 4.4.1.2. Further, stormwater runoff from the NWMI facility site would be managed by an engineered stormwater management system, including necessary detention/retention structures, constructed and operated in compliance with State and municipal stormwater management plans, procedures, and practices. Consequently, because no radioactive or hazardous liquid effluent discharge would occur from the facility during normal operations, the impact on surface water or groundwater quality would be negligible or SMALL and no impact on human health would be expected.*

### A.1.14 Support for the NWMI Facility

Comments:

**10-01:** I am here to testify in support of Northwest Medical Isotopes, LLC's proposed project. Because of our wide array of community assets, we believe that Boone County is an excellent location for the proposed facility. One of our community's premier assets is the University of Missouri's nuclear reactor. The physical proximity of the reactor, as well as its history of excellence in performance, combine to make this a perfect partnership between the University of Missouri and Northwest Medical Isotopes.

Through this partnership we will be -- which will produce 99-Mo, cancer patients throughout the United States will have more opportunities for a better outcome. The proposed location of the facility at University of Missouri's Discovery Ridge Park will provide access to Mid-Missouri

Regional Airport. This too is an enormous benefit to the project, since reducing the time between production of the drug and delivery to healthcare professionals will effectively increase the efficacy of the drug needed by the patients and doctors throughout the United States. Another asset that our community brings to the table is Boone County's ability to utilize our economic development tool, as Chap -- known as Chapter 100 Bond. With this tool, in cooperation with our taxing entities, we can make this project successful. This is a community-wide partnership, which has the potential to grow ever stronger through the collaboration created by effectively utilizing our community assets, the University's research reactor, Mid-Missouri Regional Airport, and our ability to utilize the economic tool Chapter 100 Bond. Our community directly benefits from this partnership because this project will bring good-paying jobs and capital investment, and it creates the possibility of pharmaceutical companies joining the research hub of Discovery Ridge, with that enhanced tax base benefiting all citizens. Please accept this testimony made on behalf of the Boone County Commission in support of the Northwest Medical Isotopes, LLC facility location.

**09-01:** I appreciate the opportunity to testify before the NRC in support of the Northwest Medical Isotopes proposal. This is an important initiative for obviously several different reasons. One is that we have a highly-skilled workforce in Boone County and can easily support the 80-plus jobs that will be required in the production of technetium.

Secondly, obviously for Boone County, the 1,600 workers that will be required to construct the building is very important to the economy here in Mid-Missouri and in the whole state of Missouri.

Second -- next, you know, I have -- in my former life I was a physician and have been on staff of both the University of Missouri Hospital and Boone Hospital; and I know how important, you know how important the use of radioisotopes is to the healthcare community, to the men and women who do diagnostic and therapeutic intervention, and you know how important this tool is to continue. And it's – it's -- I know there are a lot of healthcare providers that are uncomfortable with the prospect that Technetium may be in short supply in the pending near future. And, last, and really most important in my opinion is the fact that so many of us may be requiring this tool. You know, whether there's -- of the 18 million doses of Technetium a year, which, obviously, do the math, is 50,000 a day, many of us will need this diagnostic tool for heart disease, bone, skin, and other emerging technologies. And it means so much if we're able to bring the production of this very essential radioisotope back into the United States where we can produce it here and deliver it to the 300-plus citizens of the United States who continue to need this and will need this in the future.

**04-01**: I wanted to put on record the Columbia Chamber of Commerce's support of the Northwest Medical Isotopes application. I wanted to highlight a couple of items that we are supportive of Missouri and Columbia is the home to world-class medical research resources, and Columbia is at the strategic central location of that access point, and it accesses to other critical markets across the country. So we're supportive of that effort. Also, the Discovery Ridge site utilizes the proximity nourished Missouri and its proximity to transport access at the intersections of two major highways and our access to a regional airport. Also, we have an ample workforce available for the construction phase through the decommissioning phase of this facility. So, once again, the Columbia Chamber of Commerce wants to be on record in support of the Northwest Medical Isotopes application.

**05-01**: I mention that simply to reinforce the point that this project, Northwest Medical Isotopes, has from the start been the perfect example of a private-public or a public-private partnership. Much like REDI, which is also a public-private partnership, this project is a prime example of a company in the city of Columbia, county of Boone, state of Missouri, and our great native University working together to do whatever's necessary to bring a great project to fruition.

You will hear some more and have heard from several folks tonight about more specific information relating to this project. My role is to discuss the overall economic pro-- economic impact of the project and how it will impact our community and state.

REDI's worked with Northwest for over two years by assisting Northwest and bringing together the right organizational leadership to help move this project to this point. I mentioned many of them just a second ago, but must stress the critical role of the University and the University team at the research reactor. This is simply an amazing opportunity for Columbia, the University, Missouri and, in fact, the United States and our citizens.

There are approximately 50,000 doses of this drug that will be produced at this proposed facility administered every day in North America. There's no other producer in the United States for this credible diagnostic medical pharmaceutical. Our research reactor, in collaboration between Northwest and the University, are the critical components for this project.

It's estimated that construction of this $70 million radioisotope production facility in fully operational state will require over 180 full-time skilled construction personnel from Central Missouri and take longer than a year. When the facility's in operation, it's estimated to employ 98 full-time employees. I will tell you those positions will range from extremely highly-skilled technical jobs to those tasked with maintenance of equipment in the facilities. I make that point to note the variety of employment opportunities this project brings to our community. Not included in these construction and operational employment and cost estimates are the ancillary jobs this project will create. Obviously these radiopharmaceuticals require very rapid delivery to the medical facilities that administer them around the country.

This project will be located at University's Discovery Ridge Research Park on 7.4 acres. Discovery Ridge is another great example of great public-private partnerships, as it houses ABC Laboratories, which is an environmental testing organization serving the pharmaceutical industry, and other clients like IDEXX, a bioscience company serving veterinary and the animal health research industry. This site is critically located within a few miles of Interstate Highway 70, sets immediately adjacent to U.S. Highway 63. This location provides critical north, south, east, west transportation assets from the center of the United States and is only about six miles from Columbia Regional Airport.

All necessary utilities and street infrastructures, including an adjacent overpass providing access to Highway 63, is already in place at the lot line for a fast timeline for this project. That fact simply demonstrates our community's long-term commitment to support this very type of development at Discovery Ridge. In addition to the investment and employment opportunities I've mentioned, it's also anticipated over the life of this project this project will produce over $76 million in tax revenues to support our school, our city, our county, and our state. In closing, on behalf of REDI and myself, our community, our county, our state, and the thousands of U.S. citizens whose lives will be positively impacted by this project on a daily basis, I give our support and approval.

**08-01**: The opportunities that we look forward to are those that allow for the growth of employment as well as investment. We're very, very pleased to have provided an assistance proposal to Northwest Isotopes approximately a year and a half ago that does just that; creates a number of great jobs, a great deal of investment in one of our targeted industries of life sciences. It also does something that I consider very important; it creates an opportunity to save lives.

**03-01**: Large-scale production of moly-99 is currently only completed at five facilities worldwide. Moly-99 has not been produced domestically since 1991. These five facilities rely on aging research reactors, which are periodically subject to planned and unplanned maintenance. Some of these unplanned maintenance outages have led to shortages of moly-99, frequently impacting patient access to technetium for these important diagnostic procedures.

Mallinckrodt is also a major producer of moly-99 at our facility in the Netherlands, so we are very familiar with what is needed to produce commercial quantities of this isotope. As the world's largest consumer of moly-99, Mallinckrodt closely follows new efforts to produce this critical isotope and supports construction of new facilities for its production. We are very familiar with Northwest Medical Isotopes' plan to license and construct a facility in Columbia, Missouri for the production of moly-99 and the recycling of their target material. As we understand it, they intend to utilize a network of two to three university research reactors and build a new moly-99 production facility, all of which should provide additional moly-99 capacity.

We believe their technology offers distinct advantages because it is based on the well-proven fission method of moly-99 production and uses existing reactors. Their operation will, importantly, also be based upon low-enriched uranium, which meets the objectives of the U.S. Government's nonproliferation policy, as stated at the 2012 Nuclear Security Summit in Seoul, South Korea and in 2014 in the Netherlands.

Nuclear medicine procedures performed in the U.S. consume half of the world's supplies of moly-99. A domestic moly-99 production facility will reduce radioactive decay losses in transit from the current suppliers in Europe, South Africa, and Australia. A U.S. supply, if robust enough to supply the entire market, will also eliminate or reduce transport problems we've had in the past relying on shipments from Europe, incidents including volcanic activity in Iceland and flood destructions due to terrorist concerns. Discussions leading up to the passage of the American Medical Isotope Production Act of 2012 cited all of these issues as a reason to encourage domestic production of moly-99.

Mallinckrodt applauds Northwest Medical Isotopes' efforts to build its facility in Columbia and encourages the NRC to provide the necessary resources for an expedient review of their construction permit and operating license applications.

<u>Response:</u>

*These comments generally support the application and note the medical and socioeconomic benefits of constructing and operating the proposed NWMI facility at the University of Missouri's Discovery Ridge Park in Columbia, Missouri. The commenters cite the use of a proven technology, the benefit of providing a domestic supply of Mo-99 for medical use, public–private partnership, and the proximity of the proposed NWMI facility site to transportation infrastructure.*

*Section 3.7 of the EIS describes the current socioeconomic factors, including labor force, employment, and unemployment data for the City of Columbia and Boone County, which have the potential to be directly or indirectly affected from construction, operations, and decommissioning of the proposed NWMI facility. Section 4.7 of the EIS describes the potential socioeconomic impacts from constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site. The impact analysis considered potential changes in regional employment, housing availability, tax revenues, and public services.*

*Section 3.9 of the EIS describes the local transportation systems, including roadway networks and traffic volumes near the proposed Discovery Ridge site. Section 4.10 of the EIS describes the potential transportation impacts during the construction operations, and decommissioning of the proposed NWMI facility at the Discovery Ridge site.*

*Section 5.4 of the EIS evaluates the costs and benefits of the proposed action and compares the environmental impacts of the proposed NWMI facility with those that would be associated with using alternative technologies. Table 5–13 provides a tabular comparison of the potential environmental impacts of constructing, operating, and decommissioning the proposed NWMI facility at the Discovery Ridge site with the potential environmental impacts of using alternative technologies.*

## A.2 References

80 FR 72115. U.S. Nuclear Regulatory Commission. "Northwest Medical Isotopes, LLC- intent to conduct scoping process and prepare an environmental impact statement; public meeting and request for comment." *Federal Register* 80(222): 72115–72117. November 18, 2015.

7 CFR Part 657. *Code of Federal Regulations*, Title 7, *Agriculture*, Part 657, "Important farmlands inventory."

7 CFR Part 658. *Code of Federal Regulations*, Title 7, *Agriculture*, Part 658, "Farmland protection policy act.

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, "Standards for protection against radiation."

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic licensing of production and utilization facilities."

10 CFR Part 71. *Code of Federal Regulations*, Title 10, *Energy*, Part 71, "Packaging and transportation of radioactive material."

49 FR 9375. U.S. Nuclear Regulatory Commission. "Environmental Protection Regulations for Domestic Licensing and Related Regulatory Functions and Related Conforming Amendments." *Federal Register* Notice 49(49): 99352–9406. March 12, 1984.

American Medical Isotopes Production Act of 2012. 42 U.S.C. §2065 et seq.

Atomic Energy Act of 1954, as amended. 42 U.S.C. §2011 et seq.

Farmland Protection Policy Act of 1981. 7 U.S.C. §4201 et seq.

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

National Historic Preservation Act of 1966. 54 U.S.C. §300101 et seq.

Resource Conservation and Recovery Act of 1976. 42 U.S.C. §6901 et seq.

[NRC] U.S. Nuclear Regulatory Commission. 2015a. Official Transcript Proceedings, Public Scoping Meeting for Northwest Medical Isotopes, LLC. December 8, 2015. ADAMS No. ML15356A133.

[NRC] U.S. Nuclear Regulatory Commission. 2015b. Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review. ADAMS No. ML15308A362.

[NRC] U.S. Nuclear Regulatory Commission. 2016. "Summary of the Public Scoping Meeting Conducted Related to the Review of the Proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility." Washington, DC: NRC. January 20, 2015. ADAMS No. ML15356A096.

# APPENDIX B
# APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

# B. APPLICABLE LAWS, REGULATIONS, AND OTHER REQUIREMENTS

A number of Federal laws and regulations affect environmental protection, health, safety, compliance, and consultation at U.S. Nuclear Regulatory Commission (NRC)-licensed facilities. Certain Federal environmental requirements have been delegated to State authorities for enforcement and implementation. Furthermore, States have enacted laws to protect public health and safety and the environment. It is the agency's policy to ensure that NRC-licensed facilities are operated in a manner that provides adequate protection of public health and safety and of the environment through compliance with applicable Federal and State laws, regulations, and other requirements.

The requirements that may be applicable to the operation of NRC-licensed facilities encompass a broad range of Federal laws and regulations that address environmental, historical and cultural, health and safety, transportation, and other concerns. Generally, these laws and regulations relate to how a facility would conduct the work involved in performing a proposed action to protect workers, the public, and environmental resources. Some of these laws and regulations require permits or consultation with other Federal agencies or State, Tribal, or local governments.

The Atomic Energy Act of 1954, as amended (AEA) (42 U.S.C. 2011 et seq.), authorizes the NRC to enter into agreement with any State to assume regulatory authority for certain activities (42 U.S.C. 2021). Missouri is a non-agreement state; thus, the NRC has regulatory responsibility over byproducts, sources, and quantities of special nuclear materials.

State legislatures develop their own laws. State statutes supplement, as well as implement, Federal laws for the protection of air, water quality, and groundwater. State legislation may address solid waste management programs, locally rare or endangered species, and historical and cultural resources.

The Clean Water Act of 1977 (CWA), as amended (33 U.S.C. 1251 et seq.), allows for primary enforcement and administration through State agencies, as long as the State program is at least as stringent as the Federal program. The State program must conform to the CWA and to the delegation of authority for the Federal National Pollutant Discharge Elimination System (NPDES) program from the U.S. Environmental Protection Agency (EPA) to the State. The primary mechanism to control water pollution is the requirement for direct dischargers to obtain an NPDES permit or a State Pollutant Discharge Elimination System permit, when the authority has been delegated from the EPA, under the CWA, as is the case for Missouri.

One important difference between Federal regulations and certain State regulations is the definition of waters regulated by the State. Certain State regulations may include underground waters, whereas the CWA only regulates surface waters.

## B.1 Federal, State, and Local Requirements

Construction and operation of the Northwest Medical Isotopes, LLC (NWMI) facility would be subject to Federal, State, and local requirements. Tables B–1, B–2, and B–3 identify the principal Federal, State, County, and city environmental regulatory requirements that may be applicable to the proposed, NWMI medical radioisotope production facility (NWMI facility). Along with each regulatory requirement is a brief description. The requirements are organized into categories, such as general requirements, water resources, and pollution prevention.

**Table B–1. Potentially Applicable Federal Statutes, Regulations, and Orders**

| Statute/Regulation/Order | Description |
|---|---|
| **General Requirements** | |
| Atomic Energy Act of 1954, as amended, 42 U.S.C. 2011 et seq.; Energy Reorganization Act of 1974, 42 U.S.C. 5801 et seq. | The 1954 Atomic Energy Act, as amended (AEA), and the Energy Reorganization Act of 1974, give the NRC the licensing and regulatory authority for nuclear energy uses within the commercial sector. The Acts give the NRC responsibility for licensing and regulating commercial uses of atomic energy and research and test reactors, and allow the agency to protect workers and the public by establishing dose and concentration limits for activities under NRC jurisdiction. The NRC implements its responsibilities under the AEA through regulations established in Title 10 of the *Code of Federal Regulations* (CFR). |
| National Environmental Policy Act of 1969, as amended, 42 U.S.C. 4321 et seq. | The National Environmental Policy Act, as amended (NEPA), requires Federal agencies to integrate environmental values into their decisionmaking process by considering the environmental impacts of proposed Federal actions and reasonable alternatives to those actions. NEPA establishes policy, sets goals (in Section 101), and provides means (in Section 102) for carrying out the policy. Section 102(2) contains action-forcing provisions to ensure that Federal agencies follow the letter and spirit of the Act. For major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of NEPA requires Federal agencies to prepare a detailed statement that includes the environmental impacts of the proposed action and other specified information. |
| 10 CFR Part 30 | 10 CFR Part 30, “Rules of general applicability to domestic licensing of byproduct material,” contains NRC regulations issued under the AEA, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242) to provide for the domestic licensing of byproduct material. This part also gives notice to certain persons who knowingly provide—to any licensee, applicant, certificate holder, contractor, or subcontractor—~~any~~ components, equipment, materials, or other goods or services that relate to a licensee’s, certificate holder’s or applicant’s activities subject to this part, that they may be individually subject to NRC enforcement action for violation of 10 CFR 30.10. |
| 10 CFR Part 50 | 10 CFR Part 50, “Domestic licensing of production and utilization facilities,” contains NRC regulations issued under the AEA, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242) to provide for the licensing of production and utilization facilities. This part also gives notice to certain persons who knowingly provide—to any licensee, applicant, contractor, or subcontractor—~~any~~ components, equipment, materials, or other goods or services that relate to a licensee’s or applicant’s activities subject to this part, that they may be individually subject to NRC enforcement action for violation of 10 CFR 50.5. |

| Statute/Regulation/Order | Description |
| --- | --- |
| 10 CFR Part 70 | 10 CFR Part 70, "Domestic licensing of special nuclear material," contains NRC regulations issued under the AEA, as amended (68 Stat. 919), and Title II of the Energy Reorganization Act of 1974 (88 Stat. 1242), that establish procedures and criteria for the issuance of licenses to receive title to, own, acquire, deliver, receive, possess, use, and transfer special nuclear material. This part also gives notice to certain persons who knowingly provide—to any licensee, applicant for a license, employee of a licensee or applicant, contractor (including a supplier or consultant), subcontractor, or employee of a contractor or subcontractor of any licensee of applicant for a license—any components, equipment, materials, or other goods or services that relate to a licensee's or applicant's activities in this part, that they may be individually subject to NRC enforcement action for violation of 10 CFR 70.10. |
| **Air Quality Protection** | |
| Clean Air Act of 1970, as amended,<br>42 U.S.C. 7401 et seq. | The Clean Air Act, as amended (CAA), is intended to "protect and enhance the quality of the nation's air resources so as to promote the public health and welfare and the productive capacity of its population." The CAA establishes regulations to ensure maintenance of air quality standards and authorizes individual States to manage permits. Section 118 of the CAA requires each Federal agency, with jurisdiction over properties or facilities engaged in any activity that might result in the discharge of air pollutants, to comply with all Federal, State, inter-State, and local requirements with regard to the control and abatement of air pollution. Section 109 of the CAA directs the U.S. Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards for criteria pollutants. EPA has identified these standards and set them for the following criteria pollutants: particulate matter, sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, and lead. Section 111 of the CAA requires the establishment of national performance standards for new or modified stationary sources of atmospheric pollutants. Section 160 of the CAA requires the evaluation of specific emission increases before permit approval to prevent significant deterioration of air quality. Section 112 requires specific standards for the release of hazardous air pollutants (including radionuclides). These standards are implemented through plans developed by each State and approved by the EPA. The CAA requires sources to meet standards and to obtain permits to satisfy those standards. Nuclear facilities may be required to comply with CAA Title V, Sections 501–507, for sources subject to new source performance standards or sources subject to National Emission Standards for Hazardous Air Pollutants. EPA regulates emissions of air pollutants in 40 CFR Parts 50 to 99. |
| **Environmental Justice and Public Health Protection** | |
| 10 CFR Part 20 | 10 CFR Part 20, "Standards for protection against radiation," contains NRC regulations that establish standards for protection against ionizing radiation resulting from activities conducted under licenses issued by the NRC. The NRC issued these regulations under the AEA, as amended, and the Energy Reorganization Act of 1974, as amended. The purpose of these regulations is to control the receipt, possession, use, transfer, and disposal of licensed material by any licensee in such a manner that the total dose to an individual (including doses resulting from licensed and unlicensed radioactive material and from radiation sources other than background radiation) does not exceed the standards for protection against radiation prescribed in the regulations in this part. |

| Statute/Regulation/Order | Description |
|---|---|
| Executive Order 12898 | Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations,” requires Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. Amended by Executive Order 12948. |
| Executive Order 13045 | Executive Order 13045, “Protection of Children from Environmental Health Risks and Safety Risks,” prioritizes the identification and assessment of environmental health and safety risks that may disproportionately affect children and ensures that those risks are addressed. |
| Noise Control Act of 1972, as amended, 42 U.S.C. 4901 et seq. | The Noise Control Act of 1972, as amended, requires facilities to maintain noise levels that do not jeopardize public health or safety. |
| Occupational Safety and Health Administration occupational noise exposure regulations, 29 CFR 1910.95 | Occupational Safety and Health Administration (OSHA) regulations establish workplace standards for noise. |
| Occupational Safety and Health Act of 1970, as amended, 29 U.S.C. 651 et seq. | The Occupational Safety and Health Act of 1970 requires compliance with all applicable worker safety and health legislation (including guidelines in 29 CFR Part 1960). |
| Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions, 69 FR 52040 (2004) | The NRC is committed to the general goals of Executive Order 12898 and to full compliance with the NEPA requirements. |
| **Historic Preservation and Cultural Resources** | |
| National Historic Preservation Act of 1966, as amended, 54 U.S.C. 300101 et seq. | The National Historic Preservation Act, as amended (NHPA), was enacted to create a national historic preservation program, including the National Register of Historic Places and the Advisory Council on Historic Preservation. Section 106 of the Act requires Federal agencies to take into account the effects of their undertakings on historic properties. The Advisory Council on Historic Preservation regulations implementing Section 106 of the Act are found in 36 CFR Part 800. The regulations call for public involvement in the Section 106 consultation process, including Indian Tribes and other interested members of the public, as applicable. |
| **Land Use Protection** | |
| Farmland Protection Policy Act of 1981, 7 U.S.C. 4201 et seq. | The Farmland Protection Policy Act sets guidelines that require all agencies to identify prime farmland proposed to be converted to nonagricultural land use and to evaluate the impact of the conversion. |
| **Protected Species** | |
| Endangered Species Act of 1973, as amended, 16 U.S.C. 1531 et seq. | The Endangered Species Act of 1973, as amended (ESA), was enacted to prevent the further decline of endangered and threatened species and to restore those species and their critical habitats. Section 7 of the Act requires Federal agencies to consult with the U.S. Fish and Wildlife Service or the National Marine Fisheries Service on Federal actions that may affect listed species or designated critical habitats. |

| Statute/Regulation/Order | Description |
|---|---|
| Magnuson–Stevens Fishery Conservation and Management Act, as amended, 16 U.S.C. 1801–1884 | The Magnuson-Stevens Fishery Conservation and Management Act, as amended (MSA), governs marine fisheries management in U.S. Federal waters. The Act created eight regional fishery management councils and includes measures to rebuild overfished fisheries, protect essential fish habitat, and reduce bycatch. Under Section 305 of the Act, Federal agencies are required to consult with National Marine Fisheries Service for any Federal actions that may adversely affect essential fish habitat. |
| Fish and Wildlife Coordination Act of 1934, as amended 16 U.S.C. 661 et seq. | The Fish and Wildlife Coordination Act requires Federal agencies that construct, license, or permit water resource development projects to consult with USFWS (or NMFS, when applicable) and State wildlife resource agencies for any project that involves an impoundment of more than 10 acres (4 hectares), diversion, channel deepening, or other water modification regarding the impacts of that action to fish and wildlife and any mitigative measures to reduce adverse impacts. |
| Migratory Bird Treaty Act of 1918, as amended, 16 U.S.C. 703 et seq. | The Migratory Bird Treaty Act of 1918, as amended, prohibits the pursuit, hunt, kill, take, capture, possession, delivery for shipment, shipment, import, export, transport, sale, purchase, barter, or offer for sale, purchase, or barter of any native migratory birds or their eggs, feathers, or nests. The Act is intended to protect birds that have common migration patterns between the United States, Canada, Mexico, Japan, and Russia. The U.S. Fish and Wildlife Service has statutory authority and responsibility for enforcing the Migratory Bird Treaty Act. |
| **Waste Management and Pollution Prevention** | |
| Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq. | The Resource Conservation and Recovery Act (RCRA) requires the EPA to define and identify hazardous waste; establish standards for its transportation, treatment, storage, and disposal; and require permits for persons engaged in hazardous waste activities. Section 3006 (42 U.S.C. 6926) allows States to establish and administer these permit programs with EPA approval. EPA regulations implementing the Act are found in 40 CFR Parts 260 to 299. Regulations imposed on a generator or on a treatment, storage, or disposal facility vary according to the type and quantity of material or waste generated, treated, stored, or disposed of. The method of treatment, storage, and disposal also affects the extent and complexity of the requirements. |
| Pollution Prevention Act of 1990, 42 U.S.C. 13101 et seq. | The Pollution Prevention Act of 1990 establishes a national policy for waste management and pollution control that focuses first on source prevention or reduction and then on environmental issues, safe recycling, treatment, and disposal. |

| Statute/Regulation/Order | Description |
|---|---|
| **Water Resources Protection** | |
| Federal Water Pollution Control Act of 1972 (amended by the Clean Water Act of 1977), 33 U.S.C. 1251 et seq. and the National Pollutant Discharge Elimination System (NPDES), 40 CFR Part 122 | The Federal Water Pollution Control Act (aka Clean Water Act) of 1972, as amended (CWA), was enacted to "restore and maintain the chemical, physical, and biological integrity of the Nation's water." The Act requires all branches of the Federal Government that have jurisdiction over properties or facilities engaged in any activity that might result in a discharge or runoff of pollutants to surface waters to comply with Federal, State, inter-State, and local requirements. Under Section 303(c) of the CWA, states have the primary responsibility for reviewing, establishing, and revising water quality standards, which consist of the designated uses of a waterbody, or waterbody segment, the water quality criteria necessary to protect those designated uses, and an antidegradation policy. As authorized by Section 402 of the CWA, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into U.S. waters. The NPDES program requires all facilities that discharge pollutants from any point source into U.S. waters to obtain an NPDES permit. A facility may also require an NPDES General Permit for Industrial Stormwater due to stormwater runoff from industrial or commercial facilities to U.S. waters. EPA is authorized under the CWA to directly implement the NPDES program; however, EPA has authorized many States to implement all or parts of the national program. The Missouri Department of Natural Resources (MDNR) is the responsible State agency for NPDES permitting. Section 401 of the CWA requires States to certify that the permitted discharge would comply with all limitations necessary to meet established State water quality standards, treatment standards, or schedule of compliance.<br><br>The U.S. Army Corps of Engineers is the lead agency for enforcement of CWA wetland requirements (33 CFR Part 320). Under Section 401 of the CWA, EPA or a delegated State agency has the authority to review and approve, impose a condition, or deny Federal permits or licenses that might result in a discharge to State waters, including wetlands. |
| Coastal Zone Management Act of 1972, as amended, 16 U.S.C. 1451 et seq. | The Coastal Zone Management Act, as amended (CZMA), was enacted by Congress in 1972 to address the increasing pressures of overdevelopment upon the Nation's coastal resources. The National Oceanic and Atmospheric Administration (NOAA) administers the CZMA. The CZMA encourages States to preserve; protect; develop; and, where possible, restore or enhance valuable natural coastal resources, such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. Participation by States is voluntary. To encourage States to participate, the CZMA makes Federal financial assistance available to any coastal State or territory, including those on the Great Lakes, which is willing to develop and implement a comprehensive coastal management program. |
| Wild and Scenic Rivers Act, 16 U.S.C. 1271 et seq. | The Wild and Scenic River Act created the National Wild and Scenic Rivers System, which was established to protect the environmental values of free-flowing streams from degradation by impacting activities, including water resources projects. |

| Statute/Regulation/Order | Description |
|---|---|
| **Transportation** | |
| Federal Aviation Regulations, (FARs). 14 CFR Part 77—Safe, Efficient Use, and Preservation of the Navigable Airspace and 49 CFR Part 291— Cargo Operations in Interstate Air Transportation | These Federal Aviation Administration (FAA) regulations set standards used to determine if any object, including the permanent or temporary construction or alteration of a structure, is an obstruction to air navigation, navigation aids, or navigational facilities and could affect their safe and efficient use. Regulations also apply to cargo operations in interstate air transportation by air carriers. The FAA is part of the U.S Department of Transportation (USDOT). |
| Hazardous Materials Transportation Act of 1975, as amended, 49 U.S.C. 5101 et seq., 49 CFR Part 173, Subpart I—Class 7 (Radioactive) Materials | The Hazardous Materials Transportation Act of 1975, as amended, regulates the transportation of hazardous materials (including radioactive material) in and between States. States may regulate the transport of hazardous materials if consistent with USDOT regulations in 49 CFR Parts 171 through 177. USDOT requirements for shipping and packaging radioactive materials are in 49 CFR Part 173, Subpart I. |
| U.S. Department of Transportation, Federal Aviation Administration Advisory Circular, AC 150/5200-33B | The Federal Aviation Administration (FAA) Advisory Circular, AC 150/5200-33B, "Hazardous wildlife attractants on or near airports," provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public-use airports. It also discusses airport development projects that could affect aircraft movement near hazardous wildlife attractants. |

**Table B–2. Potentially Applicable Missouri State Requirements**

| Statute/Regulation/Order | Citation | Responsible Agency | Description |
|---|---|---|---|
| **Air Quality Protection** | | | |
| Missouri Air Conservation Law | Missouri Revised Statutes, Chapter 643 | MDNR, Air Conservation Commission of the State of Missouri | Describes the prevention, abatement, and control of air pollution |
| **Protected Species** | | | |
| Endangered Species Law | Missouri Revised Statutes, Chapter 252 | Missouri Department of Conservation | Describes the protection of endangered wildlife and lists those species considered to be threatened with extinction. |
| **Waste Management and Pollution Prevention** | | | |
| Missouri Statute on Environmental Control | Missouri Revised Statutes, Chapter 260 | MDNR, Environmental Improvement and Energy Resources Authority | Conserves the air, land, and water resources of the State by requiring the prevention or reduction of the pollution and proper methods of disposal of solid waste or sewage. |

| Statute/Regulation/Order | Citation | Responsible Agency | Description |
|---|---|---|---|
| **Water Resources Protection** | | | |
| Missouri Clean Water Law | Missouri Revised Statutes, Chapter 644 | MDNR, Clean Water Commission | Describes water pollution control programs to conserve the waters of the State and to protect, maintain, and improve the quality thereof for public water supplies. |

**Table B–3. City of Columbia and Boone County, Missouri, Ordinances and Plans**

| Ordinance or Plan | Responsible Agency | Description |
|---|---|---|
| **Land Use Protection** | | |
| Boone County Zoning Regulations | Boone County Resource Management Department | Promotes the health and safety and conserves the values of property throughout Boone County; lessens or avoids undue congestion in the public streets or highways; prevents overcrowding of land; avoids undue concentration of population; facilitates the adequate provision of transportation, water, sewerage, schools, parks, and other public requirements. |
| Code of Ordinances, City of Columbia, Missouri Chapter 6, Buildings and Building Regulations | City of Columbia | Includes ordinances regarding construction of buildings; installation of heating, ventilation, and air conditioning (HVAC) systems; installation of plumbing systems; and installation of electrical wiring. |
| Code of Ordinances, City of Columbia, Missouri Chapter 12A, Article II, Land Disturbance Permit Requirements | City of Columbia | Protects the health, safety, and property of Columbia by regulating the disturbance of land surface areas by preserving trees, preventing erosion on disturbed areas, and controlling stormwater drainage. A land disturbance permit is required for any land disturbance activity, including streets and utility construction on any site that results in a disturbed area of 1 acre (0.4 ha) or more in size. |
| Code of Ordinances, City of Columbia, Missouri Chapter 9, Article II, Fire Code | City of Columbia | Establishes requirements to provide safety and property protection from fires and explosions from building and structures. |
| **Water Resources Protection** | | |
| Boone County Storm Water Ordinance | Boone County Resource Management Department | Establishes stormwater management requirements and controls to protect and safeguard the general health, safety, and welfare of the public residing in watersheds within Boone County. |

| Ordinance or Plan | Responsible Agency | Description |
|---|---|---|
| Boone County Sanitary Sewer Use Regulations | Boone County Regional Sewer District | Protects and promotes the public health and ensures the safe and efficient delivery of wastewater collection and centralized treatment services within the areas of Boone County, Missouri. |
| Code of Ordinances, City of Columbia, Missouri Chapter 27, Article II | City of Columbia | Application process for utility service and billing and fees for utility services. |
| Code of Ordinances, City of Columbia, Missouri Chapter 12A, Article V | City of Columbia | Establishes minimum stormwater management requirements and controls to protect and safeguard the general health, safety, and welfare of the public. Requires a stormwater management plan to be prepared and certified. |

## B.2 Operating Permits and Other Requirements

Table B–4 lists the permits and licenses that NWMI plans to obtain from Federal, State, and local authorities to construct and operate the NWMI facility.

**Table B–4. Permits and Approvals Required for Construction and Operations**

| Agency | Regulatory Authority | Permit or Approval | Summary of Activities | Status |
|---|---|---|---|---|
| NRC | Atomic Energy Act 10 CFR 50.35 and 50.50 | Construction Permit | Construction of the NWMI facility | Preliminary safety analysis report for the construction permit was submitted in 2015 |
| | Atomic Energy Act 10 CFR 50.50 and 50.57 | Operating License | Operation of the NWMI facility | Application under development |
| | Atomic Energy Act 10 CFR Part 30 | By-Product Material License | Possession, use, and transfer of radioactive by-product material | To be addressed in operating license application |
| | Atomic Energy Act 10 CFR Part 70 | Special Nuclear Material License | Receipt, possession, use, and transfer of special nuclear material | To be addressed in operating license application |
| EPA | CWA, 40 CFR Part 112, Subpart D, Appendix F | Spill Prevention, Control and Control Countermeasure (SPCC) Plan for construction and operation | Storage of oil during construction and operation | NWMI plans to submit the SPCC plan 30 days prior to construction |

| Agency | Regulatory Authority | Permit or Approval | Summary of Activities | Status |
|---|---|---|---|---|
| | Resource Conservation and Recovery Act (RCRA), 40 CFR Part 262 | Notification of RCRA Subtitle C activity | Generation of hazardous waste | NWMI plans to submit the notification 60 days prior to construction |
| DOT | Hazardous Material Transportation Act, 49 CFR Part 173, Subpart I | Certificate of Registration | Transportation of radioactive materials | NWMI plans to obtain certificate before transporting radioactive and other hazardous materials. |
| MDNR | Federal CAA; Missouri Revised Statute Chapter 643; Missouri Code of State Regulations, 10 CSR Division 10 | Construction permit; Operating Permit | Construction of an air emission source that is not exempted; Operation of an air emission source | NWMI plans to contact MDNR to determine if permits are required. |
| MDNR | Federal CWA; Missouri Revised Statute Chapters 640 and 644; Missouri Code of State Regulations, 10 CSR Division 20 | Construction Stormwater Permit | Discharge of stormwater runoff from the site during construction | NWMI plans to submit application 30 days prior to starting construction |
| | | Industrial Stormwater Permit | Discharge of stormwater from the site during operations | NWMI plans to submit application 1 year prior to starting operations |
| | | Section 401 Water Quality Certification | Activities, including facility construction or operations, which may cause a discharge into navigable waters | NWMI plans to request a waiver from the State from the Section 401 Water Quality Certification requirement. |
| | Resources Conservation and Recovery Act; Missouri Revised Statute Chapter 260; Missouri Code of State Regulations, 10 CSR Division 25-5.262 | Notification of Regulated Activity | Missouri identification number for generation of hazardous waste | NWMI plans to submit notification 90 days prior to generating hazardous waste |

| Agency | Regulatory Authority | Permit or Approval | Summary of Activities | Status |
|---|---|---|---|---|
| | | Certified Resource Recovery Facility | Reuse, reclamation, or recycling 1,000 kg (2,204 lb) or more of site-generated hazardous waste | NWMI plans to register facility 90 days prior to generating hazardous waste |
| | | Notification to MDNR of Conditional Exemption | Notify MDNR in writing and by certified delivery of the claim of conditional exemption for low-level mixed waste stored and treated in the facility | NWMI plans to submit notification 90 days prior to operations |
| City of Columbia | Clean Water Act; Code of Ordinances, City of Columbia, Missouri, Chapter 27 | Application for utility service | Allows the facility to connect to Columbia Water Treatment Plant | NWMI plans to submit application 30 days prior to construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 6, Article II | Building Permit | Approval of building code and standards, including site plan | NWMI plans to submit application 60 days prior to construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 6, Article III | Electrical Plan Approval | Electrical Code | NWMI plans to submit application 60 days prior to construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 6, Article IV | Plumbing Plan Approval | Plumbing Code | NWMI plans to submit application 60 days prior to construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 6, Article V | HVAC Plan approval | Mechanical Code | NWMI plans to submit application 60 days prior to construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 6 | Certificate of Occupancy | Facilities Meeting Building Code | NWMI plans to submit upon completion of construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 9, Article II | Fire Prevention Plan Approval | Fire Code | NWMI plans to submit application 60 days prior to construction |

| Agency | Regulatory Authority | Permit or Approval | Summary of Activities | Status |
|---|---|---|---|---|
| | Code of Ordinances, City of Columbia, Missouri Chapter 12A, Article II | Land Disturbances Permit | Land disturbance activity, including construction on any site that results in a disturbed area of 1 acre (0.4 ha) or more | NWMI plans to submit application 30 days prior to construction |
| | Code of Ordinances, City of Columbia, Missouri Chapter 12A, Article V | Stormwater Management Plan Approval | Approval required prior to approval for land disturbance permit | NWMI plans to submit information 45 days prior to construction |
| Boone County Resource Management Department | Boone County Storm Water Ordinance | Stormwater Discharge Permit | Stormwater management | NWMI plans to submit application 30 days prior to construction |
| | | Land Disturbance Permit | Activity disturbing 0.4 ha (1 acre) or more of land or disturbing 278.7 $m^3$ (3,000 $ft^2$) in environmentally sensitive areas | NWMI plans to submit application 30 days prior to construction |
| | Boone County Zoning Ordinance | Application for Commercial Building Permit | Construction of a commercial building | NWMI plans to submit application 30 days prior to construction |
| Boone County Regional Sewer District | Boone County Sanitary Sewer Use Regulations | Sanitary Sewer Connection Approval | Building connection to District wastewater treatment works | NWMI plans to submit information 30 days prior to construction |

Source: NWMI 2015

## B.3 References

10 CFR Part 20. *Code of Federal Regulations*, Title 10, *Energy*, Part 20, “Standards for protection against radiation.”

10 CFR Part 30. *Code of Federal Regulations*, Title 10, *Energy*, Part 30, “Rules of general applicability to domestic licensing of byproduct material.”

10 CFR Part 40. *Code of Federal Regulations*, Title 10, *Energy*, Part 40, “Domestic licensing of source material.”

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, “Domestic licensing of production and utilization facilities.”

10 CFR Part 70. *Code of Federal Regulations*, Title 10, *Energy*, Part 70, “Domestic licensing of special nuclear material.”

14 CFR Part 77. *Code of Federal Regulations*, Title 14, *Aeronautics and Space*, Part 77, “Safe, efficient use, and preservation of the navigable airspace.”

29 CFR Part 1910. *Code of Federal Regulations*, Title 29, *Labor*, Part 1910, “Occupational safety and health standards.”

29 CFR Part 1960. *Code of Federal Regulations*, Title 29, *Labor*, Part 1960, “Basic program elements for federal employee occupational safety and health programs and related matters.”

33 CFR Part 320. *Code of Federal Regulations*, Title 33, *Navigation and Navigable Waters*, Part 320, “General regulatory policies.”

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, “Protection of historic properties.”

40 CFR Part 50. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 50, “National primary and secondary ambient air quality standards.”

40 CFR Part 112. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 112, “Oil pollution prevention.”

40 CFR Part 122. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 122, “EPA administered permit programs: The National Pollutant Discharge Elimination System.”

40 CFR Part 260. *Code of Federal Regulations*, Title 40, *Protection of Environment*, Part 260, “Hazardous Waste Management System: General.”

49 CFR Part 107. *Code of Federal Regulations*, Title 49, *Transportation*, Part 107, “Hazardous materials program procedures.”

59 FR 7629. Executive Order No. 12898. “Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.” *Federal Register* 59(32): 7629–7633. February 16, 1994.

60 FR 6381. Executive Order No. 12948. “Amendment to Executive Order No. 12898.” *Federal Register* 60(21):6381. February 1, 1995.

62 FR 19885. Executive Order No. 13045. “Protection of Children from Environmental Health Risks and Safety Risks.” *Federal Register* 62(78):19885–19888. April 21, 1997.

69 FR 52040. U.S. Nuclear Regulatory Commission. “Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions.” *Federal Register* 69(163):52040–52048. August 24, 2004.

Atomic Energy Act of 1954, as amended. 42 U.S.C. §2011 et seq.

Clean Air Act of 1970, as amended. 42 U.S.C. §7401 et seq.

Clean Water Act of 1972, as amended. 33 U.S.C. §1251 et seq.

Coastal Zone Management Act of 1972, as amended. 16 U.S.C. §1451 et seq.

Endangered Species Act of 1973, as amended. 16 U.S.C. §1531 et seq.

Energy Reorganization Act of 1974, as amended. 42 U.S.C. §5801 et seq.

Farmland Protection Policy Act of 1981. 7 U.S.C. §4201 et seq.

Fish and Wildlife Coordination Act of 1934, as amended. 16 U.S.C. §661 et seq.

Hazardous Material Transportation Act of 1975, as amended. 49 U.S.C. §5101 et seq.

Magnuson–Stevens Fishery Conservation and Management Act, as amended. 16 U.S.C. §1801 et seq.

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

National Historic Preservation Act of 1966, as amended. 54 U.S.C. §300101 et seq.

Noise Control Act of 1972, as amended. 42 U.S.C. §4901 et seq.

[NWMI] Northwest Medical Isotopes, LLC. 2015. Preliminary Safety Analysis Report (PSAR), Chapter 19, “Environmental Report.” Corvallis, OR: NWMI. January 2015. ADAMS Nos. ML15210A123, ML15210A128, ML15210A129, and ML15210A131.

Occupational Safety and Health Act of 1970, as amended. 29 U.S.C. §651 et seq.

Pollution Prevention Act of 1990. 42 U.S.C. §13101 et seq.

Resource Conservation and Recovery Act of 1976, as amended. 42 U.S.C. §6901 et seq.

Wild and Scenic Rivers Act, as amended. 16 U.S.C. §1271 et seq.

# APPENDIX C
# CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

# C. CHRONOLOGY OF ENVIRONMENTAL REVIEW CORRESPONDENCE

This appendix contains a chronological listing of correspondence between the U.S. Nuclear Regulatory Commission (NRC) and external parties as part of its environmental review for the Northwest Medical Isotopes, LLC (NWMI), medical radioisotope production facility (NWMI facility).

Documents listed in Table C–1 below are available electronically on the NRC's website at: http://www.nrc.gov/reading-rm.html. From this website, the public can gain access to the NRC's Agencywide Documents Access and Management System (ADAMS), which provides text and image files of the agency's public documents. The table below includes the ADAMS accession number for each document. If you need assistance in accessing or searching in ADAMS, contact the Public Document Room Staff at 1-800-397-4209. Some of the ADAMS accession numbers below lead to a folder containing several documents. Some of the documents within these folders contain proprietary information and are not publicly available. Documents marked with an asterisk are not publicly available at the request of the sender.

## C.1 Environmental Review Correspondence

Table C–1 lists the environmental review correspondence in date order, beginning with the request by NWMI to construct the NWMI facility.

**Table C–1. Environmental Review Correspondence**

| Date | Correspondence Description | ADAMS No. |
|---|---|---|
| January 23, 2015 | NRC Letter to NWMI, Status of the Acceptance Review of Part One of the Application for Construction Permit (TAC No. MF2288). | ML14349A501 |
| February 5, 2015 | NWMI Construction Permit Application, Part 1 | ML15086A261 |
| April 30, 2015 | NRC *Federal Register* Notice (FRN) of Receipt of Part 1 of the NWMI Construction Permit Application | ML15070A329 |
| June 8, 2015 | NRC FRN of Acceptance for Docketing Part 1 of the NWMI Construction Permit Application | ML15125A082 |
| July 20, 2015 | Construction Permit Application, Part 2 | ML15210A182 |
| August 5, 2015 | NRC Letter to NWMI, Environmental Site Audit Regarding the Northwest Medical Isotopes, LLC Radioisotope Production Facility | ML15202A643 |
| October 13, 2015 | Summary of the Environmental Site Audit Related to the Review of the Construction Permit Application for Northwest Medical Isotopes, LLC | ML15266A139 |
| November 2, 2015 | Request for Additional Information for the Environmental Review of the Northwest Medical Isotopes, LLC Construction Permit Application | ML15288A102 |
| November 6, 2015 | NRC *Federal Register* Notice (FRN) of Receipt of Part 2 of the NWMI Construction Permit Application | ML15348A021 |
| November 18, 2015 | NRC FRN of Intent to Conduct Scoping Process and Prepare an Environmental Impact Statement | ML15300A468 |

| Date | Correspondence Description | ADAMS No. |
|---|---|---|
| November 12, 2015 | NRC Letter to NWMI, Notice of Intent to Prepare an Environmental Impact Statement and Conduct Scoping | ML15300A456 |
| November 17, 2015 | NRC Letter to Missouri Department of Natural Resources, Division of Environmental Quality, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to U.S. Environmental Protection Agency – Region 7, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Missouri Department of Natural Resources, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to U.S. Department of Energy, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Missouri Department of Transportation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Missouri Department of Health and Senior Services, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Missouri Department of Health and Senior Services, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Missouri Department of Public Safety, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Missouri Department of Conservation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to Boone County Government Center, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 17, 2015 | NRC Letter to City of Columbia, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |

| Date | Correspondence Description | ADAMS No. |
|---|---|---|
| November 17, 2015 | NRC Letter to Mid-Missouri Regional Planning Commission, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15308A362 |
| November 19, 2015 | NRC Letter to Daniel Boone Regional Library, Maintenance of Reference Materials at the Daniel Boone Regional Library for the Environmental Review of Northwest Medical Isotopes, LLC Construction Permit Application | ML15321A069 |
| November 19, 2015 | NRC Letter to State Historic Preservation Office, Missouri Department of Natural Resources, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15314A686 |
| November 19, 2015 | NRC Letter to Advisory Council on Historic Preservation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15314A363 |
| November 20, 2015 | NRC Letter to Absentee-Shawnee Tribe of Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Caddo Nation of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Cherokee Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Cheyenne and Arapaho Tribes, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Chickasaw Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Choctaw Nation of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Citizen Potawatomi Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Delaware Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |

| Date | Correspondence Description | ADAMS No. |
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| November 20, 2015 | NRC Letter to Eastern Shawnee Tribe of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Iowa Tribe of Kansas and Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Iowa Tribe of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Miami Tribe of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Muscogee (Creek) Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Omaha Tribe of Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Osage Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Otoe-Missouria Tribe of Indians, Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Pawnee Nation of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Peoria Tribe of Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Ponca Tribe of Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Ponca Tribe of Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |

| Date | Correspondence Description | ADAMS No. |
|---|---|---|
| November 20, 2015 | NRC Letter to Prairie Band Potawatomi Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Quapaw Tribe of Indians, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Sac and Fox Nation of Missouri in Kansas and Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Sac and Fox Nation, Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Sac and Fox Tribe of the Mississippi in Iowa, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Shawnee Tribe, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to United Keetoowah Band of Cherokee Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Winnebago Tribe of Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Wyandotte Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Kaw Nation, Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Yankton Sioux Tribe of South Dakota, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NWMI Letter to NRC, Response to Environmental Request for Additional Information | ML15328A070 |
| November 29, 2015 | List of ESA-protected species that may occur within the proposed Discovery Ridge site | ML15335A002 |

| Date | Correspondence Description | ADAMS No. |
|---|---|---|
| December 1, 2015 | Pawnee Nation of Oklahoma, Request for Section 106 Consultation and Review for Proposed Construction located Discovery Ridge Park, Columbia, Boone County, MO | ML16020A338 |
| December 3, 2015 | Conference call with NRC and FWS to confirm list of ESA-protected species that may occur within the proposed Discovery Ridge site | ML15362A225 |
| December 7, 2015 | Quapaw Tribe of Oklahoma Letter to NRC, Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Review | ML16020A339 |
| December 9, 2015 | State Historic Preservation Office, Missouri Department of Natural Resources Letter to NRC | ML16020A340 |
| December 9, 2015 | United Keetoowah Band of Cherokee Indians in Oklahoma email to NRC | ML16049A297 |
| December 10, 2015 | Miami Tribe of Oklahoma email to NRC | ML16056A421 |
| December 24, 2015 | NRC Letter to Northwest Medical Isotopes, LCC, Acceptance for Docketing of Part Two of the Application for A Production Facility Construction Permit | ML15341A112 |
| December 28, 2015 | Tribal correspondence to NRC* | ML16210A477 |
| December 29, 2016 | Tribal correspondence to NRC* | ML16077A324 |
| January 4, 2016 | NRC FRN of Acceptance for Docketing Part 2 of the NWMI Construction Permit Application | ML15348A021 |
| January 4, 2016 | U.S. Environmental Protection Agency Letter to NRC, Scoping Comments | ML16007A004 |
| January 19, 2016 | NRC Letter to NWMI, Request for Additional Information for the Environmental Review of the Northwest Medical Isotopes, LCC, Construction Permit Application | ML15364A376 |
| February 12, 2016 | NWMI Letter to NRC, Responses to the U.S. Nuclear Regulatory Commission Request for Additional Information, Letter dated January 19, 2016 | ML16053A221 |
| March 28, 2016 | NRC Letter to NWMI, Request for Additional Information Regarding Application for Construction Permit and NRC Staff Review Schedule | ML16056A122 |
| April 6, 2016 | NRC Letter to NWMI, Issuance of Environmental Scoping Summary Report Associated with the Staff's Review of the Application by Northwest Medical Isotopes, LLC, for a Construction Permit for a Radioisotope Production Facility | ML16056A628 |
| April 15, 2016 | List of ESA-protected species that may occur within the University of Missouri Research Reactor alternative site | ML16117A529 |
| April 25, 2016 | NWMI Letter to NRC, Responses to the NRC Environmental Request for Additional Information – Letter dated March 28, 2016 | ML16123A119 |
| June 16, 2016 | NRC Letter to NWMI, Request for Additional Information for the Environmental Review of the Application for Construction Permit (TAC Nos. MF6134 AND MF6135) | ML16152A019 |

| Date | Correspondence Description | ADAMS No. |
|---|---|---|
| July 18, 2016 | NWMI Letter to NRC, Responses to the NRC Environmental Request for Additional Information – Letter dated June 16, 2016 | ML16210A305 |
| September 1, 2016 | NWMI Letter to NRC, Additional Clarification on RAIs POSA3-1A, POSA3-1B, POSA3-2A, POSA3-3A, NOI3-1B, and PA3-1 | ML16270A377 |

# APPENDIX D
# CONSULTATION CORRESPONDENCE

# D. CONSULTATION CORRESPONDENCE

## D.1 Section 7 Consultation

### D.1.1 Federal Agency Obligations Under ESA Section 7

As a Federal agency, the U.S. Nuclear Regulatory Commission (NRC) must comply with the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.), as part of any action authorized, funded, or carried out by the agency, such as the proposed agency action that this environmental impact statement (EIS) evaluates: whether to issue a construction permit under 10 CFR Part 50 that would allow construction of a medical radioisotope production facility. Under section 7 of the ESA, the NRC must consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) (referred to jointly as "the Services" and individually as "Service"), as appropriate, to ensure that the proposed agency action is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat.

The ESA and the regulations that implement ESA section 7, 50 CFR Part 402, "Interagency cooperation—Endangered Species Act of 1973, as amended," describe the consultation process that Federal agencies must follow in support of agency actions. As part of this process, the Federal agency shall either request that the Services provide a list of any listed or proposed species or designated or proposed critical habitats that may be present in the action area or request that the Services concur with a list of species and critical habitats that the Federal agency has created (50 CFR 402.12(c)). If it is determined that any such species or critical habitats may be present, the Federal agency is to prepare a biological assessment to evaluate the potential effects of the action and determine whether the species or critical habitat are likely to be adversely affected by the action (50 CFR 402.12(a); 16 U.S.C. 1536(c)). Furthermore, biological assessments are required for any agency action that is a "major construction activity" (50 CFR 402.12(b)), which the ESA regulations define to include major Federal actions significantly affecting the quality of the human environment under the National Environmental Policy Act of 1969, as amended (42 U.S.C. 4321 et seq.; herein referred to as NEPA) (50 CFR 402.02).

Federal agencies may fulfill their obligations to consult with the Services under ESA section 7 and to prepare a biological assessment in conjunction with the interagency cooperation procedures required by other statutes, including NEPA (50 CFR 402.06(a)). In such cases, the Federal agency should include the results of the ESA section 7 consultation in the NEPA document (50 CFR 402.06(b)). Accordingly, Section D.1.2 describes the biological assessment prepared for the proposed agency action evaluated in this EIS, and Section D.1.3 describes the chronology and results of the ESA section 7 consultation.

### D.1.2 Biological Assessment

The NRC considers this EIS to fulfill its obligation to prepare a biological assessment under ESA section 7. Accordingly, the NRC did not prepare a separate biological assessment for the proposed NWMI facility construction permit.

Although the contents of a biological assessment are at the discretion of the Federal agency (50 CFR 402.12(f)), the ESA regulations suggest information that agencies may consider for inclusion. The NRC has considered this information in the following EIS sections.

Section 3.5 describes the action area and the Federally listed and proposed species and designated and proposed critical habitat that have the potential to be present in the action area. This section includes information pursuant to 50 CFR 402.12(f)(1), (2), and (3).

Section 4.5 provides an assessment of the potential effects of the proposed construction, operations, and decommissioning of the NWMI facility on the species and critical habitat present and the NRC's effect determinations, which are consistent with those identified in Section 3.5 of the *Endangered Species Consultation Handbook* (FWS and NMFS 1998). The NRC also addresses cumulative effects and alternatives to the proposed action. This section includes information under 50 CFR 402.12(f)(4) and (5).

### D.1.3 Chronology of ESA Section 7 Consultation

Upon receipt of NWMI's construction permit application, the NRC staff considered whether any Federally listed, proposed, or candidate species or designated or proposed critical habitats may be present in the action area (as defined at 50 CFR 402.02) for the proposed construction, operations, and decommissioning of the NWMI facility. No species under the NMFS's jurisdiction occur within the action area. Therefore, the NRC staff did not consult with the NMFS. With respect to species under the FWS's jurisdiction, the NRC staff requested information from FWS on Federally listed, proposed, and candidate species and critical habitat that may be in the vicinity of the NWMI site and the one alternative site, in accordance with the ESA section 7 regulations at 50 CFR 402.12(c). The NRC staff requested this information through the FWS's Information for Planning and Conservation (IPaC) database system (FWS 2015a, 2016). Based on this inquiry, the FWS provided a letter dated November 20, 2015, which identified threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the proposed Discovery Ridge site and/or may be affected by the proposed NWMI facility. In addition, the NRC staff called FWS to confirm the accuracy of the species list, as suggested in the November 20, 2015, letter (NRC 2015e). During that call, FWS stated that it did not have any additional comments regarding the project other than those stated in its November 20, 2015 letter (NRC 2015e). In Section 3.5, the NRC staff concludes that no ESA-protected, proposed, or candidate species or designated or proposed critical habitats are likely to occur in the action area; and Section 4.5 concludes that the proposed action would have no effect on any ESA-protected, proposed, or candidate species or designated or proposed critical habitats. The FWS (2013) does not typically provide its concurrence with "no effect" determinations by Federal agencies. Thus, the ESA does not require further informal consultation or the initiation of formal consultation with the FWS for the proposed NWMI construction permit. Nonetheless, because this EIS constitutes the NRC's biological assessment, the NRC staff will submit a copy of this EIS, upon its issuance, to the FWS for review in accordance with 50 CFR 402.12(j).

Table D–1 lists the letters, e-mails, and other correspondence related to the NRC's ESA obligations with respect to its review of the NWMI construction permit application.

**Table D–1. Section 7 Consultation Correspondence**

| Date | Description | ADAMS No.[a] |
|---|---|---|
| November 20, 2015 | List of ESA-protected species that may occur within the proposed Discovery Ridge site | ML15335A002 |
| December 3, 2015 | Conference call with NRC and FWS to confirm list of ESA-protected species that may occur within the proposed Discovery Ridge site | ML15362A225 |

| Date | Description | ADAMS No.[(a)] |
|---|---|---|
| April 15, 2016 | List of ESA-protected species that may occur within the University of Missouri Research Reactor alternative site | ML16117A529 |

[(a)] These documents can be accessed through the NRC's Agencywide Documents Access and Management System (ADAMS) at the following URL: http://adams.nrc.gov/wba/.

## D.2 Essential Fish Habitat Consultation

The NRC must comply with the Magnuson–Stevens Fishery Conservation and Management Act, as amended (MSA) (16 U.S.C. 1801 et seq.), for any actions authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken that may adversely affect any essential fish habitat identified under the MSA.

In Section 3.5 of this EIS, the NRC staff concludes that NMFS has not designated essential fish habitat under the MSA within the vicinity of the proposed Discovery Ridge site and that the proposed NWMI construction permit would have no effect on essential fish habitat. Thus, the MSA does not require the NRC to consult with NMFS for the NWMI construction permit.

## D.3 Section 106 Consultation

### National Historic Preservation Act of 1966 Consultation

The National Historic Preservation Act of 1966, as amended (NHPA) (54 U.S.C. 300101 et seq.), requires Federal agencies to consider the effects of their undertakings on historic properties and consult with applicable State and Federal agencies, Tribal groups, and individuals and organizations with a demonstrated interest in the undertaking before taking action. Historic properties are defined as resources eligible for listing on the National Register of Historic Places. The historic preservation review process (Section 106 of the NHPA) is outlined in regulations issued by the Advisory Council on Historic Preservation (ACHP) in 36 CFR Part 800. In accordance with 36 CFR 800.8(c), the NRC has indicated its intent to comply with Section 106 through the NEPA process.

Table D–2 lists the chronology of consultations and consultation documents related to the NRC Section 106 review.

**Table D–2. NHPA Correspondence**

| Date | Description | ADAMS No.[(a)] |
|---|---|---|
| November 19, 2015 | NRC Letter to State Historic Preservation Office, Missouri Department of Natural Resources, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Environmental Review | ML15314A686 |
| November 19, 2015 | NRC Letter to Advisory Council on Historic Preservation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15314A363 |

| Date | Description | ADAMS No.[(a)] |
| --- | --- | --- |
| November 20, 2015 | NRC Letter to Absentee-Shawnee Tribe of Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Caddo Nation of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Cherokee Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Cheyenne and Arapaho Tribes, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Chickasaw Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Choctaw Nation of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Citizen Potawatomi Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Delaware Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Eastern Shawnee Tribe of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
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| November 20, 2015 | NRC Letter to Iowa Tribe of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Miami Tribe of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |

| Date | Description | ADAMS No.[a] |
|---|---|---|
| November 20, 2015 | NRC Letter to The Muscogee (Creek) Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Omaha Tribe of Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Osage Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Otoe-Missouria Tribe of Indians, Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Pawnee Nation of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Peoria Tribe of Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Ponca Tribe of Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Ponca Tribe of Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Prairie Band Potawatomi Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to The Quapaw Tribe of Indians, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Sac and Fox Nation of Missouri in Kansas and Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Sac and Fox Nation, Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |

| Date | Description | ADAMS No.[a] |
|---|---|---|
| November 20, 2015 | NRC Letter to Sac and Fox Tribe of the Mississippi in Iowa, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Shawnee Tribe, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to United Keetoowah Band of Cherokee Indians of Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Winnebago Tribe of Nebraska, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Wyandotte Nation, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Kaw Nation, Oklahoma, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| November 20, 2015 | NRC Letter to Yankton Sioux Tribe of South Dakota, Request for Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Application Review | ML15316A036 |
| December 1, 2015 | Pawnee Nation of Oklahoma, Request for Section 106 Consultation and Review for Proposed Construction located Discovery Ridge Park, Columbia, Boone County, MO | ML16020A338 |
| December 7, 2015 | Quapaw Tribe of Oklahoma Letter to NRC, Scoping Comments Concerning the Northwest Medical Isotopes, LLC Radioisotope Production Facility Review | ML16020A339 |
| December 9, 2015 | State Historic Preservation Office, Missouri Department of Natural Resources Letter to NRC | ML16020A340 |
| December 9, 2015 | United Keetoowah Band of Cherokee Indians in Oklahoma email to NRC | ML16049A297 |
| December 10, 2015 | Miami Tribe of Oklahoma email to NRC | ML16056A421 |
| December 28, 2015 | Tribal correspondence to NRC* | ML16210A477 |
| December 29, 2015 | Tribal correspondence to NRC* | ML16077A324 |

[a] These documents, with the exception of those marked with an asterisk, are publicly available and can be accessed through the NRC's Agencywide Documents Access and Management System (ADAMS) at the following URL: http://adams.nrc.gov/wba/. Documents marked with an asterisk are not publicly available at the request of the sender.

## D.4 References

10 CFR Part 50. *Code of Federal Regulations*, Title 10, *Energy*, Part 50, "Domestic licensing of production and utilization facilities."

36 CFR Part 800. *Code of Federal Regulations*, Title 36, *Parks, Forests, and Public Property*, Part 800, "Protection of historic properties."

50 CFR Part 402. *Code of Federal Regulations*, Title 50, *Wildlife and Fisheries*, Part 402, "Interagency cooperation—Endangered Species Act of 1973, as amended."

[ESA] Endangered Species Act of 1973, as amended. 16 U.S.C. §1531 et seq.

[FWS] U.S. Fish and Wildlife Service. 2013. "Endangered Species Program: What We Do: Consultations: Frequently Asked Questions." July 15, 2013. Available at <http://www.fws.gov/endangered/what-we-do/faq.html#8> (accessed 24 April 2016).

[FWS] Fish and Wildlife Service. 2015. Letter from A. Salveter, FWS, to NRC, Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project. Consultation Code: 03E14000-2016-SLI-0314. November 20, 2015. ADAMS No. ML15335A002.

[FWS] Fish and Wildlife Service. 2016. Information for Planning and Conservation (IPaC) Report for Boone County, Missouri Project. ADAMS No. ML16117A529.

[FWS and NMFS] U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. *Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Ac*. March 1998. 315 p. Available at <http://www.fws.gov/endangered/esa-library/pdf/esa_section7_handbook.pdf> (accessed 24 April 2016).

[MSA] Magnuson–Stevens Fishery Conservation and Management Act, as amended. 16 U.S.C. §1801 et seq.

[NEPA] National Environmental Policy Act of 1969, as amended. 42 U.S.C. §4321 et seq.

[NRC] U.S. Nuclear Regulatory Commission. 2015. Teleconference Summary with M. Moser, NRC, and A. Salveter, FWS. Subject: Scoping Comments Regarding the Environmental Review for the Northwest Medical Isotopes, LLC (NWMI) Construction Permit Application. December 3, 2015. ADAMS No. ML15362A225.

[NHPA] National Historic Preservation Act of 1966, as amended. 54 U.S.C. §300101 et seq.

| NRC FORM 335 (12-2010) NRCMD 3.7 U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET** *(See instructions on the reverse)* | 1. REPORT NUMBER (Assigned by NRC, Add Vol., Supp., Rev., and Addendum Numbers, if any.) NUREG-2209 |
| --- | --- |
| 2. TITLE AND SUBTITLE<br>Environmental Impact Statement for the Construction Permit for the Northwest Medical Isotopes, LLC (NWMI) Medical Radioisotope Production Facility, Draft Report for Comment | 3. DATE REPORT PUBLISHED<br>MONTH: October YEAR: 2016 |
| | 4. FIN OR GRANT NUMBER |
| 5. AUTHOR(S)<br>See Chapter 7 | 6. TYPE OF REPORT<br>Technical |
| | 7. PERIOD COVERED (Inclusive Dates) |

8. PERFORMING ORGANIZATION - NAME AND ADDRESS (If NRC, provide Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address; if contractor, provide name and mailing address.)

Division of License Renewal
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001

9. SPONSORING ORGANIZATION - NAME AND ADDRESS (If NRC, type "Same as above", if contractor, provide NRC Division, Office or Region, U. S. Nuclear Regulatory Commission, and mailing address.)

Same as above

10. SUPPLEMENTARY NOTES

Docket No. 50-609

11. ABSTRACT (200 words or less)

The U.S. Nuclear Regulatory Commission (NRC) has prepared this environmental impact statement (EIS) in response to an application submitted by Northwest Medical Isotopes, LLC (NWMI), for a construction permit of a medical radioisotope production facility. The EIS includes the analysis that evaluates the environmental impacts of the proposed action and considers the following three alternatives to the proposed action: (1) the no action alternative (i.e., the construction permit is denied), (2) one alternative site, and (3) two alternative technologies.

After weighing the environmental, economic, technical, and other benefits against environmental and other costs, and considering reasonable alternatives, the NRC staff recommends, unless safety issues mandate otherwise, the issuance of the proposed construction permit to NWMI. The NRC staff based its recommendation on the following factors:

- NWMI's Environmental Report;
- the NRC staff's consultation with Federal, State, and local agencies and Tribal representatives;
- the NRC staff's independent environmental review; and
- the NRC staff's consideration of public comments.

| 12. KEY WORDS/DESCRIPTORS (List words or phrases that will assist researchers in locating the report.) | 13. AVAILABILITY STATEMENT |
| --- | --- |
| Northwest Medical Isotopes, LLC (NWMI)<br>NWMI Medical Radioisotope Production Facility (NWMI facility)<br>NWMI<br>Environmental Impact Statement (EIS)<br>National Environmental Policy Act (NEPA) | unlimited |
| | 14. SECURITY CLASSIFICATION<br>*(This Page)* unclassified<br>*(This Report)* unclassified |
| | 15. NUMBER OF PAGES |
| | 16. PRICE |

Printed
on recycled
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Federal Recycling Program

**UNITED STATES**
**NUCLEAR REGULATORY COMMISSION**
WASHINGTON, DC 20555-0001

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**NUREG-2209**
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**Environmental Impact Statement for the Construction Permit for the Northwest Medical Isotopes Radioisotope Production Facility**

**October 2016**