19.5 ALTERNATIVES

NWMI proposed to establish, as soon as practicable, a domestic capability to produce a continuous supply of ^{99}Mo for the U.S. medical community. The purpose of the proposed action is to ensure a reliable domestic supply of ^{99}Mo, the most widely used medical isotope worldwide. This section describes the alternatives considered for the production of ^{99}Mo. To determine the reasonable alternatives, NWMI identified specific criteria (e.g., facility, location, regulatory) necessary to satisfy the purpose of, and need for, the proposed action.

19.5.1 The No-Action Alternative

The current demand for ^{99m}Tc in the U.S. requires a weekly supply of approximately 6,000 six-day Ci of ^{99}Mo, approximately 50 percent of the annual U.S. demand. The U.S. supply of ^{99}Mo is currently imported. Under the No-Action Alternative, the U.S. medical community would continue to rely on this source of supply and a domestic supply of ^{99}Mo would not be established. The U.S. Government has established a policy to encourage the domestic production of medical isotopes (Senate Bill-99). The RPF would provide a significant contribution toward advancing this policy. Under the No-Action Alternative, this benefit would not be realized.

Accordingly, the Discovery Ridge property, the site of the proposed RPF, would not be constructed or operated. The environmental consequences of the No-Action Alternative are assumed to be the status quo, and the consequences discussed in Section 19.4 would be circumvented. In the absence of NRC approval of the RPF license, ^{99}Mo customers would be required to meet their isotope needs through the existing supply chain that does not include any U.S. producers.

19.5.2 Reasonable Alternatives

19.5.2.1 Site Alternatives

NWMI identified three alternatives for siting the RPF in addition to Discovery Ridge. Each of these three sites is located next to an existing university nuclear research reactor. The siting study of proposed site locations next to university reactors included the following (NWMI-2013-002, *Site Selection: Radioisotope Production Facility*):

- University of Missouri Research Reactor (MURR) – Columbia, Missouri
- Oregon State University TRIGA Reactor (OSTR) – Corvallis, Oregon
- McClellan Business Park (McClellan) – Davis, California

These proposed sites are described in the following subsections.

19.5.2.1.1 University of Missouri, Adjacent to the University of Missouri Research Reactor

This site is adjacent to MURR on the MU campus, near existing buildings on a partially paved parking lot. MURR is located near Highway 70, just off the MU main campus. No current roadway weight and height restrictions exist, and the roadways are sufficient for transport of radioactive materials and waste. MU added the stipulation that university personnel operate and staff the RPF at this location.

19.5.2.1.2 Oregon State University, Adjacent to the University Oregon State TRIGA Reactor

This site is next to OSU Radiation Center where the OSTR is located, approximately 129 km (80 mi) south of Portland, Oregon, in an area that includes a partially paved parking lot and a small number of existing laboratory buildings. The site is immediately east of the university reactor on an area covering approximately 1.21 ha (3 acres). Relocation of several buildings and rerouting of transportation routes would be required.

19.5.2.1.3 McClellan Business Park

This site is near the UC Davis McClellan Nuclear Research Center (MNRC), located off the UC Davis campus at McClellan Business Park, 16 m (10 mi) northeast of Sacramento, California, and near the U.S. Interstate 5 corridor. McClellan Air Force Base was closed in 1995 and privatized, creating the McClellan Business Park. The site includes a 4,181 m^2 (45,000 ft^2) clear span and high-bay building approximately 61 m (200 ft) from MNRC.

19.5.2.2 Screening

To determine the preferred site, a Simple Multi-Attribute Rating Technique (SMART) decision analysis methodology was used. The methodology is based on DOE *Guidebook to Decision-Making Methods* (DOE, 2001). NWMI developed the site-specific scoring criteria used in this evaluation. Site selection criteria were developed through discussions between NWMI and its subcontractors. A summary of the siting criteria, description, and ranking is provided in Table 19-87. The criteria were weighted from 1 to 10 based on importance to NWMI.

Table 19-87. Summary of Site-Specific Scoring Criteria (2 pages)

Siting criteria	Description	Weight
Political and local logistics support	Ability of NWMI to leverage connections for local logistical support, based on regional politics and importance of project to economic development	10
Facility operations	Management and operation of RPF, including staff (i.e., balance of NWMI personnel vs. University faculty staff)	10
Production logistics	Number of 6-day Ci processed and delivered to distributor	10
Transportation	Anticipated transportation costs and inclement weather interference with the process of transporting irradiated targets and ^{99}Mo product to distributors	8
Radioactive, hazardous, and mixed secondary waste generation (i.e., air, liquids, solids)	Site ability to meet Federal, State, and local requirements and availability of waste disposition pathway	8
Federal, State, local, and county requirements to construct and operate facility	Challenges presented by required NRC licensing ([a]NUREG-1537) and State, county, and local environmental permitting (e.g., air, water)	5
Federal and State taxes and incentives	Includes costs associated with sales tax, property tax, corporate income tax, hiring credits, etc. Criteria does not include RPF ownership and lease terms; these would be dealt with by NWMI separately	3
Available space	Obtaining required space for RPF (without increasing complexity of RPF design and construction costs) and space for future expansion (i.e., boutique isotopes, education, research and development)	3
Construction costs	Site-specific cost estimates; variations in labor rates and materials; and construction indices	2

Table 19-87. Summary of Site-Specific Scoring Criteria (2 pages)

Siting criteria	Description	Weight
Natural or human-made disaster potential	Based on FEMA, local seismic activity, etc.	1
Total Weight		60

[a] NUREG-1537, *Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors – Format and Content*, Part 1, U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C., February 1996.

FEMA = Federal Emergency Management Agency. NWMI = Northwest Medical Isotopes, LLC.
NRC = U.S. Nuclear Regulatory Commission. RPF = radioisotope production facility.

The following describe the priority and weighting criteria:

Political and local logistics support (Weight 10) – NWMI's ability to leverage connections for local support is dependent on regional politics and the importance of the project to local economic development efforts. This support will play a large role in the financial success of the company. For this reason, political and local logistics support was given the highest weight.

Facility operations (Weight 10) – This criterion consists of management and operation of the facility, including staff (i.e., would NWMI have sole responsibility for operations, or would the university be involved?). NWMI prefers to directly staff and operate the production facility, rather than have the facility operated by the university, but some limited involvement by the university reactor faculty could be beneficial.

Production logistics (Weight 10) – This criterion consists of the number of 6-day Ci processed and delivered to the distributor, based on time to transport between reactors and processing facility. Due to the short half-lives of ^{99}Mo (66 hr) and ^{99m}Tc (6 hr), the transport time plays a critical role in the amount of product delivered to the end client. Product is shipped between all three facilities regardless of the selected production location, but total transit time for irradiated targets returning to the production facility affects the final product significantly.

Transportation (Weight 8) – The costs of transporting nuclear material and potential inclement weather impact timely transport of both irradiated targets from university research reactors and delivery of the ^{99}Mo to the distributor.

Radioactive, hazardous, and mixed secondary waste generation (Weight 8) – The selected RPF site must comply with Federal, State, and local radioactive and hazardous waste requirements for waste generation and have a suitable waste disposition pathway.

Federal, State, county, and local requirements to construct and operate facility (Weight 5) – This criterion considers the required NRC licensing (NUREG-1537) and State, county, and local environmental permitting (e.g., air, water). Because of the proximity to existing reactors, no site is expected to face insurmountable permitting or licensing challenges, but differences between sites could lead to delays in beginning operations.

Federal and State taxes and incentives (Weight 3) – Taxes (including sales tax on equipment and construction materials, property tax, and corporate income tax), employment hiring credits, and incentives are not expected to be strong differentiators between locations, but differences could affect the cost of construction, equipment, and operations. Taxes and incentives were given a low weight.

Available space (Weight 3) – This criterion considers the available space for the production facility (without increasing the complexity of the facility design and construction costs) and suitability for future expansion (e.g., boutique isotopes, education, research, and development). All sites have the minimum amount of space required for the production facility, but differences in available space could impact the complexity of facility design (leading to operational complexities), differences in cost of construction, and ability to expand the production facility in the future.

Construction costs (Weight 2) – This criterion considers site-specific cost variations and construction cost indices for each location (using RSMeans[4]). Local labor rates, materials costs, and current site condition could affect the cost of construction at each site.

Natural or human-made disaster potential (Weight 1) – This criterion is based on Federal Emergency Management Agency (FEMA) disaster declarations and USGS seismic activity predictions. Because each site is adjacent to an existing reactor, the disaster potential was considered a less significant differentiator and given the lowest weight.

Based on the siting criteria established and using readily available public information and observations from site visits, the sites were scored using a scale of 1 to 5 (5 being most favorable, 1 being least). The NWMI team determined that all four of the sites are viable and acceptable, with Discovery Ridge selected as the preferred site of the proposed RPF (see Table 19-88).

Table 19-88. Evaluation of Alternative Sites

Siting criteria	DR		MURR		OSTR		MNRC	
	Score	Wt. score	Score	Wt. Score	Score	Wt. score	Score	Wt. score
Political and local logistics support	4	40	4	40	4	40	1	10
Facility operations	4	40	4	40	3	30	3	30
Production logistics	4	40	2	20	3	30	3	30
Transportation	4	32	4	32	2	16	3	24
Radioactive, hazardous, and mixed secondary waste generation (i.e., air, liquids, solids)	4	32	4	32	4	32	3	24
Federal, State, county, and local requirements to construct and operate facility	4	20	4	20	4	20	2	10
Federal and State taxes and incentives	5	15	5	15	3	9	1	3
Available space	5	15	3	9	1	3	2	6
Construction costs	4	8	4	8	3	6	3	6
Natural or human-made disaster potential	3	3	3	3	4	4	2	2
Total		**245**		**219**		**190**		**145**
Weighted Percentage		82%		73%		63%		48%

DR = Discovery Ridge. MURR = University of Missouri Research Reactor.
MNRC = McClellan Nuclear Research Center. OSTR = Oregon State University TRIGA Reactor.

The Discovery Ridge site total weighted score of 82 percent was followed by the MURR location. Given the high weighting of certain criteria (i.e., political and local logistical support, facility operations, and production logistics) and high scores for these criteria, the MURR and Discovery Ridge sites have an advantage over both the proposed McClellan Business Park and OSTR sites.

[4] RSMeans is a trademark R.S. Means Company, LLC, Kingston, Massachusetts.

The proposed site at the McClellan Business Park ranks fourth for the RPF location. The McClellan Business Park score was 34 percentage points lower than the Discovery Ridge site, primarily due to a lack of political and local support, Federal and state taxes and incentives, limited available greenfield space, and weaker ties to the UC Davis reactor team. However, the site's strengths include an existing building and abundant available space. The OSTR site, which ranked third, had limited available space, transportation routes and State and local financial incentives.

In consideration of these factors, the Discovery Ridge site was selected as the proposed site for the RPF. The siting alternatives of the MNRC Business Park and OSTR locations were not further evaluated. The MURR site was considered to be viable and was identified as a reasonable alternative; its evaluation is provided in the following subsections.

19.5.2.3 University of Missouri Research Reactor Site Evaluation

19.5.2.3.1 Site Description

The MURR site is located in Columbia, Missouri, approximately 201 km (125 mi) east of Kansas City and 201 km (125 mi) west of St Louis. The site is 2.4 km (1.5 mi) south of U.S. Interstate 70, just west of Research Park Drive. The Missouri River lies 13.6 km (8.5 mi) west of the site. The site is located 6.4 km (4 mi) northwest of the Discovery Ridge site.

The site is located directly to the south of the existing reactor building on a partially paved parking lot. Access to the site is provided from Research Park Drive and South Providence Road. The site is 1.6 km (1 mi) southwest of the main MU campus. The site's latitude and longitude is 38° 55' 53" north and 92° 20' 31" west.

The MURR site is situated on a 3.0 ha (7.4-acre) lot in the central portion of the University Research Park, a 34.0 ha (84-acre) tract of land approximately 1.6 km (1 mi) southwest of the MU main campus. The campus is situated in the southern portion of Columbia. The University Research Park consists of low-occupancy research buildings. Personnel are currently working in facilities located within 457.2 m (1,500 ft) of the alternative site.

The site's 8 km (5-mi) radius encompasses nearly the entire City of Columbia and parts of the outlying metropolitan area. The nearest permanent residence is located approximately 762 m (2,500 ft) north of the reactor facility near Stadium Boulevard (State Highway 740) on Brandon Road.

Existing land uses within each concentric ring can generally be described as follows:

- **0–1 km (0–0.06 mi)** – There is very little residential development within 1 km (0.06 mi) of the MURR site. Most of the land is owned by MU. Recreational areas include a golf course to the west and a park to the south. There are three major University sports venues located in this area: Memorial Stadium/Faurot Field (62,000 seats), Mizzou Arena (15,061 seats), and Hearnes Center (13,300 seats).
- **1–2 km (0.6–1.3 mi)** – Major residential areas are located north, northwest, and south of the proposed RPF site. A shopping center, business district, two hospitals, and a large portion of MU's main campus are located within this area. With the exception of a small area to the southeast, there is no room for any substantial residential or nonresidential (industrial, commercial, or business) development.

- **2–4 km (1.3–2.5 mi)** – The major residential areas are located in the northern half of the ROI and to the southwest. A shopping center, business district, two hospitals, two colleges, three high schools, three middle/junior high schools, and nine elementary schools are located in this area. Recreational areas include two golf courses and eight parks. The downtown area of Columbia, which consists mainly of government offices and retail, commercial, and business uses, is located to the northeast. Development should continue within this area, most likely south of the reactor facility.
- **4–6 km (2.5–3.7 mi)** – Most residential development is within the northern half of the ROI. Three shopping centers, two hospitals, one middle/junior high school, three elementary schools, and an industrial park are located in this area. Recreational areas include two golf courses and five parks. Substantial amounts of land exist for residential or commercial development.
- **6–8 km (3.7–5 mi)** – The only substantial residential development is northeast of the proposed RPF site. A shopping center, two middle/junior high schools, and four elementary schools are located in this area. Recreational areas include one park. Substantial amounts of land presently exist for residential or commercial development.

19.5.2.3.2 Land Use and Visual Resources

The MURR site is currently used for industrial purposes and would remain as such if the RPF was constructed at that location. Construction of the RPF is not anticipated to threaten any important land use resources; therefore, the land use impact due to project construction would be small. Similarly during operation of the RPF, land use impacts would not change beyond those impacts associated with construction; therefore, the land use impact due to operation of the RPF would be small. Impacts to land use that could be reasonably assumed from decommissioning activities are anticipated to be similar to the impacts previously identified and associated with construction and, as such, would be small.

The RPF would be designed to blend in with the architecture of the existing MURR facilities. Because the site is presently industrial in nature, the impacts to visual resources as a result of construction, operation, and decommissioning of the RPF at this location would be small.

19.5.2.3.3 Air Quality Meteorology

The impacts to air quality from RPF construction, operation, and decommissioning at the MURR site are anticipated to be similar to those associated with the Discovery Ridge site (discussed in Section 19.4.2.1). Potential air pollution emissions during construction would include dust from earth-moving and material-handling activities, and exhaust emissions from construction equipment and vehicles. In general, these emissions would be the same as the emissions associated with any large construction project. Emission-specific control measures (e.g., watering areas of disturbed soil) would be implemented to limit air quality impacts and ensure compliance with applicable Federal and State regulations. Therefore, air quality impacts associated with facility construction would be small. Impacts associated with operation would be similar to those previously identified in Section 19.4.2.1, and are considered small. Air quality impacts that could be reasonably assumed from decommissioning activities are anticipated to be similar to impacts identified and associated with construction and, as such, would be small.

19.5.2.3.4 Noise

Noise during construction at the MURR site would be very similar to that discussed in Section 19.4.2.3 for the Discovery Ridge site. The primary source of noise during construction would be the operation of heavy equipment. This noise would be noticeable in the immediate construction area, but would presumably attenuate to acceptable levels before reaching sensitive receptors.

Vehicular traffic due to construction workers commuting to and from the site and deliveries of equipment and supplies to the site would increase noise levels in the immediate vicinity of several sensitive receptors. Increased traffic noise would likely be noticeable at some of these receptors; therefore, noise impacts associated with project construction would be moderate.

During operation, project-related traffic would be greatly reduced, and there would be no use of heavy construction equipment on the site. As discussed in Section 19.4.2.3, no significant sources of noise have been identified for project operation. Therefore, noise impacts associated with operation would be small.

Any impacts to noise levels that could be reasonably assumed from decommissioning activities are anticipated to be similar to impacts identified and associated with construction and, as such, would be moderate.

19.5.2.3.5 Geologic Environment

The proposed MURR location would be located on flat terrain, requiring some cut and fill to bring the ground surface to the final grade. The excavation would be considered similar to the Discovery Ridge site, with a maximum depth of excavation anticipated to be 4.7 m (15.5 ft) and an estimated 6,881 m^3 (9,000 yd^3) excavated for the building footprint. The material excavated would be soil; no blasting is anticipated.

The area under the MURR site is underlain by competent limestone bedrock that is not expected to subside due to construction of buildings and related infrastructure. There is no evidence of subsidence or sinkholes near the MURR site. The impacts to geology for construction, operation, and decommissioning of the facility, if the RPF is constructed at the MURR site, are similar to those of the Discovery Ridge site and are considered small.

19.5.2.3.6 Water Resources

No streams or other surface water bodies have been identified within the boundaries of the MURR site. Construction of the RPF would have no direct impacts on surface water. The nearest stream is Grind Stone Creek, approximately 305 m (1,000 ft) south of the facility. Federal, State, and local regulations and permit procedures provide minimum requirements for stormwater management during construction activities to prohibit adverse impacts on surface water or stormwater. During construction, any stormwater would be collected in a detention/retention pond. Disturbed soils would be stabilized as part of construction work. Earthen berms, dikes, and sediment fences would be used as necessary during all phases of construction to limit runoff. These measures would prevent the local surface drainages from being affected substantially by construction activities. The impacts of RPF construction on surface water are considered small.

For the MURR site, the RPF would obtain its water from the water system owned and operated by MU. The amount used by the RPF is anticipated to be an extremely small percentage of the capacity of the MU water supply system.

Some dewatering due to groundwater and precipitation may be required during construction at the deepest excavation. No alterations to groundwater systems would occur due to the facility construction. Runoff controls would be in place during construction as part of the BMPs to prevent uncontrolled releases of water. The potential for water or other liquids from spills or leaks to cause significant migration of contaminants downward to the groundwater system is considered unlikely. No groundwater withdrawals or returns are required during construction. As such, direct and indirect impacts of RPF construction and operation on groundwater at the MURR site are small.

Any impacts to water resources that could be reasonably assumed from decommissioning activities are anticipated to be similar to impacts identified and associated with RPF construction and, as such, are small.

19.5.2.3.7 Ecological Resources

The MURR site is on previously disturbed land. Missouri has determined that there are no threatened or endangered "listed species" on the facility site (MU, 2006b). There are two species of concern in the surrounding area: the Trout-Perch and Topeka Shiner are both found in Hinkson Creek to the west of the MURR site. Hinkson Creek, which drains the MURR site, is a major tributary of Perche Creek, the principal stream of the Boone County drainage basin. Perche Creek enters the county from the northwest, flows southward, and then flows southeasterly before entering the Missouri River approximately 13.7 km (8.5 mi) from the MURR site. To preserve the Trout-Perch and the Topeka Shiner, Hinkson Creek and its tributaries should be protected from soil erosion, water pollution, and in-stream activities that modify or diminish aquatic habitats. No activities associated with construction or operation of the RPF at the MURR site would contribute to soil erosion. All potential water runoff would be captured in stormwater detention ponds. As such, direct and indirect impacts of RPF construction and operation on ecological resources are small.

Any impacts to ecological resources that could be reasonably assumed from decommissioning activities are anticipated to be similar to impacts identified and associated with construction and, as such, are small.

19.5.2.3.8 Historical and Cultural Resources

The buildings in the near vicinity of the MURR site were constructed recently and are not listed in the NRHP. MU previously performed an assessment of the potential impact of construction on historic properties at the MURR site, in accordance with Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. § 470 et seq.), and in accordance with the provisions of 36 CFR 800. The study determined that there are no buildings, or sites of historical or archaeological importance, located on the MURR site (MU, 2006a). There is insignificant impact to historical properties, as stated in the draft NRC environmental assessment (NRC, 2001) related to the MURR request for a construction permit recapture license amendment filed on December 27, 2000 (MURR, 2000). The MURR site would be located on previously disturbed land; therefore, the potential for an impact on historical or archaeological resources due to the construction and operation of the RPF is small.

Any impacts to historical and cultural resources that could be reasonably assumed from decommissioning activities at the MURR site are anticipated to be similar to impacts identified and associated with RPF construction and, as such, are small.

19.5.2.3.9 Socioeconomics

The socioeconomic impacts associated with siting the RPF at the MURR site would be similar to those for the Discovery Ridge site. The ROI for both sites, Boone Country, are the same. Impacts to housing, education, taxes, and utilities (including power and sanitary sewer) would be similar. Water at the MURR site would be obtained from the MU-owned and operated water system that, as previously stated, has the capacity to absorb the additional demand from the RPF.

Any impacts to socioeconomics that could be reasonably assumed from decommissioning activities at the MURR site are anticipated to be similar to impacts identified and associated with RPF construction and, as such, are small.

19.5.2.3.10 Human Health

Nonradiological – Construction and operation of the RPF at the MURR site would be essentially the same as the Discovery Ridge site described in Section 19.4.8.1 for the following:

- Nonradioactive chemical sources (location, type, strength)
- Nonradioactive liquid, gaseous, and solid waste management and effluent control systems
- Nonradioactive effluents released into the on-site and off-site environment
- Chemical exposure to the public and on-site workforce
- Physical occupational hazards
- Mitigation measures for nonradiological human health impacts

Nonradiological chemical sources, wastes, effluents, and occupational hazards associated with the RPF would be controlled to ensure compliance with applicable environmental and occupational regulations and standards, as discussed in Section 19.4.8.1. As such, the nonradiological human health impacts associated with RPF construction and operation at the MURR site would be small.

Radiological – The RPF constructed at the MURR site would be basically the same as the Discovery Ridge site, and the following aspects of the facility would be the same:

- Characteristics of radiation sources and expected radioactive effluents
- Compliance with 10 CFR 20.1301, including calculated radiation dose rates at the fence line
- Annual radiation dose to the maximally exposed worker
- Mitigation measures to minimize public and occupational exposures to radioactive material

Radiation sources and radioactive effluents would be controlled to ensure compliance with applicable regulations and standards, as discussed in Section 19.4.8.2. The radiological human health impacts associated with RPF construction and operation at the MURR site would be expected to be small.

19.5.2.3.11 Transportation

The MURR site is located within the city limits of Columbia, Missouri. The area is served by two major highways: U.S. Interstate 70 and U.S. Highway 63. U.S. Interstate 70 is a major east-west route across the U.S. that connects St. Louis and Kansas City. This interstate currently carries approximately 72,530 vehicles/day and is projected to carry more than 109,410 vehicles/day by the year 2026. U.S. Highway 63 is a major north-south route that connects Columbia, Missouri, and Memphis, Tennessee. This highway currently carries approximately 44,300 vehicles/day and is projected to carry over 68,930 vehicles/day by the year 2026.

The MURR presently has approximately 140 employees (MU, 2006b). Construction, operation, and decommissioning of the RPF would add 98 employees to the area, with a similar number of vehicles. The number of vehicles used by facility staff represents a very small percentage of the total number of vehicles used in the area daily. As such, there is no significant impact on transportation in the area associated with the construction, operation, or decommissioning of the RPF at the MURR site.

19.5.2.4 Process Alternatives

Alternatives to the process proposed for the RPF include different irradiation, target fabrication, and separations processes selected for use by NWMI. Trade studies were identified as part of the preconceptual planning. Alternatives are divided into the following categories:

- Irradiation technique alternatives
- Process alternatives

19.5.2.4.1 Irradiation Alternatives

A major component of design is the selection of the irradiation process. A few varying processes exist to make ^{99}Mo, including:

- Neutron capture of molybdenum-98 (^{98}Mo)
- Use of a linear accelerator for the production of ^{99}Mo
- Use of LEU aqueous homogeneous reactors.

Neutron activation/capture – This process of ^{99}Mo production begins with naturally occurring molybdenum, ^{98}Mo, and uses one of two techniques to create ^{99}Mo. The first technique bombards ^{98}Mo with neutrons in a nuclear reactor. When successful, the result of the collision is a free-released gamma ray and ^{99}Mo (Figure 19-47). The second technique employs an accelerator to produce neutrons in a similar fashion. Neutron capture involves using free neutrons to collide with a ^{98}Mo target.

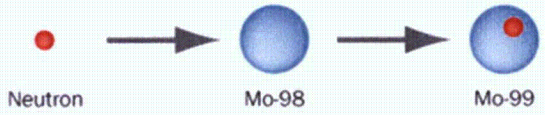

Figure 19-47. Molybdenum-98 Bombarded with Neutrons to Form Molybdenum-99

The National Academy of Sciences published a report (NAS, 2009) that documents the probability of ^{99}Mo generation from uranium fission at 37 barns (b). A barn is a unit of measure equal to 10^{24} cubic centimeters (cm^2). Because nuclear interaction rates are determined by the cross-sectional area of the target atom available to the incident particle, the barn represents a scaled probability of interaction. Thus, an interaction that has a large number of barns has a higher probability of occurrence than an interaction with a lower number. So for comparison, the neutron capture by ^{98}Mo for the production of ^{99}Mo is approximately 0.13 b. This is much smaller than the 37 b cross-section for ^{99}Mo production from the fission of uranium; thus, it has a lower probability of occurrence and would require more neutrons to achieve the same quantity of Mo. Another negative aspect of this method is that the ^{99}Mo produced has a low specific activity. Most of the Mo produced by this method is ^{98}Mo because of the long half-life of the ^{98}Mo and molybdenum-100 (^{100}Mo). According to the National Academy of Sciences report, the specific activity of molybdenum produced by neutron capture is two to four times lower than that produced from the fission of uranium (NAS, 2009).

Linear accelerators – This technology uses multiple linear accelerators to produce ^{99}Mo. The linear accelerator accelerates electrons that collide with a metal target, producing extremely intense high-energy photons. The most common method is to use a photon to produce ^{99}Mo through the ^{100}Mo(γ,n)^{99}Mo reaction (Figure 19-48). The second method uses protons in one of two ways, either to produce ^{99}Mo through the ^{100}Mo(p,pn)^{99}Mo reaction or produce ^{99m}Tc directly through the ^{100}Mo(p,2n)^{99m}Tc reaction.

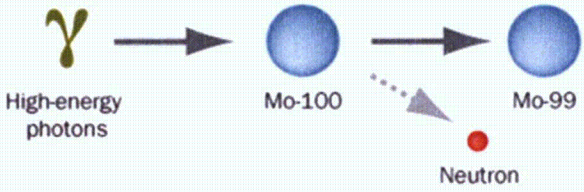

Figure 19-48. Molybdenum-100 High Energy Reactions to Form Molybdenum-99

The National Academy of Sciences reported that the cost of construction and operation of multiple accelerators would have to be analyzed to determine if these approaches could be feasible (NAS, 2009). Another option is to use the accelerator to produce ^{99m}Tc directly from a ^{100}Mo source; however, the short half-life of ^{99m}Tc (6 hr) makes this approach impracticable.

Another possible application is to use a linear accelerator to induce fission on uranium targets, essentially replacing the traditional reactor with an accelerator. An extraction process would still be needed to recover the ^{99}Mo from any option associated with an accelerator, as with a traditional reactor.

LEU aqueous homogeneous reactor approach – This process consists of an array of aqueous homogeneous reactors to produce ^{99}Mo, ^{131}I, and xenon-133 (^{133}Xe). The aqueous homogeneous reactor uses an LEU uranyl nitrate solution for fuel and target material. A typical facility would consist of a small number of reactor modules. The use of LEU uranyl nitrate solution for both reactor fuel and target material allows ^{99}Mo to be produced in the entire reactor solution. To produce ^{99}Mo, ^{131}I, and ^{133}Xe, LEU is dissolved in nitric acid and brought to criticality. To extract these isotopes, the solution is transferred from the reactor to a vent tank. After degassing, the solution is transferred to an extraction column where it undergoes a purification and separation process. The processed solution is cleaned up and returned to the reactor. The ^{99}Mo is then handled in a manner similar to the NWMI process.

19.5.2.4.2 Additional Process Alternatives

In addition to the acid dissolution process proposed by NWMI, an alkaline dissolution process has also been used. A sodium hydroxide solution is used to dissolve the entire target. Dissolution produces a sodium aluminate solution containing sodium molybdate along with small amounts of fission products, other actinides, and residue. The solution is recovered, thus removing suspended solids, and purified by a method such as ion exchange. The ^{99}Mo recovery yield from the solution typically exceeds 85 to 90 percent. The sorbed molybdate is typically washed with a dilute ammonium hydroxide solution and then removed from the column using a concentrated saline or ammonium hydroxide solution. The ^{99}Mo is then recovered, configured, and shipped.

19.5.3 Cost-Benefit of the Alternatives

Table 19-89 summarizes the cost and benefit analyses of the Discovery Ridge and MURR alternative sites and alternative technologies.

Table 19-89. Cost-Benefit Summary of the Alternatives (4 pages)

Factor	Discovery Ridge	University of Missouri Research Reactor
Environmental Degradation		
Land use and visual resources	Land use is presently set aside for a research park. Construction and operation is harmonious with land use at the park. The RPF would be designed to blend in with the current facilities. No degradation is anticipated associated with land use or visual resources.	Land use is presently industrial. Siting the RPF is not anticipated to impact current land use. The RPF would be designed to blend in with the existing MURR facilities. No degradation is anticipated associated with land use or visual resources.
Air quality and noise	RPF construction would be anticipated to produce dust and emission from earth-moving activities. The RPF would emit minor emissions of NO_x and CO_2 along with levels of radionuclides below [a]10 CFR 20 levels. Construction of the RPF would result in a temporary increase in noise and be limited to receptors close to the site. Operation of the RPF is anticipated to have noise levels well below noise limits.	RPF construction would be anticipated to produce dust and emission from earth-moving activities. The RPF would emit minor emissions of NO_x and CO_2 along with levels of radionuclides below [a]10 CFR 20 levels. These emissions would be small. Construction of the RPF would result in a temporary increase in noise and be limited to receptors close to the site. Operation of the RPF is anticipated to have noise levels well below noise limits.

Table 19-89. Cost-Benefit Summary of the Alternatives (4 pages)

Factor	Discovery Ridge	University of Missouri Research Reactor
Geologic environment	A short-term increase in soil erosion and dust production during construction would be anticipated. No degradation to the geologic environment would be anticipated during facility operations.	A short-term increase in soil erosion and dust production during construction would be anticipated. No degradation to the geologic environment would be anticipated during facility operations.
Water resources	The nearest water body is 152 m (500 ft) northwest of the site. All surface water would be managed during construction with BMPs and is not anticipated to impact surface or groundwater sources. No groundwater would be used during construction or operation. No degradation would be anticipated associated with water resources.	The site does not have any surface water bodies within its boundaries. All surface water during construction would be managed with BMPs and is not anticipated to impact surface or groundwater sources. No groundwater would be used during construction or operation. No degradation is anticipated associated with water resources.
Ecological resources	The site is on ground that has been historically used for agriculture. There are no threatened or endangered species on the site. There is a potential impact to fauna species near the site due to noise levels at the site during construction. The fauna would be expected to return to the surrounding area after construction is complete. The potential impact to off-site aquatic environments would be mitigated with the use of BMPs. There is a potential for bird strikes to elevated equipment during night construction.	The site is on previously disturbed ground, and there are no threatened or endangered species on the site. There are two species, the Trout-Perch and the Topeka Shiner, found in Hinkson Creek to the west of the site. Hinkson Creek drains the MURR site. Releases from the MURR site could migrate to Hinkson Creek and impact the Trout-Perch and Topeka Shiner. A potential exists for an accident or uncontrolled release to degrade the Trout-Perch and the Topeka Shiner habitat. The potential also exists for impacts to fauna species near the site due to noise levels at the site during construction. The fauna would be expected to return to the surrounding area after construction is complete. The potential impact to off-site aquatic environments would be mitigated with the use of BMPs. There is a potential for bird strikes to elevated equipment during night construction.
Historical and cultural resources	The closest building on the NRHP is 1.6 km (1 mi) to the northwest of the site. Construction and operation is not anticipated to impact that property. There are no historical or culturally important areas. No degradation associated with historical and cultural resources at the site is anticipated.	None of the buildings on the site are on the NRHP, and there are no historically or culturally important areas. No degradation is anticipated that is associated with historical and cultural resources.

Table 19-89. Cost-Benefit Summary of the Alternatives (4 pages)

Factor	Discovery Ridge	University of Missouri Research Reactor
Socio-economics	Construction and operation would result in a small increase in the demand for housing, utilities, public schools, and other public services. However, this impact is anticipated to be small because the majority of workers would be obtained from the local labor force. Construction would result in an increase in the amount of local traffic due to commuting construction workers and delivery of supplies and materials to the site. Operations would result in increased local traffic from commuting employees.	Construction and operation would result in a small increase in the demand for housing, utilities, public schools, and other public services. This impact is anticipated to be small because the majority of workers would be obtained from the local labor force. Construction would result in an increase in the amount of local traffic due to commuting construction workers and delivery of supplies and materials to the site. Operations would result in increased local traffic from commuting employees.
Human health	Potential hazards to workers during construction would be typical to those on a construction site, including slips, trips, falls, heavy lifting, noise, sharp objects, and movement of heavy equipment. Impacts to the public would include fugitive dust, traffic, and air emissions. These impacts are expected to be temporary and localized at and near the site. Chemicals used within the facility during operation would be contained within piping and tanks, limiting the workforce and public exposure. Minor impacts to the public would be experienced due to increased vehicle emissions from commuting employees and minor doses of radiation from the transport of radioactive materials. Radioactive gaseous emissions released from the RPF would be below regulatory limits.	Potential hazards to workers during construction would be typical to those on a construction site, including slips, trips, falls, heavy lifting noise, sharp objects, and movement of heavy equipment. Impacts to the public would include fugitive dust, traffic, and air emissions. These impacts are expected to be temporary and localized at and near the site. Chemicals used within the facility during operation would be contained within piping and tanks, limiting the workforce and public exposure. Minor impacts to the public would be experienced due to increased vehicle emissions from commuting employees and minor doses of radiation from the transport of radioactive materials. Releases of radioactive gaseous emissions anticipated from the RPF would be below regulatory limits.
Environ-mental justice	RPF construction and operation would not disproportionally impact minority and/or low-income populations.	Construction and operations would not disproportionally impact minority and/or low-income populations.

Table 19-89. Cost-Benefit Summary of the Alternatives (4 pages)

Factor	Discovery Ridge	University of Missouri Research Reactor
Other Costs		
	No other environmental costs have been identified.	No other environmental costs have been identified.
Environmental Benefits		
	Construction would result in 83 jobs at the peak of construction. A total of 98 full-time jobs would be filled during Operations at a salary 75 percent higher than the current Boone County average.	Construction would result in 83 jobs at the peak of construction. A total of 98 full-time jobs would be filled during Operations at a salary 75 percent higher than the current Boone County average.
Expected Increase in Tax Revenue		
	Constructing would result in additional tax revenue of approximately $2.5 million in Columbia, Boone County, and Missouri during operation and approximately $76 million over the period spanning construction through decommissioning.	Constructing would result in additional tax revenue of approximately $2.5 million in Columbia, Boone County, and Missouri during operation and approximately $76 million from construction through decommissioning.
Improvements to Infrastructure		
	No improvements beyond those presently planned for Discovery Ridge are expected for construction or operation.	No improvements to the infrastructure are expected due to construction or operations.
Other benefits		
	Operations would benefit the health of people who need diagnostic tests that require ^{99m}Tc; NWMI intends to provide a reliable supply of 50 percent of the U.S. need for ^{99m}Tc.	Operations would benefit the health of people who need diagnostic tests that require ^{99m}Tc; NWMI intends to provide a reliable supply of 50 percent of the U.S. need for ^{99m}Tc.

[a] 10 CFR 20, "Standards for Protection Against Radiation," *Code of Federal Regulations*, Office of the Federal Register, as amended.

BMP = best management practice.
MURR = University of Missouri Research Reactor.
NRHP = National Register of Historic Places.
NWMI = Northwest Medical Isotopes, LLC.
RPF = radioisotope production facility.

19.5.4 Comparison of the Potential Environmental Impacts

This section compares the environmental impacts, costs, and benefits discussed in Sections 19.5.1, 19.5.2, and 19.5.3. Table 19-90 and Table 19-91 summarize the potential construction and operational impacts of the Discovery Ridge site and alternatives, respectively.

Table 19-90. Comparison of the Potential Construction Impacts of the Discovery Ridge Site and Alternatives

Category	Impacts		
	Discovery Ridge	MURR	No Action
Land use	Small	Small	None
Visual resources	Small	Small	None
Air quality	Small	Small	None
Noise	Moderate	Moderate	None
Geology, soils, seismology	Small	Small	None
Water resources			
Surface	Small	Small	None
Ground	Small	Small	None
Ecological resources	Small	Small	None
Historical and cultural resources	Small	Small	None
Socioeconomic			
Housing	Small	Small	None
Public services	Small	Small	None
Public education	Small	Small	None
Taxes	Small ($2,534,962)	Small ($2,534,962)	None
Transportation	Small	Small	None
Employment	Small (82)	Small (82)	None
Human health	Small	Small	None
Waste management	Small	Small	None
Transportation	Small	Small	None
Postulated accidents	Small	Small	None
Environmental justice	Small	Small	None

MURR = University of Missouri Research Reactor.

Table 19-91. Comparison of the Potential Operational Impacts of the Discovery Ridge Site and Alternatives

Category	Impacts		
	Discovery Ridge	MURR	No Action
Land Use	Small	Small	None
Visual Resources	Small	Small	None
Air Quality	Small	Small	None
Noise	Small	Small	None
Geology, Soils, Seismology	Small	Small	None
Water Resources			
Surface	Small	Small	None
Ground	Small	Small	None
Ecological Resources	Small	Small	None
Historical and Cultural Resources	Small	Small	None
Socioeconomic			
Housing	Small	Small	None
Public Services	Small	Small	None
Public Education	Small	Small	None
Taxes	Small ($72,827,264)	Small ($72,827,2643)	None
Transportation	Small	Small	None
Employment	Small (98)	Small (98)	None
Taxes	Small	Small	None
Human Health	Small	Small	None
Waste Management	Small	Small	None
Transportation	Small	Small	None
Postulated Accidents	Small	Small	None
Environmental Justice	Small	Small	None

MURR = University of Missouri Research Reactor.

19.6 CONCLUSIONS

19.6.1 Unavoidable Adverse Environmental Impacts of the Proposed Action

Unavoidable adverse impacts are predicted adverse environmental impacts that cannot be avoided and for which there are no practical means of further mitigation. This section considers unavoidable adverse impacts from construction and operation of the proposed RPF. The decommissioning of the facility would return the site to its present state. If the site is returned to its current state, there would be no unavoidable adverse environmental impacts associated with the proposed action.

19.6.1.1 Unavoidable Adverse Environmental Impacts of Construction

The impacts associated with construction are discussed in Section 19.4, and as described in that section, all impacts are considered *small*. Table 19-92 summarizes construction-related impacts that result in a measurable loss or permanent change in resources, the mitigation and control measures available to reduce those impacts, and the remaining unavoidable adverse impacts after mitigation and control measures are applied.

Table 19-92. Construction-Related Unavoidable Adverse Environmental Impacts (2 pages)

Element	Adverse impact	Mitigation measure	Unavoidable adverse environmental impacts
Land Use and Visual Resources	Construction would permanently impact 3 ha (7.4 acres) of Lot 15 (open space in Discovery Park).	Construction activities comply with all relevant Federal, State, and local regulatory requirements, including BMPs and stormwater management plans to control erosion and runoff.	A total of 3 ha (7.4 acres) within Discovery Ridge would be impacted.
	Partial obstruction of views of the existing landscape	Visual impacts are minimized through landscaping of the site.	A minor change in existing landscape would be expected.
	Visual obstruction via dust generation	BMPs, including dust control, would be used to limit any impact.	Unavoidable adverse environmental impacts are anticipated to be small.
Geologic Environment	Soil erosion	Stormwater management plans and BMPs	Potential impacts are limited to immediate off-site areas and are associated with runoff and siltation onto the roadside, which are anticipated to be small.
Air Quality	Emissions and fugitive dust	Application of BMPs, including dust suppression, periodically watering unpaved construction areas, covering haul trucks when loaded or unloaded, minimizing material handling (e.g., drop heights, double-handling), phased grading to minimize the area of disturbed soils, revegetating road medians and slopes.	Unavoidable adverse environmental impacts are expected to be small.
	Vehicle emissions	Encouraging car pooling	Unavoidable adverse environmental impacts are expected to be small.

Table 19-92. Construction-Related Unavoidable Adverse Environmental Impacts (2 pages)

Element	Adverse impact	Mitigation measure	Unavoidable adverse environmental impacts
Noise and Vibration	Increase in noise relative to baseline conditions most noticeable during periods of high-activity onsite and during shift changes in the morning and late afternoon.	Construction activities occur during the day, a noise permit would be obtained for after-hours noise. Maintenance of noise-limiting devices on vehicles and equipment are some of the BMPs that would be applied.	Unavoidable adverse environmental impacts are small.
Water Resources	No surface water impacts would be anticipated. Minimal groundwater dewatering at the deepest excavation.	Stormwater would be collected in a detention/retention pond, and runoff controls would be applied.	Unavoidable adverse environmental impacts are not anticipated.
Ecological Resources	Temporary displacement of fauna species (because of noise), bird strikes with lights.	BMPs for artificial lights are used to prevent bird collisions and stormwater runoff would limit any potential impact.	Unavoidable adverse environmental impacts are anticipated to be small.
Public Services	Use of water, sanitary sewer and power, public education, tax revenues, transportation.	No mitigation is required.	Unavoidable adverse environmental impacts are anticipated to be small.
Environmental Justice	No adverse impacts on minority or low-income populations have been identified.	Level of impact is comparable for all populations and mitigation is not required.	Impacts to low income and minority populations are not anticipated.
Cultural and Historical Resources	No adverse impacts on cultural or historic resources have been identified.	A Phase I archeological survey was performed and the SHPO reviewed the findings and indicated that no further consultation is needed.	Unavoidable adverse environmental impacts are not anticipated.
Human Health	Nonradiological impacts	Mitigated through work practices, BMPs, and OSHA compliance.	Unavoidable adverse environmental impacts are anticipated to be small.
	Radiological impacts	None until LEU arrives onsite (covered under operations)	Unavoidable adverse environmental impacts are anticipated to be small.

BMP = best management practice.
LEU = low-enriched uranium.
OSHA = Occupational Safety and Health Administration.
RPF = radioisotope production facility.
SHPO = State Historic Preservation Office.

For many of the impacts related to construction activities, the mitigation measures are referred to as BMPs. Typically, these mitigation measures are based on the types of activities that are to be performed. The mitigation measures are implemented through permitting requirements and the plans and procedures developed for the construction activities.

Unavoidable adverse impacts from construction of the RPF would be direct and permanent disturbance of 3 ha (7.4 acres) of Lot 15 that changes open space to a fully constructed facility with surrounding landscaping and partially obstructs views of the existing landscape. Even with application of BMPs, construction activities would result in localized increases in air emissions, including GHGs, dust, noise, vibration, and soil erosion, which may impact on-site workers, other Discovery Ridge tenants, and nearby residents. Because there are no streams, ponds, or water bodies present on the RPF site, and no groundwater dewatering would be anticipated, potential construction-related impacts to water resources are limited to off-site impacts associated with runoff and siltation that are not fully mitigated through stormwater management plans and BMPs. There may be temporary displacement of fauna species (because of noise), and bird strikes with illumination. BMPs for artificial lights would be used to minimize bird collisions.

Impacts to land and visual resources from facility construction are mitigated by returning lands within the site boundary, which surround the developed area, to a combination of open and landscaped spaces on completion of construction. Potential noise impacts also include traffic noise associated with the construction workforce traveling to and from the RPF.

19.6.1.2 Unavoidable Adverse Environmental Impacts of Operations

Operational impacts, all of which are considered *small*, are discussed in detail throughout Section 19.4. Table 19-93 summarizes operations-related impacts that result in a measurable loss or permanent change in resources, the mitigation and control measures available to reduce these impacts, and the remaining adverse impacts after mitigation and control measures are applied. As indicated in Table 19-93, most of the adverse impacts are either avoidable or negligible after mitigation and control measures are considered.

Unavoidable adverse impacts from operation of the RPF include a change to the viewshed, potential stormwater, infrequent bird collisions with buildings, emissions and dust from traffic, operating noise and vibration, and an increase in potential for nonradiological and radiological hazards to the public and occupational workers.

Visual impacts to the viewshed would occur as a result of the main building's exhaust stacks and exhaust from them. The surrounding viewshed includes light industrial development; therefore, impacts are minor. Stormwater runoff during plant operation from paved and compacted surfaces would be controlled via drainage ditches and basins. Infrequent bird collisions with buildings at the RPF and associated structures could result in some bird mortality. However, the RPF has a relatively low profile, and the effects on bird populations from collisions with buildings would be minimized. A small level of noise and vibration from equipment would occur during operations. Noise would be limited to the interior of the facility and the immediate exterior area, where it would be perceived as being close to ambient levels. There would be an increase in potential for nonradiological and radiological hazards to the public and workers. These hazards would be mitigated through the facility's design, engineering controls, and administrative controls.

Table 19-93. Operations-Related Unavoidable Adverse Environmental Impacts (3 pages)

Element	Adverse impact	Mitigation measure	Unavoidable adverse environmental impacts
Land Use and Visual Resources	Visual impacts as a result of the main building associated with the three main processing exhaust vent stacks.	The majority of the facility structures have a relatively low profile. The exhaust stacks would extend to approximately 22.9 m (75 ft) high abovegrade. No mitigation is required.	Minor impacts to viewscape would occur as a result of the completed facility; thus, impacts are small.
	Quantities of gaseous effluent released from the facility during operations are not anticipated to result in visibility impacts.	No mitigation is required.	Unavoidable adverse environmental impacts are not anticipated.
Air Quality	Increased vehicle emissions and dust from the commuting workforce and routine deliveries to/from the RPF.	The volume of traffic during operations would be considerably lower than during construction. Vehicles are limited to paved areas, reducing emissions of fugitive dust.	Unavoidable adverse environmental impacts are small.
	Emission of CO, NO_x, PM, VOCs, and CO_2.	The offgas system would be designed to filter emissions. Monitoring would be conducted.	No impacts are expected to exceed the primary ambient air quality standards, which are established to protect public health; therefore, unavoidable adverse environmental impacts are not anticipated.
	The majority of effluent would be from radioisotope production and the release of a small amount of gaseous fission products.	The offgas system would be designed to filter and/or retain these fission products in the RPF until they are less than the established allowable concentrations for residential receptors. Monitoring would be conducted.	No impacts are expected to exceed Table 2 in [a]10 CFR 20, Appendix B; therefore, unavoidable adverse environmental impacts are not anticipated.
Noise and Vibration	Noise and vibration would be generated from process equipment, ventilation, heating and cooling systems, and increased traffic.	These noise sources would largely be limited to the interior of the facility. The exterior noises would not be significantly above ambient level. No mitigation is required.	Unavoidable adverse environmental impacts are anticipated to be small.

Table 19-93. Operations-Related Unavoidable Adverse Environmental Impacts (3 pages)

Element	Adverse impact	Mitigation measure	Unavoidable adverse environmental impacts
Geologic Environment	Stormwater runoff and process wastewater	BMPs would be used to manage stormwater runoff from paved and compacted surfaces to drainage ditches and basins. Process wastewater would be contained within enclosed systems, treated, and evaporated. Process wastewater would not be disposed to the subsurface bedrock or local soils.	Unavoidable adverse environmental impacts are anticipated to be small.
Water Resources	Stormwater runoff	BMPs would be used to manage stormwater runoff from paved and compacted surfaces to drainage ditches and basins.	Unavoidable adverse environmental impacts are small.
	Liquid discharge	The facility would be designed to have zero liquid discharge from the radiologically controlled area and there would be no use or release water from the facility to the adjacent environment that would affect surface water.	Unavoidable adverse environmental impacts are not anticipated.
Ecological Resources	Exposure of flora and fauna to herbicides used for vegetation management, potential bird collisions with the facility, and potential stormwater runoff	BMPs would limit herbicide use and contain the broad application to within the site. Potential impacts to aquatic environments offsite are mitigated because of stormwater retention systems on the site. Bird collisions occur at low frequencies.	Unavoidable adverse environmental impacts are anticipated to be small.
Environmental Justice	No adverse impacts on minority or low-income populations have been identified.	Level of impact is comparable for all populations, and mitigation is not required.	Impacts to low income and minority populations are not anticipated.
Cultural and Historical Resources	No adverse impacts on cultural or historic resources have been identified.	A Phase I Archeological Survey was performed and the SHPO reviewed the findings and indicated that no further consultation is needed.	Unavoidable adverse environmental impacts are not anticipated.
Human Health	Potential nonradiological public and occupational hazards pertaining to operation of the RPF are associated with emissions, discharges, waste associated with processes within the facility, and accidental spills/releases.	Control systems would be used to mitigate risks and control exposure.	Unavoidable adverse environmental impacts are anticipated to be small.

Table 19-93. Operations-Related Unavoidable Adverse Environmental Impacts (3 pages)

Element	Adverse impact	Mitigation measure	Unavoidable adverse environmental impacts
Human Health (cont).	Worker exposure to wastes and chemicals	Processes and procedures would reduce the probability of an exposure. Emergency response plans would mitigate the effects of accidents and spills.	Unavoidable adverse environmental impacts are anticipated to be small.
	Radiological impacts – public	The facility would be designed such that the radiological impacts at the fence line to any individual would be below applicable limits. Engineered controls used would include: shielding, ventilation control, access control, contamination control, etc.	Unavoidable adverse environmental impacts are anticipated to be small.
	Radiological impacts – workers	Administrative controls (e.g., regulation compliance, waste minimization goals, etc.) would be used to ensure that workers do not receive dose above the regulatory reference.	Unavoidable adverse environmental impacts are anticipated to be small.

[a] 10 CFR 20, Appendix B, "Annual Limits on Intake (ALI) and Derived Air Concentrations (DAC) of Radionuclides for Occupational Exposure; Effluent Concentration; Concentrations for Release to Sewerage," *Code of Federal Regulations*, Office of the Federal Register, as amended.

BMP = best management practice.
PM = particulate matter.
RPF = radioisotope production facility.
SHPO = State Historic Preservation Office.
VOC = volatile organic compound.

19.6.2 Relationship between Short-Term Uses and Long-Term Productivity of the Environment

This environmental review focuses on the analyses and resulting conclusions associated with the environmental impacts from activities during the construction and operation at the RPF. These activities are considered short-term uses for purposes of this section. In this section, the long-term is considered to be initiated with the conclusion of RPF decommissioning. This section includes an evaluation of the extent that the short-term uses preclude any options for future long-term use of the RPF site.

19.6.2.1 Construction of the Radioisotope Production Facility and Long-Term Productivity

Subsection 19.6.1.1 summarizes the potential unavoidable adverse environmental impacts of construction and the measures proposed to reduce those impacts. Some small adverse environmental impacts could remain after all practical measures to avoid or mitigate them are taken. However, none of these impacts represent long-term effects that preclude any options for future use of the RPF site.

The acreage disturbed during construction of the facility would be larger than that required for the RPF due to the need for construction parking areas and the material staging and laydown areas. These disturbances, along with noise from construction activities, may displace some wildlife and alter existing vegetation. Once the RPF is completed, the areas not needed for operations would be restored with landscaping.

Construction of the RPF would include the installation of water and sewer lines that connect the facility to the Consolidated Public Water Supply District #1 water supply system. This additional infrastructure would be available and beneficial to any future use of the RPF site after decommissioning. There would be no effects on the long-term productivity of the RPF site as a result of these impacts.

Construction traffic would increase the volume of traffic on local roads, but not to the extent that modifications to the traffic infrastructure or increased rate of maintenance would be required. As presented in the Section 19.4.7, the facility construction has a small positive socioeconomic effect on the local area. These impacts include new construction-related jobs, local spending by the construction workforce, and payment of taxes within the area and region. The beneficial impacts from the construction workforce and indirect economic output and employment resulting from construction expenditures to the local community are limited to the duration of construction. However, the changes that result from increased tax revenues and employment of operational workers would continue throughout the operational life of the RPF.

Construction of the RPF would have insignificant impacts on populations identified as minority or low-income. The percentage of minority or low-income population within the impacted area does not exceed 20 percent of the State or the county, and the percentage of minority or low-income population in the impacted area does not exceed 50 percent of the total population.

19.6.2.2 Operation of the Radioisotope Production Facility and Long-Term Productivity

Section 19.6.1.2 summarizes the potential unavoidable adverse environmental impacts of RPF operation and the measures proposed to reduce or eliminate those impacts. Some small adverse environmental impacts could remain after all practical measures to avoid or mitigate them are taken. However, none of these impacts represent long-term effects that preclude any options for future use of the RPF site.

The RPF site is located in an area that was previously disturbed for agricultural use and later acquired by MU for use as a research park. Operation of the RPF, therefore, represents a continuation of the planned land use. Once the facility is decommissioned to NRC standards, the land could be available for other industrial or non-industrial uses.

During operation, noise levels are largely expected to be similar to ambient levels because facility-generated noise would be limited by the walls and other physical barriers of the facility itself. Operation of the RPF would slightly increase air emissions from the exhaust stacks. The majority of effluent would be from radioisotope production and include the release of a small amount of gaseous fission products. However, the results of modeling showed that no pollutant released during normal operations would exceed the NAAQS. Facility equipment would be operated in accordance with applicable Federal, State, and local regulations, and would not be expected to result in any long-term decrease in regional air quality. Once the facility is decommissioned, none of these impacts would preclude future use of the site. Operation of the RPF would have a comparable impact on all populations in the region around the site.

19.6.2.3 Summary of the Relationship Between Short-Term Use and Long-Term Productivity

The impacts resulting from construction and operation of the RPF result in both adverse and beneficial short-term impacts. The principal short-term adverse impacts are small residual impacts (after mitigation measures are implemented) to land use and visual resources, ecological resources, human health, and air quality. There are no long-term impacts to the environment.

The principal short-term benefits are the creation of additional jobs, additional tax revenues, and improvements to local infrastructure. The principal long-term benefit would be the continued availability of the improved infrastructure and potential benefits from increased tax revenues after RPF decommissioning.

The short-term impacts and benefits and long-term benefits do not affect the long-term productive use of the RPF site.

19.6.3 Irreversible and Irretrievable Commitments of Resources Used to Support the Proposed Action

This section describes the expected irreversible and irretrievable environmental resource commitments used in the RPF construction and operation. The phrase "irreversible commitment of resources" describes environmental resources that are potentially changed by either RPF construction or operation such that they could not be restored at some later time to the resource's prior state. Irretrievable commitments of resources are generally materials that are used for the new facility in such a way that they could not, by practical means, be recycled or restored for other uses.

19.6.3.1 Irreversible Environmental Commitments of Resources

Irreversible environmental resource commitments resulting from the new facility, in addition to the materials used for radioisotope production, are described in the following subsections.

19.6.3.1.1 Land Use

The land used for the RPF would not irreversibly committed because once the RPF ceases operations and the facility is decommissioned in accordance with NRC requirements, the land supporting the facility could be returned to other industrial or nonindustrial uses. There would be no long-term storage or disposal of radioactive and nonradioactive wastes at the site. Medical isotopes would not be stored for any significant time period as these items would be transported to clients as quickly as possible. LEU will be recycled.

19.6.3.1.2 Water Resources

The RPF requires water from the Consolidated Public Water Supply District #1 water supply system for construction, isotope production, potable water, fire protection, and facility heating and cooling. The Consolidated Public Water Supply District #1 presently supplies 5.49 ML/day (1.45 Mgal/day). Construction requirements of the RPF are small compared to the available water supply. As noted in Section 19.2.4, the RPF would require 4,885 L/day (1,286 gal/day) during operations, less than one percent of the total Consolidated Public Water Supply District #1 operational capacity. This leaves a significant excess capacity. Because there would be significant excess capacity within the Consolidated Public Water Supply District #1, there are no indirect effects associated with the demand from the RPF. There are also no direct impacts to water quality or hydrology from the RPF, and therefore, there would be no irreversible impacts.

19.6.3.1.3 Ecological Resources

Long-term irreversible losses of ecological resources are not anticipated. Subsequent to the completion of construction, floral and faunal resources are expected to recover in areas that are not affected by ongoing operations. Losses of fauna due to operations are anticipated to be attributable to bird collisions with buildings at the RPF, as wildlife occurrence on the site would be relatively infrequent. There are no wetlands or water bodies located at the RPF site.

All water for the RPF facility would be provided by the Consolidated Public Water Supply District #1, and the RPF would not be discharging into any water body, thus avoiding any environmental impacts. Stormwater BMPs would control runoff and minimize runoff impacts to any off-site water body.

19.6.3.1.4 Socioeconomic Resources

No irreversible commitments would be made to socioeconomic resources, as they would be available to be reallocated for other purposes once the RPF is decommissioned.

19.6.3.1.5 Historic and Cultural Resources

No known historic or cultural resources would be irreversibly altered as a result of RPF construction or operation.

19.6.3.1.6 Air Quality

Dust and other emissions, such as vehicle exhaust, would be released to the air during construction activities. Implementation of controls and limits at the source of emissions on the construction site result in the reduction of impacts offsite. Mitigations, such as dust suppression BMPs, would also reduce dust from construction activities.

During operations, emissions would be a product of vehicle exhaust, isotope production, and fuel combustion, resulting in very low levels of gaseous pollutants and particulates released from the facility into the air. Contractors, vendors, and subcontractors are required to adhere to appropriate Federal and State occupational health and safety regulations to protect workers from adverse conditions, including air emissions. Emissions during operations were shown through modeling to be in compliance with applicable Federal and State regulations, which would minimize their impact on public health and the environment.

19.6.3.1.7 Irretrievable Commitments of Resources

Irretrievable commitments of resources during RPF construction would generally be similar to that of any small-scale facility construction project. Materials consumed during the construction phase are shown in Table 19-7. These materials are irretrievable unless they are recycled at decommissioning.

Approximately 1,647 L (435 gal) of diesel fuel would be expected to be used on an average monthly basis during construction. The use of construction materials in the quantities associated with the facility has a small impact on the availability of such resources.

During RPF operations, the primary irreversibly and irretrievably resource committed is the uranium used as the source for the molybdenum isotope to eventually produce ^{99m}Tc for medical diagnostics. The amount of uranium that NWMI will require on an annual basis and over the lifetime of the operating license (assuming a 30-yr operating license) is *small* when compared to the amount consumed by other users and the total global supply of uranium.

The World Nuclear Association (WNA) studies of supply and demand of uranium indicate that a total of 5,902,500 metric tons (MT) of uranium were available in 2013. Current usage is about 66,000 t U/yr representing an 90-yr supply of uranium at current prices based on known resources (WNA, 2014). This represents a higher level of assured resources than is normal for most minerals.

Uranium is a relatively common metal found in rocks and seawater. The world's known uranium resources increased by at least one-quarter in the last decade due to increased mineral exploration. Australia has a substantial part (about 29 percent) of the world's uranium, Kazakhstan has 12 percent, Russia has nine percent, Canada has eight percent, and the U.S. has four percent. The amount of uranium could increase to a 200-yr supply as market prices rise and other conventional sources of uranium are used. Therefore, the uranium that is used to generate the medical radioisotopes has a negligible impact with respect to the long-term availability of uranium worldwide.

While a given quantity of material consumed during new facility construction and operation at the RPF site would be irretrievable, except for materials recycled during decommissioning, the impact on their availability would be small.

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Appendix A

CONSULTATION LETTERS

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NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-021

Jennifer Szymanski
Regional ESA Section 7 Coordinator
U.S. Fish and Wildlife Service
5600 American Blvd. West, Suite 990
Bloomington, MN 55437-1458

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Ms. Szymanski:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this project and to ask for information and comments relative to threatened and endangered species, critical habitats, other wildlife species, wetlands, and any other natural resources that would be relevant to our analysis of this project. To facilitate your review, a short description of the project and a site map of the proposed site are presented in Attachment A.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

ATTACHMENT A
Description of the Proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility

NWMI is preparing an application for submission to the NRC to construct, operate, and decommission a Radioisotope Production Facility (RPF). This facility is proposed to be located at the University of Missouri System (UM System) Discovery Ridge Research Park in Columbia, Missouri. The proposed operations of the RPF includes fabrication of low enriched uranium (LEU) targets, deliver targets to a network of university research nuclear reactors for irradiation, receive irradiated targets, and extract and purify molybdenum-99 (^{99}Mo) from the irradiated LEU. The LEU would be reclaimed and recycled into targets for delivery to the network of university research reactors. The ^{99}Mo would be sold and distributed through the existing U.S. supply chain network.

Schedule

- Submit construction application to NRC (4th Q 2014)
- NRC review and approval (Expected 4th Q 2015)
- Site preparation and construction: (2015 – 2016)
- Facility Operations (2017 – 2045)

Site Location

The proposed 7.5 acre site is situated in Boone County, Missouri, within the UM System, Discovery Ridge Research Park in Columbia, Missouri north of Discovery Ridge Drive (Figure B-1). The approximate center of the NWMI RPF is Longitude: 92°16'34.63" and Latitude: 38°54'3.31".

Site Description

The proposed site is located on Lot 15 of the Phase II section of the Discovery Ridge Research Park. The site is all on property owned by UM System. The facility would be approximately 330 feet (ft) in the long dimension and 110 ft wide with a maximum height of 45 ft not counting the stacks (Figure B-2). The site would include an outer fence perimeter and provide the necessary initial security barrier. The fenced area would include paved roads laid out for the turning radius of tractor/trailers used to transport the materials.

Additional information can be found at the UM System, Discovery Ridge Research Park website, http://www.umsystem.edu/ums/aa/umrpi/discoveryridge.

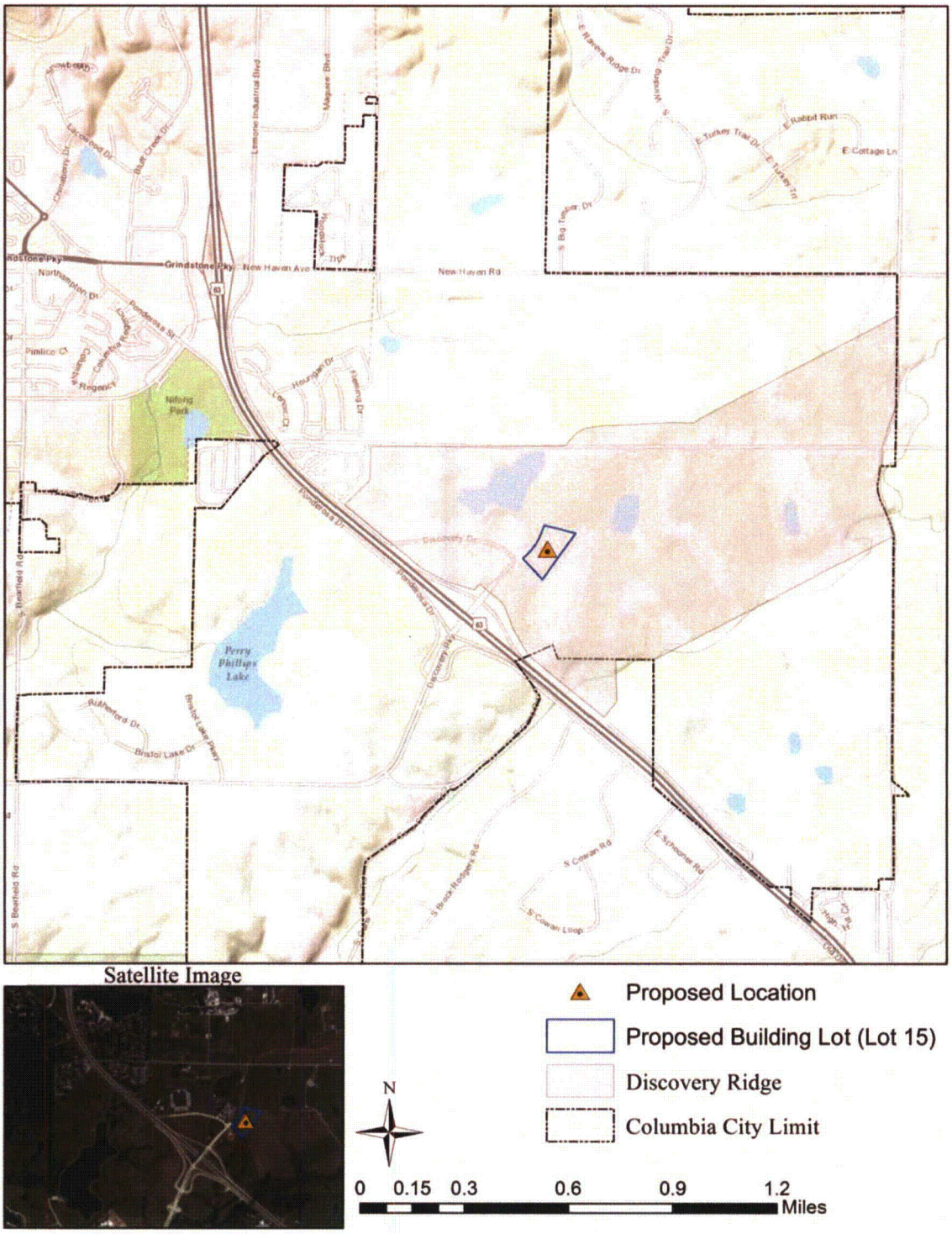

Figure A-1. Proposed Location NWMI RPF – Discovery Ridge located in Columbia, Missouri

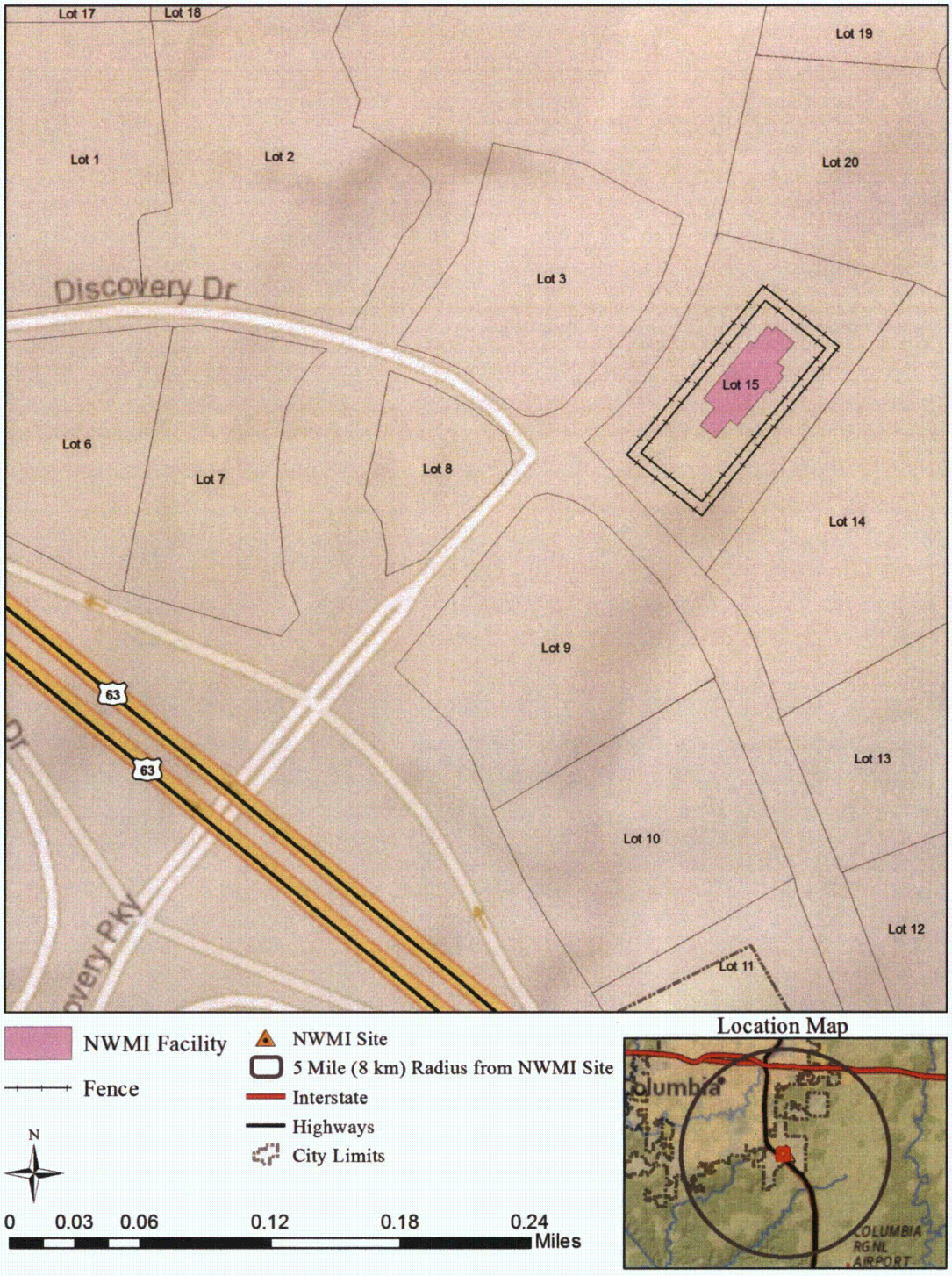

Figure A-2. NWMI RPF General Layout.

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-022

Missouri Department of Conservation
Atten: Resource Sciences Division
P.O. Box 180
Jefferson City, Mo 65102

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Sirs:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park (T.48N – R.12W).

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this project and to ask for information and comments relative to State of Missouri species of conservation concern, critical habitats, wetlands, and any other natural resources that would be relevant to our analysis of this project. To facilitate your review, a short description of the project and a site map of the proposed site are presented in Attachment A.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

ATTACHMENT A
Description of the Proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility

NWMI is preparing an application for submission to the NRC to construct, operate, and decommission a Radioisotope Production Facility (RPF). This facility is proposed to be located at the University of Missouri System (UM System) Discovery Ridge Research Park in Columbia, Missouri. The proposed operations of the RPF includes fabrication of low enriched uranium (LEU) targets, deliver targets to a network of university research nuclear reactors for irradiation, receive irradiated targets, and extract and purify molybdenum-99 (^{99}Mo) from the irradiated LEU. The LEU would be reclaimed and recycled into targets for delivery to the network of university research reactors. The ^{99}Mo would be sold and distributed through the existing U.S. supply chain network.

Schedule

- Submit construction application to NRC (4th Q 2014)
- NRC review and approval (Expected 4th Q 2015)
- Site preparation and construction: (2015 – 2016)
- Facility Operations (2017 – 2045)

Site Location

The proposed 7.5 acre site is situated in Boone County, Missouri, within the UM System, Discovery Ridge Research Park in Columbia, Missouri north of Discovery Ridge Drive (Figure B-1). The approximate center of the NWMI RPF is Longitude: 92°16'34.63" and Latitude: 38°54'3.31".

Site Description

The proposed site is located on Lot 15 of the Phase II section of the Discovery Ridge Research Park. The site is all on property owned by UM System. The facility would be approximately 330 feet (ft) in the long dimension and 110 ft wide with a maximum height of 45 ft not counting the stacks (Figure B-2). The site would include an outer fence perimeter and provide the necessary initial security barrier. The fenced area would include paved roads laid out for the turning radius of tractor/trailers used to transport the materials.

Additional information can be found at the UM System, Discovery Ridge Research Park website, http://www.umsystem.edu/ums/aa/umrpi/discoveryridge.

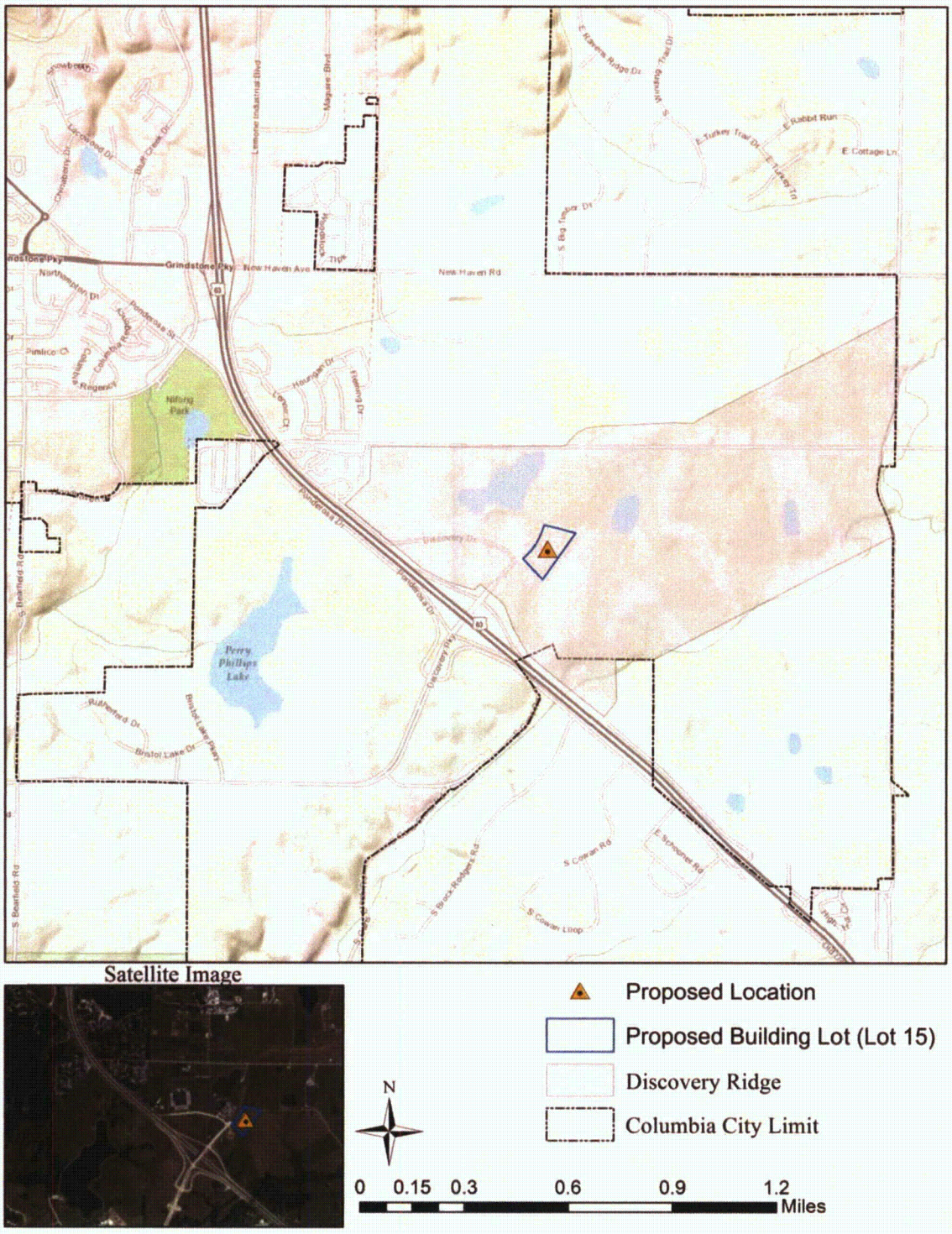

Figure A-1. Proposed Location NWMI RPF – Discovery Ridge located in Columbia, Missouri

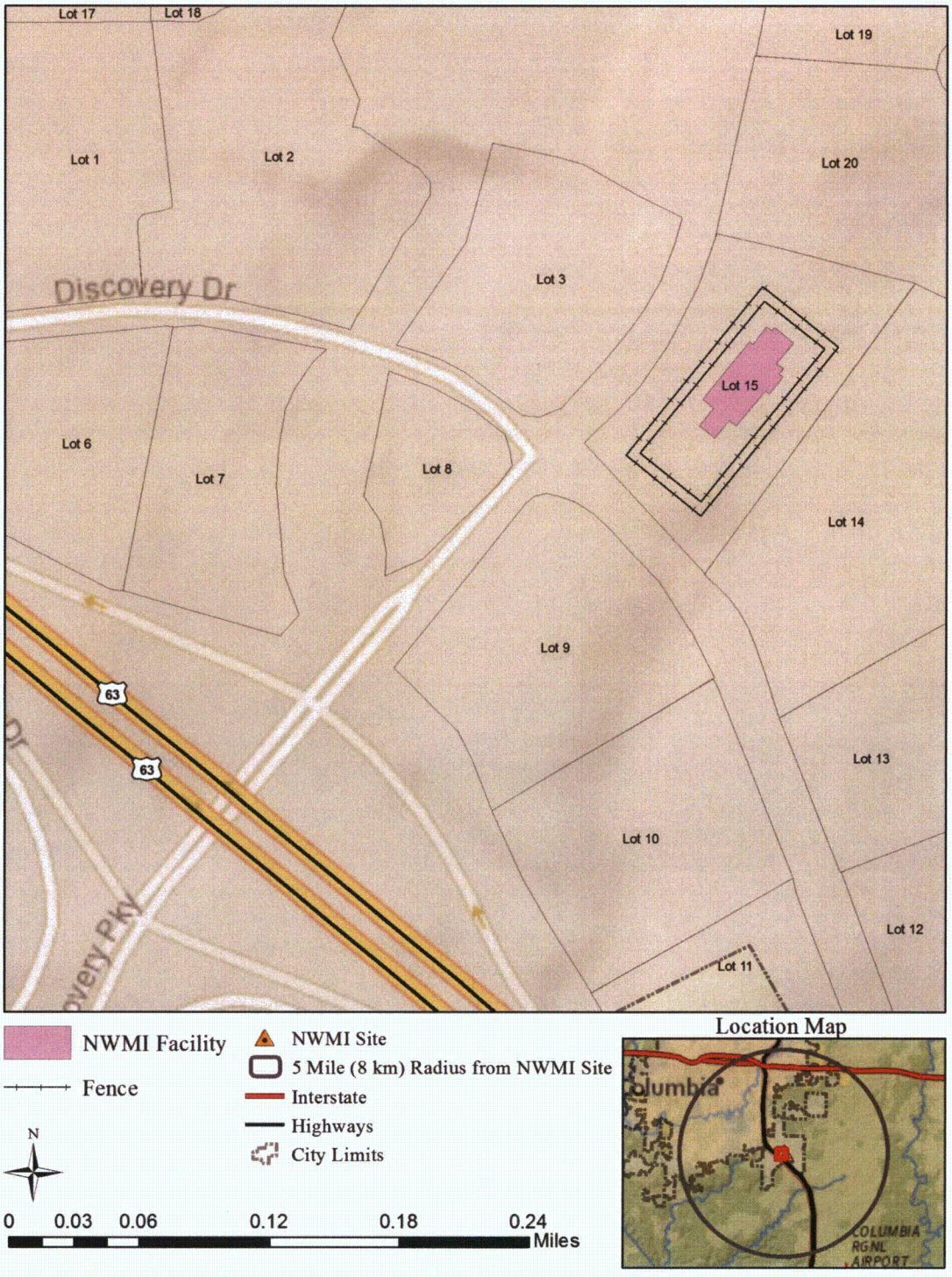

Figure A-2. NWMI RPF General Layout.

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-015

The Honorable Scott Bighorse
Principal Chief
Osage Nation
P. O. Box 779 Grandview
Pawhuska, Oklahoma 74056

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Mr. Bighorse:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this proposed project and to ask for information and comments relative to the following:

- Information you may have regarding historic sites or cultural resources within or near the proposed site
- Any specific knowledge of any locations on or near the site that you believe have traditional religious and cultural significance

A Cultural Resource Investigations Phase 1 Survey has been completed for the proposed site (Attachment A). No on-site historical properties or archeological sites were identified. In addition, a short description of the project and a site map of the proposed site are presented in Attachment B.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-018

The Honorable Gary Pratt
Chairperson
Iowa Tribe of Oklahoma
335588 East 750 Road
Perkins, Oklahoma 74059

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Mr. Pratt:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this proposed project and to ask for information and comments relative to the following:

- Information you may have regarding historic sites or cultural resources within or near the proposed site
- Any specific knowledge of any locations on or near the site that you believe have traditional religious and cultural significance

A Cultural Resource Investigations Phase 1 Survey has been completed for the proposed site (Attachment A). No on-site historical properties or archeological sites were identified. In addition, a short description of the project and a site map of the proposed site are presented in Attachment B.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-017

The Honorable Guy Munroe
Chair
Kaw Nation
P.O. Box 50
Kaw City, Oklahoma 74641

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Mr. Munroe:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this proposed project and to ask for information and comments relative to the following:

- Information you may have regarding historic sites or cultural resources within or near the proposed site
- Any specific knowledge of any locations on or near the site that you believe have traditional religious and cultural significance

A Cultural Resource Investigations Phase 1 Survey has been completed for the proposed site (Attachment A). No on-site historical properties or archeological sites were identified. In addition, a short description of the project and a site map of the proposed site are presented in Attachment B.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-016

The Honorable Douglas G. Lankford
Chief
Miami Tribe of Oklahoma
P.O. Box 1326
Miami, Oklahoma 74354

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Mr. Lankford:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this proposed project and to ask for information and comments relative to the following:

- Information you may have regarding historic sites or cultural resources within or near the proposed site
- Any specific knowledge of any locations on or near the site that you believe have traditional religious and cultural significance

A Cultural Resource Investigations Phase 1 Survey has been completed for the proposed site (Attachment A). No on-site historical properties or archeological sites were identified. In addition, a short description of the project and a site map of the proposed site are presented in Attachment B.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-019

The Honorable Clifford Wolfe, Jr.
Chairman
Omaha Tribe of Nebraska
PO Box 368
Macy, Nebraska 68039

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Mr. Wolfe:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this proposed project and to ask for information and comments relative to the following:

- Information you may have regarding historic sites or cultural resources within or near the proposed site
- Any specific knowledge of any locations on or near the site that you believe have traditional religious and cultural significance

A Cultural Resource Investigations Phase 1 Survey has been completed for the proposed site (Attachment A). No on-site historical properties or archeological sites were identified. In addition, a short description of the project and a site map of the proposed site are presented in Attachment B.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

July 14, 2014
NWMI-LTR-020

The Honorable Robert Flying Hawk
Chairman
Yankton Sioux Tribe of South Dakota
PO Box 1153
Wagner, South Dakota 57380

RE: NORTHWEST MEDICAL ISOTOPES, LLC – PROPOSED RADIOISOTOPE PRODUCTION FACILITY LOCATED AT THE UNIVERSITY OF MISSOURI SYSTEM DISCOVERY RIDGE RESEARCH PARK, COLUMBIA, MISSOURI

Dear Mr. Flying Hawk:

Northwest Medical Isotopes, LLC (NWMI) is preparing an application for submission to the U.S. Nuclear Regulatory Commission (NRC) to construct, operate, and decommission a radioisotope production facility (RPF) on a site located in Columbia, Missouri. The facility would be located within lot 15 of the University of Missouri System (UM System) Discovery Ridge Research Park.

The NRC requires a license applicant to assess the impacts of its proposed action on the environment. NWMI will document this assessment in an Environmental report (ER) that will be submitted to the NRC as part of the formal license application. The NRC will then prepare an analysis in compliance with the *National Environmental Policy Act* (NEPA) of 1969 as part of the licensing process. In addition, the NRC will contact you and if needed initiate consultation.

We are contacting you early in the application process to inform you of this proposed project and to ask for information and comments relative to the following:

- Information you may have regarding historic sites or cultural resources within or near the proposed site
- Any specific knowledge of any locations on or near the site that you believe have traditional religious and cultural significance

A Cultural Resource Investigations Phase 1 Survey has been completed for the proposed site (Attachment A). No on-site historical properties or archeological sites were identified. In addition, a short description of the project and a site map of the proposed site are presented in Attachment B.

Your response to this request for information would be most helpful if received by August 14, 2014. Should you have any questions or need additional information, please contact me on 509-430-6921 or carolyn.haass@nwmedicalisotopes.com.

Sincerely;

Carolyn C. Haass

Carolyn C. Haass
Vice President and Technical Program Director

cc: Michael Brooks, Regional Economic Development, Inc. (Columbia, Missouri)
Steven Lauzier, University of Missouri
William Schuster, U.S. Nuclear Regulatory Commission

NWMI
NORTHWEST MEDICAL ISOTOPES

ATTACHMENT A
Cultural Resource Investigation
Phase 1 Survey

Cultural Resource Investigations
Phase I Survey
Lot 15 – Discovery Ridge
Boone County, Missouri

Nuclear Regulatory Commission Project

Prepared for:
Northwest Medical Isotopes L.L.C.

Prepared By:

Environmental Research Center of Missouri, Inc.
1201 Moreau Drive
Jefferson City, Missouri
Phone: 573-635-9569
Email: craigsturdevant@mchsi.com

Principal Investigator:
Craig Sturdevant
September 2013
ERC Project No. 3023

ERC

ABSTRACT

During September 2013 a Phase I cultural resources survey was carried out for a 7.5 acre tract of land at Discovery Ridge, Boone County, Missouri. The area is the location of a proposed commercial development project.

There are no National Register of Historic Places (NRHP) properties located within the proposed project area; State Historic Preservation Office (SHPO) GIS records indicate presence of no recorded archaeology sites within the project boundaries; and no recorded SHPO historic architectural sites are present within the project area of potential effect. 19th century plat maps do not illustrate any structures within the project area.

The field investigation was carried out under poor surface visibility conditions in a grass/hay setting. Shovel testing was implemented following guidelines described in this report. No evidence of the presence of prehistoric occupation was identified within the project area. No evidence of the presence of early historic occupation was identified within the project boundaries.

On the basis of the negative findings regarding presence of possibly significant cultural resources, it is the recommendation of this Phase I cultural resources survey that the proposed project proceed as planned in terms of Section 106 compliance concerns. No significant cultural resources will be threatened by the proposed project actions.

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INTRODUCTION

Purpose of Study

In compliance with current environmental regulations and policies, Northwest Medical Isotopes L.L.C. entered into a contractual agreement with Environmental Research Center of Missouri, Inc. (ERC) to conduct a Phase I cultural resource survey of a 7.5 acre tract of land at Discovery Ridge in Boone County, Missouri. The study followed the Missouri Department of Natural Resources (DNR) "Guidelines for Cultural Resource Contract Reports and Professional Qualifications" and is submitted in accordance with current environmental regulations and policies and in agreement with the study contract.

The project actions included discussion of the project with Missouri Department of Natural Resources/Historic Preservation Program staff, a records and literature review, and an intensive pedestrian field investigation of the project area. The study methods used are described and the results of the findings of these actions are presented in terms of cultural resource descriptions, when present, and recommendations for cultural resource compliance in reference to the proposed project actions. The project area cultural and environmental settings are briefly described.

Under state and federal legislation and policies outlined by the Antiquities Act of 1906, the Historic Sites Act of 1935, the National Historic Preservation Act (NHPA) of 1966 as amended, the National Environmental Policy Act of 1970, the 1986 Protection of Historic Properties and other regulations regarding specific activities such as strip mining, it is necessary to inventory archaeological and historical resources located within proposed project areas which may be threatened by federally regulated or funded actions and evaluate any disruptive effects these actions might have on resources that are present. Briefly, the National Historic Preservation Act requires that an area threatened by a federally funded and/or regulated project consider cultural resources which might be impacted by project related actions; the State Historic Preservation Officer (SHPO) and/or federal agency involved may request that a cultural resource survey be conducted prior to granting permission to proceed with the proposed project actions. If any cultural resources are identified, they are evaluated in terms of National Register of Historic Places (NRHP) eligibility criteria. Where NRHP eligible sites are found to occupy compliance project areas, consultation is initiated which may include the Advisory Council on Historic Preservation (Council), the SHPO, and the governmental agency involved in the project. If an eligible site cannot be avoided, a Memorandum of Agreement may be prepared which would stipulate specific compliance actions to be initiated prior to project actions. The project initiator, if not a federal agency, may be requested to concur. The present project is partially funded or regulated by a federal agency. As a result, cultural resource compliance has been implemented by a federal agency and Missouri SHPO and the present survey has been carried out in order to meet NHPA requirements.

Project Personnel and Schedule

The present project was carried out during December 2010. Principal Investigator and report author is Craig Sturdevant. Sturdevant has a Master of Arts degree in Anthropology from the University of Iowa, Iowa City and meets state and federal requirements for Principal Investigator for cultural resource compliance projects. John Carrel, ERC research associate, was field technician for the project.

The Project

The total proposed project area includes approximately 7.5 acres of land located south of Columbia on the east side of US 63 in the commercial area known as Discovery Ridge. A detailed project plan and profile was not included in the scope of work and it was assumed that any cultural resources located within area surveyed would be threatened by project actions. The project is located in Section 33, Township 48 North, Range 12 West, Boone County, Missouri (Figure 1).

The present investigation has been carried out utilizing Phase I survey procedures as outlined in the methods section of this report and available standard procedures for determining presence/absence of buried resources. Findings and recommendations are made with the understanding that it sometimes may not be possible to identify all possibly significant resources within a project area, particularly where vegetation is extremely heavy or valley settings with deep alluvium.

[Proprietary Information]

INVESTIGATION METHODS

Introduction

The major goal of the this investigation was the inventory and evaluation of cultural resources within the designated project zone through the use of currently accepted Phase I survey techniques and records and literature review. It is important that sufficient data are collected to allow development of appropriate recommendations concerning the significance of the identified cultural resources in the project zone in terms of National Register of Historic Places (NRHP) eligibility criteria. The methods and techniques used during the present investigation allowed an intensity of coverage that should have identified all potentially significant cultural resources. Deeply buried sites and very low material density sites are possible to miss no matter how intensive the survey techniques. This study has been initiated in order to carry out federally mandated Section 106 compliance regulations. The scope of work placed emphasis upon identification of cultural resources within the project area along with recovery of sufficient data to allow the Missouri SHPO to make an informed determination of possible significance of those resources.

The following section includes a discussion of the methods that have been employed in this study. These consist of a pre-field evaluation of pertinent literature and records from which the field survey techniques and site designation criteria are developed, an intensive pedestrian survey of the project area, an attempt to recover sufficient data for site designation and evaluation in terms of NRHP eligibility requirements, notation of locational information regarding site provenience and physiographic setting, post-field activates involving data analysis, and report preparation. The methods and techniques and justifications for interpretations are discussed below.

Records & Literature Review

A review of relevant publications and records prior to the field component of the study is important in establishing an understanding of the cultural sequence and types of cultural resources which might be expected to occur. The process begins with review of cultural resource management (CRM) reports that have been produced for the areas near the project zone. These reports are housed in the Missouri Department of Natural Resources State Historic Preservation Office (SHPO), Jefferson City, Missouri and are catalogued by county as well as author. The repository also includes historic - architecture site forms for the state, NRHP forms for Missouri, and correspondence regarding the proposed project. Archaeological Survey of Missouri (ASM) records located at the SHPO were also reviewed. The ASM files contain information on reported archaeological sites in Missouri that have been gathered for over 70 years which are catalogued by county and section, township, and range and UTM coordinates. The SHPO GIS data includes overlays illustrating recorded archaeology sites and areas that have been the subject of previous cultural resource surveys. Other resources consulted

that contain important data include the state library in Jefferson City, the State Archives in Jefferson City, local historic societies when available, and the State Historic Society in Columbia. Other archaeologists and architectural historians, particularly those employed by the state that are involved with Section 106 procedures, are consulted regarding their knowledge of significant cultural resources in a project area.

Field Procedures

The archaeological field component of the present study involved pedestrian coverage of the defined project area by ERC personnel. Transect width utilized ranged from 5 to 15 meters depending upon visibility and site potential based on terrain, streams, and other factors that have been shown to correlate with site presence/absence such as presettlement prairie or woodland setting. All vegetation-free zones are observed for presence of prehistoric cultural materials. Throughout most of Missouri, this can include lithic debitage (chert flakes and shatter), fire-cracked rock, pottery sherds and occasionally bone and shell fragments. Features such as fire hearths and burial tumuli may also be encountered. Where vegetation covers the surface for over 10 meters, shovel tests are implemented. This involves removal of around a 50 cm by 50 cm area of sod and then controlled removal of subsurface soil matrix to depths of up to 50 cm below surface. Soils are carefully observed to determine presence/absence of cultural evidence. Where soil conditions allow, soils are screened through a portable 1/4 inch screen. Shovel testing that does not include screening of matrix is implemented where larger numbers of shovel tests are necessary and surface visibility conditions are poor. In this instance, soil matrix is removed by shovel and carefully scraped with a trowel to look for prehistoric/early historic evidence.

Where evidence of presence of an archaeological resource is defined, the location is noted on a U.S.G.S. quadrangle and a sketch map and description of the site area are field prepared. Where features or structures are encountered, photographs are taken. The field procedures incorporated in the pedestrian survey are directed toward two major goals: The first was the inventory of all possibly significant cultural resources within the project zone and the second the attempt to recover sufficient information to allow interpretation of NRHP eligibility of these sites by the MoSHPO.

While subjective, ERC has developed a set of criteria for determining the presence of an archaeological resource, which are currently accepted by the SHPO as appropriate. These criteria are not presented as appropriate for all situations but as the general practice followed by ERC in making decisions regarding presence/absence of archaeological resources for cultural resource compliance purposes. One extreme would record a site where any evidence of cultural activity occurs. The other extreme would require a significant cultural resource to be present to result in recording a site. The present approach attempts to find a middle ground, which hopefully allows for further consideration for both the cultural resource and the proposed project action prior to threat to either.

An archaeology site is designated when evidence of prehistoric and/or early historic land use is present and at least one of the following specific criteria is met:

A. A prehistoric feature is present

B. Two or more artifacts are identified within a 10 by 10m or less area

C. A shovel test recovers 2 or more artifacts.

Where a site is identified and when the landowner grants permission, materials recovered by the field investigation are placed in field site number marked collection bags. If permission is not attained, materials are observed and potential diagnostics and tools measured, photographed and left in the field or given to the landowner when requested. When a permanent site number is assigned, retained materials are curated with the site designation. Where material density at a site is obviously high only a representative sample is retained.

Historic architecture resources include structures and features. Where structures are present that are over 45 years old or exhibit some form of possible exceptional significance they are photographed and a description of architectural features is prepared along with preliminary evaluation of NRHP eligibility when located within a direct impact project zone. Historic structures are not recorded where it is obvious that the structures are less than 45 years old and not significant in any other respect. Where an area of potential effect (APE) has been established beyond the physical APE, architectural resources within this defined APE obviously 45 years or older are photographed and located on report maps.

Analysis Procedures

Significance of cultural resources is interpreted from National Register of Historic Place eligibility criteria that are listed below:

> "The quality of significance in American History, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:
>
> A) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B) that are associated with the lives of persons significant in our past; or

C) that embody the distinctive characteristics of type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant distinguishing entity whose components may lack individual distinction; or

D) that have yielded, or may be likely to yield, information important in prehistory or history: (36 CFR Part 60.6).

Cultural resources that are identified during the Phase I survey are evaluated in terms of meeting one or more of the above criteria. In general, archaeological sites most often are evaluated with reference to D above. A statewide planning document was prepared by the DNR/HPP that allows minimal means for evaluation of potential significance of cultural resources (Weichman and Weston 1986). The statewide plan includes information regarding traditions, types of traditions expected, forms of data that may be potentially important, and research questions that can be incorporated in the interpretation of cultural resource significance where available. Generally, a cultural resource will be evaluated on the basis of types of materials recovered (uniqueness, affiliation, type), resource integrity (degree of disturbance), and material/feature density (density and quantity of artifacts and presence and number of potentially extant features such as hearths, house sites, and burial tumuli). Usually, if an archaeological site exhibits sub-plow zone integrity and produces diagnostic artifacts or features, the site is interpreted as significant in that it would very likely contain sufficient data to contribute to the understanding of the cultural history of the area and meet NRHP eligibility criterion D. The consultant makes recommendations regarding NRHP eligibility. The determination of eligibility process requires consultation with the SHPO and the federal agency involved in the project.

Statement of Findings and Recommendations

Where ERC locates a cultural resource within the designated project boundaries, recommendations of significance and justification are made to the MoSHPO and the federal agency involved. A decision regarding significance would be made at that level in terms of possible NRHP eligibility of the resource. Recommendations that may be made include "not eligible for NRHP status", "possibly eligible for NRHP status", or "eligible for NRHP status." Where a recommendation of not eligible is accepted by the SHPO and federal agency a proposed compliance project can proceed as planned; a recommendation of possibly eligible results in agency request that the project be modified to avoid the resource or given further evaluation in order to establish NRHP eligibility; a recommendation of eligible results in a request to modify the project to avoid the cultural resource or proceed with the consultation process as outlined by 36 CFR Part 800: Protection of Historic Properties that governs the Section 106 review process established by the National Historic Preservation Act of 1966 as amended.

PROJECT SETTING

Environmental Setting

The project area lies on the border of the Dissected Till Plains to the north and Ozark Plateau on the south in Central Lowlands Province of North America. The bedrock in the area consists of Mississippian limestones covered with varying depths of clays and glacial drift as well as limestone residuum and colluvium and alluvium (cf. Branson 1944; Stout and Hoffman 1973).

The project is located within a presettlement prairie zone (Kucera 1961; Schroeder 19891:7) in an upland divide between Cedar Creek on the east and Bonne Femme headwaters on the west. The area exhibited a wide variety of indigenous floral species in the past (Chapman 1975:12-16). Early surveyors list several species of oak, hickory, black walnut, hackberry, sycamore, elm, and elders in the bottoms along with open oak-hickory upland woodlands to the east, west, and south and grasses that would have included Big and Little Bluestem, Indian Grass, Switch Grass, Side-oats Grama, and pockets of Bluejoint and Canada Wild Rye in the project area (Allgood and Persinger 1979:60).

Some species of animals present during the pioneer period have been extirpated from their former ranges since the Euro-American settlement of the area. These species include gray wolf, elk, and bison (Chapman 1975). The mountain lion and black bear occur rarely in the forested regions of the interior Ozark Highlands (Wood and McMillan 1976). More common species in the drainage basin include white-tailed deer, gray fox, red fox, coyote, raccoon, beaver, bobcat, mink, opossum, muskrat, spotted skunk, squirrels, rabbit, and woodchuck. It is probable that the project area exhibited typical prairie/woodland ecotonal populations in which a variety of large and small game was available in both woodland and prairie settings.

The climate within the project area is midcontinental and experiences temperature extremes both seasonally and on a day-to-day basis. This area of Missouri is in the path of cold air moving down out of Canada, warm moist air coming up from the Gulf of Mexico, and dry air from the west. The mean annual precipitation in the area is around 40 inches which includes 12 to 17 inches of snow per year. The mean length of the growing season is around 187 days. The killing freezes generally begin between October 15 and 20 and end between April 15 and 20 (Chapman 1975).

The project area exhibits few characteristics suggesting high potential for presence of intensive or extensive prehistoric occupation. The counties north of the Missouri river exhibit an ecotonal situation that included a relatively high percentage of presettlement prairie and lesser amount of presettlement woodland (Schroeder 1981). While Boone County was made up only of 16% presettlement prairie, the present project occupies the only expansive prairie zone in the county. Earlier studies have well

illustrated the finding that known prehistoric occupations in the region are almost entirely located within presettlement woodland zones with less than 3% of the known prehistoric sites found within presettlement prairie zones (cf. Sturdevant 1983). Another major consideration that appears to have entered into prehistoric site selection involved availability of cherts that were a primary raw material for much of the subsistence technology. Bedrock in the general area does include Missisippian age cherts that were utilized extensively by prehistoric occupants as raw material for tools. These cherts would not have been easily accessible in the project area. The project setting would have also lacked immediate availability of a consistent water supply necessary to support any intensive or extensive human habitation resulting in a low prehistoric site potential.

Cultural Setting

The project is located in the Central Missouri Drainage Basin (Figure 2). The occupation of Missouri by prehistoric populations has been generally established to include nine to ten traditions (cf. Chapman 1975; 1980). These traditions apply in varying degree to the entire state with some traditions often not accounted for in specific drainages. These traditions are incorporated in what is called the cultural sequence which is a major factor utilized in interpretation of cultural data, particularly regarding National Register of Historic Place (NRHP) significance. These traditions are listed below in the sequence provided by Chapman (1975; 1980).

Paleo-Indian	12000 to 8000 B.C.
Dalton	8000 to 7000 B.C.
Early Archaic	7000 to 5000 B.C.
Middle Archaic	5000 to 3000 B.C.
Late Archaic	3000 to 1000 B.C.
Early Woodland	1000 to 500 B.C.
Middle Woodland	500 B.C. to A.D. 400
Late Woodland	A.D. 400 to 900
Mississippian	A.D. 900 to 1400

Paleo-Indian: With the exception of a possible earlier "Early Man" tradition, the Paleo-Indian is generally accepted as the earliest known occupation of Missouri. These specialized hunters lived in small nomadic bands or family groups and left some traces of their transitory settlement pattern in the forms of hunting camps, kill sites, quarry sites, and possibly small base camps (cf. Ford 1974:388). The major diagnostic materials associated with the occupation includes the Clovis and Folsom fluted spear/knife points. Most fluted point finds have been located along major river valleys such as the Missouri River although some have been recovered along streams such as the Moreau River. This has been suggested to indicate that these nomadic hunters and gatherers followed these streams in their movement through the Midwest area. Chapman indicates that his division of the Northeast and Northwest Prairie region at a point in Cooper and Howard counties above Boonville on the Missouri River separates the major occupation zones of the

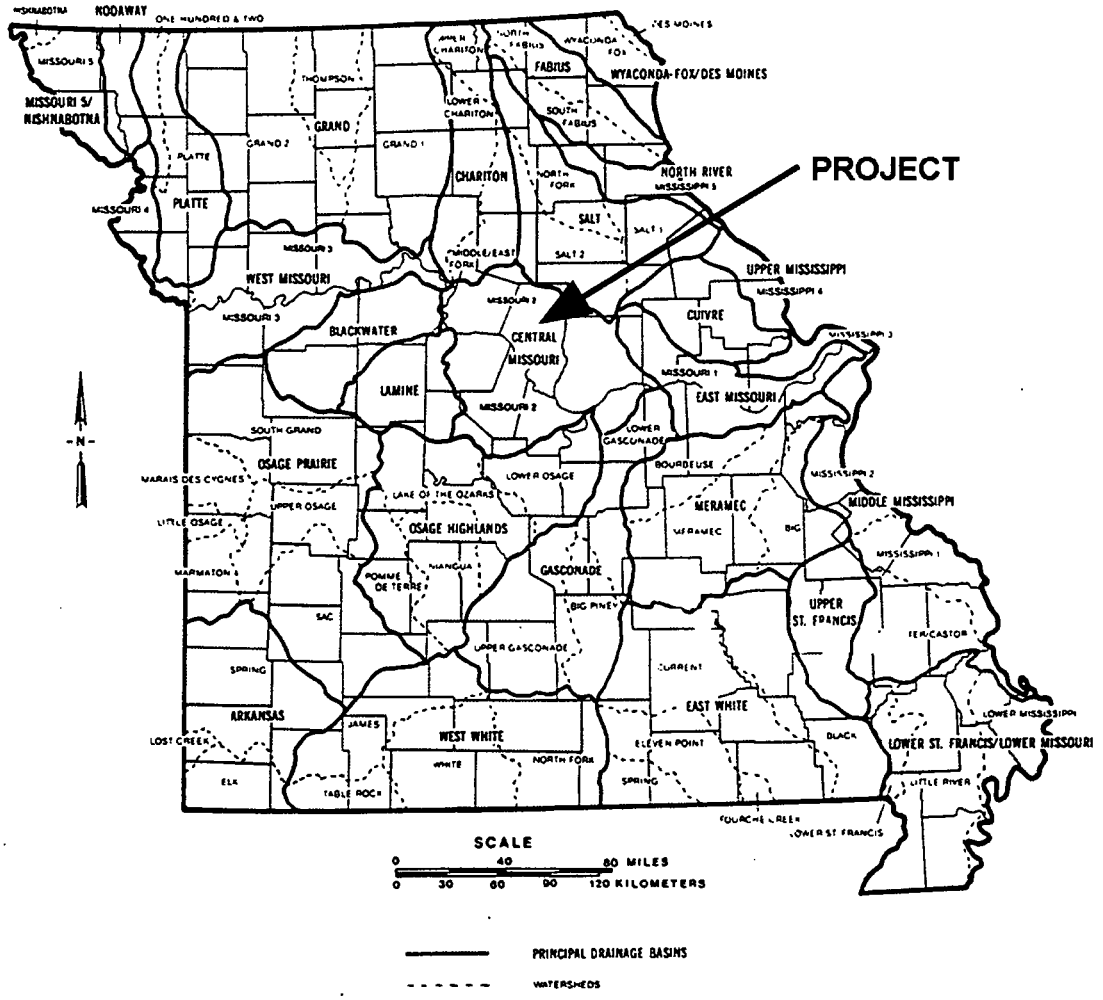

Figure 2.
DNR Study Unit/Drainage Basin Location of Project

Paleo-Indian populations. That is, the steep bluffs below this point appear to have been more conducive to Paleo-Indian occupation than the more prairie related terrain above this point. Fluted points are generally more plentiful below this point toward St. Louis than above this point toward Kansas City (Chapman 1975:75). Chapman's review of Paleo-Indian diagnostics illustrates larger numbers of reported fluted points beginning in Howard County and continuing toward St. Louis with a small number reported from Callaway County (1975:67).

Dalton: Chapman characterizes the Dalton period as a time of transition from Paleo-Indian big game hunting to the hunting-foraging subsistence strategy of the following Archaic period (1975:96). All known Dalton sites in Missouri are small camps

and all apparently represent short-term utilization. The basic Paleo-Indian tool kit was still in use during Dalton times although tools associated with plant food processing were added. Point types with long flutes have been replaced by types with basal thinning and or short flutes. The major diagnostic includes the Dalton Serrated and perhaps the Dalton adze. Distribution roughly parallels the Paleo-Indian.

Early Archaic: By the Early Archaic the transition to a subsistence pattern based on foraging was well underway. Subsistence activities were broadened to exploit more ecological niches. Hunting and gathering continued as the major economic activities but emphasis was placed on aquatic resources and vegetal foods. Although nomadic wandering was being replaced by "a regular hunting-gathering range with specific base camp sites that were returned to at regular intervals" (Chapman 1975:135), the typical Early Archaic site continued to be a small hunting and or collecting camp. These 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. Diagnostics of Early Archaic include Graham Cave Notched that has been recovered in the general area (Chapman 1975). Hardin Barbed is also generally associated with Early Archaic occupation.

Middle Archaic: The Middle Archaic was basically a continuation and expansion of a forager tradition begun in the Dalton and Early Archaic. A drying climate forced greater reliance upon collecting vegetal foods and small animals as opposed to wet environment subsistence. Sites continued to be small, exhibiting semi-nomadic or seasonal occupation with no specific topographic location associated (Chapman 1975:159). The tool kit continued to expand, depending upon the extraction activity in the specific niche. The drying climate was reflected in the marked tendency for Middle Archaic sites to be located almost exclusively in or very near bottomland settings (Chapman 1975). There are no complexes associated with the period in this general area. Collectors in the area often have Big Sandy forms in their collections. It is assumed that Middle Archaic was present but in an as yet poorly defined situation. Site forms for the drainage are inconclusive in terms of presence of Middle Archaic diagnostics.

Late Archaic: The Late Archaic is somewhat better known than earlier traditions. This is a result of the greater population apparently represented by the Late Archaic which resulted in more expansive and numerous occupations. This period generally lacks the small dart point of the earlier traditions that suggests that hunting had become less important for subsistence. In addition, tool kit function appears to have expanded suggesting reliance on a much larger variety of potential foods requiring varied extraction and processing techniques. The Late Archaic began toward the climax of a warming trend that reached its height around 2000 B.C. (Cleland 1966), with a resultant diminishing of the faunal and floral forest species. The Late Archaic peoples had to adapt to new ecological niches with concomitant changes in subsistence related artifacts. Emphasis was probably placed on a method of procurement that could effectively exploit various types of resources which were available in reliable quantities at varying seasons. Using a central-based wandering settlement pattern in which the particular seasonal

resources available would determine the type and location of temporary camps radiating from more permanent occupation sites, Late Archaic settlement pattern appears to have been somewhat more restricted than previous foraging traditions. Diagnostic artifacts of this period include the Sedalia Lanceolate and Diggers, Clear Fork Gouge, Smith Basal Notch, Afton, Etley, Nebo Hill, Stone Square, as well as 3/4 groove granite axes. Evidence of the Sedalia complex are often found just over the crown of the slope of high ridges (Chapman 1975:200). Late Archaic occupations are one of the more commonly identified traditions in the drainage according to ASM records.

Early Woodland: The Early Woodland period is identified by presence of Black Sand Incised pottery and is poorly represented throughout most of Missouri. In spite of intensive surveys in various areas of the state, only a few unquestionable Early Woodland sites have been identified and include Avondale, Renner, and Shields sites in the Kansas City area and a few in the northeast portion of the state. These and other possible Early Woodland sites are generally found in the major river valleys, particularly along the Missouri River.

Middle Woodland: The Middle Woodland period occupation in northern Missouri is focused on three related regional centers: The Havana center in the Lower Illinois River Valley and adjacent Mississippi River valley in the northeast, the Kansas City Hopewell, and Big Bend centers. The latter two are on the Missouri River. Analyses of pottery from the three centers indicate there was an intrusion of people into the Big Bend and Kansas City areas from the Havana center to the east (Wedel 1943) although the initial intrusion appears to have been related to subsistence and/or political stress (Struever & Houart 1972) in the Havana center, contacts among the three centers was maintained throughout the Middle Woodland period (Chapman 1980). These continued contacts insured the Big Bend and Kansas City areas of a place in the Classic Middle Woodland's Hopewell Interaction Sphere. Evidence for a Middle Woodland occupation is very sparse outside of the areas noted. Some rock shelters and open habitation sites in the general area have produced Middle Woodland diagnostics and Chapman identified south Boone County as a major Middle Woodland center (1980). There has been no corroborating evidence through field investigations regarding the assertion by Chapman. In general, with the exception of the Big Bend and Kansas City Hopewell, Middle Woodland diagnostics usually are interpreted from lithics such as Snyders points with ceramics reflecting Hopewellian occupation lacking but for the centers.

Late Woodland: The Late Woodland period exhibits the most numerous defined components within prehistoric sites in the general project area. The occupation in this portion of Missouri has sometimes been defined as a regression from the preceding traditions in that emphasis on horticulture developed earlier in the Woodland was supplanted by earlier hunting subsistence reliance. This pattern is seen in the increase in small temporary camps along with use of bow and arrow. Diagnostics include grit and limestone tempered pottery, arrow points, burial mounds, and shallow side notched points. Several Late Woodland sites have been identified in the county including both

open habitation sites and burial tumuli. A large number the archaeological sites identified in the general project area have exhibited Late Woodland diagnostics (Sturdevant 1978).

Mississippian: The Early Mississippian period is not well documented in the general area of the project. Steed-Kisker, an Early Mississippi phase, is located in the Kansas City area while Cahokia and the St. Louis area represent a climax associated with Early Mississippian (Chapman 1980). Diagnostics for this period include small triangular arrow points and shell tempered ceramics. Where Early Mississippian experienced climax levels, temples and towns were part of the settlement pattern. In the immediate area only triangular points and an occasional shell tempered sherd have been reported. Early Mississippian Steed-Kisker people apparently abandoned the Kansas City area around A.D. 1250 and around A.D. 1350 the Oneota cultural tradition appeared suddenly in the Big Bend area near the junction of the Grand, Chariton, and Missouri rivers. It is speculated that Oneota developed in northern Missouri and Iowa and its formation was stimulated by developments at the Cahokia center. While the extent of Cahokia influences remains unknown, cultural developments of the period in that area have been connected to the cultural background and growth of the historic Siouan-speaking people (Griffin 1960). The most prominent Oneota village in the Big Bend area is the Utz site and it was there the Utz phase, which documents the Oneota culture of the area, was defined. The Utz phase, and the Oneota occupation, began at about A.D. 1350 and lasted to the end of the Mississippian period (A.D. 1700) when Oneota blends into what is recognized as the Historic Missouri Indian tribe.

Historic Period: During the period from 1730 to 1790, the Missouri tribe was being depleted by smallpox and its power was continually being tested by its enemies to the north. By the 1780's, the Missouri became heavily dependent on their allies the Osage for protection. In spite of this, the Sac and Fox conquered and dispersed the Missouri tribe in the 1790's. Those who were not killed joined the Osage, Kansas, and Oto tribes. The great smallpox epidemic of 1823 reduced their numbers to less than one hundred and Missouri as a distinct cultural entity became extinct. The last full-blood Missouri Indian died on the Oto reservation in 1907 (Chapman 1946:29).

The lands encompassed by the project were but a small part of North American territory claimed by France until 1762 when it was transferred to Spain by secret treaty. Spain retroceded the land to France in 1801 and France ended up selling it to the U.S. in 1803 as the Louisiana Purchase. In 1812, congress created the Territory of Missouri and in 1821 Missouri was recognized as the twenty-first state (March 1963). In general, the post-1800 history of central Missouri reflects both the general patterns of agricultural developments in the Midwest and specific influences which shaped the region. The process of early settlement and the struggle to produce beyond a meager subsistence, the expansion of the agricultural and commercial activities and creation of a stable society, followed by an era in which regional concerns were shaped by state and national trends, are all recognized as part of the evolution of the Midwest. In the case of northern Missouri, an understanding of its Euro-American past requires recognition of the

influence of the settlers themselves and of the land which they occupied. The early settlers came primarily from the Upper South, especially Kentucky, Tennessee, and Virginia. Prior to the Civil War, first tobacco and then corn played an important role in the agricultural economy of the region. The first permanent settlers began entering the area in the early 1800's, a process that really began only after the acquisition of the Louisiana territory by the U.S. in 1803. Congress created the territory of Missouri in 1812 and nine years later recognized Missouri as the twenty-first state (Meyer 1963). The rapid development from uncharted wilderness to statehood stemmed directly from the massive westward movement of population during the early nineteenth century. Most of the settlers who came to mid-Missouri were attracted to the land. The fertile soil, adequate rainfall, and a growing season that averaged six months a year made the region particularly well-suited for agriculture. A rich, friable loam predominated, with substantial stands of timber which provided building materials and generally reminded the immigrants of the lands which they had left behind.

The background of the settlers made them receptive to cultivating a crop that would reproduce the agricultural patterns of their native states. Most of the early settlers came from the Upper South that included slave holding states. March (1967) suggests that within the "slave belt" through central Missouri, major crops included hemp and tobacco. These crops, particularly tobacco, demand intensive labor for productivity. Tobacco is generally favored as a cash crop in that it produced a greater value in proportion to bulk when compared to grain crops. In areas such as the project, transportation would have been a problem prior to the railways. Cash crops such as tobacco in areas that did not provide viable river transportation soon shifted to local consumption crops such as corn and wheat. While not well documented at present, it is apparent that agricultural pursuits were almost entirely geared toward corn and wheat by the time of the Civil War. It is further apparent that slave holding had begun to drop at a relatively high rate prior to the Civil War (Campbell 1874). The land and its location, then, became major shaping forces of the economic system of the area, altering the previous patterns established in the southeast and brought to the Midwest. The coming of the railroad in the 1850's through the 1870's opened the interior to greater trade and agricultural products have been the major source of livelihood in the general area since this time.

INVESTIGATION FINDINGS

Records and Literature Review

Boone County, Missouri currently contains 49 National Register of Historic Places (NRHP) properties. These include the following:

Ballenger Building (*Downtown Columbia, Missouri MPS*), 27-29 South Ninth St., Columbia (1/21/04)

Bond's Chapel Methodist Episcopal Church, MO A, 2.5 mi. NE of Hartsburg, Hartsburg vicinity (9/09/93)

Boone, John W. ("Blind"), House (*Social Institutions of Columbia's Black Community TR* [see note*]), 4th St. between E Broadway and Walnut, Columbia (9/04/80)

Central Dairy Building (*Downtown Columbia, Missouri MPS*), 1104-1106 East Broadway, Columbia (1/20/05)

Chance, Albert Bishop, House and Gardens, 319 E Sneed St., Centralia (7/03/79)

Chatol (F. Gano Chance House, Chance Guest House), 543 S Jefferson, Centralia (4/20/79)

Coca-Cola Bottling Co. Building (*Downtown Columbia, Missouri MPS*), 10 Hitt St., Columbia (2/14/06)

Columbia Cemetery, 30 East Broadway, Columbia (2/01/07)

Columbia National Guard Armory, 701 E Ash St., Columbia (3/25/93)

Conley, Sanford F., House, 602 Sanford Pl., Columbia (12/18/73)

Douglass, Fred, School (*Social Institutions of Columbia's Black Community TR* [see note*]), 310 N Providence Rd. (9/04/80)

Downtown Columbia Historic District (*Downtown Columbia, Missouri MPS*; map [see note]), parts of 7th, 8th, 9th, 10th, E. Broadway, Cherry, Hitt, Locust, and E. Walnut Streets, Columbia (11/08/06)

Downtown Columbia Historic District (*Downtown Columbia, Missouri MPS*; boundary increase), 1019,1020,1023 & 1025-33 E. Walnut St., Columbia (5/08/08)

East Campus Neighborhood Historic District, roughly bounded by Bouchelle, College, University, and High Sts., including parts of Willis, Bass, Dorsey, and Anthony Sts., Columbia (2/16/96)

Eighth Broadway Historic District [Miller Building, Matthews Hardware, Metropolitan Building], 800-810 E. Broadway Blvd., Columbia (4/22/03)

Elkins, Samuel H. and Isabel Smith, House, 315 N 10th St., Columbia (9/12/96)

First Christian Church, 101 N 10th St., Columbia (10/29/91)

Francis Quadrangle Historic District (Red Campus), bounded by Conley Ave., Elm, 6th and 9th Sts., Columbia (12/18/73)

Frederick Apartments, 1001 University Ave., Columbia (4/16/13)

Gordon, David, House and Collins Log Cabin (Gordon Manor, Fairmount, Cedar View), 2100 E Broadway, Columbia (8/29/83)

Gordon Tract Archaeological Site, address restricted (3/16/72)

Greenwood (Greenwood Heights), 3005 Mexico Gravel Rd., Columbia (1/15/79)

Guitar, David, House (Confederate Hill), 2815 Oakland Gravel Rd., Columbia (9/09/93)

Hackman, Samuel E., Building, 30 S St., Hartsburg (12/10/98)

Hamilton-Brown Shoe Factory, 1123 Wilkes Blvd., Columbia (7/19/02)

Hunt, William B., House, 8939 W Terrapin Hills Rd., Columbia vicinity (1/09/97)

Kress Building (*Downtown Columbia, Missouri MPS*), 1025 E. Broadway, Columbia (3/09/05)

Maplewood, Nifong Blvd. and Ponderosa Dr., Columbia (4/13/79)

McCain Furniture Store (*Downtown Columbia, Missouri MPS*), 916 E. Walnut, Columbia (8/17/05)

Missouri, Kansas and Texas Railroad Depot, 402 E Broadway, Columbia (1/29/79)

Missouri State Teachers Association, 407 S 6th St., Columbia (9/04/80)

Missouri Theater, 201-215 S 9th St., Columbia (6/06/79)

Missouri United Methodist Church, 204 S 9th St., Columbia (9/04/80)

Mount Zion Church and Cemetery (*Rural Church Architecture of Missouri, c. 1819 to c. 1945 MPS*), 11070 Mount Zion Rd., Hallsville vicinity (1/14/13)

North Ninth Street Historic District (*Downtown Columbia, Missouri MPS*) (map [see note]), 5-36 North Ninth St., Columbia (1/21/04)

Payne, Moses U., House, 201 N Roby Farm Rd., Rocheport vicinity (10/07/94)

Pierce Pennant Motor Hotel (Candlelight Lodge), 1406 Old Hwy. 40 W, Columbia (9/02/82)

Rocheport Historic District, MO 240, Rocheport (10/08/76)

St. Paul's A.M.E. Church (*Social Institutions of Columbia's Black Community TR* [see note*]), 501 Park St. (9/04/80)

Sanborn Field and Soil Erosion Plots, University of Missouri Campus, Columbia (10/15/66; **NHL 7/19/64**)

Second Baptist Church (*Social Institutions of Columbia's Black Community TR* [see note*]), 407 E Broadway (9/04/80)

Second Christian Church (*Social Institutions of Columbia's Black Community TR* [see note*]), 401 N 5th St. (9/04/80)

Senior Hall, Stephens College Campus, Columbia (8/02/77)

Stephens College, South Campus, 1200 E. Broadway, Columbia (11/25/05)

Taylor, John N. and Elizabeth, House, 716 West Broadway, Columbia (5/25/01)

Tiger Hotel, 23 S 8th St., Columbia (2/29/80)

Virginia Building, 111 South Ninth Street, Columbia (3/13/02)

Wabash Railroad Station and Freight House (Norfolk and Western Depot), 126 N 10th St., Columbia (10/11/79)

West Broadway Historic District, 300-922 W. Broadway (except 800, 808, 812), Columbia (4/27/10)

Wright Brothers Mule Barn, 1101-1107 Hinkson Ave. & 501-507 Fay St., Columbia (11/01/07)

There are no previously recorded prehistoric archaeology sites within the project boundaries (Figure 3). [Proprietary Information] The project area contains no recorded historic architecture or possibly significant historic events.

Review of 19th and 20th century plat maps and 20th century USGS topographic quadrangles found no evidence of structures within the proposed project area. The 1967/81 USGS topographic quadrangle does not illustrate any structures in the project boundaries.

Field Investigation Findings

The field investigation was carried out under generally mixed to poor surface visibility conditions averaging less than 20% in a grass/hay setting (Figure 4). Shovel tests were utilized in order to interpret presence/absence of cultural resources as described in the methods section of this report. The presence of erosion cuts and paths along with shovel tests allowed for a sample of subsurface soil matrix for interpretation of potential for presence/absence of buried cultural resources.

The field investigation failed to identify any evidence of the presence of prehistoric occupation of the area. Typically, this includes presence of chert debitage, fire-cracked rock, lithic artifacts, and occasionally ceramics. None of these materials were encountered on the surface or in shovel tests. No prehistoric sites have been recorded.

Historic resources include recently constructed roads which do not meet the investigators' historic site designation criteria. No historic sites have been recorded.

It is the finding of this Phase I cultural resources survey that Lot 15 in the Discovery Ridge development contains no possibly significant cultural resources.

[Proprietary Information]

Figure 4.
Aerial Photograph of Project Area Surveyed (YELLOW)

RECOMMENDATIONS

During September 2013 a Phase I cultural resources survey was carried out for a 7.5 acre tract of land at Discovery Ridge, Boone County, Missouri. The area is the location of a proposed commercial development project.

There are no National Register of Historic Places (NRHP) properties located within the proposed project area; DNR GIS records indicate presence of no recorded archaeology sites within the project boundaries; and no recorded Missouri DNR historic architectural sites are present within the project area of potential effect (APE). 19th century plat maps do not illustrate any structures within the project area.

The field investigation was carried out under poor surface visibility conditions in a grass/hay setting. Shovel testing was implemented following guidelines described in this report. No evidence of the presence of prehistoric occupation was identified within the project area. No evidence of the presence of early historic occupation was identified within the project boundaries.

On the basis of the negative findings regarding presence of possibly significant cultural resources, it is the recommendation of this Phase I cultural resources survey that the proposed project proceed as planned in terms of Section 106 compliance concerns. No significant cultural resources will be threatened by the proposed project actions.

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ATTACHMENT B
Description of the Proposed Northwest Medical Isotopes, LLC Radioisotope Production Facility

NWMI is preparing an application for submission to the NRC to construct, operate, and decommission a Radioisotope Production Facility (RPF). This facility is proposed to be located at the University of Missouri System (UM System) Discovery Ridge Research Park in Columbia, Missouri. The proposed operations of the RPF includes fabrication of low enriched uranium (LEU) targets, deliver targets to a network of university research nuclear reactors for irradiation, receive irradiated targets, and extract and purify molybdenum-99 (^{99}Mo) from the irradiated LEU. The LEU would be reclaimed and recycled into targets for delivery to the network of university research reactors. The ^{99}Mo would be sold and distributed through the existing U.S. supply chain network.

Schedule

- Submit construction application to NRC (4th Q 2014)
- NRC review and approval (Expected 4th Q 2015)
- Site preparation and construction: (2015 – 2016)
- Facility Operations (2017 – 2045)

Site Location

The proposed 7.5 acre site is situated in Boone County, Missouri, within the UM System, Discovery Ridge Research Park in Columbia, Missouri north of Discovery Ridge Drive (Figure B-1). The approximate center of the NWMI RPF is Longitude: 92°16'34.63" and Latitude: 38°54'3.31".

Site Description

The proposed site is located on Lot 15 of the Phase II section of the Discovery Ridge Research Park. The site is all on property owned by UM System. The facility would be approximately 330 feet (ft) in the long dimension and 110 ft wide with a maximum height of 45 ft not counting the stacks (Figure B-2). The site would include an outer fence perimeter and provide the necessary initial security barrier. The fenced area would include paved roads laid out for the turning radius of tractor/trailers used to transport the materials.

Additional information can be found at the UM System, Discovery Ridge Research Park website, http://www.umsystem.edu/ums/aa/umrpi/discoveryridge.

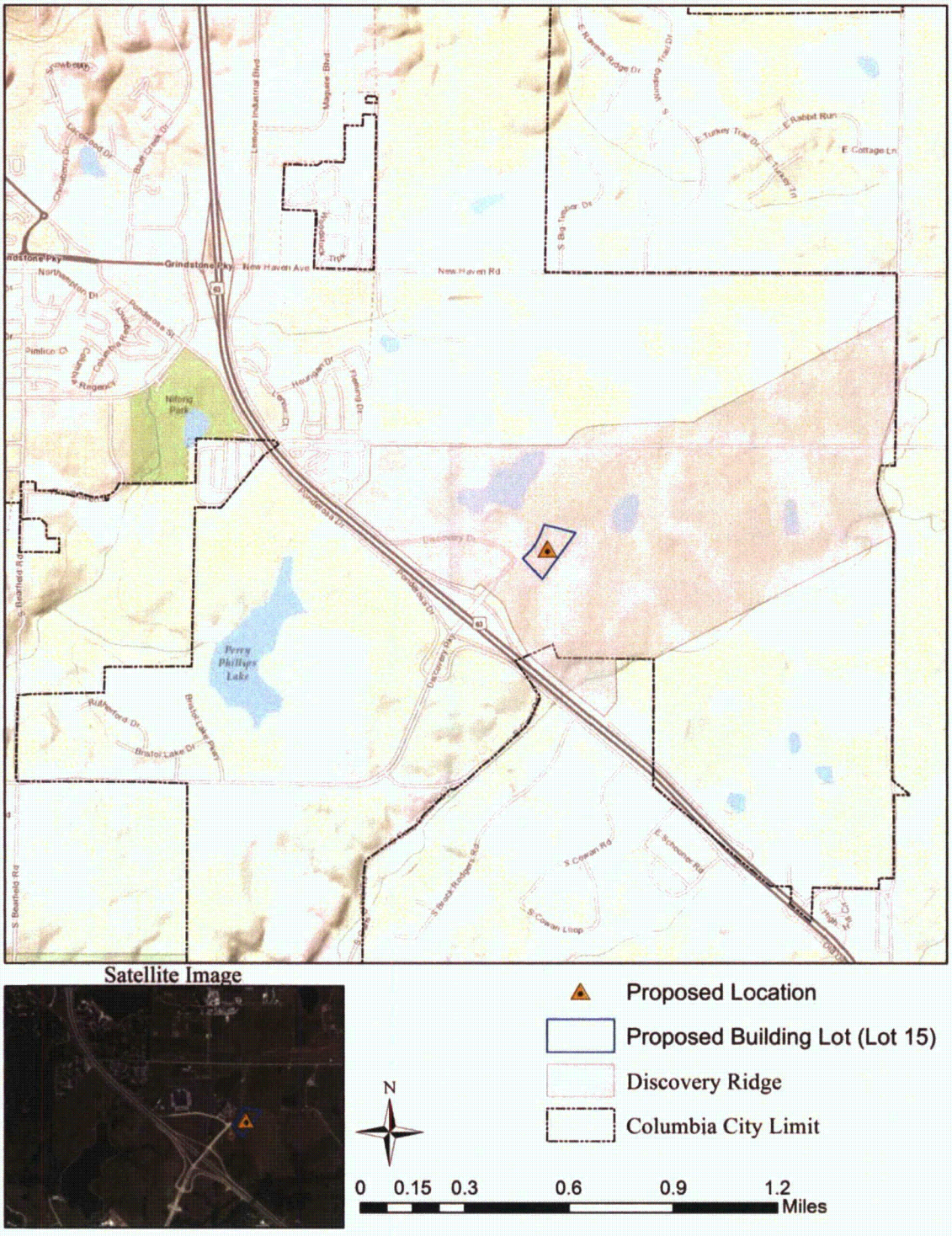

Figure B-1. Proposed Location NWMI RPF – Discovery Ridge located in Columbia, Missouri

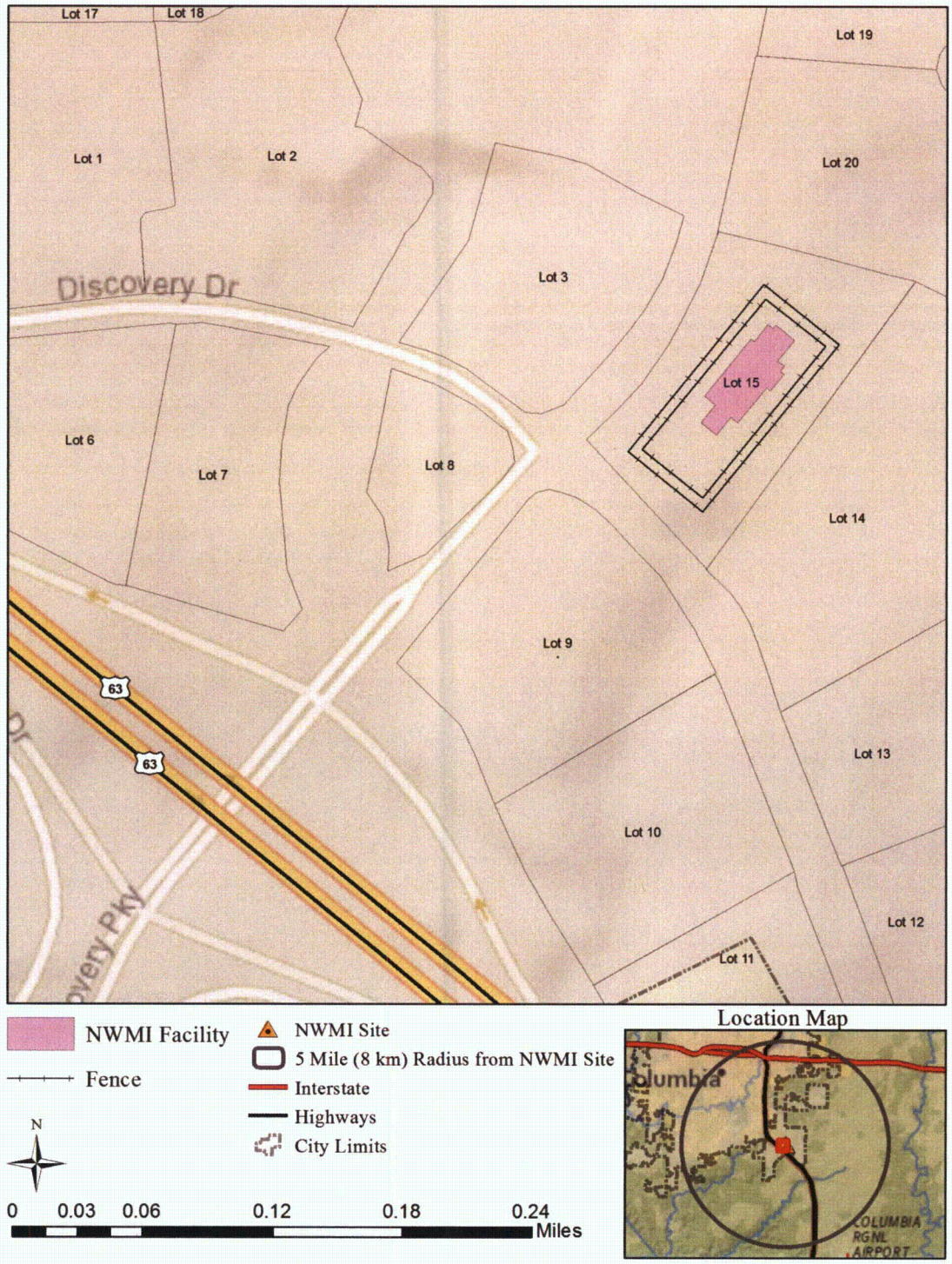

Figure B-2. NWMI RPF General Layout.

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Appendix B

MISSOURI STATE HISTORIC PRESERVATION OFFICE CONSULTATION LETTER AND RESPONSE

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Environmental Research Center of Missouri, Inc.
1201 Moreau Drive
Jefferson City, Missouri 65101
573.635.9569
craigsturdevant@mchsi.com

October 7, 2013

Mr. Mark Miles
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, Missouri 65102

Re: Cultural Resource Investigations, Phase I Survey, Lot 15 – Discovery Ridge, Boone County, Missouri

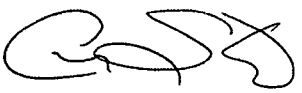
Dear Mark:

Please find one paper and an electronic copy of the above noted report. Please send your response to:

Carolyn Haass
Vice President/Technical Program Director
Northwest Medical Isotopes, LLC
Vice President/Technical Program Director
815 NW 9th Ave, Suite 256
Corvallis, Oregon 97330

Thank you for your time and consideration in this matter. If you have any questions, please call me.

Sincerely,



Craig Sturdevant
President/ERC

c. C. Haas
J. Beller

Cultural Resource Investigations
Phase I Survey
Lot 15 – Discovery Ridge
Boone County, Missouri

Nuclear Regulatory Commission Project

Prepared for:
Northwest Medical Isotopes L.L.C.

Prepared By:

Environmental Research Center of Missouri, Inc.
1201 Moreau Drive
Jefferson City, Missouri
Phone: 573-635-9569
Email: craigsturdevant@mchsi.com

Principal Investigator:
Craig Sturdevant
September 2013
ERC Project No. 3023

ERC

ABSTRACT

During September 2013 a Phase I cultural resources survey was carried out for a 7.5 acre tract of land at Discovery Ridge, Boone County, Missouri. The area is the location of a proposed commercial development project.

There are no National Register of Historic Places (NRHP) properties located within the proposed project area; State Historic Preservation Office (SHPO) GIS records indicate presence of no recorded archaeology sites within the project boundaries; and no recorded SHPO historic architectural sites are present within the project area of potential effect. 19th century plat maps do not illustrate any structures within the project area.

The field investigation was carried out under poor surface visibility conditions in a grass/hay setting. Shovel testing was implemented following guidelines described in this report. No evidence of the presence of prehistoric occupation was identified within the project area. No evidence of the presence of early historic occupation was identified within the project boundaries.

On the basis of the negative findings regarding presence of possibly significant cultural resources, it is the recommendation of this Phase I cultural resources survey that the proposed project proceed as planned in terms of Section 106 compliance concerns. No significant cultural resources will be threatened by the proposed project actions.

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INTRODUCTION

Purpose of Study

In compliance with current environmental regulations and policies, Northwest Medical Isotopes L.L.C. entered into a contractual agreement with Environmental Research Center of Missouri, Inc. (ERC) to conduct a Phase I cultural resource survey of a 7.5 acre tract of land at Discovery Ridge in Boone County, Missouri. The study followed the Missouri Department of Natural Resources (DNR) "Guidelines for Cultural Resource Contract Reports and Professional Qualifications" and is submitted in accordance with current environmental regulations and policies and in agreement with the study contract.

The project actions included discussion of the project with Missouri Department of Natural Resources/Historic Preservation Program staff, a records and literature review, and an intensive pedestrian field investigation of the project area. The study methods used are described and the results of the findings of these actions are presented in terms of cultural resource descriptions, when present, and recommendations for cultural resource compliance in reference to the proposed project actions. The project area cultural and environmental settings are briefly described.

Under state and federal legislation and policies outlined by the Antiquities Act of 1906, the Historic Sites Act of 1935, the National Historic Preservation Act (NHPA) of 1966 as amended, the National Environmental Policy Act of 1970, the 1986 Protection of Historic Properties and other regulations regarding specific activities such as strip mining, it is necessary to inventory archaeological and historical resources located within proposed project areas which may be threatened by federally regulated or funded actions and evaluate any disruptive effects these actions might have on resources that are present. Briefly, the National Historic Preservation Act requires that an area threatened by a federally funded and/or regulated project consider cultural resources which might be impacted by project related actions; the State Historic Preservation Officer (SHPO) and/or federal agency involved may request that a cultural resource survey be conducted prior to granting permission to proceed with the proposed project actions. If any cultural resources are identified, they are evaluated in terms of National Register of Historic Places (NRHP) eligibility criteria. Where NRHP eligible sites are found to occupy compliance project areas, consultation is initiated which may include the Advisory Council on Historic Preservation (Council), the SHPO, and the governmental agency involved in the project. If an eligible site cannot be avoided, a Memorandum of Agreement may be prepared which would stipulate specific compliance actions to be initiated prior to project actions. The project initiator, if not a federal agency, may be requested to concur. The present project is partially funded or regulated by a federal agency. As a result, cultural resource compliance has been implemented by a federal agency and Missouri SHPO and the present survey has been carried out in order to meet NHPA requirements.

Project Personnel and Schedule

The present project was carried out during December 2010. Principal Investigator and report author is Craig Sturdevant. Sturdevant has a Master of Arts degree in Anthropology from the University of Iowa, Iowa City and meets state and federal requirements for Principal Investigator for cultural resource compliance projects. John Carrel, ERC research associate, was field technician for the project.

The Project

The total proposed project area includes approximately 7.5 acres of land located south of Columbia on the east side of US 63 in the commercial area known as Discovery Ridge. A detailed project plan and profile was not included in the scope of work and it was assumed that any cultural resources located within area surveyed would be threatened by project actions. The project is located in Section 33, Township 48 North, Range 12 West, Boone County, Missouri (Figure 1).

The present investigation has been carried out utilizing Phase I survey procedures as outlined in the methods section of this report and available standard procedures for determining presence/absence of buried resources. Findings and recommendations are made with the understanding that it sometimes may not be possible to identify all possibly significant resources within a project area, particularly where vegetation is extremely heavy or valley settings with deep alluvium.

[Proprietary Information]

INVESTIGATION METHODS

Introduction

The major goal of the this investigation was the inventory and evaluation of cultural resources within the designated project zone through the use of currently accepted Phase I survey techniques and records and literature review. It is important that sufficient data are collected to allow development of appropriate recommendations concerning the significance of the identified cultural resources in the project zone in terms of National Register of Historic Places (NRHP) eligibility criteria. The methods and techniques used during the present investigation allowed an intensity of coverage that should have identified all potentially significant cultural resources. Deeply buried sites and very low material density sites are possible to miss no matter how intensive the survey techniques. This study has been initiated in order to carry out federally mandated Section 106 compliance regulations. The scope of work placed emphasis upon identification of cultural resources within the project area along with recovery of sufficient data to allow the Missouri SHPO to make an informed determination of possible significance of those resources.

The following section includes a discussion of the methods that have been employed in this study. These consist of a pre-field evaluation of pertinent literature and records from which the field survey techniques and site designation criteria are developed, an intensive pedestrian survey of the project area, an attempt to recover sufficient data for site designation and evaluation in terms of NRHP eligibility requirements, notation of locational information regarding site provenience and physiographic setting, post-field activates involving data analysis, and report preparation. The methods and techniques and justifications for interpretations are discussed below.

Records & Literature Review

A review of relevant publications and records prior to the field component of the study is important in establishing an understanding of the cultural sequence and types of cultural resources which might be expected to occur. The process begins with review of cultural resource management (CRM) reports that have been produced for the areas near the project zone. These reports are housed in the Missouri Department of Natural Resources State Historic Preservation Office (SHPO), Jefferson City, Missouri and are catalogued by county as well as author. The repository also includes historic - architecture site forms for the state, NRHP forms for Missouri, and correspondence regarding the proposed project. Archaeological Survey of Missouri (ASM) records located at the SHPO were also reviewed. The ASM files contain information on reported archaeological sites in Missouri that have been gathered for over 70 years which are catalogued by county and section, township, and range and UTM coordinates. The SHPO GIS data includes overlays illustrating recorded archaeology sites and areas that have been the subject of previous cultural resource surveys. Other resources consulted

that contain important data include the state library in Jefferson City, the State Archives in Jefferson City, local historic societies when available, and the State Historic Society in Columbia. Other archaeologists and architectural historians, particularly those employed by the state that are involved with Section 106 procedures, are consulted regarding their knowledge of significant cultural resources in a project area.

Field Procedures

The archaeological field component of the present study involved pedestrian coverage of the defined project area by ERC personnel. Transect width utilized ranged from 5 to 15 meters depending upon visibility and site potential based on terrain, streams, and other factors that have been shown to correlate with site presence/absence such as presettlement prairie or woodland setting. All vegetation-free zones are observed for presence of prehistoric cultural materials. Throughout most of Missouri, this can include lithic debitage (chert flakes and shatter), fire-cracked rock, pottery sherds and occasionally bone and shell fragments. Features such as fire hearths and burial tumuli may also be encountered. Where vegetation covers the surface for over 10 meters, shovel tests are implemented. This involves removal of around a 50 cm by 50 cm area of sod and then controlled removal of subsurface soil matrix to depths of up to 50 cm below surface. Soils are carefully observed to determine presence/absence of cultural evidence. Where soil conditions allow, soils are screened through a portable 1/4 inch screen. Shovel testing that does not include screening of matrix is implemented where larger numbers of shovel tests are necessary and surface visibility conditions are poor. In this instance, soil matrix is removed by shovel and carefully scraped with a trowel to look for prehistoric/early historic evidence.

Where evidence of presence of an archaeological resource is defined, the location is noted on a U.S.G.S. quadrangle and a sketch map and description of the site area are field prepared. Where features or structures are encountered, photographs are taken. The field procedures incorporated in the pedestrian survey are directed toward two major goals: The first was the inventory of all possibly significant cultural resources within the project zone and the second the attempt to recover sufficient information to allow interpretation of NRHP eligibility of these sites by the MoSHPO.

While subjective, ERC has developed a set of criteria for determining the presence of an archaeological resource, which are currently accepted by the SHPO as appropriate. These criteria are not presented as appropriate for all situations but as the general practice followed by ERC in making decisions regarding presence/absence of archaeological resources for cultural resource compliance purposes. One extreme would record a site where any evidence of cultural activity occurs. The other extreme would require a significant cultural resource to be present to result in recording a site. The present approach attempts to find a middle ground, which hopefully allows for further consideration for both the cultural resource and the proposed project action prior to threat to either.

An archaeology site is designated when evidence of prehistoric and/or early historic land use is present and at least one of the following specific criteria is met:

A. A prehistoric feature is present

B. Two or more artifacts are identified within a 10 by 10m or less area

C. A shovel test recovers 2 or more artifacts.

Where a site is identified and when the landowner grants permission, materials recovered by the field investigation are placed in field site number marked collection bags. If permission is not attained, materials are observed and potential diagnostics and tools measured, photographed and left in the field or given to the landowner when requested. When a permanent site number is assigned, retained materials are curated with the site designation. Where material density at a site is obviously high only a representative sample is retained.

Historic architecture resources include structures and features. Where structures are present that are over 45 years old or exhibit some form of possible exceptional significance they are photographed and a description of architectural features is prepared along with preliminary evaluation of NRHP eligibility when located within a direct impact project zone. Historic structures are not recorded where it is obvious that the structures are less than 45 years old and not significant in any other respect. Where an area of potential effect (APE) has been established beyond the physical APE, architectural resources within this defined APE obviously 45 years or older are photographed and located on report maps.

Analysis Procedures

Significance of cultural resources is interpreted from National Register of Historic Place eligibility criteria that are listed below:

> "The quality of significance in American History, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling and association, and:
>
> A) that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B) that are associated with the lives of persons significant in our past; or

C) that embody the distinctive characteristics of type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant distinguishing entity whose components may lack individual distinction; or

D) that have yielded, or may be likely to yield, information important in prehistory or history: (36 CFR Part 60.6).

Cultural resources that are identified during the Phase I survey are evaluated in terms of meeting one or more of the above criteria. In general, archaeological sites most often are evaluated with reference to D above. A statewide planning document was prepared by the DNR/HPP that allows minimal means for evaluation of potential significance of cultural resources (Weichman and Weston 1986). The statewide plan includes information regarding traditions, types of traditions expected, forms of data that may be potentially important, and research questions that can be incorporated in the interpretation of cultural resource significance where available. Generally, a cultural resource will be evaluated on the basis of types of materials recovered (uniqueness, affiliation, type), resource integrity (degree of disturbance), and material/feature density (density and quantity of artifacts and presence and number of potentially extant features such as hearths, house sites, and burial tumuli). Usually, if an archaeological site exhibits sub-plow zone integrity and produces diagnostic artifacts or features, the site is interpreted as significant in that it would very likely contain sufficient data to contribute to the understanding of the cultural history of the area and meet NRHP eligibility criterion D. The consultant makes recommendations regarding NRHP eligibility. The determination of eligibility process requires consultation with the SHPO and the federal agency involved in the project.

Statement of Findings and Recommendations

Where ERC locates a cultural resource within the designated project boundaries, recommendations of significance and justification are made to the MoSHPO and the federal agency involved. A decision regarding significance would be made at that level in terms of possible NRHP eligibility of the resource. Recommendations that may be made include "not eligible for NRHP status", "possibly eligible for NRHP status", or "eligible for NRHP status." Where a recommendation of not eligible is accepted by the SHPO and federal agency a proposed compliance project can proceed as planned; a recommendation of possibly eligible results in agency request that the project be modified to avoid the resource or given further evaluation in order to establish NRHP eligibility; a recommendation of eligible results in a request to modify the project to avoid the cultural resource or proceed with the consultation process as outlined by 36 CFR Part 800: Protection of Historic Properties that governs the Section 106 review process established by the National Historic Preservation Act of 1966 as amended.

PROJECT SETTING

Environmental Setting

The project area lies on the border of the Dissected Till Plains to the north and Ozark Plateau on the south in Central Lowlands Province of North America. The bedrock in the area consists of Mississippian limestones covered with varying depths of clays and glacial drift as well as limestone residuum and colluvium and alluvium (cf. Branson 1944; Stout and Hoffman 1973).

The project is located within a presettlement prairie zone (Kucera 1961; Schroeder 19891:7) in an upland divide between Cedar Creek on the east and Bonne Femme headwaters on the west. The area exhibited a wide variety of indigenous floral species in the past (Chapman 1975:12-16). Early surveyors list several species of oak, hickory, black walnut, hackberry, sycamore, elm, and elders in the bottoms along with open oak-hickory upland woodlands to the east, west, and south and grasses that would have included Big and Little Bluestem, Indian Grass, Switch Grass, Side-oats Grama, and pockets of Bluejoint and Canada Wild Rye in the project area (Allgood and Persinger 1979:60).

Some species of animals present during the pioneer period have been extirpated from their former ranges since the Euro-American settlement of the area. These species include gray wolf, elk, and bison (Chapman 1975). The mountain lion and black bear occur rarely in the forested regions of the interior Ozark Highlands (Wood and McMillan 1976). More common species in the drainage basin include white-tailed deer, gray fox, red fox, coyote, raccoon, beaver, bobcat, mink, opossum, muskrat, spotted skunk, squirrels, rabbit, and woodchuck. It is probable that the project area exhibited typical prairie/woodland ecotonal populations in which a variety of large and small game was available in both woodland and prairie settings.

The climate within the project area is midcontinental and experiences temperature extremes both seasonally and on a day-to-day basis. This area of Missouri is in the path of cold air moving down out of Canada, warm moist air coming up from the Gulf of Mexico, and dry air from the west. The mean annual precipitation in the area is around 40 inches which includes 12 to 17 inches of snow per year. The mean length of the growing season is around 187 days. The killing freezes generally begin between October 15 and 20 and end between April 15 and 20 (Chapman 1975).

The project area exhibits few characteristics suggesting high potential for presence of intensive or extensive prehistoric occupation. The counties north of the Missouri river exhibit an ecotonal situation that included a relatively high percentage of presettlement prairie and lesser amount of presettlement woodland (Schroeder 1981). While Boone County was made up only of 16% presettlement prairie, the present project occupies the only expansive prairie zone in the county. Earlier studies have well

illustrated the finding that known prehistoric occupations in the region are almost entirely located within presettlement woodland zones with less than 3% of the known prehistoric sites found within presettlement prairie zones (cf. Sturdevant 1983). Another major consideration that appears to have entered into prehistoric site selection involved availability of cherts that were a primary raw material for much of the subsistence technology. Bedrock in the general area does include Missisippian age cherts that were utilized extensively by prehistoric occupants as raw material for tools. These cherts would not have been easily accessible in the project area. The project setting would have also lacked immediate availability of a consistent water supply necessary to support any intensive or extensive human habitation resulting in a low prehistoric site potential.

Cultural Setting

The project is located in the Central Missouri Drainage Basin (Figure 2). The occupation of Missouri by prehistoric populations has been generally established to include nine to ten traditions (cf. Chapman 1975; 1980). These traditions apply in varying degree to the entire state with some traditions often not accounted for in specific drainages. These traditions are incorporated in what is called the cultural sequence which is a major factor utilized in interpretation of cultural data, particularly regarding National Register of Historic Place (NRHP) significance. These traditions are listed below in the sequence provided by Chapman (1975; 1980).

Paleo-Indian	12000 to 8000 B.C.
Dalton	8000 to 7000 B.C.
Early Archaic	7000 to 5000 B.C.
Middle Archaic	5000 to 3000 B.C.
Late Archaic	3000 to 1000 B.C.
Early Woodland	1000 to 500 B.C.
Middle Woodland	500 B.C. to A.D. 400
Late Woodland	A.D. 400 to 900
Mississippian	A.D. 900 to 1400

Paleo-Indian: With the exception of a possible earlier "Early Man" tradition, the Paleo-Indian is generally accepted as the earliest known occupation of Missouri. These specialized hunters lived in small nomadic bands or family groups and left some traces of their transitory settlement pattern in the forms of hunting camps, kill sites, quarry sites, and possibly small base camps (cf. Ford 1974:388). The major diagnostic materials associated with the occupation includes the Clovis and Folsom fluted spear/knife points. Most fluted point finds have been located along major river valleys such as the Missouri River although some have been recovered along streams such as the Moreau River. This has been suggested to indicate that these nomadic hunters and gatherers followed these streams in their movement through the Midwest area. Chapman indicates that his division of the Northeast and Northwest Prairie region at a point in Cooper and Howard counties above Boonville on the Missouri River separates the major occupation zones of the

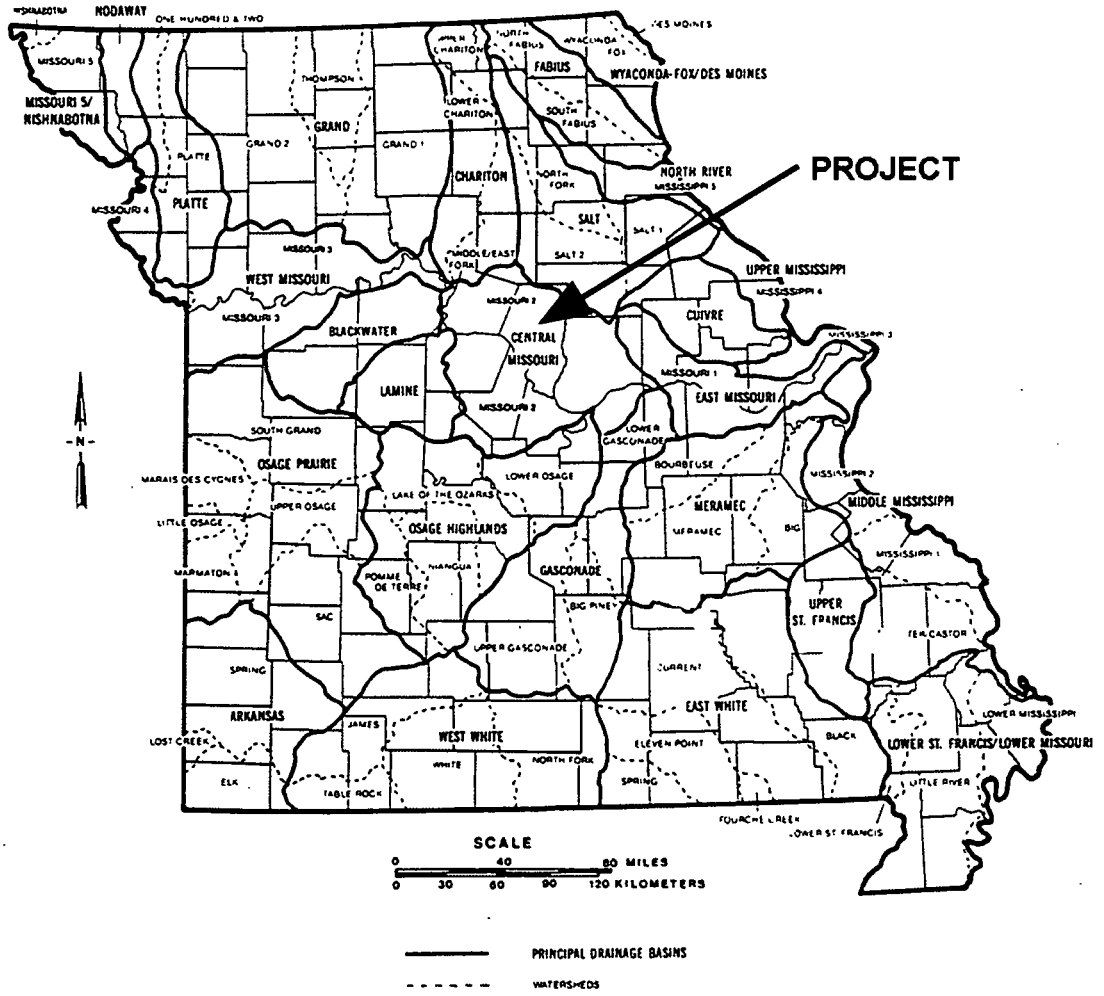

Figure 2.
DNR Study Unit/Drainage Basin Location of Project

Paleo-Indian populations. That is, the steep bluffs below this point appear to have been more conducive to Paleo-Indian occupation than the more prairie related terrain above this point. Fluted points are generally more plentiful below this point toward St. Louis than above this point toward Kansas City (Chapman 1975:75). Chapman's review of Paleo-Indian diagnostics illustrates larger numbers of reported fluted points beginning in Howard County and continuing toward St. Louis with a small number reported from Callaway County (1975:67).

Dalton: Chapman characterizes the Dalton period as a time of transition from Paleo-Indian big game hunting to the hunting-foraging subsistence strategy of the following Archaic period (1975:96). All known Dalton sites in Missouri are small camps

and all apparently represent short-term utilization. The basic Paleo-Indian tool kit was still in use during Dalton times although tools associated with plant food processing were added. Point types with long flutes have been replaced by types with basal thinning and or short flutes. The major diagnostic includes the Dalton Serrated and perhaps the Dalton adze. Distribution roughly parallels the Paleo-Indian.

Early Archaic: By the Early Archaic the transition to a subsistence pattern based on foraging was well underway. Subsistence activities were broadened to exploit more ecological niches. Hunting and gathering continued as the major economic activities but emphasis was placed on aquatic resources and vegetal foods. Although nomadic wandering was being replaced by "a regular hunting-gathering range with specific base camp sites that were returned to at regular intervals" (Chapman 1975:135), the typical Early Archaic site continued to be a small hunting and or collecting camp. These 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. Diagnostics of Early Archaic include Graham Cave Notched that has been recovered in the general area (Chapman 1975). Hardin Barbed is also generally associated with Early Archaic occupation.

Middle Archaic: The Middle Archaic was basically a continuation and expansion of a forager tradition begun in the Dalton and Early Archaic. A drying climate forced greater reliance upon collecting vegetal foods and small animals as opposed to wet environment subsistence. Sites continued to be small, exhibiting semi-nomadic or seasonal occupation with no specific topographic location associated (Chapman 1975:159). The tool kit continued to expand, depending upon the extraction activity in the specific niche. The drying climate was reflected in the marked tendency for Middle Archaic sites to be located almost exclusively in or very near bottomland settings (Chapman 1975). There are no complexes associated with the period in this general area. Collectors in the area often have Big Sandy forms in their collections. It is assumed that Middle Archaic was present but in an as yet poorly defined situation. Site forms for the drainage are inconclusive in terms of presence of Middle Archaic diagnostics.

Late Archaic: The Late Archaic is somewhat better known than earlier traditions. This is a result of the greater population apparently represented by the Late Archaic which resulted in more expansive and numerous occupations. This period generally lacks the small dart point of the earlier traditions that suggests that hunting had become less important for subsistence. In addition, tool kit function appears to have expanded suggesting reliance on a much larger variety of potential foods requiring varied extraction and processing techniques. The Late Archaic began toward the climax of a warming trend that reached its height around 2000 B.C. (Cleland 1966), with a resultant diminishing of the faunal and floral forest species. The Late Archaic peoples had to adapt to new ecological niches with concomitant changes in subsistence related artifacts. Emphasis was probably placed on a method of procurement that could effectively exploit various types of resources which were available in reliable quantities at varying seasons. Using a central-based wandering settlement pattern in which the particular seasonal

resources available would determine the type and location of temporary camps radiating from more permanent occupation sites, Late Archaic settlement pattern appears to have been somewhat more restricted than previous foraging traditions. Diagnostic artifacts of this period include the Sedalia Lanceolate and Diggers, Clear Fork Gouge, Smith Basal Notch, Afton, Etley, Nebo Hill, Stone Square, as well as 3/4 groove granite axes. Evidence of the Sedalia complex are often found just over the crown of the slope of high ridges (Chapman 1975:200). Late Archaic occupations are one of the more commonly identified traditions in the drainage according to ASM records.

Early Woodland: The Early Woodland period is identified by presence of Black Sand Incised pottery and is poorly represented throughout most of Missouri. In spite of intensive surveys in various areas of the state, only a few unquestionable Early Woodland sites have been identified and include Avondale, Renner, and Shields sites in the Kansas City area and a few in the northeast portion of the state. These and other possible Early Woodland sites are generally found in the major river valleys, particularly along the Missouri River.

Middle Woodland: The Middle Woodland period occupation in northern Missouri is focused on three related regional centers: The Havana center in the Lower Illinois River Valley and adjacent Mississippi River valley in the northeast, the Kansas City Hopewell, and Big Bend centers. The latter two are on the Missouri River. Analyses of pottery from the three centers indicate there was an intrusion of people into the Big Bend and Kansas City areas from the Havana center to the east (Wedel 1943) although the initial intrusion appears to have been related to subsistence and/or political stress (Struever & Houart 1972) in the Havana center, contacts among the three centers was maintained throughout the Middle Woodland period (Chapman 1980). These continued contacts insured the Big Bend and Kansas City areas of a place in the Classic Middle Woodland's Hopewell Interaction Sphere. Evidence for a Middle Woodland occupation is very sparse outside of the areas noted. Some rock shelters and open habitation sites in the general area have produced Middle Woodland diagnostics and Chapman identified south Boone County as a major Middle Woodland center (1980). There has been no corroborating evidence through field investigations regarding the assertion by Chapman. In general, with the exception of the Big Bend and Kansas City Hopewell, Middle Woodland diagnostics usually are interpreted from lithics such as Snyders points with ceramics reflecting Hopewellian occupation lacking but for the centers.

Late Woodland: The Late Woodland period exhibits the most numerous defined components within prehistoric sites in the general project area. The occupation in this portion of Missouri has sometimes been defined as a regression from the preceding traditions in that emphasis on horticulture developed earlier in the Woodland was supplanted by earlier hunting subsistence reliance. This pattern is seen in the increase in small temporary camps along with use of bow and arrow. Diagnostics include grit and limestone tempered pottery, arrow points, burial mounds, and shallow side notched points. Several Late Woodland sites have been identified in the county including both

open habitation sites and burial tumuli. A large number the archaeological sites identified in the general project area have exhibited Late Woodland diagnostics (Sturdevant 1978).

Mississippian: The Early Mississippian period is not well documented in the general area of the project. Steed-Kisker, an Early Mississippi phase, is located in the Kansas City area while Cahokia and the St. Louis area represent a climax associated with Early Mississippian (Chapman 1980). Diagnostics for this period include small triangular arrow points and shell tempered ceramics. Where Early Mississippian experienced climax levels, temples and towns were part of the settlement pattern. In the immediate area only triangular points and an occasional shell tempered sherd have been reported. Early Mississippian Steed-Kisker people apparently abandoned the Kansas City area around A.D. 1250 and around A.D. 1350 the Oneota cultural tradition appeared suddenly in the Big Bend area near the junction of the Grand, Chariton, and Missouri rivers. It is speculated that Oneota developed in northern Missouri and Iowa and its formation was stimulated by developments at the Cahokia center. While the extent of Cahokia influences remains unknown, cultural developments of the period in that area have been connected to the cultural background and growth of the historic Siouan-speaking people (Griffin 1960). The most prominent Oneota village in the Big Bend area is the Utz site and it was there the Utz phase, which documents the Oneota culture of the area, was defined. The Utz phase, and the Oneota occupation, began at about A.D. 1350 and lasted to the end of the Mississippian period (A.D. 1700) when Oneota blends into what is recognized as the Historic Missouri Indian tribe.

Historic Period: During the period from 1730 to 1790, the Missouri tribe was being depleted by smallpox and its power was continually being tested by its enemies to the north. By the 1780's, the Missouri became heavily dependent on their allies the Osage for protection. In spite of this, the Sac and Fox conquered and dispersed the Missouri tribe in the 1790's. Those who were not killed joined the Osage, Kansas, and Oto tribes. The great smallpox epidemic of 1823 reduced their numbers to less than one hundred and Missouri as a distinct cultural entity became extinct. The last full-blood Missouri Indian died on the Oto reservation in 1907 (Chapman 1946:29).

The lands encompassed by the project were but a small part of North American territory claimed by France until 1762 when it was transferred to Spain by secret treaty. Spain retroceded the land to France in 1801 and France ended up selling it to the U.S. in 1803 as the Louisiana Purchase. In 1812, congress created the Territory of Missouri and in 1821 Missouri was recognized as the twenty-first state (March 1963). In general, the post-1800 history of central Missouri reflects both the general patterns of agricultural developments in the Midwest and specific influences which shaped the region. The process of early settlement and the struggle to produce beyond a meager subsistence, the expansion of the agricultural and commercial activities and creation of a stable society, followed by an era in which regional concerns were shaped by state and national trends, are all recognized as part of the evolution of the Midwest. In the case of northern Missouri, an understanding of its Euro-American past requires recognition of the

influence of the settlers themselves and of the land which they occupied. The early settlers came primarily from the Upper South, especially Kentucky, Tennessee, and Virginia. Prior to the Civil War, first tobacco and then corn played an important role in the agricultural economy of the region. The first permanent settlers began entering the area in the early 1800's, a process that really began only after the acquisition of the Louisiana territory by the U.S. in 1803. Congress created the territory of Missouri in 1812 and nine years later recognized Missouri as the twenty-first state (Meyer 1963). The rapid development from uncharted wilderness to statehood stemmed directly from the massive westward movement of population during the early nineteenth century. Most of the settlers who came to mid-Missouri were attracted to the land. The fertile soil, adequate rainfall, and a growing season that averaged six months a year made the region particularly well-suited for agriculture. A rich, friable loam predominated, with substantial stands of timber which provided building materials and generally reminded the immigrants of the lands which they had left behind.

The background of the settlers made them receptive to cultivating a crop that would reproduce the agricultural patterns of their native states. Most of the early settlers came from the Upper South that included slave holding states. March (1967) suggests that within the "slave belt" through central Missouri, major crops included hemp and tobacco. These crops, particularly tobacco, demand intensive labor for productivity. Tobacco is generally favored as a cash crop in that it produced a greater value in proportion to bulk when compared to grain crops. In areas such as the project, transportation would have been a problem prior to the railways. Cash crops such as tobacco in areas that did not provide viable river transportation soon shifted to local consumption crops such as corn and wheat. While not well documented at present, it is apparent that agricultural pursuits were almost entirely geared toward corn and wheat by the time of the Civil War. It is further apparent that slave holding had begun to drop at a relatively high rate prior to the Civil War (Campbell 1874). The land and its location, then, became major shaping forces of the economic system of the area, altering the previous patterns established in the southeast and brought to the Midwest. The coming of the railroad in the 1850's through the 1870's opened the interior to greater trade and agricultural products have been the major source of livelihood in the general area since this time.

INVESTIGATION FINDINGS

Records and Literature Review

Boone County, Missouri currently contains 49 National Register of Historic Places (NRHP) properties. These include the following:

Ballenger Building (*Downtown Columbia, Missouri MPS*), 27-29 South Ninth St., Columbia (1/21/04)

Bond's Chapel Methodist Episcopal Church, MO A, 2.5 mi. NE of Hartsburg, Hartsburg vicinity (9/09/93)

Boone, John W. ("Blind"), House (*Social Institutions of Columbia's Black Community TR* [see note*]), 4th St. between E Broadway and Walnut, Columbia (9/04/80)

Central Dairy Building (*Downtown Columbia, Missouri MPS*), 1104-1106 East Broadway, Columbia (1/20/05)

Chance, Albert Bishop, House and Gardens, 319 E Sneed St., Centralia (7/03/79)

Chatol (F. Gano Chance House, Chance Guest House), 543 S Jefferson, Centralia (4/20/79)

Coca-Cola Bottling Co. Building (*Downtown Columbia, Missouri MPS*), 10 Hitt St., Columbia (2/14/06)

Columbia Cemetery, 30 East Broadway, Columbia (2/01/07)

Columbia National Guard Armory, 701 E Ash St., Columbia (3/25/93)

Conley, Sanford F., House, 602 Sanford Pl., Columbia (12/18/73)

Douglass, Fred, School (*Social Institutions of Columbia's Black Community TR* [see note*]), 310 N Providence Rd. (9/04/80)

Downtown Columbia Historic District (*Downtown Columbia, Missouri MPS*; map [see note]), parts of 7th, 8th, 9th, 10th, E. Broadway, Cherry, Hitt, Locust, and E. Walnut Streets, Columbia (11/08/06)

Downtown Columbia Historic District (*Downtown Columbia, Missouri MPS*; boundary increase), 1019,1020,1023 & 1025-33 E. Walnut St., Columbia (5/08/08)

East Campus Neighborhood Historic District, roughly bounded by Bouchelle, College, University, and High Sts., including parts of Willis, Bass, Dorsey, and Anthony Sts., Columbia (2/16/96)

Eighth Broadway Historic District [Miller Building, Matthews Hardware, Metropolitan Building], 800-810 E. Broadway Blvd., Columbia (4/22/03)

Elkins, Samuel H. and Isabel Smith, House, 315 N 10th St., Columbia (9/12/96)

First Christian Church, 101 N 10th St., Columbia (10/29/91)

Francis Quadrangle Historic District (Red Campus), bounded by Conley Ave., Elm, 6th and 9th Sts., Columbia (12/18/73)

Frederick Apartments, 1001 University Ave., Columbia (4/16/13)

Gordon, David, House and Collins Log Cabin (Gordon Manor, Fairmount, Cedar View), 2100 E Broadway, Columbia (8/29/83)

Gordon Tract Archaeological Site, address restricted (3/16/72)

Greenwood (Greenwood Heights), 3005 Mexico Gravel Rd., Columbia (1/15/79)

Guitar, David, House (Confederate Hill), 2815 Oakland Gravel Rd., Columbia (9/09/93)

Hackman, Samuel E., Building, 30 S St., Hartsburg (12/10/98)

Hamilton-Brown Shoe Factory, 1123 Wilkes Blvd., Columbia (7/19/02)

Hunt, William B., House, 8939 W Terrapin Hills Rd., Columbia vicinity (1/09/97)

Kress Building (*Downtown Columbia, Missouri MPS*), 1025 E. Broadway, Columbia (3/09/05)

Maplewood, Nifong Blvd. and Ponderosa Dr., Columbia (4/13/79)

McCain Furniture Store (*Downtown Columbia, Missouri MPS*), 916 E. Walnut, Columbia (8/17/05)

Missouri, Kansas and Texas Railroad Depot, 402 E Broadway, Columbia (1/29/79)

Missouri State Teachers Association, 407 S 6th St., Columbia (9/04/80)

Missouri Theater, 201-215 S 9th St., Columbia (6/06/79)

Missouri United Methodist Church, 204 S 9th St., Columbia (9/04/80)

Mount Zion Church and Cemetery (*Rural Church Architecture of Missouri, c. 1819 to c. 1945 MPS*), 11070 Mount Zion Rd., Hallsville vicinity (1/14/13)

North Ninth Street Historic District (*Downtown Columbia, Missouri MPS*) (map [see note]), 5-36 North Ninth St., Columbia (1/21/04)

Payne, Moses U., House, 201 N Roby Farm Rd., Rocheport vicinity (10/07/94)

Pierce Pennant Motor Hotel (Candlelight Lodge), 1406 Old Hwy. 40 W, Columbia (9/02/82)

Rocheport Historic District, MO 240, Rocheport (10/08/76)

St. Paul's A.M.E. Church (*Social Institutions of Columbia's Black Community TR* [see note*]), 501 Park St. (9/04/80)

Sanborn Field and Soil Erosion Plots, University of Missouri Campus, Columbia (10/15/66; **NHL 7/19/64**)

Second Baptist Church (*Social Institutions of Columbia's Black Community TR* [see note*]), 407 E Broadway (9/04/80)

Second Christian Church (*Social Institutions of Columbia's Black Community TR* [see note*]), 401 N 5th St. (9/04/80)

Senior Hall, Stephens College Campus, Columbia (8/02/77)

Stephens College, South Campus, 1200 E. Broadway, Columbia (11/25/05)

Taylor, John N. and Elizabeth, House, 716 West Broadway, Columbia (5/25/01)

Tiger Hotel, 23 S 8th St., Columbia (2/29/80)

Virginia Building, 111 South Ninth Street, Columbia (3/13/02)

Wabash Railroad Station and Freight House (Norfolk and Western Depot), 126 N 10th St., Columbia (10/11/79)

West Broadway Historic District, 300-922 W. Broadway (except 800, 808, 812), Columbia (4/27/10)

Wright Brothers Mule Barn, 1101-1107 Hinkson Ave. & 501-507 Fay St., Columbia (11/01/07)

There are no previously recorded prehistoric archaeology sites within the project boundaries (Figure 3). [Proprietary Information] The project area contains no recorded historic architecture or possibly significant historic events.

Review of 19th and 20th century plat maps and 20th century USGS topographic quadrangles found no evidence of structures within the proposed project area. The 1967/81 USGS topographic quadrangle does not illustrate any structures in the project boundaries.

Field Investigation Findings

The field investigation was carried out under generally mixed to poor surface visibility conditions averaging less than 20% in a grass/hay setting (Figure 4). Shovel tests were utilized in order to interpret presence/absence of cultural resources as described in the methods section of this report. The presence of erosion cuts and paths along with shovel tests allowed for a sample of subsurface soil matrix for interpretation of potential for presence/absence of buried cultural resources.

The field investigation failed to identify any evidence of the presence of prehistoric occupation of the area. Typically, this includes presence of chert debitage, fire-cracked rock, lithic artifacts, and occasionally ceramics. None of these materials were encountered on the surface or in shovel tests. No prehistoric sites have been recorded.

Historic resources include recently constructed roads which do not meet the investigators' historic site designation criteria. No historic sites have been recorded.

It is the finding of this Phase I cultural resources survey that Lot 15 in the Discovery Ridge development contains no possibly significant cultural resources.

[Proprietary Information]

Figure 4.
Aerial Photograph of Project Area Surveyed (YELLOW)

RECOMMENDATIONS

During September 2013 a Phase I cultural resources survey was carried out for a 7.5 acre tract of land at Discovery Ridge, Boone County, Missouri. The area is the location of a proposed commercial development project.

There are no National Register of Historic Places (NRHP) properties located within the proposed project area; DNR GIS records indicate presence of no recorded archaeology sites within the project boundaries; and no recorded Missouri DNR historic architectural sites are present within the project area of potential effect (APE). 19th century plat maps do not illustrate any structures within the project area.

The field investigation was carried out under poor surface visibility conditions in a grass/hay setting. Shovel testing was implemented following guidelines described in this report. No evidence of the presence of prehistoric occupation was identified within the project area. No evidence of the presence of early historic occupation was identified within the project boundaries.

On the basis of the negative findings regarding presence of possibly significant cultural resources, it is the recommendation of this Phase I cultural resources survey that the proposed project proceed as planned in terms of Section 106 compliance concerns. No significant cultural resources will be threatened by the proposed project actions.

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STATE OF MISSOURI
Jeremiah W. (Jay) Nixon, Governor • Sara Parker Pauley, Director
DEPARTMENT OF NATURAL RESOURCES
www.dnr.mo.gov

October 10, 2013

Carolyn Haas
Vice President/Technical Program Director
Northwest Medical Isotopes. LLC
815 NW 9th Avenue, Suite 256
Corvallis, Oregon 97330

Re: Lot 15, Discovery Ridge (NRC) Boone County, Missouri

Dear Ms. Haas:

Thank you for submitting information on the above referenced project for our review pursuant to Section 106 of the National Historic Preservation Act (P.L. 89-665, as amended) and the Advisory Council on Historic Preservation's regulation 36 CFR Part 800, which requires identification and evaluation of cultural resources.

We have reviewed the September 2013 report entitled *Cultural Resource Investigations, Phase I Survey, Lot 15 – Discovery Ridge, Boone County, Missouri* by the Environmental Research Center of Missouri, Inc. Based on this review it is evident that a thorough and adequate cultural resources survey has been conducted of the project area. We concur with the investigator's recommendation that there will be **no historic properties affected** and, therefore, we have no objection to the initiation of project activities.

Please be advised that, should project plans change, information documenting the revisions should be submitted to this office for further review. In the event that cultural materials are encountered during project activities, all construction should be halted, and this office notified as soon as possible in order to determine the appropriate course of action.

If you have any questions, please write Judith Deel at State Historic Preservation Office, P.O. Box 176, Jefferson City, Missouri 65102 or call 573/751-7862. Please be sure to include the SHPO Log Number (**003-BO-14**) on all future correspondence or inquiries relating to this project.

Sincerely,

STATE HISTORIC PRESERVATION OFFICE

Mark A. Miles
Director and Deputy State
Historic Preservation Officer

MAM:jd

c Larry W. Camper, NRC
Craig Sturdevant, ERC

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