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9.0 ALTERNATIVES TO THE PROPOSED ACTION

This chapter assesses alternatives to the proposed siting and construction of a new nuclear power plant at the {existing Callaway site}.

Chapter 9 describes the alternatives to construction and operation of a new nuclear unit with closed cycle cooling adjacent to the {Callaway Plant Unit 1} site location, and alternative plant and transmission systems. The descriptions provide sufficient detail to facilitate evaluation of the impacts of the alternative generation options or plant and transmission systems relative to those of the proposed action. The chapter is divided into four sections:

- "No-Action" Alternative
- Energy Alternatives
- Alternative Sites
- Alternative Plant and Transmission Systems

9.1 NO-ACTION ALTERNATIVE

The "No-Action" alternative refers to a scenario where a new nuclear power plant, as described in Chapter 2, is not constructed and no other generating station, either nuclear or non-nuclear, is constructed and operated.

The most significant effect of the No-Action alternative would be the loss of the potential 1,600 MWe of additional baseload generating capacity that {Callaway Plant Unit 2} would provide, which could lead to a reduced ability of the existing power suppliers to maintain reserve margins and supply lower cost power to customers. Chapter 8 Need for Power describes a {1.4%} annual increase in electricity demand in {Missouri} over the next 10 years. Under the No-Action alternative, this increased need for power would need to be met by means that involve no new generating capacity.

As discussed in Chapter 8, in {the applicant's relevant service area (AmerenUE's regulated service area) the ability to import additional resources is limited}. Demand-side management is one alternative; however, even using optimistic projections, demand-side management will not meet future demands.

{Consequences of the No-Action alternative include blackouts resulting from an inability to supply adequate power resources to customers. On the other hand, however, benefits of the No-Action alternative include an avoidance of the negative impacts discussed in Chapters 4 and 10.}

Implementation of the No-Action alternative could result in the future need for other generating sources, including continued reliance on carbon-intensive fuels, such as coal, oil, and natural gas. Therefore, the predicted environmental impacts, as well as other unidentified impacts, could occur in other areas.

9.2 ENERGY ALTERNATIVES

This section discusses the potential environmental impacts associated with electricity generating sources other than the proposed facility at the {Callaway} site. These alternatives include: purchasing electric power from other sources to replace power that would have been generated by a new unit at the {Callaway} site, a combination of new generating capacity and conservation measures, and other generation alternatives that were deemed not to be {competitive alternates to the proposed facility.}

Alternatives that do not require new generating capacity were considered, including energy conservation and Demand-Side Management (DSM). Alternatives that would require the construction of new generating capacity, such as wind, geothermal, oil, natural gas, hydropower, municipal solid wastes (MSW), coal, photovoltaic (PV) cells, solar power, wood waste/biomass, and energy crops, as well as any reasonable combination of these alternatives, were also considered.

Alternatives that do not require new generating capacity are discussed in Section 9.2.1, while alternatives that do require new generating capacity are discussed in Section 9.2.2. Some of the alternatives discussed in Section 9.2.2 were eliminated from further consideration based on their availability in the region, overall feasibility, and environmental consequences. Section 9.2.3, describes the remaining, competitive alternatives in further detail relative to specific criteria such as environmental impacts, reliability, and economic factors.

9.2.1 ALTERNATIVES NOT REQUIRING NEW GENERATING CAPACITY

{This section describes the assessment of the economic and technical feasibility of supplying the demand for energy without constructing new generating capacity. Specific alternatives include:

- Initiating conservation measures (including implementing DSM actions)
- Reactivating or extending the service life of existing plants within the power system
- Purchasing power from other utilities or power generators
- A combination of these alternatives that would be equivalent to the output of the proposed facility and therefore eliminate its need.

9.2.1.1 Conservation Programs

The Missouri PSC requires electric utilities to implement DSM as a means to conserve energy and to take DSM energy savings into account in long-range planning. AmerenUE has promoted DSM programs since the 1970s. Currently, AmerenUE has an extensive offering of residential, commercial, and industrial programs designed to reduce both peak demands and daily energy consumption. DSM programs are discussed in detail in Section 8.2.2.

It is estimated that the AmerenUE DSM program resulted in an annual peak demand generation reduction of about 122 MWe in 2007 and AmerenUE believes that generation savings can continue to be increased from DSM practices. The most aggressive load growth projection anticipates a DSM savings of about 450 MWe in 2020. These DSM savings are an important part of the plan for meeting projected regional demand growth in the near-term (AUE, 2008a).

However, since the most viable and cost-effective DSM options are pursued first, it is not likely that demand reductions of similar size will be available or practical in the future. Consequently, DSM is not deemed a feasible replacement for the additional baseload generation capacity that will be provided by Callaway Plant Unit 2. AmerenUE does not foresee the availability of another 1,600 MWe (equivalent to the Callaway Plant Unit 2 generating capacity) of feasible and cost-effective DSM to meet projected load power demand. Therefore, it is concluded that DSM and/or conservation measures are not a feasible alternative for replacing the approximate 1,600 MWe baseload capacity that Callaway Plant Unit 2 will provide.

9.2.1.2 Reactivating or Extending Service Life of Existing Plants

Few new in-state electric generating facilities are scheduled to be built during the next 5 years. There are no large, retired generating units in the AmerenUE service territory. Additionally, some aging fossil-fired generating capacity may be de-rated or retired in order to comply with both federal and state air emission requirements, including the increasingly stringent sulfur dioxide, particulate matter, ozone and mercury provisions of Missouri's clean air laws and regulations. There is a reasonable possibility that new regulations and laws will be enacted to regulate greenhouse gases, including carbon intensive emissions generated by fossil fuel burning power plants in the near future.

In the current Integrated Resource Plan (IRP) and resource allocation plan, AmerenUE has assumed that the Meramec coal fired steam generating plant will be retired and decommissioned in the fall of 2021 resulting in the loss of about 900 MWe of baseload generating capacity. AmerenUE is making substantial investments in its existing fossil fuel generating units to maintain and install environmental controls necessary to keep them operational and in compliance with environmental requirements. Details of these potential changes are discussed in Section 8.3. Section 8.3 also discusses planned or proposed uprates and life extension projects for existing plants.

9.2.1.3 Purchasing Power from Other Utilities or Power Generators

AmerenUE issued a Request For Information (Request) in 2007 as the first step in determining if there were any viable power providers available that were capable of supplying substantial quantities of electric baseload power resources to AmerenUE beginning in the year 2014 to meet its growing future demand. The Request is discussed in greater detail in Section 8.4. AmerenUE wanted the information to evaluate the option of purchasing power to meet its baseload demand needs. There were only two responses to the Request from prospective power providers. Both were planned coal powered steam generation power plants that had substantial risk and uncertainties associated with their ability to supply reliable baseload power. There were significant environmental permitting and financial concerns and uncertainties for these proposed plants that were significant risk factors as to their future construction and operation viability. Neither of the responses to AmerenUE's power supply Request was deemed to be a reliable or cost-effective alternative to the proposed plant and it was concluded that power purchases were not a feasible alternative to the proposed plant.

AmerenUE has contracted for 100 MWe (equivalent to 20 MWe capacity) of renewable energy through a planned wind power project located in Illinois that is expected to be completed in 2010 (AUE, 2008a).

Even if new power supplies outside the AmerenUE service territory were to become available, the ability to import additional electricity over the grid, particularly during times of peak demand, is limited. The current transmission facilities that allow the importation of electricity into the State already operate at peak capacity during peak load periods.}

9.2.1.4 {Combination of Alternatives Not Requiring New Generation

As discussed in Sections 9.2.1.1 through 9.2.1.3, the only alternative resulting in generation savings over the forecast period is DSM. The projected savings associated with DSM reach a maximum of 450 MWe in 2020 and that savings is included in the IRP forecast. The combination of alternatives in this category is equal to the DSM savings and, therefore, would not result in the elimination of the need for the proposed facility.}

9.2.2 ALTERNATIVES THAT REQUIRE NEW GENERATING CAPACITY

{Many technologies are currently available for generation of electricity. The alternative generation sources considered in the analysis are:

- Wind,
- Geothermal,
- Hydropower,
- Solar Power,
  - Concentrating Solar Power Systems,
  - "Flat Plate" Photovoltaic (PV) Cells,
- Wood Waste and Other Biomass,
- Municipal Solid Waste,
- Energy Crops,
- Petroleum liquids (Oil),
- Fuel Cells,
- Coal,
- Natural Gas,
- Integrated Gasification Combined Cycle (IGCC).

Based on the installed capacity of 1,600 MWe net that Callaway Plant Unit 2 will produce, not all of the above-listed alternative sources are competitive.

The current mix of power generation options in Missouri is one indicator of the feasible choices for electric generation technology within the state. AmerenUE evaluated Missouri's electric power generating capacity and utilization characteristics. "Capacity" is the categorization of the various installed technology choices in terms of their potential output. "Utilization" is the degree to which each choice is actually used.

All alternatives were evaluated as if they were located at the proposed Callaway Plant Unit 2 site. This assumption was made because of the data available to AmerenUE about this site. This section includes descriptions of power generating alternatives that AmerenUE has concluded are not reasonable alternatives, as well as the basis for this conclusion. This COL application is premised on the installation of a facility that would primarily serve as a large base-load generator and that any feasible alternative would also need to be able to generate baseload power. In performing this evaluation, AmerenUE has utilized information from the NRC Generic Environmental Impact Statement (GEIS) for License Renewal of Nuclear Plants (NRC, 1996).}

The GEIS is useful for the analysis of alternative sources because NRC has determined that the technologies of these alternatives will enable the agency to consider the relative environmental consequences of an action given the environmental consequences of other activities that also meet the purpose of the proposed action. To generate the set of reasonable alternatives that are considered in the GEIS, common generation technologies were included and various state energy plans were consulted to identify the alternative generation sources typically being considered by state authorities across the country.

Each of the alternatives is discussed in the subsequent sections relative to the following criteria:

- The alternative energy conversion technology is developed, proven, and available in the relevant region within the life of the COL.
- The alternative energy source provides baseload generating capacity equivalent to the capacity needed.
- The alternative energy source does not create more environmental impacts than a nuclear power plant would, and the costs of an alternative energy source do not make it economically infeasible.

Each of the potential alternative technologies considered in this analysis is consistent with national policy goals for energy use and is not prohibited by federal, state, or local regulations. Based on one or more of these criteria described above, several of the alternative energy sources were considered technically or economically infeasible after a preliminary review and were not considered further. Alternatives considered to be technically and economically feasible are described in greater detail in Section 9.2.3.

9.2.2.1 Wind

In general, areas identified by the National Renewable Energy Laboratory (NREL) as wind resource Class 4 and above are regarded as potentially economical for wind energy production with current technology. Class 4 wind resources are defined as having mean wind speeds between 15.7 mph and 16.8 mph (25.3 kph to 27.0 kph) at 50 m (164 ft) elevation (EERE, 2007a).

{As a result of advances in technology and the current level of financial incentive support, a number of additional areas with a slightly lower wind resource (Class 3+) may also be suitable for wind development. Class 3 wind resources are defined as having mean wind speeds between 14.3 mph and 15.7 mph (23.0 kph to 25.3 kph) at 50 m (164 ft) elevation, with Class 3+ wind resources occupying the high end of this range.

There are no Class 3+ or Class 4 sites within the AmerenUE service territory. The Callaway site is rated Class 1 and, therefore, wind is not considered to be a feasible alternative to the proposed nuclear plant at the Callaway site or within the AmerenUE service territory. A Letter of Intent for supply of wind generated power was signed by AmerenUE in 2007. The potential provider for this power is located in Illinois as discussed in Section 8.3.2.}

9.2.2.2 Geothermal

As illustrated by Figure 8.4 in the GEIS (NRC, 1996), geothermal plants might be located in the western continental U.S., Alaska, and Hawaii, where hydrothermal reservoirs are prevalent.

{Missouri is not a candidate for large scale geothermal energy and could not produce the proposed 1,600 MWe net of baseload power. Therefore, geothermal energy is not a feasible alternative to a new nuclear unit at the Callaway site.}

9.2.2.3 Hydropower

The GEIS (NRC, 1996) estimates land use of 1,600 sq miles (4,144 sq km) per 1,000 MWe generated by hydropower. Based on this estimate, hydropower would require flooding more than 2,600 sq miles (6,734 sq km) to produce a baseload capacity of 1,600 MWe net, resulting in a large impact on land use, assuming suitable topography and hydrologic resources are available.

{According to a study performed by the Idaho National Engineering and Environmental Laboratory (INEEL), Missouri has 29 possible hydropower sites: 6 developed and with a power-generating capacity of 104.2 MW, 12 developed and presently without power generating capacity but with a possible generating capacity of 180.9 MW, and 11 undeveloped sites with a possible 37.7 MWe of generating capacity (INEEL, 1997). Hydropower resources in Missouri are not capable of generating the 1,600 MWe net of baseload capacity that would be provided by Callaway Plant Unit 2. Therefore, hydropower is not a feasible alternative to a new nuclear unit at the Callaway site.}

9.2.2.4 Solar Power

Solar energy depends on the availability and strength of sunlight (strength is measured as kWh per sq m), and solar power is considered an intermittent source of energy. Solar facilities would have equivalent or greater environmental impacts than a new nuclear facility at the {Callaway} site. Such facilities would also have higher costs per unit of capacity of energy production than a new nuclear facility.

{In order to look at the availability of solar resources in the AmerenUE service territory, two collector types must be considered: concentrating collectors and flat-plate collectors. Concentrating collectors are mounted to a tracker, allowing them to face the sun at all times of the day. In Missouri, approximately 4,000 to 4,500 watt-hours per sq m per day (W-hr/m^2/day) can be collected using concentrating collectors. Flat-plate collectors are usually fixed in a tilted position to best capture direct rays from the sun and also to collect reflected light from clouds or the ground. In Missouri, approximately 4,500 to 5,000 W-hr/m^2/day can be collected using flat-plate collectors (EERE, 2007b). Like wind, solar capacity factors are too low to meet the baseload equivalence of capacity of Callaway Plant Unit 2 (1,600 MWe net). Average annual capacity factors for solar power systems are relatively low at 24% for photovoltaics and 32% for solar thermal power. The capacity factor for Callaway Plant Unit 2 would be 90% to 95% baseload capacity.

Land use requirements and the associated environmental impact of construction are much greater, compared to nuclear power, for any solar generation technology necessary to generate the 1,600 MWe net of baseload power, and thus is not considered to be an alternative to Callaway Plant Unit 2. The area of land required depends on the available solar insolation and type of plant, but is approximately 6.5 acres to 13 acres (2.6 hectares to 5.2 hectares) per MWe (Millennium, 2001) for photovoltaic systems and 5 acres to 10 acres (2 hectares to 4 hectares) per MWe for solar thermal power plant (NREL, 2007).} The footprint needed to produce a 1,600 MWe net baseload capacity is much too large to construct at the proposed plant site.

{Environmental impacts of solar power systems can vary based on the technology used and the site specific conditions.

- Land use and aesthetics are the primary environmental impacts of solar power.
- Land requirements for each of the individual solar energy technologies are large, compared to the land used by a new nuclear plant.
- Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.
- PV technology creates environmental impacts related to manufacture and disposal. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems because there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal (CEC, 2004). There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term.

  Generally, PV cells are sealed and the risk of release is considered slight; however, the long-term impact of these chemicals in the environment is unknown. Another environmental consideration with solar technologies is the lead-acid batteries that are used with some systems. The impact of these lead batteries is lessening; however, as batteries become more recyclable, batteries of improved quality are produced and better quality solar systems that enhance battery lifetimes are created (REW, 2001)

Based on the early development stage of flat plate photovoltaic cells and the extremely large land requirement, PV cells are non-competitive with the proposed nuclear plant at the Callaway Plant site.}

9.2.2.4.1 Concentrating Solar Power Systems

Concentrating solar plants produce electric power by converting solar energy into high temperature heat using various mirror configurations. The heat is then channeled through a conventional generator, via an intermediate medium (i.e., water or salt). Concentrating solar plants consist of two parts: one that collects the solar energy and converts it to heat, and another that converts heat energy to electricity.

Concentrating solar power systems can be sized for “village” power (10 kWe) or grid-connected applications (up to 100 MWe). Some systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. These attributes, along with solar-to-electric conversion efficiencies, make concentrating solar power an attractive renewable energy option in the southwest part of the U.S. and other Sunbelt regions worldwide (EERE, 2006b).

There are three kinds of concentrating solar power systems—troughs, dish/engines, and power towers – classified by how they collect solar energy (EERE, 2006b).

Concentrating solar power technologies utilize many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the energy for conversion into electricity. This "evolutionary" aspect – as distinguished from "revolutionary" or "disruptive" – allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

{Concentrating solar power has a relatively low cost and an ability to deliver power during periods of peak demand. This means it can be a major contributor to the nation's future needs for distributed sources of energy (EERE, 2006b). However, these technologies are still in the demonstration phase of development and cannot be considered competitive with fossil or nuclear-based technologies. In addition, concentrating solar power plants only perform efficiently in high-intensity sunlight locations. The Callaway site, AmerenUE's service area, and the state of Missouri are not included in these arid and semi-arid regions. The Department of Energy's Solar Energy Technologies Program pursues concentrating solar power research and development to provide clean, reliable, affordable solar thermal electricity for the nation. The goal of the program is to ensure that solar thermal technologies such as concentrating solar power make an important contribution to the world's growing need for energy (EERE, 2006b). Based on the early stage of development of these systems and the low intensity sunlight in the AmerenUE service territory, this technology is not considered to be a competitive alternative to the proposed nuclear project.}

9.2.2.4.2 "Flat Plate" Photovoltaic Cells

The second common method for capturing the sun's energy is through the use of PV cells. A typical PV or solar cell might be a 10 cm (4 inches) per side square, producing approximately 1 watt of power.

When more power is needed, some 40 PV cells can be connected to form a "module." For larger power needs, about 10 such modules are mounted in PV arrays, which can measure up to several meters on a side.

"Flat-plate" PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight over the course of a day. Ten to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system (NREL, 2007). The land requirement for this technology is approximately 14 hectares (35 acres) per MWe (NRC, 1996). In order to produce the 1,600 MWe net baseload capacity as {Callaway Plant Unit 2}, 22,660 hectares (55,993 acres) would be required for construction of the photovoltaic modules.

{Currently, PV solar power is not competitive with other methods of producing electricity as a large baseload generator. When calculating the cost of solar systems, the totality of the system must be examined. It is important to remember that all systems are unique in their quality and size, making it difficult to make broad generalizations about price.

Costs of PV cells in the future may be expected to decrease with improvements in technology and increased production. These costs would still be substantially in excess of the costs of power from a new nuclear plant. Therefore, PV cells are non-competitive with a new nuclear plant at the Callaway site.}

9.2.2.5 Wood Waste and Other Biomass

{The use of wood waste and other biomass to generate electricity is largely limited to states with significant wood resources. Electric power is generated in these states by the pulp, paper, and paperboard industries, which consume wood and wood waste for energy, benefiting from the use of waste materials that could otherwise represent a disposal problem. Plant sizes up to 50 to 100 MWe have been built or proposed. However, the majority of the successful plants have been in the 25 to 35 MWe range (AUE, 2008a). This would not meet the proposed 1,600 MWe net baseload capacity.

Nearly all of the wood-energy-using electricity generation facilities in the U.S. use steam turbine conversion technology. The technology is relatively simple to operate and it can accept a wide variety of biomass fuels. However, at the scale appropriate for biomass, the technology is expensive and inefficient. Therefore, the technology is relegated to applications where there is a readily available supply of low, zero, or negative cost delivered feedstock.

Construction of a wood-fired plant would have an environmental impact that would be similar to that for a coal-fired plant, although facilities using wood waste for fuel would be built on smaller scales. Like coal-fired plants, wood-waste plants require large areas for fuel storage, processing, and waste (i.e., ash) disposal. Additionally, the operation of wood-fired plants creates environmental impacts, including impacts on the aquatic environment and air (NRC, 1996).

Because the state of Missouri does not have significant wood product production resources and the fact that the majority of the successful biomass plants are limited to 25 to 35 MW, this is not a competitive alternative for the proposed nuclear unit at the Callaway site.}

9.2.2.6 Municipal Solid Waste

The initial capital costs for municipal solid waste (MSW) plants are greater than for comparable steam turbine technology at wood-waste facilities (NRC, 1996). This is because of the need for specialized waste separation and handling equipment.

The decision to burn MSW to generate energy is usually driven by the need for an alternative to landfills, rather than by energy considerations. The use of landfills as a waste disposal option is likely to increase in the near term; however, it is unlikely that many landfills will begin converting waste to energy because of the numerous obstacles and factors that may limit the growth in MSW power generation. Chief among them are environmental regulations and public opposition to siting MSW facilities.

Estimates suggest that the overall level of construction impacts from a waste-fired plant should be approximately the same as those for a coal-fired plant. Additionally, waste-fired plants have the same or greater operational impacts (including impacts on the aquatic environment, air, and waste disposal) (NRC, 1996). Some of these impacts would be moderate, but still larger than the proposed action.

{In 2006, 6,119,749 tons (5,551,745 metric tons) of solid waste were managed or disposed of in Missouri, with 7,252 tons of (6,579 metric tons) of that amount being infectious waste that is incinerated (MDNR, 2007).} As an MSW reduction method, incineration can be implemented, generating energy and reducing the amount of waste by up to 90% in volume and 75% in weight (USEPA, 2006b).

The U.S. has about 89 operational MSW-fired power generation plants, generating approximately 2,500 MWe, or about 0.3% of total national power generation. However, economic factors have limited new construction. This comes to approximately 28 MWe per MSW-fired power generation plant, and would not meet the proposed approximate 1,600 MWe net baseload capacity criterion. Burning MSW produces nitrogen oxides and sulfur dioxide as well as trace amounts of toxic pollutants, such as mercury compounds and dioxins. MSW power plants, much like fossil fuel power plants, require land for equipment and fuel storage. The non-hazardous ash residue from the burning of MSW is typically deposited in landfills (USEPA, 2008).

The cost of power for MSW-fired power generation plants would be partially offset by savings in waste disposal fees. However, MSW-fired power generation remains significantly more costly than nuclear power, even when disposal fee savings are included into the cost of power. These costs, accounting for the disposal fees, are significantly higher than the costs associated with a nuclear power plant. Based on the lack of development of this technology for large baseload applications and the higher cost, MSW is not competitive with the proposed nuclear unit at the {Callaway} site.

9.2.2.7 Energy Crops

In addition to wood and MSW fuels, there are several other concepts for fueling electric generators, including burning energy crops, converting crops to a liquid fuel such as ethanol (ethanol is primarily used as a gasoline additive), and gasifying energy crops (including wood waste). None of these technologies has progressed to the point of being competitive on a large scale or of being reliable enough to replace a baseload plant capacity of 1,600 MWe.

Estimates suggest that the overall level of construction impacts from a crop-fired plant should be approximately the same as those for a wood-fired plant. Additionally, crop-fired plants would have similar operational impacts (including impacts on the aquatic environment and air) (NRC, 1996). In addition, these systems have large impacts on land use because of the acreage needed to grow the energy crops.

Ethanol is perhaps the best known fuel derived from energy crops. It is estimated that 3.0 sq miles (7.8 sq km) of corn are needed to produce 1 million gallons of ethanol, and in {2006 Missouri produced approximately 4,108 sq miles (10,640 sq km) of corn. Currently in Missouri, more corn is used for grain products than any other purpose. If ethanol were to be proposed as an energy crop, Missouri would have to supplement its corn production from nearby states. (USDA, 2006) Surrounding states also use corn for grain products and do not have the resources to supplement ethanol based fuel facilities.}

The energy cost per KWh for energy crops is estimated to be similar to, or higher than, other biomass energy sources (EIA, 2004b). A DOE forecast concluded that the use of biomass for power generation is not projected to increase substantially in the next ten years because of the cost of biomass relative to the costs of other fuels and the higher capital costs relative to those for coal- or natural-gas-fired capacity (EIA, 2002). Therefore, energy crops are not competitive with the proposed nuclear unit at the {Callaway} site.

9.2.2.8 Petroleum Liquids (Oil)

From 2002 to 2005, petroleum costs almost doubled, increasing by 92.8%, and the period from 2004 to 2005 alone produced an average petroleum increase of 50.1% (EIA, 2006c). {From 2006 to 2007, net generation of electricity from petroleum liquids increased by about 28% in Missouri (EIA, 2007c).}

Operation of oil-fired plants would have environmental impacts (including impacts on the aquatic environment and air) that would be similar to those from a coal-fired plant. Oil-fired plants also have one of the largest carbon footprints of all the electricity generation systems analyzed. Conventional oil-fired plants result in emissions of greater than 650 grams of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 130 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Future developments such as carbon capture and storage and co-firing with biomass have the potential to reduce the carbon footprint of oil-fired electricity generation (POST, 2006).

Apart from fuel price, the economics of oil-fired power generation are similar to those for natural gas-fired power generation. Distillate oil can be used to run gas turbines in a combined-cycle system; however, the cost of distillate oil usually makes this type of combined-cycle system a less competitive alternative when natural gas is available. Oil-fired power generation experienced a significant decline in the early 1970s. {A generic, oil-fired, intermediate or peaking plant in the AmerenUE service area would have a busbar cost 3 to 4 times that of the proposed facility.} (AUE, 2008a)} Increases in world oil prices have forced utilities to use less expensive fuels; however, oil-fired generation is still an important source of power in certain regions of the U.S. (NRC, 1996).

{An oil-fired generation plant is not competitive with a new nuclear unit at the Callaway site based on the higher and more volatile fuel cost and higher emissions.}

9.2.2.9 Fuel Cells

Phosphoric acid fuel cells are the most mature fuel cell technology, but they are only in the initial stages of commercialization. During the past three decades, significant efforts have been made to develop more practical and affordable fuel cell designs for stationary power applications, but progress has been slow. Today, the most widely marketed fuel cells cost about $4,500 per kW of installed capacity.

By contrast, a diesel generator costs $800 to $1,500 per kW of installed capacity, and a natural gas turbine can cost even less. DOE has launched an initiative – the Solid State Energy Conversion Alliance – to bring about dramatic reductions in fuel cell cost. The DOE goal is to cut costs to as low as $400 per kW of installed capacity by the end of this decade, which would make fuel cells competitive for virtually every type of power application. (DOE, 2006)

As market acceptance and manufacturing capacity increase, natural-gas-fueled fuel-cell plants in the 50 to 100 MWe range are projected to become available. This will not meet the proposed 1,600 MWe net baseload capacity. At the present time, fuel cells are not economically or technologically competitive with other alternatives for baseload electricity generation and that the fuel cell alternative is not competitive with the proposed nuclear unit at the {Callaway} site.

9.2.2.10 Coal

Coal-fired steam electric plants provide the majority of electric generating capacity in the U.S., accounting for about 52% of the electric utility industry's total generation, including co-generation, in 2000 (EIA, 2001a). Conventional coal-fired plants generally include two or more generating units and have total capacities ranging from 100 MWe to more than 2,000 MWe. Coal is likely to continue to be a reliable energy source well into the future, assuming environmental constraints do not cause the gradual substitution of other fuels (EIA, 1993).

The U.S. has abundant low-cost coal reserves, and the price of coal for electric generation is likely to increase at a relatively slow rate. Even with recent environmental legislation, new coal capacity is expected to be an affordable technology for reliable, near-term development and for potential use as a replacement technology for nuclear power plants (NRC, 1996).

The environmental impacts of constructing a typical coal-fired steam plant are well known because coal is the most prevalent type of central generating technology in the U.S. The impacts of constructing a 1,000 MWe coal plant at a greenfield site can be substantial, particularly if it is sited in a rural area with considerable natural habitat. An estimated 2.66 sq miles (6.88 sq km) would be needed, resulting in the loss of the same amount of natural habitat and/or agricultural land for the plant site alone, excluding land required for mining and other fuel cycle impacts (NRC, 1996).

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a coal gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.11 Natural Gas

{There are 7 natural gas-fired plants or plants with natural gas-fired components in Missouri. Together, they are able to generate more than 2,217.5 MWe of energy (MDNR, 2000).}

Most of the environmental impacts of constructing natural gas-fired plants are similar to those of other large central generating stations. Land-use requirements for gas-fired plants are small, at 0.17 sq miles (0.44 sq km) for a 1,000 MWe plant, so land-dependent ecological, aesthetic, erosion, and cultural impacts should be small. Siting at a greenfield location would require new transmission lines and increased land-related impacts, whereas co-locating the gas-fired plant with an existing nuclear plant would help reduce land-related impacts. Also, gas-fired plants, particularly combined cycle and gas turbine facilities, take much less time to construct than other plants (NRC, 1996).

{Siting a gas-fired plant at the Callaway site would require significant fuel transportation infrastructure costs since there is no natural gas pipeline near the site.}

Based on the well-known technology, fuel availability, and generally understood environmental impacts associated with constructing and operating a natural gas-fired power generation plant, it is considered a competitive alternative and is therefore discussed further in Section 9.2.3.

9.2.2.12 Integrated Gasification Combined Cycle (IGCC)

Integrated Gasification Combined Cycle (IGCC) is an emerging, advanced technology for generating electricity with coal that combines modern coal gasification technology with both gas turbine and steam turbine power generation. The technology is substantially cleaner than conventional pulverized coal plants because major pollutants can be removed from the gas stream prior to combustion.

The IGCC alternative generates substantially less solid waste than the pulverized coal-fired alternative. The largest solid waste stream produced by IGCC installations is slag, a black, glassy, sand-like material that is potentially a marketable byproduct. Slag production is a function of ash content. The other large-volume byproduct produced by IGCC plants is sulfur, which is extracted during the gasification process and can be marketed rather than placed in a landfill. IGCC units do not produce ash or scrubber wastes.

At present, IGCC technology still has insufficient operating experience for widespread expansion into commercial-scale, utility applications. Each major component of IGCC has been broadly utilized in industrial and power generation applications. But the integration of coal gasification with a combined cycle power block to produce commercial electricity as a primary output is relatively new and has been demonstrated at only a handful of facilities around the world, including five in the U.S. Experience has been gained with the chemical processes of gasification, coal properties and their impact on IGCC design, efficiency, economics, etc.

{In 2004, the U.S. Department of Energy commissioned Booz Allen Hamilton to conduct a study on the various ways to increase IGCC's market penetration potential in the future. The study considered only coal as the feedstock. Booz Allen Hamilton concluded that it is feasible for IGCC to assume a more prominent role in energy production only after extensive research is conducted to lower the production costs. Additionally, Booz Allen Hamilton depicted three challenges that IGCC must overcome before becoming a prominent source of energy, including: overcoming the financial burden relative to competing technologies, mitigating siting risks, and managing uncertainty. Booz Allen Hamilton lays out a series of recommendations for the Department of Energy to take to begin to overcome these challenges. Many of these recommendations include conducting further studies and research tests (BAH, 2004).}

Because IGCC technology currently requires further research to achieve an acceptable level of reliability, an IGCC facility is not a competitive alternative to {Callaway Plant Unit 2}.

9.2.3 ASSESSMENT OF COMPETITIVE ALTERNATIVE ENERGY SOURCES AND SYSTEMS

For the competitive alternative energy source options identified in Section 9.2.2, the issues associated with these options were characterized based on the significance of impacts, with the impacts characterized as being SMALL, MODERATE, or LARGE. This characterization is consistent with the criteria that NRC established in 10 CFR 51, Appendix B, Table B-1, Footnote 3, as follows:

- SMALL - Environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, the Commission has concluded that those impacts that do not exceed permissible levels in the Commission's regulations are considered small.

- MODERATE - Environmental effects are sufficient to alter noticeably, but not to destabilize, any important attribute of the resource.

- LARGE - Environmental effects are clearly noticeable and are sufficient to destabilize any important attributes of the resource (NRC, 1996).

Table 9.2-1 provides a comparison of the alternatives regarding environmental categories.

9.2.3.1 Coal-Fired Generation

The environmental impacts from coal-fired generation alternatives were evaluated in the GEIS (NRC, 1996). It was concluded that construction impacts for coal-fired generation could be substantial, in part because of the large land area required (for the plant site alone, 2.65 sq miles (6.88 sq km) for a 1,000 MWe plant), which would be in addition to the land resources required for mining and other fuel cycle impacts. These construction impacts would be decreased to some degree by siting a new coal-fired plant where an existing nuclear plant is located.

9.2.3.1.1 Air Quality

The air quality impacts of coal-fired generation are considerably different from those of nuclear power. A coal-fired plant would emit sulfur dioxide (SO_2, as SO_x surrogate), oxides of nitrogen (NO_x), particulate matter (PM), and carbon monoxide (CO), all of which are regulated pollutants. Air quality impacts from fugitive dust, water quality impacts from acidic runoff, and aesthetic and cultural resources impacts are all potential adverse consequences of coal mining.

Air emissions were estimated for a coal-fired generation facility based on the emission factors contained EPA document, AP-42 (USEPA, 1995). The emissions from this facility are based on a power generation capacity of 1,600 MWe. The coal-fired generation facility assumes the use of bituminous coal fired in a circulating fluidized bed combustor (FBC). The sulfur content of the coal was assumed to be 2% by weight. Emissions control included the use of lime in the combustor unit, a wet scrubber system to control acid gas emissions, selective catalytic reduction to minimize NOx emissions and a baghouse to control PM. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe coal-fired facility.

Operating impacts of a new coal plant include concerns over adverse human health effects, such as increased cancer and emphysema. Air quality would be impacted by the release of CO_2, regulated pollutants, and radionuclides. CO_2 has been identified as a leading cause of global warming, and SO_2 and oxides of nitrogen have been identified with acid rain. Substantial solid waste, especially fly ash and scrubber sludge, would also be produced and would require constant management. Losses of aquatic biota due to cooling water withdrawals and discharges would also occur.

{The U.S. Environmental Protection Agency (USEPA) issued the Nitrogen Oxides (NOx) State Implementation Plan (SIP) Call in 1998 to reduce air-borne transport of NOx (oxides of nitrogen) emissions in the eastern United States. NOx, a precursor of particulate matter and ground-level ozone, can be transported from “upwind” sources such as Midwestern power plants to “downwind” urban areas hundreds of miles to the east that have ozone attainment problems.

Through the NOx SIP Call, USEPA required 22 states, including Missouri, and the District of Columbia to limit total NOx emissions between May 1 and September 30 to a specific maximum quantity or “cap.”

In response to air quality improvement requirements set by the USEPA, Missouri established a NOx allowance cap and trade program in eastern Missouri. As part of this program, Missouri set aside 134 NOx allowances to be awarded annually to energy efficiency and renewable energy projects located in eastern Missouri that reduce NOx emissions from power plants during the summer ozone season. Successful projects can receive awards for up to five years. The awards are in the form of NOx allowances that can be sold to the highest bidder (MDNR, 2008). The program has resulted in numerous energy efficiency and conservation projects.}

Coal burning power systems have the largest carbon footprint of all the electricity generation systems analyzed. Conventional coal systems result in emissions of greater than 1,000 grams (g) of CO_2 equivalent/kilowatt-hour (gCO_2eq/kWh). This is approximately 200 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Lower emissions can be achieved using new gasification plants (less than 800 gCO_2eq/kWh), but this is still an emerging technology and is not as widespread as proven combustion technologies (POST, 2006).

Based on the emissions generated by a coal-fired facility, air impacts would be MODERATE to LARGE.

9.2.3.1.2 Waste Management

Substantial solid waste, especially fly ash and scrubber sludge, would be produced and would require constant management (NRC, 1996).

With proper placement of the facility, coupled with current waste management and monitoring practices, waste disposal would not destabilize any resources. There would also need to be an estimated 34.4 sq miles (89 sq km) for mining the coal and disposing of the waste to support a coal plant during its operational life (NRC, 1996).

As a result of the above mentioned factors, waste management impacts would be MODERATE.

9.2.3.1.3 Economic Comparison

{The IRP estimated busbar cost of generating electricity from a coal facility is approximately $0.096 per kWh and the projected cost of generation from Callaway Plant Unit 2 in the IRP is $0.073 per kWh. The estimated cost for the coal fired facility is based on generic data and a greenfield site. It does not, for example, include the cost for developing rail transportation for getting coal to the Callaway site (AUE, 2008a).}

9.2.3.1.4 Other Impacts

{Estimated impacts for construction of the power block and coal storage area would disturb approximately 2.65 sq miles (6.88 sq km) (NRC, 1996). As a result, land use impacts would be MODERATE.

Impacts to aquatic resources and water quality would be minimized and similar to those of the proposed nuclear unit (SMALL). These impacts are discussed in Sections 5.2.3 and 5.3.1.

Three new, 200 ft (61 m) power plant structures and 600 ft (183 m) stacks potentially visible for 40 miles (64 km) in a relatively non-industrialized area would need to be constructed along with two possible 520 ft (159 m) cooling towers and associated plumes. As a result, aesthetic impacts would be LARGE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed Callaway site.

Socioeconomic impacts would result from the additional staff needed to operate the coal-fired facility, and several hundred mining jobs and additional tax revenue would be associated with the coal mining. As a result, socioeconomic impacts would be MODERATE.

As a result of increased safety technologies, accident impacts would be SMALL.

As a result of increased air emissions and public health risks such as cancer and emphysema associated with those emissions, human health impacts would be MODERATE.}

9.2.3.1.5 Summary

{In order for a coal-fired plant constructed on the Callaway site to be competitive with a nuclear plant on the same site, the coal-fired plant would need to generate power in excess of 1,600 MWe. The nuclear plant requires a much smaller construction footprint, whereas the coal-fired plant would require more than 2.66 sq miles (6.88 sq km), and greenhouse gas emissions would be significantly greater (NRC, 1996). Additionally, there would be increased transportation costs associated with a coal-fired plant. These costs would be incurred when transporting coal to the site. There is currently no railway access to the Callaway site. A railway would need to be built before locating a coal-fired plant on this site. Air pollution from a coal-fired plant is also much greater than that associated with a nuclear power plant. Although this factor can be mitigated to some extent, a nuclear plant would still have a lower amount of air pollution. Therefore, a 1,600 MWe coal-fired generation plant has a greater environmental impact than a nuclear power plant.}

9.2.3.2 Natural Gas Generation

Most environmental impacts related to constructing natural gas-fired plants should be approximately the same for steam, gas-turbine, and combined-cycle plants. These impacts, in turn, generally will be similar to those of other large central generating stations. The environmental impacts of operating gas-fired plants are generally less than those of other fossil fuel technologies of equal capacity.

9.2.3.2.1 Air Quality

Natural gas is a relatively clean-burning fossil fuel. Also, because the heat recovery steam generator does not receive supplemental fuel, the combined-cycle operation is highly efficient (56% vs. 33% for the coal-fired alternative). Therefore, the gas-fired alternative would release similar types of emissions, but in lesser quantities than the coal-fired alternative. Control technology for gas-fired turbines focuses on the reduction of NO_x emissions.

Human health effects are SMALL based on decreased air quality impacts. Natural gas technologies produce fewer pollutants than other fossil technologies, and SO_2, a contributor to acid rain, is not emitted at all (NRC, 1996). Air emissions were estimated for a natural gas-fired generation facility based on the emission factors contained EPA document, AP-42 (USEPA, 1995). Emissions from the facility were based on a power generation capacity of 1,600 MWe.

Current gas powered electricity generation has a carbon footprint around half that of coal (approximately 500 gCO_2eq/kWh), because gas has a lower carbon content than coal. This is approximately 100 times higher than the carbon footprint of a nuclear power generation facility (approximately 5 gCO_2eq/kWh). Like coal-fired plants, gas plants could co-fire biomass to reduce carbon emissions in the future (POST, 2006).

The natural gas-fired generation facility assumes the use of a combined cycle gas turbine generator (GTG). Water injection is used to control nitrogen oxides emissions. Table 9.2-2 summarizes the air emissions produced by a 1,600 MWe natural gas-fired facility. Based on the emissions generated from a natural gas-fired facility, air impacts would be MODERATE.

9.2.3.2.2 Waste Management

Gas-fired generation would result in almost no waste generation, producing minor (if any) impacts. As a result, waste management impacts would be SMALL.

9.2.3.2.3 Economic Comparison

{The IRP estimated busbar cost of generating power from a gas-fired facility is $0.114 per kWh. This cost is based on location of the plant at a greenfield site and does not include the cost of developing a pipeline to supply fuel for the plant. The equivalent estimated cost for Callaway Plant Unit 2 is $0.073 per kWh (AUE, 2008a).}

9.2.3.2.4 Other Impacts

{Land use requirements for gas-fired plants are approximately 110 acres (44 hectares) (NRC, 1996). As a result, land use impacts would be SMALL.

Consumptive water use is about the same for steam cycle plants as for other technologies, although water consumption is likely to be less for gas turbine plants. There are potential impacts to aquatic biota through increased water temperatures in receiving water bodies (NRC, 1996). Water quality impacts would be SMALL. Physical impacts are discussed in Section 4.2.

A new 100 ft (30 m) turbine building and 230 ft (70 m) exhaust stacks would need to be constructed. A closed-cycle cooling alternative could also introduce plumes. As a result, aesthetic impacts would be MODERATE.

Cultural resources, ecological resources, and threatened and endangered species impacts would be SMALL as a result of an already disturbed Callaway site.

Socioeconomic impacts would result from the approximately 150 people needed to operate the gas-fired facility, as estimated in the GEIS (NRC, 1996). As a result, socioeconomic impacts would be SMALL.

Due to increased safety technologies, accidents and human health impacts would be SMALL.}

9.2.3.2.5 Summary

{Operation of a large, baseload gas-fired plant located at the Callaway site would require construction of a large pipeline from a terminal to the plant. The air emissions from a gas-fired plant have less impact than a similar sized coal-fired plant but are much greater than those from the proposed nuclear plant. The busbar costs are much greater for a gas-fired plant. Based on these comparisons, the gas-fired alternative is not considered feasible.}

9.2.3.3 Combination of Alternatives

{Callaway Plant Unit 2} will have a baseload capacity of approximately 1,600 MWe. Any alternative or combination of alternatives would be required to generate the same baseload capacity.

Because of the intermittent nature of the resources and the lack of cost-effective technologies, wind and solar energies are not sufficient on their own to generate the equivalent baseload capacity or output of {Callaway Plant Unit 2}, as discussed in Section 9.2.2.1 and Section 9.2.2.4. As noted in Section 9.2.3.1 and Section 9.2.3.2, fossil fuel fired technology generates baseload capacity, but the associated environmental impacts are greater than for a nuclear facility.

A combination of alternatives may be possible, but should be sufficiently complete, competitive, and viable to provide NRC with appropriate comparisons to the proposed nuclear plant. {Specific combinations analyzed in the IRP are discussed in Section 8.4.}

9.2.3.3.1 Determination of Alternatives

{A number of combinations of alternative power generation sources could be used to satisfy the baseload capacity requirements of the Callaway Plant Unit 2 facility. Some of these combinations include renewable sources, such as wind and solar. Wind and solar do not, by themselves, provide a reasonable alternative energy source to the baseload power to be produced by the Callaway Plant Unit 2 facility. However, when combined with fossil fuel-fired plant(s), wind and solar may be a reasonable alternative to nuclear energy produced by the Callaway Plant Unit 2 facility.

This combination of renewable energy and natural gas fired generation represents a feasible mix of non-nuclear alternative energy sources. Many types of alternatives can be used to supplement wind energy, notably solar power. PV cells are another source of solar power that would complement wind power by using the sun during the day to produce energy while wind turbines use windy and stormy conditions to generate power. Wind and solar facilities in combination with fossil fuel facilities (coal, petroleum) could also be used to generate baseload power.

However, wind and solar facilities in combination with fossil fuel facilities would have equivalent or greater environmental impacts relative to a new nuclear facility at the Callaway site. Similarly, wind and solar facilities in combination with fossil fuel facilities would have costs higher than a new nuclear facility at the Callaway site. Therefore, wind and solar facilities in combination with fossil fuel facilities are not competitive with the proposed nuclear unit at the Callaway site.}

9.2.3.3.2 Environmental Impacts

{The environmental impacts associated with a gas-fired power generation facility sized to produce power equivalent to Callaway Plant Unit 2 have already been analyzed, as described in Section 9.2.3.2. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion will be comparably lower. If the renewable portion of the combination alternative were not enough to displace the power produced by the fossil fueled facility, then there would be some level of impact associated with the fossil fueled facility.

Consequently, if the renewable portion of the combination alternative were enough to fully displace the output of the gas-fired facility, then, when the renewable resource is available, the output of the fossil fueled facility could be eliminated, thereby eliminating its operational impacts.

The environmental impacts associated with a solar or wind facility equivalent to Callaway Plant Unit 2 have already been analyzed. It is reasonable to expect that the impacts associated with an individual unit of a smaller size would be similarly scaled. If the renewable portion of the combination alternative is unable to generate an equivalent amount of power as Callaway Plant Unit 2, then the combination alternative would have to rely on the gas-fired portion to meet the equivalent capacity of Callaway Plant Unit 2.

Consequently, if the renewable portion of the combination alternative has a potential output that is equal to that of Callaway Plant Unit 2, then the impacts associated with the gas-fired portion of the combination alternative would be lower but the impacts associated with the renewable portion would be greater. The gas-fired facility alone has impacts that are larger than Callaway Plant Unit 2; some environmental impacts of renewable energy generation are also greater than or equal to Callaway Plant Unit 2. The combination of a gas-fired plant and wind or solar facilities would have environmental impacts that are equal to or greater than those of a nuclear facility.

- ♦ All of the environmental impacts of a new nuclear plant at the Callaway site and all of the impacts from a gas-fired plant are small, except for air quality and aesthetic impacts from a gas-fired facility (which are moderate). Use of wind and/or solar facilities in combination with a gas-fire facility would be small, and therefore would be equivalent to the air quality impacts from a nuclear facility.

- All of the environmental impacts of a new nuclear plant at the Callaway site and all of the impacts from wind and solar facilities are SMALL, except for land use and aesthetic impacts from wind and solar facilities (which range from MODERATE to LARGE). Use of a gas-fired facility in combination with wind and solar facilities would reduce the land usage and aesthetic impacts from the wind and solar facilities. However, at best, those impacts would be SMALL, and therefore would be equivalent to the land use and aesthetic impacts from a nuclear facility.

Therefore the combination of wind and solar facilities and gas-fired facilities is not environmentally preferable to Callaway Plant Unit 2.}

9.2.4 CONCLUSION

{Based on a comparison of environmental impacts, it has been concluded that neither a coal-fired, gas-fired, nor a combination of alternative sources is preferable to the proposed Callaway Plant Unit 2. As discussed in Sections 9.2.3.1.3 and 9.2.3.2.3, the proposed Callaway Plant Unit 2 is also the most cost effective source of base load generation and is also the environmentally preferable alternative.}

9.2.5 REFERENCES

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Table 9.2-1—{Impacts Comparison Table}

Impact Category	Callaway Plant Unit 2	Coal-Fired Generation	Gas-Fired Generation	Combinations
Air Quality MT (tons)/yr	Small	Moderate to Large	Moderate	Small to Large
Waste Management MT (tons)/yr	Small	Moderate	Small	Small to Moderate
Land Use mi^2 (km^2)	Small	Moderate	Small	Small to Large
Water Quality	Small	Small	Small	Small to Large
Aesthetics m (ft)	Large	Large	Moderate	Small to Large
Cultural Resources	Small	Small	Small	Small
Ecological Resources	Small	Small	Small	Small
Threatened & Endangered Resources	Small	Small	Small	Small
Socioeconomics	Small	Moderate	Small	Small to Moderate
Accidents	Small	Small	Small	Small
Human Health	Small	Moderate	Small	Small to Moderate

Notes:

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

MEDIUM – Environmental effects are sufficient to alter noticeably, nut not destabilize, any important attribute of the resource.

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

Table 9.2-2—Air Emissions from Alternative Power Generation Facilities

Fuel	Bituminous Coal	Natural Gas
Combustion Facility	Circulating FBC	Combined Cycle GTG
Generation Capacity	1,600 MW	1,600 MW
Air Pollutant Emissions – metric tons (tons) per year		
Sulfur Dioxide (SO_2)	415 (457)	17 (19)
Nitrogen Dioxide (NO_2)	734 (809)	661 (729)
Carbon Monoxide (CO)	4,402 (4,852)	152 (168)
Particulate Matter (PM)	21 (23)	34 (37)
PM less than 10µm (PM10)	15 (17)	24 (26)
Carbon Dioxide, equiv. (CO_2e)	1,731,000 (1,908,000)	565,000 (623,000)

CO_2e – CO_2 equivalent

FBC – fluidized bed combustor

GTG – gas turbine generator

9.3 ALTERNATIVE SITES

This section identifies and evaluates a set of alternative site locations to the {Callaway} site. The objective of this evaluation is to verify that there are no "obviously superior" sites on which to build and operate the {Callaway Plant Unit 2} nuclear power facility.

Siting new units at existing nuclear sites ("co-locating") has provided another option to the way alternatives were originally reviewed and selected. Existing sites offer decades of environmental and operational information about the impact of a nuclear plant on the environment. Because these sites are licensed nuclear facilities, the Nuclear Regulatory Commission (NRC) has already found them to be acceptable relative to other undeveloped sites in the region of interest. The NRC recognizes (in NUREG-1555, (NRC, 2007a), Section 9.3(III)) that proposed sites may not be selected as a result of a systematic review:

> Recognize that there will be special cases in which the proposed site was not selected on the basis of a systematic site-selection process. Examples include plants proposed to be constructed on the site of an existing nuclear power plant previously found acceptable on the basis of a (NEPA) review and/or demonstrated to be environmentally satisfactory on the basis of operating experience, and sites assigned or allocated to an applicant by a State government from a list of State-approved power-plant sites. For such cases, the reviewer should analyze the applicant's site-selection process only as it applies to candidate sites other than the proposed site, and the site-comparison process may be restricted to a site-by-site comparison of these candidates with the proposed site. The site selection process is the same for this case except for the fact that the proposed site is not selected from among the candidate sites based on a site by site comparison. (NRC, 2007a)

The information provided in this section is consistent with the special case noted in NUREG-1555, (NRC, 2007a), Section 9.3(III). This section identifies and discusses the evaluation of a set of alternative locations for the proposed plant and compares the suitability of these alternative sites with the suitability of the proposed site. The objective of this assessment is to verify that no site is "environmentally preferable" (and thus, no site is "obviously superior") for the siting of a new nuclear plant.

{The nuclear site evaluated is the Callaway site. The site was chosen because it is owned by AmerenUE and is known to have been selected originally to be the site for more than one power plant. As will be demonstrated in this section, this site has many features that result in it being ranked very favorably for construction and operation of a second unit. There are no other nuclear power plant sites located within the Region of Interest (ROI). The ROI is discussed in Section 9.3.1.

An extensive investigation was conducted to identify other sites within the ROI that could serve as the location for a nuclear power plant. Additionally, within Missouri, the state in which power from the Plant will be sold, the search for potential sites was expanded to include sites close to water bodies containing sufficient water for Plant needs but outside population centers. Details of this process are explained further in this section. The process resulted in the identification and subsequent detailed evaluation of two non-nuclear brownfield and two specific greenfield candidate sites.

Callaway Plant Unit 1 is the only licensed nuclear power plant located within AmerenUE's service area or in the State of Missouri.}

9.3.1 SITE SELECTION PROCESS

The site selection process focuses on identifying and evaluating locations that represent a range of reasonable alternative sites for the proposed project. The primary objective of the site-selection process is to determine if any alternative site is "obviously superior" to the proposed site for eventual construction and operation of the nuclear power plant unit. The proposed site is then compared with the alternate candidate sites to determine if any are "environmentally preferable." The basic constraints and limitations applicable to the site-selection process are the currently implemented rules, regulations, and laws within the federal, state, and local agency levels. These provide a comprehensive basis and an objective rationale under which this selection process is performed.

{In addition to applicable federal, state, and local rules, regulations, and laws, the following documents were used as both reference and guidance for this alternative siting study and the development and implementation of the selection process for the ROI and candidate areas:

- Electric Power Research Institute (EPRI) "Siting Guide: Site Selection and Evaluation Criteria for an Early Site Permit Application, 1006878, 2002" (EPRI, 2002),
- NRC Regulatory Guide 4.2, Revision 2 "Preparation of Environmental Reports For Nuclear Power Stations, Chapter 9 Alternative Sources and Sites," 1976 (NRC, 1976),
- NRC Regulatory Guide 4.7 Revision 2 – "General Site Suitability Criteria for Nuclear Power Stations," April, 1998 (NRC, 1998),
- NRC NUREG-1555, "Environmental Standard Review Plan, Office of Nuclear Reactor Regulation, Section 9.3 Site Selection Process," July, 2007 (NRC, 2007a).}

9.3.1.1 Region of Interest and Candidate Areas

{Callaway Plant Unit 2's purpose is to serve the AmerenUE customer base as a dedicated baseload power generation asset. This is required in order to meet existing and future load requirements necessary to ensure that AmerenUE will continue to provide reliable, quality, least-cost energy to its customers. AmerenUE's service area includes most of the St. Louis metropolitan area and portions of central, northwest, northeast, eastern and southeast Missouri (Figure 9.3-1 Potential Alternatives Region of Interest depicts AmerenUE's service area, the ROI, and other pertinent siting criteria).

AmerenUE evaluated the predicted future electric power regulatory and institutional restrictions and market conditions in the State of Missouri, along with the siting criteria specified in 10 CFR 100 to determine the need for power and the objective of the Plant. Chapter 8 discusses the need for power in this region.

Based on this review and analysis, it was determined that AmerenUE's service area is the most appropriate Region of Interest (ROI) for the selection of candidate areas to fulfill the stated purpose for the new plant. The ROI was selected because it contains areas that meet the threshold criteria of being (1) remote from population centers and population dense regions, (2) in close proximity to power demand load centers, (3) reasonably close to existing transmission lines, and (4) suitable for providing sufficient cooling water sources. Figure 9.3-1 depicts a scale map of the site study area and siting study features including the AmerenUE service area, candidate areas, population, and existing transmission and generation system assets.

A review of the ROI was conducted to ensure that an appropriately ecologically diverse area of study was selected for defining appropriate candidate areas for siting a nuclear power generating facility. The review included an evaluation of environmental diversity and threshold siting criteria. A variety of landform provinces are present in the ROI including the Dissected Till Plain to the north, the Ozark Highland in central Missouri, and the Coastal Plain province in the southeast. Each of the three landform provinces contain a diversity of landforms including mountains, hills, knobs, uplands, plains, lowlands, scarplands, and cuestas. A wide variety of topography, geology, soils, hydrology, land use, land cover and vegetation, and ecological regions are present (MDC, 2002).

After review of the available candidate areas within the ROI, AmerenUE determined that there were few sites that met the threshold criteria (as discussed in Section 9.3.1.1.1) for construction and operation of a Plant. Therefore, in order to determine conclusively whether the proposed site was among the best available in areas that could be linked through transmission lines to AmerenUE's service area, AmerenUE expanded its search area to any area in Missouri that met the minimal exclusionary criteria (as defined in EPRI 2002) of being outside of population centers while close to sufficient water to meet cooling needs. This resulted in the expansion of the candidate areas to additional locations along the Missouri and Mississippi rivers, as shown on Figure 9.3-1. There is no other water body within Missouri that is available for industrial uses (i.e., not reserved for conservation purposes) that has sufficient water for its current needs as well as the demands that the Plant would place on it.

The search area was limited to the state of Missouri because AmerenUE services customers only in Missouri. The construction of a nuclear power plant results in the generation of significant tax revenue to the host political bodies, additional employment, and some environmental costs. AmerenUE believes that the state of Missouri would have concerns if the Plant were to be built in, and thus deliver its tax benefits to, another state.

The initial phase of the Site Selection Study involved determining the methodology for defining the ROI and candidate site areas. The methodology developed by EPRI (2002) under the auspices of the NRC was selected with some modification to conform to the needs of selecting alternate sites to an existing proposed site. Briefly, the following steps were implemented:

- A limited number of exclusionary criteria, those criteria sufficient to eliminate an area from further consideration, were applied to the Region of Interest to develop candidate areas (Section 9.3.1.1.2).

- A number of data bases and other sources of information were consulted to identify potential sites within the candidate areas that could be a site for a nuclear power plant (Section 9.3.1.2.1). Two brownfield sites and nine greenfield sites were identified as potential sites.

- A number of avoidance and suitability criteria were selected to provide a basis for the evaluation of the potential sites (Section 9.3.1.1.3). Avoidance criteria are those that degrade the suitability of a site but are not sufficiently onerous to *prima facie* eliminate a site from consideration. Suitability criteria are those that describe the potential environmental or safety impact of a site, but for which the negative aspects can be mitigated.

- Values were applied to each of the avoidance and suitability criteria (Section 9.3.1.3). The values provided a way to differentiate whether the criteria were favorable or unfavorable to each site. The higher the value, the more the site displays a favorable attribute of the criterion.

- A weighting was applied to each of the avoidance and suitability criteria (Section 9.3.1.3). The weighting factor reflected how important each of the avoidance suitability criteria is to the suitability of a site. The higher the number, the more important the criterion is to the decision making process.

- Available data were obtained about the identified potential candidate sites. Values and weightings were applied to each of the avoidance and suitability criteria for each site and four candidate sites were selected for more detailed evaluation (Section 9.3.1.3).

9.3.1.1.1 Threshold Criteria

Various major site characteristics (including initial threshold site criteria in 10 CFR 100) were evaluated on a regional basis across the candidate areas. The siting requirements in 10 CFR 100 include those relating to the proposed reactor design and the characteristics specific to the site. Factors relating to site characteristics include the following:

- Population density and use characteristics of the site environs, including the exclusion area, low population zone, and population center distance; and

- Physical characteristics of the site, including seismology, meteorology, geology, and hydrology.

Non-seismic siting criteria specified in 10 CFR 100 include the following (among others):

- Presence of an exclusion area and a low population area as defined in 10 CFR 100;

- Population center distance of at least one and one-third times the distance from the reactor to the outer boundary of the low population zone;

- Suitable site atmospheric dispersion characteristics;

- Threats from physical characteristics of the site must pose no undue risk to the facility being considered;

- Potential hazards associated with nearby transportation routes, industrial and military facilities will pose no undue risk to the facility being considered; and

- Sites should be located away from very densely populated centers.

NRC Regulatory Guide 4.2, Rev. 2 (1998) also contains general site suitability criteria for nuclear power stations. This Regulatory Guide recognizes that

> "the information needed to evaluate potential sites at this initial stage of site selection is assumed to be limited to information that is obtainable from published reports, public records, public and private agencies, and individuals knowledgeable about the locality of a potential site. Although in some cases the applicants may have conducted on-the-spot investigations, it is assumed here that these investigations would be limited to reconnaissance-type surveys at this stage in the site selection process."

Relevant safety issues noted in Regulatory Guide 4.2, Rev. 2 include the following:

- Geologic/seismic, hydrologic, and meteorologic characteristics of proposed sites;
- Exclusion area and low population zone;
- Population considerations;
- Accidents associated with nearby industrial, transportation and military facilities;
- Emergency planning and security plans.

Environmental issues include consideration of construction and operation of the nuclear power station on the following:

- Ecological systems;
- Water use;
- Land use;
- The atmosphere;
- Aesthetics; and
- Socioeconomics.

NUREG-1555 (July 2007 draft) establishes a methodology for NRC to use in reviewing the applicant's process for identifying candidate areas. Among the reasons that may be sufficient to exclude areas from the ROI as unsuitable are the following:

- Proximity to major centers of population density;
- Lack of existing infrastructure (e.g., roads, railroads);
- Lack of a suitable cooling water source;
- Distance to transmission lines, substations, or load centers;
- Unsuitable topographic features;
- Potential to impact valuable agricultural, residential, or industrial areas;
- Potential to impact dedicated land-use areas (e.g., parks, historical sites, wilderness areas, testing grounds); and
- Conflict with land-use planning programs or other restrictions.

In accordance with these regulatory and guidance documents, the following siting exclusionary, avoidance, and suitability factors were evaluated in selecting candidate areas.

9.3.1.1.2 Exclusionary Criteria

Siting exclusionary criteria utilized in the review were:

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- Distance from major population centers, high population density areas, cities and towns;
- Distance from and static head to water bodies with suitable supplies of cooling water;
- Distance from areas with significant flood potential;
- Distance from areas with geological hazards such as active faults and seismic activity;

9.3.1.1.3 Avoidance and Suitability Criteria

Avoidance and suitability criteria used in the review were:

- Distance from existing stable transmission system connection and areas predicted to be deficient in power;
- Distance from significant public resources such as national parks, wilderness areas, monuments, forests and other areas of special national or cultural significance, state parks, conservation areas and nature preserves, wetlands, scenic areas, historical and archeological resources, special land use and zoning, and other natural habitats; and
- Distance from airports, airstrips, military installations, industrial hazards, major highways and rail corridors; and (NRC, 2007b).

The ROI was evaluated with respect to the exclusionary criteria. In particular, the following three criteria were used to identify portions of the ROI to be excluded from consideration as a candidate area:

- A 10-mile buffer zone was established around population centers (metropolitan statistical units) of 25,000 or greater, to account for the guidance in Regulatory Guide 4.7 Rev. 2 that the low population zone be such that the distance to the nearest boundary of a densely populated center containing more than about 25,000 residents must be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. The buffer zone was selected to account for population growth and residential expansion over the years of the life of the plant.
- A zone of 15 miles from the selected water bodies was established as the outer limit of a candidate area, in recognition that with increasing distance the environmental impacts of establishing both a water intake pipeline and a discharge line become greater.
- Regions of unsuitable potential seismic activity were established.

All other criteria that were noted in the NUREG 1555 as potentially identifying a candidate area as unsuitable were either deemed not relevant for the ROI or were considered to be factors that could be mitigated through engineering designs. Therefore, the candidate areas may contain some of these criteria.

Figure 9.3-1 and Figure 9.3-2 depict the ROI and candidate areas along with relevant information pertaining to the siting study exclusionary, avoidance, and suitability criteria outlined above.

The EPRI Siting Guide (2002) geologic and seismic hazards assessment approach was used to perform a step one Geologic and Seismic Alternative Site Analysis. This was conducted to eliminate unfavorable areas for the selection of candidate areas and to identify reasonably available geologic and seismologic literature, maps, and other sources of information in order to compare the candidate sites to the proposed site.

A general site ranking was provided for each candidate site as well as the proposed site for each of five categories:

1. Vibratory Ground Motion
2. Capable Tectonic Sources
3. Surface Faulting and Deformation
4. Geologic Hazards
5. Soil Stability (EPRI, 2002).

A review of available geological, seismological, and geophysical data was performed for the ROI and candidate areas. The review encompassed both the proposed site and alternate sites from a regional perspective.

The tectonic sources that could potentially result in seismic-induced, vibratory ground motions at the proposed site and alternate sites are mainly the New Madrid Fault Seismic Zone and the Wabash Valley Seismic Zone (Frankel, 2002). The review of background seismicity zones may only be performed within a Step 3 or Step 4 EPRI analysis. NRC Regulatory Guide 1.165, Regulatory Positions 1 and 2 require that investigations of seismic sources be performed within a 200 mile (322 km) radius of the sites. (NRC, 1997) Two major sources of potential seismic activity are located within this radial distance:

- The New Madrid Seismic Zone (NMSZ) in southeastern Missouri and southwestern Illinois; and
- The Wabash Valley Seismic Zone (WVSZ) in southern Illinois and southern Indiana.

The New Madrid region was the location of three earthquakes in 1811-1812, which are the largest earthquakes recorded in the Central and Eastern United States (CEUS) (EGC, 2006). The Wabash Valley region is a zone of elevated seismicity in which a number of paleo-earthquakes have been identified (Frankel, 2002). Figure 9.3-3 through Figure 9.3-6 depict geologic and seismic hazard sources, surface faulting, surface deformation, and geologic and soils information, respectively, used for the alternative site study. A summary of the results of the geologic and seismic hazards analyses and ranking of the candidate and proposed sites is presented in Section 9.3.1.2.}

9.3.1.2 Candidate Sites

{An initial review of potential sites within both the ROI and the expanded study area was conducted. To be considered as a candidate site, a location must meet the following criteria as outlined in NUREG-1555, (NRC, 2007a), Section 9.3 (III):

- Consumptive use of water should not cause significant adverse effects on other users.

- The proposed action should not jeopardize Federal, State, and affected Native American tribal listed threatened, endangered, or candidate species or result in the destruction or adverse modification of critical habitat.
- There should not be any potential significant impacts to spawning grounds or nursery areas of populations of important aquatic species on Federal, State, and affected Native American tribal lists.
- Discharges of effluents into waterways should be in accordance with Federal, State, regional, local, and affected Native American tribal regulations and would not adversely impact efforts to meet water-quality objectives.
- There should be no preemption of or adverse impacts on land specially designated for environmental, recreational, or other special purposes.
- There would not be any potential significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.
- There are no other significant issues that preclude the use of the site.

In addition to meeting all applicable regulations and guidelines, the following factors influenced the decision to select and review sites.

- The site would be suitable for the design parameters contemplated for the new plant design.
- The location would be compatible with the applicant's current system and transmission capabilities.
- The site's expected licensing and regulatory potential must minimize the schedule and financial risk for establishing new baseload generation.

Urban land uses occupy an ever-increasing portion of Missouri's land area. The urbanized land of the St. Louis and Kansas City metropolitan areas extend into eight and five Missouri counties, respectively. Other officially designated metropolitan areas in the ROI include Cape Girardeau, Columbia, and Jefferson City, and cover eight additional counties. The State of Missouri Department of Economic Development Economic Research and Information Center utilizes a "Core-Based Statistical Areas system to identify larger areas that surround a specific population core that is defined as either a metropolitan statistical area (at least 50,000 persons) or a micropolitan statistical area (at least 10,000 persons).

Smaller cities and towns cover significant areas, although fragmented and dispersed. Large lake areas such as the Lake of the Ozarks and the Table Rock Lake-Branson area are economically developed areas that become the equivalent of small metropolitan areas during summers. Eighteen micropolitan statistical areas have been defined around Missouri population cores having an urban population cluster of between 10,000 and 50,000 persons. Most of these consist of only one county. Based on 2002 population estimates, 71% of Missouri residents lived in metropolitan areas (MERIC, 2003).

9.3.1.2.1 Databases and Sources Consulted

To identify candidate sites, a number of resources were researched, including the following:

1. Original Siting Study – A broad siting study conducted in 1971 (Callaway Plant Unit 1 and 2 Site Selection Study, Dames & Moore, 1971), referred to in this document as the original siting study;
2. Federal Properties in Missouri;
3. AmerenUE's list of generating facilities and owned real estate;
4. Missouri Department of Natural Resources (MDNR) Brownfield/Voluntary Cleanup Program's List of Brownfield sites (MDNR, 2007a);
5. MDNR Division of Environmental Quality's Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri (MDNR, 2006);
6. Location One, a web-based commercial siting tool with an inventory of available commercial and industrial sites listed for sale within the State of Missouri that is sponsored and maintained by the Missouri Department of Economic Development (LOIS, 2007 and 2008);
7. LoopNet, a subscription-based database of available real estate properties, accessed through a query made by AmerenUE to a commercial real estate agent (LoopNet, 2007 and 2008);
8. An inventory of electric generating facilities in the state of Missouri (Platts, 2005); and
9. Independent review of the candidate areas.

A description of each database as well as the results of the queries is described below.

Original Siting Study

A broad siting study was conducted on behalf of Union Electric Company (now d/b/a AmerenUE) in 1971 (Callaway Plant Unit 1 and 2 Site Selection Study, Dames & Moore, 1971), referred to in this document as the original siting study, which resulted in the selection of a greenfield site known as Reform, Missouri, for the construction of from one to four co-located nuclear power plants. An Application to Construct was submitted to NRC for the construction of two plants, resulting in the NRC issuing a Final Environmental Impact Statement (FEIS) related to the then proposed Callaway Plant Units 1 and 2 (NRC, 1975). The NRC licensed the applicant to construct two units. The original license to construct was for a maximum capacity of 4,400-MegaWatts (MWe) of power generation capacity. While Callaway Plant Unit 1 was constructed and licensed by the NRC to operate, AmerenUE elected not to complete a second unit.

The original study was an exhaustive two phase siting study which, along with the original Environmental Report, and FEIS, concluded that there were no obviously superior sites to the selected Reform site located in Missouri. Phase one of the original siting study began with an unidentified number of potential sites which were further evaluated and an unidentified number of sites were eliminated after review of siting criteria. There were 19 potential sites that were identified for further study, of which nine sites were designated as primary sites and the remaining were designated as secondary sites. Eight of the nine primary sites were located in Missouri and one was located in Illinois. Six of the primary sites were located near the Missouri River, two were located along the Mississippi River, and the site in Illinois was located near the Illinois River.

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Generally, the primary sites in the original siting study represented the apparent optimum siting conditions as of 1971. The secondary sites were either considered less desirable than the nearby primary site or had significant undesirable environmental factors or relatively high site development costs.

In Phase Two of the original study, the list of primary sites was reduced to six potential sites that were thoroughly evaluated. All of the sites identified in the original study were "greenfield" sites; i.e., previously undeveloped sites. All six potential sites were found to be acceptable from an environmental standpoint. The final proposed site (the current Callaway site) was selected as the preferred site based on a cost-effectiveness analysis.

For the current evaluation, the analyses and results of the original siting study were reviewed. All of the nineteen sites that were evaluated in phase 2 of the original siting study were evaluated in the current process. After an analysis of the data from the original report, most of these sites were screened out for further consideration in the current siting study due to site exclusionary, avoidance, and suitability factors such as the proximity to current and future population centers, population distribution and density, current land use and land use trends, or location outside of Missouri. Three sites, termed C2, C9 and C10 were retained for further analysis. These sites retain the nomenclature used in the original siting study.

Federal Properties in Missouri

In accordance with the suitability factors outlined above, a search was conducted for federal lands located within Missouri. There are four federal lands in Missouri: Whiteman Air Force Base, Fort Leonard Wood, the Lake City Army Ammunition Plant, and Richards-Gebaur Air Force Base (closed). However, none of these are located within the ROI or the expanded candidate areas.

AmerenUE's list of generating facilities and owned real estate

AmerenUE has several properties which are operating generating facilities, as described in Section 8.3.2. None of these facilities, with the exception of the Callaway Plant, are located within the candidate site areas; all have been excluded on the basis of one or more criteria discussed in Section 9.3.1.1 above.

Missouri Department of Natural Resources (MDNR) Brownfield/Voluntary Cleanup Program's List of Brownfield sites (MDNR, 2007a)

MDNR Division of Environmental Quality's Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri (MDNR, 2006)

These two databases are discussed jointly below.

Brownfield sites are those that have previous industrial or commercial development and generally require removal of hazardous wastes before being suitable for another use. Reuse of a brownfield site offers less environmental impact than use of a greenfield site, and frequently provides a net environmental benefit through reduction of existing environmental impacts and replacement with an operation with fewer environmental impacts. The option of using a brownfield site rather than a greenfield site offered obvious environmental benefit possibilities. Therefore, a search and assessment was made of suitable brownfield sites located within the candidate areas from two databases maintained by MDNR, as identified above.

The MDNR maintains a statewide list of sites that have been formally entered into the MDNR's Voluntary Cleanup Program (VCP) for assessment and remediation of hazardous materials according to the MDNR VCP protocol. This program allows the use of innovative risk-based clean up levels and remediation actions such as administrative and engineering controls including restrictive covenants and deed restrictions. The MDNR VCP list includes sites that are mostly commercial or industrial brownfield properties that have been targeted for redevelopment. A search and assessment of this list was conducted for potential candidate sites. The search did not identify any brownfield sites that met the minimum threshold siting criteria (discussed above and as outlined in NUREG-1555, (NRC, 2007a), Section 9.3 (III)). None of the brownfield sites in the MDNR VCP list were located within the candidate areas described in Section 9.3.1.1.

The MDNR also maintains a Registry of Confirmed Abandoned or Uncontrolled Hazardous Waste Disposal Sites in Missouri. The Registry includes state superfund sites, federal superfund sites in cooperation with the state, and confirmed or uncontrolled hazardous waste sites that have been assessed or cleaned up. The list includes former manufactured gas plants, formerly used defense sites, former US Department of Agriculture (USDA) Grain Bins, wood treatment facilities, and hazardous waste disposal sites. A search and assessment of this registry was conducted for potential candidate sites. The search did not identify any abandoned or uncontrolled hazardous waste sites that met the minimum threshold siting criteria (discussed above and as outlined in NUREG-1555, (NRC, 2007a), Section 9.3 (III)). None of the hazardous waste sites in the MDNR Registry were located within the candidate areas described in Section 9.3.1.1.

Location One

The Missouri Department of Economic Development, and two of Missouri's largest investor owned utilities, AmerenUE, and Aquila, Inc., sponsor Location One, a web-based searchable inventory of commercial and industrial real estate listed for sale (LOIS, 2007 and 2008). The real estate is searchable by town, county, parcel or building size, type, and location of real estate. A search and assessment of this database was conducted for potential candidate sites. The search did not identify any listed commercial or industrial sites that met the minimum threshold siting criteria (discussed above and as outlined in NUREG-1555, (NRC, 2007a), Section 9.3 (III)). None of the commercial or industrial sites in the Location One database were located within the candidate areas described in Section 9.3.1.1. None of the greenfield sites in the Location One database met the threshold criteria. Therefore, no sites from the Location One database were carried forward for further consideration.

LoopNet

LoopNet is a subscription-based database of available real estate properties, accessed through a query made by AmerenUE to a commercial real estate agent (LoopNet, 2007 and 2008). The LoopNet database search identified a total of nine available properties that met the threshold criteria of proximity to water and distance from population centers. All are greenfield sites; most have some development in the form of a farm, residence, or commercial recreational facility. These sites are described in Table 9.3-7 and were carried forward for more detailed investigation as described in Section 9.3.2.

Inventory of Electric Generating Facilities in the State of Missouri

A review was conducted of the Platts (2005) listing of generating facilities in Missouri to identify sites that may be appropriate for replacement by a nuclear power plant. No sites owned by AmerenUE met the threshold criteria. One site, the Chamois Power Plant, met the threshold criteria and was selected for further investigation as an alternative site. No discussions have been held between AmerenUE and the Chamois Power Plant owner regarding the potential for acquiring the property by AmerenUE for any purpose; this site was selected only because it has a similar industrial use and meets the threshold criteria with respect to proximity to water and distance from population centers. As the results of this alternative site evaluation indicate that this property is not significantly better than the Callaway site which is the proposed site, AmerenUE does not intend to investigate the Chamois Power Plant further or to enter into any discussions with the Chamois Power Plant owner for any purpose.

Independent Review of Candidate Areas

The results of the surveys of the available databases indicated that there were fewer than three brownfield sites in the ROI that met the threshold criteria. Therefore, AmerenUE reviewed maps of the ROI to identify commercial or industrial properties that met the threshold criteria and were large enough to accommodate a nuclear power plant. One potential site was identified, the Fred Weber Quarry in Lincoln County, Missouri. This inactive quarry site was selected for further investigation as an alternative site. No discussions have been held between AmerenUE and Fred Weber, Inc. regarding the potential for acquiring the property by AmerenUE for any purpose; this site was selected only because it is an industrial site that meets the threshold criteria with respect to proximity to water and distance from population centers. As the results of this alternative site evaluation indicate that this property is not significantly better then the Callaway site which is the proposed site, AmerenUE does not intend to investigate the Fred Weber Quarry further or to enter into any discussions with Fred Weber, Inc. for any purpose.

In total, two brownfield sites and 9 greenfield sites meeting the threshold exclusionary criteria were identified within the candidate areas.

9.3.1.3 Sites Meeting Threshold Exclusionary Criteria

A separate evaluation was made of the 9 greenfield sites that met the threshold exclusionary criteria. These sites were compared with respect to the following avoidance and suitability criteria:

- Average population per square mile within a 10 mile radius and a 50 mile radius;
- Distance from water body;
- Distance from 345 kV transmission line;
- Distance to load center (St. Louis);
- Distance from significant public resources such as national parks, wilderness areas, conservation areas, etc.;
- Distance from major airports;
- Distance to major highways; and
- Presence of minimum acreage (500 acres, as described in 10 CFR 100) to avoid further land acquisition and converted land use concerns.

The data that were developed to allow this comparison are presented in Table 9.3-8. The data for each criterion were then grouped into ranges so as to prevent needing to differentially rank essentially similar data for different sites. The selected value ranges for each criterion are presented in the right column of the table. Each site was given a rating of from 1 (most negative) to 5 (most beneficial) for each of the criteria. For example, the criterion addressing distance from a water body was given value ranges of 5 = 0-4 miles; 3 = 5-9 miles; and 1 = 10-15 miles. Each criterion was also given a ranking in recognition of its importance in defining an optimal site for a plant. Criteria were given rankings of either 8 (very important siting factor), 5 (neutral siting factor), or 3 (relatively unimportant siting factor). Finally, the site rating was multiplied by the criterion ranking to establish a weighted value for each criterion for each site. The results of these evaluations are presented in Table 9.3-8. The results show that the greenfield site (C-9) in Lamine, Cooper County, near the Missouri River, and the greenfield site (R-9) near Paynesville, Lincoln County, near the Mississippi River, were most favorable with respect to the initial siting criteria. Site C-9 (Lamine) was identified in the original siting study (Dames & Moore, 1971). Site R-9 was identified from a search in the Location One database, as discussed in Section 9.3.1.2. These two sites were brought forward as Candidate Sites for further evaluation, as discussed in Section 9.3.2 below.}

9.3.2 PROPOSED AND ALTERNATIVE SITE EVALUATION

{The alternative sites that are compared with the Callaway Plant Unit 2 site (the proposed site) include two brownfield sites (Chamois Coal Power Plant (Chamois) site and the Fred Weber, Inc. Auburn Rock Quarry (Fred Weber Quarry) site) and two greenfield sites (the Lamine site and the Paynesville site). A brownfield site is one that has been previously developed and can be redeveloped for a more profitable use.}

The alternative sites were compared to the proposed site based on information about the existing nuclear plant and the surrounding area, as well as existing environmental studies and Final Environmental Impact Statements issued by the Atomic Energy Commission and/or the U.S. Nuclear Regulatory Commission. This comparison is performed to determine whether or not any alternative sites are environmentally preferable to the proposed site.

Throughout this section, environmental impacts of the alternatives are assessed using the NRC three-level standard of significance – SMALL, MODERATE, or LARGE. This standard of significance was developed using Council on Environmental Quality guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Subpart A, Appendix B (NRC, 2007c):

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

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

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

In order to analyze the effects of building a new nuclear plant at each of these locations, it was assumed the construction and operation practices described in Chapters 4 and 5 would generally be carried to each site. In this manner, it was possible to apply a consistent description of the impacts at each site.

9.3.2.1 Chamois Generating Station Brownfield Site

A brownfield site is a property that has been previously developed and can be redeveloped for a more profitable use. The first of two brownfield sites chosen for analysis is the Chamois Generating Station on the south bank of the Missouri River in Osage County, Missouri. This site is currently owned and operated by Central Electric Power Cooperative as a 72 MWe coal burning steam power plant.

The Chamois candidate site is located in central Missouri at a latitude of 38 degrees, 41 minutes, and 4 seconds north, and a longitude of 91 degrees, 45 minutes, and 23 seconds west.

Figure 9.3-7 and Figure 9.3-8 identify the Chamois candidate site location and plant layout on geographic and USGS topography maps, respectively.

For the purposes of this alternative siting study it was assumed that the existing Chamois Generating Station would be decommissioned and replaced with a nuclear reactor similar to the proposed Callaway Plant Unit 2. It was assumed the proposed nuclear plant site would occupy at least 500 acres (202 hectares), the minimum area that would provide a regulatory required 0.5-mile (0.8 km) radius exclusion zone (NRC, 2007b).

9.3.2.1.1 Land Use

The Chamois site is located in an area of mixed residential, commercial and agricultural land use. The site is situated immediately to the east of the small town of Chamois, Missouri, population 456 (USCB, 2000a). The site is bounded to the north by the Missouri River and to the east, west and south by agricultural land. The site area is 210 acres (85 hectares), which is smaller than the area required for siting a nuclear plant.

Given the identified size of the proposed plant, a minimum of approximately 300 acres (121 hectares) of additional land would need to be purchased at this site. It may be necessary to relocate some adjoining commercial and residential establishments located in the adjacent town of Chamois to the west and approximately 200 to 300 acres (81 to 121 hectares) of quality agricultural land to the west.

The U. S. Department of Agriculture - Natural Resource Conservation Service (NRCS) has mapped the soil in Osage County and has classified the soil at the site in two categories, as “Prime farmland if drained” and as “All areas are prime farmland” (NRCS, 2006a). There are no state zoning, land use, farmland preservation plans, regulations, or county or local zoning ordinances that would restrict the development or use of the Chamois site as a nuclear power plant. Due to the necessity to significantly change several hundred acres of the surrounding area’s land use to accommodate the new nuclear site, the impact on land use in this area would be MODERATE to LARGE.

9.3.2.1.2 Air Quality

Construction activities may result in increased air emissions and the impacts would be similar at all of the alternative sites evaluated. The potential air impacts may include fugitive dust and fine particulate matter generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g. generators and compressors) will generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and, to a lesser extent, sulfur dioxides. Painting, coating and similar operations will also generate emissions from the use of volatile organic compounds. The air quality impacts of the construction and operation of a new nuclear unit would be similar at all of the candidate sites.

Emission-specific strategies, plans, and measures would be developed and implemented to limit and mitigate releases, ensuring compliance within the applicable regulatory limits. These limits are defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (USEPA, 2007a) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (USEPA, 2007b). The same or similar measures would be taken if a nuclear generating unit was to be constructed at any of the alternative sites.

The relatively minor air quality impacts attributed to the operation of a modern nuclear plant are related to ancillary minor source equipment such as emergency generators and cooling towers. Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

Osage County's status for all National Ambient Air Quality Standards (NAAQS) regulated air quality pollutants is designated as in-attainment (MDNR, 2007b). Closing the coal burning power plant at the Chamois site and replacing this generating facility with a nuclear plant would reduce the amount of particulate matter, NOx, and greenhouse gases that are released into the atmosphere. The positive impact of reduced NOx, particulates, and greenhouse gases on the general air quality in the state of Missouri would be SMALL, but the local impact may be MODERATE. In both cases, the overall impact of this transformation would be beneficial.

9.3.2.1.3 Water

Surface and groundwater uses that could affect or be affected by the construction or operation of Callaway Plant Unit 2 and associated facilities are described in Section 2.3.2. The consumptive and non-consumptive water uses are identified, and water diversions, withdrawals, consumption, and returns are quantified.

The planned Callaway Plant Unit 2 cooling water system requirements were used to compare potential impacts to water resources at the Chamois site. It is assumed that the same water needs, water source (the Aquifer) and collector well system would be used at the Chamois site.

The Missouri State Water Resources Plan was prepared by the MDNR with the purpose of identifying the state's water use problems and opportunities related to drinking water, agriculture, industrial, recreational, and environmental needs. The Chamois candidate site is located in the central region of the state and is identified in the Plan as having relatively abundant surface water and groundwater resources and, as a result, water use concerns are primarily focused on water quality and resource protection (MDNR, 1995). The existing source of cooling water for the Chamois Coal Generating Plant is a surface water intake located along the Missouri River. Water is pumped from the water intake to the plant, used for cooling, and then discharged downstream from the water intake location.

Impacts to water resources at the site from the construction and operation of a new reactor unit are anticipated to be SMALL due to the proposed replacement of the existing Chamois Plant's water usage with a system similar to that described for Callaway Plant Unit 2, the large size of both the surface water and groundwater resources, the current rural nature of the area, and resultant relatively low usage of these resources.

9.3.2.1.4 Terrestrial Ecology and Sensitive Species

The Chamois site is located in Missouri's Ozark Highlands Ecological Section which includes most of southern Missouri, most of northern Arkansas, and small parts of southwest Illinois. The Ozark Highlands Ecological Section includes a total of sixteen ecological subsections all of which are located in Missouri. The Chamois candidate site is located on the northern outer boundary of the Osage River Hills Ecological Subsection. Prior to European settlement, this ecological subsection was historically dominated by tall grass prairie intergraded from the surrounding plains (Osage, Springfield, and Central Plateau) into complex mosaics of glades, oak savanna, oak woodlands, and oak forests (MDC, 2002).

Today much of the region is dominated by fescue pasture and cropland along the alluvial plains. Much of the area has been degraded due to overgrazing and repeated timber harvest. In addition, glades and open woodlands have seceded to cedar thickets and brushy forestland in the absence of natural prairie fires. Many of the forested bottoms, including the subject site vicinity, have been cleared for agriculture (MDC, 2002).

The U.S. Fish and Wildlife Service National Wetlands Inventory's Mokane East Map identifies three palustrine wetlands on the site, and several more mapped palustrine wetland units in the site vicinity. Measures and controls that would be implemented to mitigate potential impacts to wetlands are similar to those described in Section 4.6. There are no Special State Concern Wetlands, Federally designated Wilderness Areas, Wildlife Preserves, Sanctuaries, Refuges, National Forests, Agricultural Preservation Lands, or Forest Legacy Lands known to be in the site vicinity (EDR, 2007a).

No known state or federally listed species or sensitive habitats are known to be located in the immediate candidate site area. The entire Ozark Highlands ecological region contains 142 records of 72 state-listed species of concern. Many of the occurrences are associated with rivers and streams or caves. These include several species whose only occurrence in the state is from the Osage River Hills: a perlid stonefly, a hornwort, an elderberry, and a moss (MDC, 2002). The U.S. EPA lists three mammals, the gray bat, Indiana bat and the bald eagle on the Endangered Species Protection Program Database for Osage County (EDR, 2007a). As of August 9, 2007, the bald eagle is no longer protected under the federal Endangered Species Act and Section 7 consultation with the U.S. Fish and Wildlife Service is no longer necessary. However, the bald eagle remains protected under the Bald and Golden Eagle Protection Act (USFWS, 2007).

Little or no wildlife habitat area would need to be cleared and developed because the new nuclear plant would replace the existing coal plant and the additional several hundred acres needed for the siting of the proposed nuclear plant is largely already developed commercially or agriculturally. The impacts to the terrestrial ecosystem at the site would therefore be SMALL and would predominantly occur during the conversion of the plant from coal to nuclear power. Construction Best Management Practices would be followed to minimize potential impacts.

9.3.2.1.5 Aquatic Ecology and Sensitive Species

No known state or federally listed threatened or endangered aquatic species occur at the Chamois site. However, the U.S. EPA lists Pink Mucket Clams, Niangual darter, and Geocarpon Fish on the Endangered Species Protection Program Database for Osage County (EDR, 2007a).

Because this area is a floodplain, a new levee would need to be constructed on the south bank of the Missouri River. The levee would necessarily alter the ecology of the river bank. The conversion from a surface water intake to a submerged collector well system would improve the aquatic ecology since the potential for fish impingement and entrainment would be eliminated.

Because the site is already being used for power generation and construction Best Management Practices would be followed, the construction impacts of a plant conversion project on the aquatic ecology would be SMALL and temporary. These potential impacts would primarily be related to runoff and siltation. The thermal impact that would result from cooling water discharge to the Missouri River is similar to that for the proposed site and would likely be SMALL due to permit restrictions and mitigation implementation. Because of the levee construction, however, the overall impacts to the aquatic ecology would be MODERATE.

9.3.2.1.6 Socioeconomics

Osage County is a relatively sparsely populated area. Demographic and population characteristics for the site vicinity, a 50-mile (80 km) radius from the site, are presented in Table 9.3-1. Other socioeconomic facts related to Osage County are as follows:

- The county has experienced a 3.3% population increase since the 2000 census (USCB, 2008a).
- Median household income within a 50 mile (80 km) radius was $50,661 per year in 2000 (MCDC, 2000a).
- 7.7% of the county's population within a 50 mile (80 km) radius lived below the poverty level in 2000 (MCDC, 2000a).
- The nearest large city is Jefferson City, Missouri.
- The mean value of owner-occupied housing units was $135,237 in the year 2000 (MCDC, 2000a).
- There were 1,048 firms doing business in the county in 2002 (USCB, 2008a).

The Chamois Generating Station site is currently being used for power generation, and it is expected that the shift from coal to nuclear power would not initiate any substantial shifts in population or real estate; therefore, the effect of the proposed new facility on the population and demographics of Osage County, Missouri, is expected to be SMALL. Equitable accommodation would need to be made for employees of the Chamois Generating Station whose jobs would be lost. Assuming that this can be accomplished, the effect of this new facility on socioeconomics would be SMALL.

9.3.2.1.7 Transportation

The site is located near the small town of Chamois, Osage County, in a relatively undeveloped rural area of Missouri. The site vicinity is characterized by an existing coal generating plant, transmission and rail corridors, agricultural land, state highways, and local and county roads. The Chamois candidate site is located approximately 100 miles (160 km) west of the City of St. Louis, Missouri, on State Highway 100, approximately 0.5 miles (0.8 km) east of its intersection with State Highway 89. Interstate Highway 70 is located approximately 10 miles (16 km) north of the site; however, it is greater than 20 miles (32 km) driving distance due to the distance to the nearest Missouri River bridge crossing. The nearest bridge that traverses the Missouri River is located on State Highway 19 approximately 20 miles (32 km) east of the site in Hermann, Missouri.

Significant traffic increases on the local State Highways 100, 89, and 19, which are rural two-lane highways, would be noticeable during peak construction periods. The greatest periods of traffic impact would be during shift changes. Impact on area transportation resources would generally decrease with increased distance from the site as varied routes are taken by individual vehicles. Additionally, the use of shared (e.g., carpooling) and multi-person transport (e.g., buses) during construction and/or operation of the facility would be encouraged.

A description of estimated traffic volumes and impacts associated with the proposed project is included in section 4.4.1.5. There could be a maximum of an estimated peak of 1,450 vehicles per hour. Heavy vehicle shipments and construction traffic will make up most of the traffic, assuming a peak construction workforce of about 3,950 workers (calculated at 1.3 drivers per vehicle). Staggering the shifts of various workers and increasing the amount of entrances are steps that could be taken to mitigate traffic congestion around the plant site. Impacts on local roads from the construction workforce would be temporary and would likely end after the construction was finished. However, a new operation workforce of some 850 individuals would present a continuing impact to the roads.

Additionally, construction truck traffic could exceed 100,000 truck trips over the 6-year period of construction. Rail service could pick up much of the burden, resulting in increased rail traffic, impact at railroad crossings, and noise. These impacts would be generally the same at all locations. Highway access to the Chamois site is limited to two lane roads. By implementing the appropriate measures, it is expected that there would be SMALL to MODERATE impacts on transportation during construction activities and a SMALL impact during operation of the facility.

9.3.2.1.8 Historic, Cultural, and Archeological Resources

The National Register of Historic Places (NRHP) is the official list of districts, sites, buildings, structures and objects significant in American history, architecture, archaeology, engineering, and culture. The National Register includes:

- All prehistoric units of the National Park System;
- National Historic Landmarks, which are properties recognized by the Secretary of the Interior as possessing national significance; and
- Properties significant in American, state, or local prehistory and history that have been nominated by State Historic Preservation Officers, federal agencies, and others, and have been approved for listing by the National Park Service.

The MDNR maintains a list of Missouri Historic Sites listed in the National Register of Historic Places in Missouri. A search of the most current versions available of the National Register of Historic Places and the Missouri Historic Sites list resulted in two known archaeological, National Register of Historic Places, State Historic Places or other historical resources located at the Chamois site, in the immediate vicinity, or within a 1 mile (1.6 km) radius of the site (EDR, 2007a). Townley Alvah Washington Farmstead Historic District is located in the town of Chamois. The district is situated on the corner of Third and Market Streets and is an example of a rural farmstead in an urban environment. The district includes an “I” house, smokehouse, barn, storage shed, and tool and machine shed. The “I” house was a common farmhouse style during the mid-nineteenth century that consisted of a central passage flanked by rooms on either side.

Chamois Public School is located at 402 South Main Street and was listed on the NRHP in 2003. The building is significant for its contributions to the public education system in Osage County during the last half of the nineteenth century. The building is a two story red brick building and is the only historic public school building extant in Osage County. Historic, cultural, and archaeological mitigation measures designed to protect these resources would be implemented during the construction phase.

The United States Geologic Survey (USGS) maintains a map that portrays Native American administered lands of the United States that have an area equal to or greater than 640 acres (259 hectares). A review of the most recent edition of the USGS map resulted in no known

Native American administered lands over 640 acres (259 hectares) on the Chamois site or within a one mile (1.6 km) radius (EDR, 2007a).

It is assumed that no impacts to these potential resources would occur during construction or operation of a nuclear facility at this site. Therefore, the potential impacts would be classified as SMALL.

9.3.2.1.9 Environmental Justice

Table 9.3-1 presents demographic information for a 50-mile (80 km) radius surrounding the site, the state of Missouri, and the U.S. These data demonstrate that the racial mix of the population of this area has a lesser percent population of minority races than the state of Missouri and the U.S. as a whole. The Chamois site is located in a largely rural area, and the likelihood of minority communities being disproportionately and/or adversely affected by this plant is low. There are 46,504 poor persons located within 50 miles (80 km) of the site. This is approximately 7.7% of the population in the area (MCDC, 2000a). Furthermore, this site has been operating as a power generating facility for many years. Therefore, it is anticipated that environmental justice impacts at this site would be SMALL.

9.3.2.1.10 Transmission Corridors

The site has been in use for electrical generation for many years. Figure 9.3-17 depicts the transmission plan for the Chamois candidate site. This site is adjacent to the existing Callaway-Bland transmission right-of-way. It is assumed that the existing Callaway-Bland 345 kV lines would be split at the new 345 kV switchyard to provide two outlet circuits to the north and two outlet circuits to the south. Although it will be necessary to build new infrastructure to accommodate the new output for the plant, it is anticipated that existing corridors would be sufficient to accommodate construction. A new 1-mile (1.6 km) line extension would be required from the new switchyard to the existing Callaway-Loose Creek 345 kV line. A rough cost of $800,000 is assumed for the new line extension. The plant site is developed and the surrounding corridors are traversing predominantly agricultural land. In addition, the current transmission system could be used with limited or no modifications. It is anticipated that the impacts due to transmission corridors would be SMALL.

9.3.2.2 Fred Weber Quarry Brownfield Site

The second brownfield site chosen for analysis is the Fred Weber Quarry brownfield site. The approximately 262 acre (106 hectares) site is located in the northwest corner of the intersection of State Highway 61 and County Road B in northern Lincoln County, Missouri. The candidate site is located in northeast Missouri at latitude 39 degrees, 08 minutes, and 09 seconds north and longitude 90 degrees, 57 minutes, and 33 seconds west. Figure 9.3-9 and Figure 9.3-10 identify the Fred Weber Quarry candidate site location and plant layout on geographic and USGS topography maps, respectively. The candidate site is located on an inactive limestone quarry owned by Fred Weber, Inc. (EDR, 2007c).

For the purposes of this alternative siting analysis, it was assumed that the existing rock quarry operation would be closed and replaced with a generating facility similar to the proposed Callaway Plant Unit 2 reactor and would be sited within the existing property boundaries. It was assumed the proposed nuclear plant site would occupy at least 500 acres (202 hectares), the minimum area that would provide a regulatory required 0.5-mile (0.8 km) radius exclusion zone.

9.3.2.2.1 Land Use

The Fred Weber Quarry site is located in an area of mixed residential, commercial, and agricultural land use. The site is situated approximately 0.25-mile (0.4 km) east of the small town of Auburn, Missouri. The site is bounded to the north and east by residential and agriculturally developed land. A triangular strip of commercially developed land with State Highway 61 beyond it lies to the west, and County Road B bounds the site to the south with more residential and agricultural land across the county road to the south. A minimum of approximately 248 acres (100 hectares) of additional land would need to be purchased for the operation of a new nuclear plant at this site.

The U. S. Department of Agriculture - Natural Resource Conservation Service (NRCS) has mapped the soil in Lincoln County and although most of the soil at the site has been removed for rock quarrying, approximately half of the site is classified as "Farmland of Statewide Importance" and the other half as "Prime Farmland" (NRCS, 2006c). There are no state zoning, land use, or farmland preservation plans, regulations, or county or local zoning ordinances that would restrict the development or use of the Fred Weber Quarry site as a power plant.

Agricultural land along with several small businesses and residences would have to be cleared and the quarry operation would need to be replaced to make way for the power plant. Due to the necessity to change the land use of the site and surrounding areas to accommodate the new nuclear site, the impact on land use in this area would be MODERATE.

9.3.2.2.2 Air Quality

Lincoln County's status for all National Ambient Air Quality Standards (NAAQS) regulated air quality pollutants is designated in-attainment (MDNR, 2007b). Construction activities may result in increased air emissions. Fugitive dust and fine particulate matter may be generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g. generators and compressors) will generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and, to a lesser extent, sulfur dioxides. Painting, coating, and similar operations will also generate emissions from the use of volatile organic compounds.

Emission-specific strategies, plans, and measures will be developed and implemented to limit and mitigate releases, ensuring compliance within the applicable regulatory limits. These limits are defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (USEPA, 2007a) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (USEPA, 2007b). Air quality and release permits and operating certificates will be secured where required.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL temporary impact on air quality during construction. Additionally, it is expected that siting the unit at this location would have a SMALL impact on air quality during operations.

9.3.2.2.3 Water

The Missouri State Water Resources Plan attempts to identify water use problems and opportunities related to drinking water, agriculture, industrial, recreational and environmental needs. The Fred Weber Quarry candidate site is located in the northeastern region of the state in an area identified as having relatively limited surface water and very limited groundwater resources and, as a result, water use is a concern during drought conditions. There are also concerns with water quality and resource protection. These concerns include surface water and groundwater protection from both point and non-point sources, including municipal, industrial, sewer, septic tanks, and agricultural related potential contaminant sources (MDNR, 1995).

It was assumed that the water use for the construction and operation of a nuclear plant at the Fred Weber Quarry site would be similar to the water use at the proposed site, as described in Section 2.3.2. The consumptive and non-consumptive water uses are identified, and water diversions, withdrawals, consumption, and returns are quantified.

The planned Callaway Plant Unit 2 cooling water system requirements were used to compare potential impacts to water resources at the Fred Weber Quarry site. It is assumed that the water needs would be obtained from a Mississippi River/Mississippi Alluvial Aquifer by a collector well system similar to the one described in Section 9.3.2.1.1.3 above, and a cooling water system similar to the Callaway Plant Unit 2 system would be used at the Fred Weber Quarry site. The site is located approximately 12 miles (19.3 km) west of the Mississippi River. A cooling water intake and return system would have to be constructed to supply cooling water for the plant. The impacts associated with the construction of an approximately 12 mile (19.3 km) cooling water conveyance system are expected to be LARGE during construction and SMALL during operation.

Due to the ample supply of surface water resources of the Mississippi River, the current rural nature of the area, and resultant relatively low usage of these resources, impacts to water resources at the site from the construction and operation of the new reactor unit are anticipated to be SMALL.

9.3.2.2.4 Terrestrial Ecology and Sensitive Species

The Fred Weber Quarry site is located in Missouri's Central Dissected Till Plains Section which covers all of Missouri north of the Missouri River and extends into southern Iowa and small portions of Kansas and Nebraska. Due to differences in landform, geology (including till and loess), soils, and vegetation, there are nineteen ecological subsections, with nine located in Missouri's Central Dissected Till Plains Ecological Section. The Fred Weber Quarry candidate site is located in the Mississippi River Hills Subsection. This area consists of a broad belt of hills, valleys, and bluff lands along the Mississippi River from the North River southward to the Missouri River in northeastern Missouri.

The Fred Weber Quarry site is located in the center of the Mississippi River Hills Ecological Subsection which was historically dominated by timberlands consisting of oak savannas and open-oak woodlands with occasional glade and prairie openings occurring on flatter uplands. Today some of the oldest and most productive timberland is located in this region along with fescue pasture and cropland along the alluvial plains (MDC, 2002).

The U.S. Fish and Wildlife Service National Wetlands Inventory Mokane East Map identifies 7 palustrine wetland mapped units on the site, and 22 more palustrine mapped wetland units within a 1-mile (1.6 km) radius of the approximate center of site. Measures and controls that would be implemented to mitigate potential impacts to wetlands are similar to those described in Section 4.6. There are no Special State Concern wetlands, Federally designated Wilderness Areas, Wildlife Preserves, Sanctuaries, Refugees, National Forests, agricultural preservation lands, or forest legacy lands known to be in the site vicinity (EDR, 2007c).

No known state or federally listed species or sensitive habitats are known to be located in the immediate vicinity of the site. The Mississippi River Hills Subsection contains 116 records of 53 state-listed rare or endangered species. Three of the state-listed species are found only in this subsection, including a cave-dwelling psuedoscorpion and a moss.

The U.S. EPA lists four federally listed species on the Endangered Species Protection Program Database for Lincoln County: the Indiana and gray bats, the Bald Eagle, and one plant species, the eastern prairie fringed orchid. Because the new nuclear plant would replace the existing rock quarry and the additional several hundred acres needed for the siting of the proposed nuclear plant is already developed commercially, residentially, or agriculturally, little or no additional pristine wildlife habitat area would need to be cleared and developed. The impacts to the terrestrial ecosystem at the site would therefore be SMALL and would occur predominantly during the construction of the plant. Construction Best Management Practices would be followed to minimize these impacts.

9.3.2.2.5 Aquatic Ecology and Sensitive Species

No known state or federally listed aquatic species occur at the site; however, the U.S. EPA lists scaleshell, and Curtis' pearly mussels, pink mucket clams, and pallid sturgeon fish on the Endangered Species Protection Program Database for Lincoln County (EDR, 2007c). An exceptionally high number of state-listed species are associated with the streams of this ecological region (MDC, 2002).

Because the majority of the site is already developed as a rock quarry, the rest is developed residentially and agriculturally, and construction Best Management Practices would be followed, the impacts of plant construction on the aquatic ecology would be SMALL and temporary. These potential impacts would primarily be related to runoff and siltation. The impacts of operation including the thermal impact that would result from cooling water discharge to the Mississippi River is similar to that for the proposed site and would likely be SMALL due to permit restrictions and mitigation requirements.

9.3.2.2.6 Socioeconomics

Lincoln County is a moderately populated area that borders the densely populated St. Louis metropolitan area. Demographic and population characteristics for the site vicinity, a 50-mile (80 km) radius from the site are presented in Table 9.3-2. Other socioeconomic facts related to Lincoln County are as follows:

- The county has experienced a 28.7% population increase since the 2000 census (USCB, 2008b).
- Median household income within a 50 mile (80 km) radius was $45,650 per year in 2000 (MCDC, 2000c).
- 8.5% of the county's population within a 50 mile radius lived below the poverty level in 2000 (MCDC, 2000c).
- The nearest large city is O'Fallon, Missouri.
- The mean value of owner-occupied housing units was $98,062 in 2000 (MCDC, 2000c).
- There were 3,042 firms doing business in the county in 2002 (USCB, 2008b).

The Fred Weber Quarry site is currently being used as a rock quarry, and it is expected that the shift from the quarry operation to a nuclear power plant would contribute to the already significant population growth rate; therefore, the effect of the proposed new facility on the population and demographics of Lincoln County, Missouri, is expected to be SMALL.

9.3.2.2.7 Transportation

The site is located within 1 mile (1.6 km) of the small town of Auburn and just over 4 miles (6.4 km) from the town of Silex, Missouri, in a relatively undeveloped rural area of northern Lincoln County, Missouri. The site vicinity is characterized by an existing rock quarry; residential, commercial, and agricultural land; state highways; county roads; and railroad tracks. The project site is located approximately 30 miles (48 km) north of the St. Louis Metropolitan Area, Missouri, on State Highway 61 in the northwest corner of its intersection with County Road B. Interstate Highway 70 is located approximately 20 miles (32 km) south of the site. Some noticeable traffic increases from the construction workforce on the local State Highway 61, a primary divided highway, and State Highway 47, an arterial undivided road, may be noticeable during peak construction periods. The greatest periods of traffic impact will be during shift changes. Impact on area transportation resources will generally decrease with increased distance from the site as varied routes are taken by individual vehicles.

A description of estimated traffic volumes and impacts associated with the proposed project is included in section 4.4.1.5. Impacts on local roads from the construction workforce would be temporary and would likely end after construction was finished. However, a new operations workforce of some 850 individuals would present a continuing impact to the roads. It is expected that there would be MODERATE to LARGE impacts on transportation during construction activities and SMALL impacts during operation of the facility.

9.3.2.2.8 Historic, Cultural, and Archeological Resources

No known archaeological or National Register of Historic Places, State Historic Places or other historical resources are located in the immediate vicinity or within a 1-mile (1.6 km) radius of the site. There are no Indian Reservations located within one mile (1.6 km) radius of the site (EDR, 2007c). It is assumed that no impacts to these resources would occur during construction or operation of a nuclear facility at this site. Therefore, the impacts would be classified as SMALL.

9.3.2.2.9 Environmental Justice

Table 9.3-2 presents demographic information for a 50-mile (80 km) radius surrounding the Fred Weber Quarry site, Missouri, and the U.S. These data demonstrate that the population of this area is dissimilar in composition to the State of Missouri and to the U.S. as a whole. The percentage of this population that is comprised of racial minorities is less than that in the surrounding state of Missouri or in the U.S. The Fred Weber Quarry site is located in a largely rural area, and the likelihood of minority communities being disproportionately and adversely affected by this plant is low. There are 94,961 low income persons within 50 miles (80 km) of the site. This accounts for approximately 8.5% of the population in the area (MCDC, 2000c). Furthermore, this site has been operating as a commercial stone quarry facility for a number of years. Therefore, it is anticipated that environmental justice impacts at this site would be SMALL.

9.3.2.2.10 Transmission Corridors

Figure 9.3-18 depicts the preliminary transmission plan for the Fred Weber Quarry candidate site. This site in northern Lincoln County, Missouri, is not close to any existing 345 kV lines. It is assumed that two 42-mile 345 kV lines would be required to connect the new switchyard to the Sioux 345/138 kV Substation and two 30-mile 345 kV lines would be required to connect to the Montgomery 345/161 kV Substation. The new lines to the Sioux substation could follow a portion of the AmerenUE-owned Troy-Cyrene section of the Troy-Pike 161 kV line or the Sioux-Belleau section of the Sioux-Montgomery 345 kV right-of-way. New 345 kV line extensions would total 144 miles (232 km) at an estimated cost of $115.2 million. The site has been in use as a stone quarry for many years. It will be necessary to build new infrastructure to accommodate the new output for the plant. The plant site is developed and the surrounding corridors are predominantly agricultural land. In addition, the current transmission system could be used with few or no modifications. It is anticipated that the impacts due to transmission corridors would be LARGE.

9.3.2.3 Lamine Greenfield Site

The first of two greenfield candidate sites chosen for alternative site analysis is the Lamine greenfield site, located in the town of Lamine, in Cooper County, Missouri. The candidate site is located in central Missouri at latitude 38 degrees, 58 minutes, and 20 seconds north and longitude 92 degrees, 52 minutes, and 48 seconds west. Figure 9.3-11 and Figure 9.3-12 identify the Lamine candidate site and plant layout on geographic and USGS topography maps, respectively. The candidate is located on an approximately 1,300-acre (526-hectare) property.

For the purposes of this alternative siting study, it was assumed that the power plant site would occupy at least 500 acres (202 hectares), the minimum area that would provide a regulatory required 0.5 mile (0.8 km) radius exclusion zone.

9.3.2.3.1 Land Use

The Lamine greenfield site is located in a sparsely populated area. The site is bounded by Arrow Rock Road to the north and Lamine Road to the south and east. Additionally, Sky View Lane (a two lane road) runs through the middle of the site in a north-south direction. The site area is identified as being approximately 1,300 acres (526 hectares), which would need to be purchased at this site. The land that would need to be acquired is currently undeveloped.

The U.S. Department of Agriculture – Natural Resource Conservation Service (NRCS) has mapped the soil in Cooper County and has classified approximately half the site as “Farmland of statewide importance” and half the site as “prime farmland if drained” (NRCS, 2006f). There are no state zoning, land use, farmland preservation plans, regulations, or county or local zoning ordinances that would restrict the development of use of the Lamine site as a power plant.

Due to the use of several hundred acres of greenfield land, with no need to acquire residential property or other commercial property to accommodate a new nuclear site, the impact on land use in this area would be LARGE.

9.3.2.3.2 Air Quality

Cooper County’s status for all National Ambient Air Quality Standards (NAAQS) regulated air quality pollutants is designated as in-attainment (MDNR, 2007b). Construction activities may result in increased air emissions. Fugitive dust and fine particulate matter may be generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g. generators and compressors) will generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and to a lesser extent, sulfur dioxides. Painting, coating, and similar operations will also generate emissions from the use of volatile organic compounds.

Emission-specific strategies, plans, and measures will be developed and implemented to limit and mitigate releases, ensuring compliance within the applicable regulatory limits. These limits are defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (USEPA, 2007a) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (USEPA, 2007b). Air quality and release permits and operating certificates will be secured where required.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL temporary impact on air quality during construction and a SMALL impact on air quality during operation.

9.3.2.3.3 Water

The Missouri State Water Resources Plan attempts to identify water use problems and opportunities related to drinking water, agriculture, industrial, recreational, and environmental needs. The Lamine candidate site is located in west-central Missouri in an area identified as having the largest number of reservoirs and the greatest surface water storage in the state. Additionally, surface water quality in this region is generally good (MDNR, 1995).

The planned Callaway Plant Unit 2's cooling water system requirements were used to compare potential impacts to water resources at the Lamine site similar to the Callaway Site which is also located on the Missouri River. It is assumed that the water needs could be obtained from the Missouri River/Missouri River Alluvial Aquifer by a collector well system similar to the one described in Section 9.3.2.1.1.3, and a cooling water system similar to the Callaway Plant Unit 2 system would be used at the Lamine site. The site is located about 3 miles (4.8 km) south of the Missouri River in a largely undeveloped location. A cooling water intake and return system would have to be constructed to supply cooling water to the plant. The impacts associated with the construction of an approximately 3 mile (4.8 km) cooling water conveyance system are expected to be MODERATE during construction and SMALL during operation.

Due to the anticipated ample supply of water resources of the Missouri River/Missouri River Alluvial Aquifer, the rural nature of the area, and relatively low usage of these resources, impacts to water resources at the site from the construction and operation of a new reactor unit are anticipated to be SMALL.

9.3.2.3.4 Terrestrial Ecology and Sensitive Species

The Lamine site is located in Missouri's Ozark Highlands Section which covers most of southern Missouri and much of northern Arkansas and small parts of Illinois, Oklahoma, and Kansas. Due to differences in landform, geology (including till and loess), soils, and vegetation, there are sixteen ecological subsections, all of which occur in Missouri. The Lamine candidate site is located in the Inner Ozark Border Subsection. This area consists of dissected plains and hills with various expressions of local relief with a range of 150 ft to 300 ft (46 m to 91 m). This subsection wraps around the interior Ozarks from central Missouri to southeastern Missouri.

The Lamine site is located in the western section of the Inner Ozark Border Subsection, which was historically dominated by oak savannas, woodlands, and forests, with occasional glade and prairie openings. The density of the timber generally increased with the roughness of the land. Today the region is dominated by fescue pasture.

The U.S. Fish and Wildlife Service National Wetlands Inventory Pilot Grove North Map identifies 80 palustrine mapped wetland units within a 1-mile (1.6-km) radius of the approximate center of the site (EDR, 2008b). Measures and controls that will be implemented to mitigate potential impacts to wetlands are similar to those described in Section 4.6. There are no Special State Concern wetlands, Federally designated Wilderness Areas, Wildlife Preserves, Sanctuaries, Refuges, National Forests, agricultural preservation lands, or forest legacy lands known to be in the site vicinity (EDR, 2008b).

No known state or federally listed species or sensitive habitats are known to be located in the immediate vicinity of the site. The Inner Ozark Border Subsection contains 285 records of 100 state-listed rare or endangered species. There are 20 species whose principal distributions in Missouri are within this subsection.

The U.S. EPA does not list any terrestrial flora or fauna species on the Endangered Species Protection Program Database for Cooper County (EDR, 2008b). Because the new nuclear plant would be located at a previously undeveloped site, much of the pristine wildlife habitat area would need to be cleared and developed. The impacts to the terrestrial ecosystem at the site would therefore be LARGE and would occur predominantly during the construction of the plant. Construction Best Management Practices would be followed to minimize these impacts.

9.3.2.3.5 Aquatic Ecology and Sensitive Species

The U.S. EPA lists the Topeka shiner and the pallid sturgeon fish on the Endangered Species Program Database for Cooper County (EDR, 2008b). An exceptionally high number of state-listed species are associated with the streams of this ecological region (MDC, 2002).

The site is expected to use a Collector Well Intake System which avoids the potential for impingement or entrainment of fish in the Missouri River. However, it is likely that development of the site may impact wetlands in the area. Therefore, the impact of plant construction on the aquatic ecology is estimated to be MODERATE during construction and SMALL during operation. The impacts of operation including the thermal impact that would result from cooling water discharge to the Missouri River is similar to that for the proposed site and would likely be SMALL due to distance from the river and compliance with permit restrictions.

9.3.2.3.6 Socioeconomics

Cooper County is a moderately populated area in central Missouri. Demographic and population characteristics for the site vicinity, a 50-mile (80 km) radius from the site, are presented in Table 9.3-4. Other socioeconomic facts related to Cooper County are as follows:

- The county has experienced a 4.6% population increase since the 2000 census (USCB, 2008c)
- Median household income within a 50 mile (80 km) radius was $37,326 per year in 2000 (MCDC, 2000b)
- 19.8% of the county's population within a 50 mile (80 km) radius lived below the poverty level in 2000 (MCDC, 2000b)
- The nearest large city is Columbia, Missouri.
- The mean value of owner-occupied housing units was $99,497 in 2000 (MCDC, 2000b)
- There were 1,292 firms doing business in the county in 2002 (USCB, 2008c)

Cooper County, Missouri, currently has a lower population growth rate than does Callaway County (5.7%). Additionally, the 50 mile (80 km) radius around the Lamine site has a lower household income and lower value of owner-occupied housing units than does the 50 mile (80 km) radius around the Callaway site. Therefore, the effect of the proposed new facility on the population and demographics of Cooper County, Missouri, is expected to be MODERATE and BENEFICIAL due to the increases in jobs and taxes for the county.

9.3.2.3.7 Transportation

The site is located to the west of the town of Boonville, Missouri, in a relatively undeveloped rural area of Cooper County, Missouri. The site vicinity is undeveloped land. The project site is located on CC Highway at its intersection with Lamine Road. Interstate Highway 70 is located approximately 3 miles (4.8 km) south of the site. Significant traffic increases from the construction workforce on the local Highway CC, Lamine Road, Arrow Rock Road, and Cape Verde Lane will likely be noticeable during peak construction periods. These roads would have to be improved to handle the influx of construction related traffic. This would permanently change the rural nature of the immediate vicinity. The greatest periods of traffic impact will be during shift changes. Impact on area transportation resources will generally decrease with increased distance from the site as most vehicles will utilize Interstate Highway 70. Although Interstate Highway 70 offers an excellent route for most construction related traffic to within three miles of the site, access is also provided from Highway CC from the south.

A description of estimated traffic volumes and impacts associated with the proposed project is included in Section 4.4.1.5. Impacts on local roads from the construction workforce would be temporary and would end after construction was finished. However, a new operations workforce of some 850 individuals would present a continuing impact to the roads.

Because the influx of construction related vehicles will be a significant alteration to the traffic patterns of the area, it is expected that there would be MODERATE to LARGE impacts on transportation during construction activities and a MODERATE impact during operation of the facility.

9.3.2.3.8 Historic, Cultural, and Archeological Resources

No known archaeological or National Register of Historic Places, State Historic Places or other historical resources are located within a 1-mile (1.6-km) radius of the center of the site. There are no Indian Reservations located within a 1-mile (1.6-km) radius of the center of the site (EDR, 2008b). It is assumed that no impacts to these types of resources would occur during construction or operation of a nuclear facility at this site. Therefore, the impacts would be classified as SMALL.

9.3.2.3.9 Environmental Justice

Table 9.3-4 presents demographic information for a 50-mile (80-km) radius surrounding the Lamine site, Cooper County, Missouri, and the U.S. These data demonstrate that the population of this area is similar in composition to the State of Missouri and dissimilar to that of the U.S. as a whole. The percentage of racial minorities is significantly lower than that in the U.S. The Lamine site is located in a largely rural area, and the likelihood of minority communities being disproportionately and adversely affected by this plant is low. However, there are 54,303 low income persons within 50 miles (80 km) of the site. This accounts for approximately 12.9% of the population of the area, which is a greater proportion that of the alternative sites already mentioned (MCDC, 2000b). Therefore, it is possible that environmental justice impacts at this site could be MODERATE.

9.3.2.3.10 Transmission Corridors

This site in Cooper County, MO is located approximately 14 miles (22 km) west of the AmerenUE Overton 345/161 kV substation and near the existing KCPL-owned Overton-Sibley 345 kV line. However, as there are concerns with the need for transmission service charges if this KCPL-owned line would be used in the interconnection of the proposed plant (since KCPL is an

SPP member and not a MISO member) it is believed that this line should not be considered in the initial transmission development to allow similar comparisons with other alternatives.

It is assumed that two new 14 mile (22 km) 345 kV lines from the Lamine plant switchyard to Overton Substation would be required for primary connection. It is suggested that at least one of these lines be on a separate right-of-way from the existing Overton-Sibley 345 kV line.

A new 44-mile (71 km) 345 kV line would be proposed to connect to the new Lamine switchyard to the existing Thomas Hill 345/161 kV Substation in Randolph County. The new transmission line could follow an existing AECI 69 kV right-of-way from Fayette north to Thomas Hill.

A new 72-mile (116 km) 345 kV line would be proposed to connect the new switchyard to a new Barnett 345/161 kV Substation north of Eldon in Miller County and to the existing Mariosa Delta 345/161 kV substation east of Jefferson City.

New 345 kV line extensions would total 144 miles (232 km) at an estimated cost of $115.2 million. (If there are no transmission service issues with using the Overton-Sibley 345 kV line in the plant interconnection, then at least one of the two 345 kV lines to Overton 345/161 kV Substation may be deferred, resulting in a cost reduction of approximately $11.2-22.4 million.) Thus it is anticipated that transmission corridor impacts at this site would be LARGE.

9.3.2.4 Paynesville Greenfield Site

The second of two greenfield candidate sites chosen for alternative site analysis is the Paynesville greenfield site, located near the town of Elsberry, in Lincoln County, Missouri. The candidate site is located in eastern Missouri at latitude 39 degrees, 11 minutes, and 46 seconds north and longitude 90 degrees, 53 minutes, and 40 seconds west. Figure 9.3-13 and Figure 9.3-14 identify the Paynesville candidate site and plant layout on geographic and USGS topography maps, respectively. The candidate site is located on an approximately 850-acre (344-hectare) property.

For the purposes of this alternative siting study, it was assumed that the proposed nuclear plant site would occupy at least 500 acres (202 hectares), the minimum area that would provide a regulatory required 0.5 mile (0.8 km) radius exclusion zone.

9.3.2.4.1 Land Use

The Paynesville greenfield site is located in a sparsely populated area. The site is bounded by Highway N to the east, Highway F to the North, Richards Road to the West, and Barnes Road to the South. The site area is estimated to be approximately 850 acres (344 hectares), which would need to be purchased at this site. The land that would need to be acquired is currently undeveloped although a farm is located on the property.

The U.S. Department of Agriculture – Natural Resource Conservation Service (NRCS) has mapped the soil in Lincoln County and has classified approximately half of the site as “not prime farmland,” a quarter as “farmland of statewide importance,” and the remaining quarter as “all areas are prime farmland” (NRCS, 2006e). There are no state zoning, land use, farmland preservation plans, regulations, or county or local zoning ordinances that would restrict the development or use of the Sledd site as a power plant.

Due to the use of several hundred acres of greenfield land, with no need to acquire residential property or other commercial property to accommodate a new nuclear site, the impact on land use in this area would be LARGE.

9.3.2.4.2 Air Quality

Lincoln County's status for all National Ambient Air Quality Standards (NAAQS) regulated air quality pollutants is designated as in-attainment (MDNR, 2007b). Construction activities may result in increased air emissions. Fugitive dust and fine particulate matter may be generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g. generators and compressors) will generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and to a lesser extent, sulfur dioxides. Painting, coating, and similar operations will also generate emissions from the use of volatile organic compounds.

Emission-specific strategies, plans, and measures would be developed and implemented to limit and mitigate releases, ensuring compliance within the applicable regulatory limits. These limits are defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (USEPA, 2007a) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (USEPA, 2007b). Air quality and release permits and operating certificates will be secured where required.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL temporary impact on air quality during construction and a SMALL impact on air quality during operation.

9.3.2.4.3 Water

The Missouri State Water Resources Plan attempts to identify water use problems and opportunities related to drinking water, agriculture, industrial, recreational, and environmental needs. The Paynesville candidate site is located in the northeastern region of the state in an area identified as having relatively limited surface water and very limited groundwater resources and, as a result, water use is a concern during drought conditions. There are also concerns with water quality and resource protection. These concerns include surface water and groundwater protection from both point and non-point sources, including municipal, industrial, sewer, septic tanks, and agricultural related potential containment sources (MDNR, 1995).

The planned Callaway Plant Unit 2's cooling water system requirements were used to compare potential impacts to water resources at the Paynesville site. It is assumed that the water needs could be obtained from a Mississippi River/Mississippi River Alluvial Aquifer by a collector well system similar to the one described in Section 9.3.2.1.1.3 above, and a cooling water system similar to the Callaway Plant Unit 2 system would be used at the Paynesville site. The site is located about 7.5 miles (12 km) west of the Mississippi River. A cooling water intake and return system would have to be constructed to supply cooling water to the plant. The impacts associated with the construction of an approximately 7.5 mile (12 km) cooling water conveyance system are expected to be LARGE during construction and SMALL during operation.

Due to the anticipated ample supply of water resources of the Mississippi River/Mississippi River Alluvial Aquifer, the current rural nature of the area and resultant relatively low usage of these resources, impacts to water resources at the site from the construction and operation of a new reactor unit are anticipated to be SMALL.

9.3.2.4.4 Terrestrial Ecology and Sensitive Species

The Paynesville site is located in Missouri's Central Dissected Till Plains Section which covers all of Missouri north of the Missouri River and extends into southern Iowa and small portions of Kansas and Nebraska. Due to differences in landform, geology (including till and loess), soils, and vegetation, there are nineteen ecological subsections, with nine located in Missouri's Central Dissected Till Plains Ecological Section. The Paynesville candidate site is located in the Mississippi River Hills Subsection. This area consists of a broad belt of hills, valleys, and bluff lands along the Mississippi River from the North River southward to the Missouri River in northeastern Missouri.

The Paynesville site is located on the eastern edge of the Mississippi River Hills Ecological Subsection, which was historically dominated by timberlands consisting of oak savannas and open-oak woodlands with occasional glade and prairie openings occurring on flatter uplands. Today some of the oldest and most productive timberland is located in this region along with fescue pasture and cropland along the alluvial plains (MDC, 2002).

The U.S. Fish and Wildlife Service National Wetlands Inventory Auburn Map identifies fifteen palustrine mapped wetland units within a 1-mile (1.6-km) radius of the approximate center of the site. Measures and controls that will be implemented to mitigate potential impacts to wetlands are similar to those described in Section 4.6. There are no Special State Concern wetlands, Federally designated Wilderness Areas, Wildlife Preserves, Sanctuaries, Refuges, National Forests, agricultural preservation lands, or forest legacy lands known to be in the site vicinity (EDR, 2008a).

No known state or federally listed species or sensitive habitats are known to be located in the immediate vicinity of the site. The Mississippi River Hills Subsection contains 116 records of 53 state-listed rare or endangered species. Three of the state-listed species are found only in this subsection, including a cave-dwelling psuedoscorpion and a moss.

The U.S. EPA lists four federally listed species on the Endangered Species Protection Program Database for Lincoln County: the Indiana and gray bats, the Bald Eagle, and one plant species, the eastern prairie fringed orchid. Because the nuclear power plant would be located at a previously undeveloped site, much of the pristine wildlife habitat area would need to be cleared and developed. The impacts to the terrestrial ecosystem at the site would therefore be LARGE and would occur predominantly during the construction of the plant. Construction Best Management Practices would be followed to minimize these impacts.

9.3.2.4.5 Aquatic Ecology and Sensitive Species

The U.S. EPA lists scaleshell, Curtis' pearly mussels, pink mucket clams, and pallid sturgeon fish on the Endangered Species Protection Program Database for Lincoln County (EDR, 2008a). An exceptionally high number of state-listed species are associated with the streams of this ecological region (MDC, 2002).

The site is expected to use a Collector Well Intake System which avoids the potential for impingement or entrainment of fish in the Mississippi River. However, it is likely that development of the site may impact wetlands in the area. Therefore, the impact of plant construction on the aquatic ecology is estimated to be MODERATE during construction and SMALL during operation. The impacts of operation including the thermal impact that would result from cooling water discharge to the Mississippi River is similar to that for the proposed site and would likely be SMALL due to distance from the river and compliance with permit restrictions.

9.3.2.4.6 Socioeconomics

Lincoln County is a moderately populated area that borders the densely populated St. Louis metropolitan area. Demographic and population characteristics for the site vicinity, a 50-mile (80 km) radius from the site, are presented in Table 9.3-5. Other socioeconomic facts related to Lincoln County are as follows:

- The county has experienced a 28.7% population increase since the 2000 census (USCB, 2008b).
- Median household income within a 50 mile (80 km) radius was $53,601 per year in 2000 (MCDC, 2000e).
- 8.1% of the county's population within a 50 mile (80 km) radius lived below the poverty level in 2000 (MCDC, 2000e).
- The nearest large city is O'Fallon, Missouri.
- The mean value of owner-occupied housing units was $149,102 in 2000 (MCDC, 2000e).
- There were 3,042 firms doing business in the county in 2002 (USCB, 2008b).

Lincoln County, Missouri, has experienced a much larger population growth rate than has Callaway County (5.7%). The median household income and the value of owner-occupied housing units in Lincoln County are greater than that in Callaway County. Due to this site's proximity to the St. Louis environs, it is expected that the region can absorb the influx of construction workers as well as the permanent workforce with ample housing within a one-hour drive. Therefore, the effect of the proposed new facility on the population and demographics, including housing and taxes of Lincoln County, Missouri, is expected to be MODERATE and beneficial.

9.3.2.4.7 Transportation

The site is located near the town of Elsberry, Missouri, in a relatively undeveloped rural area of Lincoln County, Missouri. The site vicinity is undeveloped land except for the presence of a farm. The project site is located on Richards Road at its intersection with Highway F. Interstate Highway 70 is located approximately 28 miles (45 km) south of the site. Some noticeable traffic increases from the construction workforce on the local State Route 61 and Highways F and N will be noticeable during peak construction periods. The greatest periods of traffic impact will be during shift changes. Impact on area transportation resources will generally decrease with increased distance from the site as varied routes are taken by individual vehicles. The site can be accessed from the west via State Route 61 and from the east via Highway N.

A description of estimated traffic volumes and impacts associated with the proposed project is included in Section 4.4.1.5. Impacts on local roads from the construction workforce would be temporary and would likely end after construction was finished. However, a new operations workforce of some 850 individuals would present a continuing impact to the roads. It is expected that there would be MODERATE to LARGE impacts on transportation during construction activities and a SMALL impact during operation of the facility.

9.3.2.4.8 Historic, Cultural, and Archeological Resources

No known archeological or National Register of Historic Places, State Historic Places or other historical resources are located within a 1-mile (1.6-km) radius of the center of the site. There are no Indian Reservations located within a 1-mile (1.6-km) radius of the site (EDR, 2008a). It is assumed that no impacts to these resources would occur during construction or operation of a nuclear facility at this site. Therefore, the impacts would be classified as SMALL.

9.3.2.4.9 Environmental Justice

Table 9.3-5 presents demographic information for a 50-mile (80-km) radius surrounding the Paynesville site, Lincoln County, Missouri, and the U.S. These data demonstrate that the population of this area is similar in composition to the State of Missouri and dissimilar to that of the U.S. as a whole. The percentage of this population that is comprised of racial minorities is similar to that in the surrounding state of Missouri and significantly lower than that of the U.S. The Paynesville site is located in a largely rural area, and the likelihood of minority communities being disproportionately and adversely affected by this plant is low. There are 101,324 low income persons within 50 miles (80 km) of the site. This accounts for approximately 8.1% of the population in the area, which is proportional to both the Chamois and Fred Weber candidate sites (MCDC, 2000e). Because the proportions of low income persons are not disproportionately larger in this area, it is anticipated that environmental justice impacts at this site would be SMALL.

9.3.2.4.10 Transmission Corridors

This site in northern Lincoln County, MO is not close to any existing 345 kV lines. It is assumed that two 48-mile (77 km) 345 kV lines would be required to connect the new Paynesville plant switchyard to the Sioux 345/138 kV Substation and two 35-mile (56 km) 345 kV lines would be required to connect to the Montgomery 345/161 kV Substation. The new lines to Sioux could follow a portion of the AmerenUE owned Troy-Cyrene section of the Troy-Pike 161 kV line or the Sioux-Belleau section of the Sioux-Montgomery 345 kV right-of-way.

New 345 kV line extensions would total 166 miles (267 km) at an estimated cost of $132.8 million. Thus it is anticipated that transmission corridor impacts at this site would be LARGE.}

9.3.2.5 Evaluation of the Existing Nuclear Site

{Co-locating the new reactor is preferable to both the brownfield alternative and the greenfield alternative. Co-location reduces the costs when compared to either greenfield or brownfield development because the new reactor will be able to take advantage of the infrastructure that serves the existing reactor.

Analyses of site suitability, appropriate seismicity and geological setting, federal, state, and local regulatory restrictions, and many other significant issues have been conducted for the proposed site, and are discussed in Chapters 2, 4, and 5. Discussion of resource commitments for the proposed alternative site is provided in Section 10.1 through Section 10.3.

A cost-benefit analysis for the proposed site is detailed in Section 10.4. The costs and resource commitments needed for construction and operation of the new facility would be similar regardless of the site at which the unit is located. The information presented in Section 10.1 through Section 10.4 is therefore applicable to all of the candidate sites.

9.3.2.5.1 Callaway Plant Unit 2 (Proposed Site)

The Callaway Plant Unit 2 site is the proposed site for locating the nuclear power plant. The Callaway Plant Unit 2 site is located northwest of the existing nuclear power plant, Callaway Plant Unit 1, within the Callaway site in Missouri near the Missouri River as shown in Figure 2.1-1. A topographical map of the Callaway site is shown in Figure 2.2-3. Figure 9.3-15 and Figure 9.3-16 identify the Callaway proposed site location on geographic and USGS topography maps, respectively. A detailed description of the Callaway Plant Unit 2 site and surroundings, as well as the impacts of construction and operation, is provided in Chapters 2, 4, and 5. This information is summarized below.

9.3.2.5.1.1 Land Use

Section 2.2 contains a description of land use at the Callaway site and in the site vicinity. Maps depicting land use within the Callaway site and the vicinity are presented in Figure 2.2-1 and Figure 2.2-2. The Callaway site is owned by AmerenUE. The areas devoted to major land uses within the Callaway site are summarized in Table 2.2-1. Land use in the area surrounding the Callaway Plant Unit 2 site is predominantly rural.

AmerenUE-owned land accessible by the public which is subject to use restrictions includes approximately 6,600 acres (2,671 hectares) of the 7,371 acre (2,983 hectare) Callaway site. This property, known as the Reform Conservation Area, is managed by the Missouri Department of Conservation (MDC). It is anticipated that construction and operation of the proposed project would not interfere with recreational uses of this area.

No comprehensive land use or zoning plans exist covering the rural portions of Callaway County including the Callaway site and vicinity. The impacts to land use at this site would be expected to be SMALL because the new reactor would be placed near the existing Callaway Plant Unit 1 location largely on land that is already disturbed.

9.3.2.5.1.2 Air Quality

Callaway County's status for all National Ambient Air Quality Standards (NAAQS) regulated air quality pollutants is designated as in-attainment (MDNR, 2007b). Construction activities may result in increased air emissions. Fugitive dust and fine particulate matter may be generated during earth moving and material handling activities. Vehicles and engine-driven equipment (e.g. generators and compressors) generate combustion product emissions such as carbon monoxide, oxides of nitrogen, and, to a lesser extent, sulfur dioxides. Painting, coating, and similar operations also may generate emissions from the use of volatile organic compounds.

Emission-specific strategies, plans, and measures would be developed and implemented to limit and mitigate releases, ensuring compliance with the applicable regulatory limits. These limits are defined by the primary and secondary National Ambient Air Quality Standards in 40 CFR 50 (USEPA, 2007a) and the National Emission Standards for Hazardous Air Pollutants in 40 CFR 61 (USEPA, 2007b). Air quality and release permits and operating certificates would be secured where required.

Based on the design of the new reactor and the actions that will be taken to comply with permit requirements for emissions, it is expected that siting the unit at this location would have a SMALL impact on air quality.

9.3.2.5.1.3 Water

Surface and groundwater resources and uses that could affect or be affected by the construction or operation of Callaway Plant Unit 2 and associated facilities are described in Section 2.3. The consumptive and non-consumptive water uses are identified, and water diversions, withdrawals, consumption, and returns are quantified.

At the Callaway site, a collector well intake system will be installed along the Missouri River to supply makeup cooling water for Callaway Plant Units 1 and 2. The collector well intake system is described in Section 3.4. A system of collector wells will supply cooling system makeup water for both units on the Callaway site. Water will be pumped through a common line up the corridor and split for usage by the two plants. The proposed collector wells will be distributed along the north bank of the Missouri River. It is expected that 80 to 90% of the water will be derived from surface water recharge to the aquifer, while 10 to 20% will be derived from up gradient sources of groundwater.

The impacts to water resources are expected to be SMALL and would be less than or similar to impacts due to the existing reactor at the site. As discussed in Section 2.3, current groundwater use at the site for existing operational and domestic use does not noticeably alter offsite groundwater characteristics.

Additional groundwater withdrawals required for constructing the new reactor are not expected to destabilize offsite groundwater resources, as discussed in Chapter 4. Due to the large size of both the surface water and groundwater resources and the current rural nature of the area and resultant low usage of these resources, impacts to water resources at the site from construction and operation of the new reactor unit are anticipated to be SMALL.

9.3.2.5.1.4 Terrestrial Ecology and Sensitive Species

The Callaway Plant Unit 2 site is located in Missouri's Central Dissected Till Plains Section which covers all of Missouri north of the Missouri River and extends into southern Iowa and small portions of Kansas and Nebraska. Due to differences in landform, geology (including till and loess), soils, and vegetation, there are nineteen ecological subsections, with nine located in Missouri in the Central Dissected Till Plains Ecological Section. The proposed site is located in the southern area of the Claypan Till Plains Subsection. The subsection lies in northeastern Missouri in the triangle between the Mississippi, Missouri, and Chariton Rivers.

The distinguishing feature of this subsection is the presence of well-developed claypan soils on a flat glacial till plain. The Callaway Plant Unit 2 site is located in the southern portion of the Claypan Till Plains Ecological Subsection. Most of the subsection was formerly prairie, with narrow belts of timber along stream courses. Most of the subsection is now farmland, of which more than 50% is cropland (MDC, 2002).

The U.S. Fish and Wildlife Service National Wetlands Inventory Mokane East Map identifies 36 palustrine wetland mapped units within an approximate 0.5-mile (0.8 km) radius of the site. Measures and controls that would be implemented to mitigate potential impacts to wetlands are described in Section 4.6. There are no special state concern wetlands, federally designated wilderness areas, wildlife preserves, sanctuaries, national forests, agricultural preservation lands, or forest legacy lands found in the site vicinity (EDR, 2007d). A state conservation area (Reform) is discussed in Section 2.4.1. A discussion of state and federal rare, threatened and endangered species is provided in Section 2.4.1.2.

Because the new nuclear plant would be located adjacent to an operating power generating facility, and the additional acreage needed for the siting of the proposed nuclear plant is already disturbed land, little or no additional pristine wildlife habitat area would need to be cleared and developed. The impacts to the terrestrial ecosystem at the site would therefore be SMALL and would predominantly occur during the construction of the plant. Construction Best Management Practices would be followed to minimize these impacts. The impacts of operation to terrestrial species would be SMALL.

9.3.2.5.1.5 Aquatic Ecology and Sensitive Species

A discussion of state and federal rare, threatened and endangered species is provided in Section 2.4.2.2.

Because the majority of the site is already developed as a nuclear power plant, the remainder has been previously disturbed during the construction of the Callaway, and construction Best Management Practices would be followed, the impacts of Callaway Plant Unit 2 construction on the aquatic ecology would be SMALL and temporary. These potential impacts would primarily be related to runoff and siltation. The impacts of operation including the thermal impact that would result from cooling water discharge to the Mississippi River would likely be SMALL due to permit restrictions and mitigation requirements.

The site is expected to use a Collector Well Intake System which avoids the potential for impingement or entrainment of fish in the Missouri River. However, it is likely that development of the site may impact wetlands in the area. Therefore, the impact of plant construction on the aquatic ecology is estimated to be MODERATE during construction and SMALL during operation. The impacts of operation including the thermal impact that would result from cooling water discharge to the Missouri River is similar to that for the proposed site and would likely be SMALL due to distance from the river and compliance with permit restrictions.

9.3.2.5.1.6 Socioeconomics

In 2005, the estimated population within a 50-mile (80 km) radius of the Callaway Plant Unit 2 site was 613,142 people. Demographic characteristics for the site vicinity, a 50 mile (80 km) radius form the site are presented in Table 9.3-3. Other socioeconomic facts related to Callaway County are as follows:

- Callaway County experienced a 5.7% population increase since the 2000 census (USCB, 2008d).
- The median household income within 50 miles (80 km) is slightly higher than $51,145 per year in 2000 (MCDC, 2000d).
- Approximately 7.4% of the county's population within 50 miles (80 km) lived below the poverty level in 2000 (MCDC, 2000d).
- The nearest large city is Jefferson City, MO.
- The mean value of owner-occupied housing units within a 50 mile (80 km) radius was $135,961 in 2000 (MCDC, 2000d).
- There were 2,629 firms doing business in the county in 2002 (USCB, 2008d).

The local and regional socioeconomic effect analysis of the proposed Callaway Plant Unit 2 is presented in Section 2.5. Although construction and operation of a new reactor would create both temporary and permanent jobs, the percent of the population employed by the new plant (and therefore the effect of the new reactor operation on the area's population) is expected to be SMALL and BENEFICIAL. The additional jobs and local tax revenues generated by the construction and operation of Callaway Plant Unit 2 is expected to have a beneficial effect on the local economy}

9.3.2.5.1.7 Transportation

Callaway County is bisected in the east/west direction by I-70 and in the north/south direction by U.S. Route 54. State Route 94 runs generally in an east/west direction parallel to the Missouri River. A network of smaller lettered State or numbered County roads connects the communities and provides access to the main highways. The most important of these with respect to the Callaway site are State Route D providing access to the site from I-70, State Route O forming much of the northern site boundary, and State Route CC running north/south connecting State Route O to the north with State Route 94 to the south, intersecting County Route 459 which gives access to the site. State Route CC and County Routes 428, 448, 461, and 468 all traverse portions of the AmerenUE property. County Route 459 is located entirely on AmerenUE property.

Major land-based transportation routes and utility routes within the region are depicted in Figure 2.2-7 and Figure 2.2-9. A description of estimated traffic volumes and impacts associated with the proposed project is included in section 4.4.1.5. Impacts on local roads would be temporary and would likely end after construction was finished. It is estimated that there would be SMALL to MODERATE impacts on transportation during construction activities and a SMALL impact during operation of the facility.

9.3.2.5.1.8 Historic, Cultural, and Archeological Resources

It is anticipated that historic and cultural impacts would be SMALL because the site is largely already disturbed and surveys have not indicated the presence of cultural resources in new areas to be disturbed as discussed in Section 2.5.3.

9.3.2.5.1.9 Environmental Justice

Table 9.3-3 presents demographic information for a 50-mile (80 km) radius surrounding the Callaway Plant Unit 2 site, Missouri, and the U.S. These data demonstrate that the population of this area has a lower percentage of minority population than the State of Missouri and the U.S. as a whole. The Callaway Plant Unit 2 site is located in a largely rural area, and the likelihood of minority communities being disproportionately and adversely affected by this plant is low, as discussed further in Section 2.5.4. There are 45,036 poor persons within 50 miles (80 km) of the site. This accounts for approximately 7.4% of the population in the area (MCDC, 2000d). This is lower than the Lamine, Fred Weber, and Paynesville candidate sites, and is on par with the Chamois candidate site. Therefore, it is anticipated that environmental justice impacts at this site would be SMALL.

9.3.2.5.1.10 Transmission Corridors

The transmission corridor is discussed in Section 3.7, and impacts are discussed in Sections 4.3 and 5.1.2. An assessment was made to identify additions and modifications to the transmission system needed to connect the new reactor unit to the power grid. These are described in Section 3.7. The results of the assessment indicated that Callaway Plant Unit 2 would require the following new facilities and upgrades to connect to the existing transmission system:

- One new 345 kV, 16 breaker, breaker-and-a-half switchyard to transmit power from Callaway Plant Unit 2,
- Two new 345 kV, 2,090 MVA (normal rating) circuits connecting the new Callaway Plant Unit 2 switchyard to the existing Callaway Plant Unit 1 switchyard,

- An extension of the Loose Creek 345 kV transmission line from a tie point on the Loose Creek transmission line near Chamois to the Callaway Plant Unit 1 switchyard resulting in approximately 6.7 miles (10.8 km) of new transmission line.

Due to the rural nature of the areas that would be transected by these transmission lines, and the use of environmental mitigation measures during construction, any impacts are expected to be SMALL in nature.}

9.3.3 SUMMARY AND CONCLUSIONS

The advantages of the {Callaway Plant Unit 2} site over the alternative sites are summarized as follows:

- {The postulated consumptive use of water by a new unit at the Callaway Plant Unit 2 site would be no greater than water use at the alternative sites.
- The impacts of development of a new unit at the proposed site on endangered species are not greater than impacts postulated for the alternative sites.
- No Federal, State, or affected Native American tribal lands are affected by the proposed site.
- The Callaway Plant Unit 2 site does not contain spawning and/or nesting grounds for any threatened or endangered species. Thus, the impacts on spawning or nesting areas are not greater than impacts at the alternative sites.
- The Callaway Plant Unit 2 site impact review does not postulate effluent discharge beyond the limits of National Pollutant Discharge Elimination System (NPDES) permits or regulations. Based on the information available for the alternative sites, the impacts from effluent discharge at the proposed site would be no greater than impacts at the alternative sites.
- The siting of the new unit at the Callaway site would not require changes to any federal or state land use plans or county zoning ordinances.
- Co-locating Callaway Plant Unit 2 with the existing nuclear facility on land that is already largely disturbed and industrial in current use would have lesser land use effect than at the alternative greenfield or brownfield sites. Therefore, land impacts at the proposed site would be no greater than the impacts at the alternative sites.
- The potential impacts of a new nuclear facility on terrestrial and aquatic environments at the Callaway site would be no greater than the impacts at the alternative sites.
- The Callaway site is in a generally rural setting and has a population density that meets the population criteria of 10 CFR Part 100.

As summarized in Table 9.3-6, no alternative sites are environmentally preferable, and therefore cannot be considered obviously superior, to the Callaway Plant Unit 2 site. Development of a greenfield or brownfield site would offer no advantages and would increase both the severity of environmental impacts and the cost of the new facility.

The existing facility currently operates under an NRC license, and the proposed location has already been found acceptable under the requirements for that license. Further, operational experience at the Callaway site has shown that the environmental impacts are SMALL, and operation of a new unit at the site should have essentially the same or less environmental impacts.}

9.3.4 REFERENCES

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atitude=35.58.20&longitude=92.52.48&sitename=Site+C-9&radii=10+20+30+40+50&state=29&units=+&tablelist=all&cntypops=on&_debug=, Date Accessed: April 28, 2008.

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Table 9.3-1—{Profile of Demographic Characteristics Chamois Candidate Site (50 Mile Radius)}

Geographic Area	Race						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Chamois, MO 50 Mile (80 km) Radius	592,171 94.5%	16,724 2.7%	2,038 0.3%	5,647 0.9%	178 0.0%	2,083 0.3%	7,791 1.2%
Missouri	4,748,083 84.9%	629,391 11.2%	25,076 0.4%	61,595 1.1%	3,178 0.1%	45,827 0.8%	82,061 1.5%
U.S.	211,460,626 75.1%	34,658,190 12.3%	2,475,956 0.9%	10,242,998 3.6%	398,835 0.1%	15,359,073 5.5%	6,826,228 2.4%

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Table 9.3-2—{Profile of Demographic Characteristics Fred Weber Quarry Candidate Site (50 mile Radius)}

Geographic Area	Race						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Fred Weber Quarry, 50 Mile (80 km) Radius	909,783 79.8%	194,581 17.1%	2,950 0.3%	11,659 1.0%	426 0.0%	5,517 0.5%	14,797 1.3%
Missouri	4,748,083 84.9%	629,391 11.2%	25,076 0.4%	61,595 1.1%	3,178 0.1%	45,827 0.8%	82,061 1.5%
U.S.	211,460,626 75.1%	34,658,190 12.3%	2,475,956 0.9%	10,242,998 3.6%	398,835 0.1%	15,359,073 5.5%	6,826,228 2.4%

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Table 9.3-3—{Profile of Demographic Characteristics Callaway Site (50 mile Radius)}

Geographic Area	Race						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Callaway, MO, 50 Mile (80 km) Radius	590,206 94.5%	16,894 2.7%	1,987 0.3%	5,556 0.9%	178 0.0%	2,098 0.3%	7,801 1.2%
Missouri	4,748,083 84.9%	629,391 11.2%	25,076 0.4%	61,595 1.1%	3,178 0.1%	45,827 0.8%	82,061 1.5%
U.S.	211,460,626 75.1%	34,658,190 12.3%	2,475,956 0.9%	10,242,998 3.6%	398,835 0.1%	15,359,073 5.5%	6,826,228 2.4%

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Table 9.3-4—{Profile of Demographic Characteristics Lamine Candidate Site}

Geographic Area	Race						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Lamine, 50 Mile (80 km) Radius	401,297 89.5%	27,823 6.2%	2,049 0.5%	5,787 1.3%	242 0.1%	3,477 0.8%	7,695 1.7%
Missouri	4,748,083 84.9%	629,391 11.2%	25,076 0.4%	61,595 1.1%	3,178 0.1%	45,827 0.8%	82,061 1.5%
U.S.	211,460,626 75.1%	34,658,190 12.3%	2,475,956 0.9%	10,242,998 3.6%	398,835 0.1%	15,359,073 5.5%	6,826,228 2.4%

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Table 9.3-5—{Profile of Demographic Characteristics Paynesville Candidate Site}

Geographic Area	Race						
	One Race						Two or More Races
	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Other Race	
Paynesville, 50 Mile (80 km) Radius	972,568 76.3%	253,851 19.9%	3,087 0.2%	21,008 1.6%	533 0.0%	5,474 0.4%	18,250 1.4%
Missouri	4,748,083 84.9%	629,391 11.2%	25,076 0.4%	61,595 1.1%	3,178 0.1%	45,827 0.8%	82,061 1.5%
U.S.	211,460,626 75.1%	34,658,190 12.3%	2,475,956 0.9%	10,242,998 3.6%	398,835 0.1%	15,359,073 5.5%	6,826,228 2.4%

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Table 9.3-6—{Summary Comparison of Candidate and Potential Sites}

Location	Callaway Plant site	Chamois Brownfield	Fred Weber Quarry Brownfield	Lamine Greenfield	Paynesville Greenfield
Land Use	Small	Moderate to Large	Moderate	Large	Large
Air Quality	Small	Small to Moderate (Beneficial)	Small	Small	Small
Water	Small	Small	Small to Large	Small to Moderate	Small
Terrestrial Ecology	Small	Small	Small	Large	Large
Aquatic Ecology	Small to Moderate	Moderate	Small	Small to Moderate	Small to Moderate
Socioeconomics	Small (Beneficial)	Small	Small	Moderate (Beneficial)	Moderate (Beneficial)
Historic, Cultural, and Archaeological Resources	Small	Small	Small	Small	Small
Environmental Justice	Small	Small	Small	Moderate	Small
Transmission Corridors	Small	Small	Large	Large	Large
Transportation	Small to Moderate	Small to Moderate	Small to Large	Moderate to Large	Small to Large
Is this Site a Candidate Site? (Yes or No)	Yes	Yes	Yes	Yes	Yes
Is this Candidate Site a Good Alternative Site to the Proposed Site?	Yes	Yes	Yes	Yes	Yes
Is the Site Obviously Superior?	Preferred Alternative	No	No	No	No
Is the Site Environmentally Preferable?	Preferred Alternative	No	No	No	No

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Table 9.3-7—{Summary of LoopNet Greenfield Sites}

	Missouri River						Mississippi River		
Criterion	**Highway 94**	**30543 Hwy N**	**Pheasant Hunting Farm**	**Tower Road**	**Fayette**	**14636 Z Hwy**	**Hwys 79 & 47**	**Eolia**	**Paynesville**
Population per Sq Mile within 10 Miles	14.8	14.3	64.7	31.9	23.9	8	66.3	13.9	3.1
Population per Sq Mile within 50 Miles	71.7	51.5	57	124.2	55.4	29.3	437.5	162.1	282.2
Distance From the River (Miles)	0.5	15	7.5	5	15	15	3	10	7.5
Distance to 345 kV Line (Miles)	10	10	10	3	15	30	13	43	20
Distance to St. Louis (Miles)	85	160	145	60	145	190	40	60	55
Distance to Park/ Federal Land (Miles)	7.5	7.5	10	3	7.5	10	3	5	7.5
Distance to Closest Airport (Miles) (STL/KC)	70 STL	93 KC	112.5 KC	52 STL	115 KC	70 KC	25 STL	60 STL	42.5 STL
Distance to Hwy 70 (Miles)	10	6	7.5	6	15	42.5	15	28	28
Acreage	357	534	400	305	340	218	662	355	850

Table 9.3-8—{Greenfield Site Comparison Matrix}

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SITE LEGEND

Site Code	Site Name	Site Code	Site Name
C-2	Annada	R-4	Pheasant Hunting Farm
C-9	Lamine	R-5	Tower Road
C-10	Foley	R-6	Fayette
R-1	Hwys 79 & 47	R-7	14636 Z Hwy
R-2	Highway 94	R-8	Eolia
R-3	30543 Hwy N	R-9	Paynesville

Criterion														
Weighting Factor (see legend)														
		Missouri River							**Mississippi River**					Value Range
Pop. Per SQ Mi w/ 10 mi		**C9**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (#/sq. mi)	48.9	14.8	14.3	64.7	31.9	23.9	8	24.6	20.1	66.3	13.9	3.1	5 = 0 - 24 #/sq mi
	Value	3	5	5	1	3	5	5	5	5	1	5	5	3 = 25 - 49 #/sq mi
8	Weighted Value	24	40	40	8	24	40	40	40	40	8	40	40	1 = 50 - 75 #/sq mi
		Missouri River							**Mississippi River**					Value Range
Pop. Per SQ Mi w/ 50 mi		**C9**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (#/sq. mi)	57.6	71.7	51.5	57	124.2	55.4	29.3	209.3	35.4	437.5	162.1	282.2	5 = 0 - 149 #/sq mi
	Value	5	5	5	5	5	5	5	3	5	1	3	3	3 = 150 - 299 #/sq mi
2	Weighted Value	10	10	10	10	10	10	10	6	10	2	6	6	1 = 300 - 450 #/sq mi
		Missouri River							**Mississippi River**					Value Range
Dist From The River		**C9**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	3	0.5	15	7.5	5	15	15	5	7.5	3	10	7.5	5 = 0 - 4 mi
	Value	5	5	1	3	3	1	1	3	3	5	1	3	3 = 5 - 9 mi
8	Weighted Value	40	40	8	24	24	8	8	24	24	40	8	24	1 = 10 - 15 mi

Table 9.3-8—{Greenfield Site Comparison Matrix}

(Page 2 of 3)

Criterion														
Weighting Factor (see legend)														
Dist. To 345 kV		**Missouri River**							**Mississippi River**					Value Range
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	0	10	10	10	3	15	30	28	23	13	43	20	5 = 0 - 14 mi
	Value	5	5	5	5	5	3	1	3	3	5	1	3	3 = 15 - 29 mi
8	Weighted Value	40	40	40	40	40	24	8	24	24	40	8	24	1 = 30 - 45 mi
Dist to STL		**Missouri River**							**Mississippi River**					Value Range
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	150	85	160	145	60	145	190	50	80	40	60	55	5 = 0 - 64 mi
	Value	1	3	1	1	5	1	1	5	3	5	5	5	3 = 65 - 129 mi
5	Weighted Value	5	15	5	5	25	5	5	25	15	25	25	25	1 = 130 - 195 mi
Dist to Park/Fed Land		**Missouri River**							**Mississippi River**					Value Range
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	7.5	7.5	7.5	10	3	7.5	10	3	5	3	5	7.5	1 = 0 - 3 mi
	Value	5	5	5	5	1	5	5	1	3	1	3	5	3 = 3.1 - 6 mi
8	Weighted Value	40	40	40	40	8	40	40	8	24	8	24	40	5 = 6.1 - 10 mi
Dist to Airport STL/KC		**Missouri River**							**Mississippi River**					Value Range
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	115 KC	70 STL	93 KC	112.5 KC	52 STL	115 KC	70 KC	48 STL	38 STL	25 STL	60 STL	42.5 STL	1 = < 10 mi
	Value	5	3	3	5	3	5	3	3	3	3	3	3	3 = 11 -100 mi
3	Weighted Value	15	9	9	15	9	15	9	9	9	9	9	9	5 = > 100 mi
Dist to HWY-70		**Missouri River**							**Mississippi River**					Value Range
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	3	10	6	7.5	6	15	42.5	35	45	15	28	28	1 = 0 -10 mi
	Value	1	1	1	1	1	3	5	5	5	3	5	5	3 = 11 - 19 mi
3	Weighted Value	3	3	3	3	3	9	15	15	15	9	15	15	5 = 20 - 45 mi

Table 9.3-8—{Greenfield Site Comparison Matrix}

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Criterion														
Weighting Factor (see legend)														
Acreage 500 AC		**Missouri River**							**Mississippi River**					Value Range
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
	Data (miles)	1,300	357	534	400	305	340	218	1,400	5,652	662	355	850	1 = < 400 acres
	Value	5	1	5	3	1	1	1	5	5	5	1	5	3 = 400 - 500 acres
8	Weighted Value	40	8	40	24	8	8	8	40	40	40	8	40	5 = > 500 acres
Value Range Total **Weighted Total**		**Missouri River**							**Mississippi River**					
		C9	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**C2**	**C10**	**R1**	**R8**	**R9**	
		16	14	17	19	13	20	21	15	15	16	18	16	
		217	205	195	169	151	159	143	191	201	181	143	223	
		Weight [a]		**Weighted Scale**					**Rationale**					
									Definition of "better" or "more important"					
		8	Population Per Square Mile (Within 10 Miles)						Fewer people for emergency evacuation					
		2	Population Per Square Mile (Within 50 Miles						Fewer people impacted by aesthetics, etc.					
		8	Distance to Nearest River (In Miles)						Closer - easier to obtain water					
		8	Distance to Nearest 345 kV Line (In Miles)						Closer - less env. impact to connect					
		5	Distance to Center of St. Louis (In Miles)						Closer to load center					
		8	Distance to Nearest Edge of Significant Areas (Parks, etc.)						Further to env. sensitive property					
		3	Distance to Airport (STL or KC)						Further - less impact to aviation routes					
		3	Distance to Highway 70						Further - less potential for disruption during emergency					
		8	Acreage						More - no need to acquire additional acreage					
		[a] Higher number is more important criterion.												
					Calculation									
				Value Range x Weight = Weighted Value										

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Figure 9.3-1—{Potential Alternatives Region of Interest}

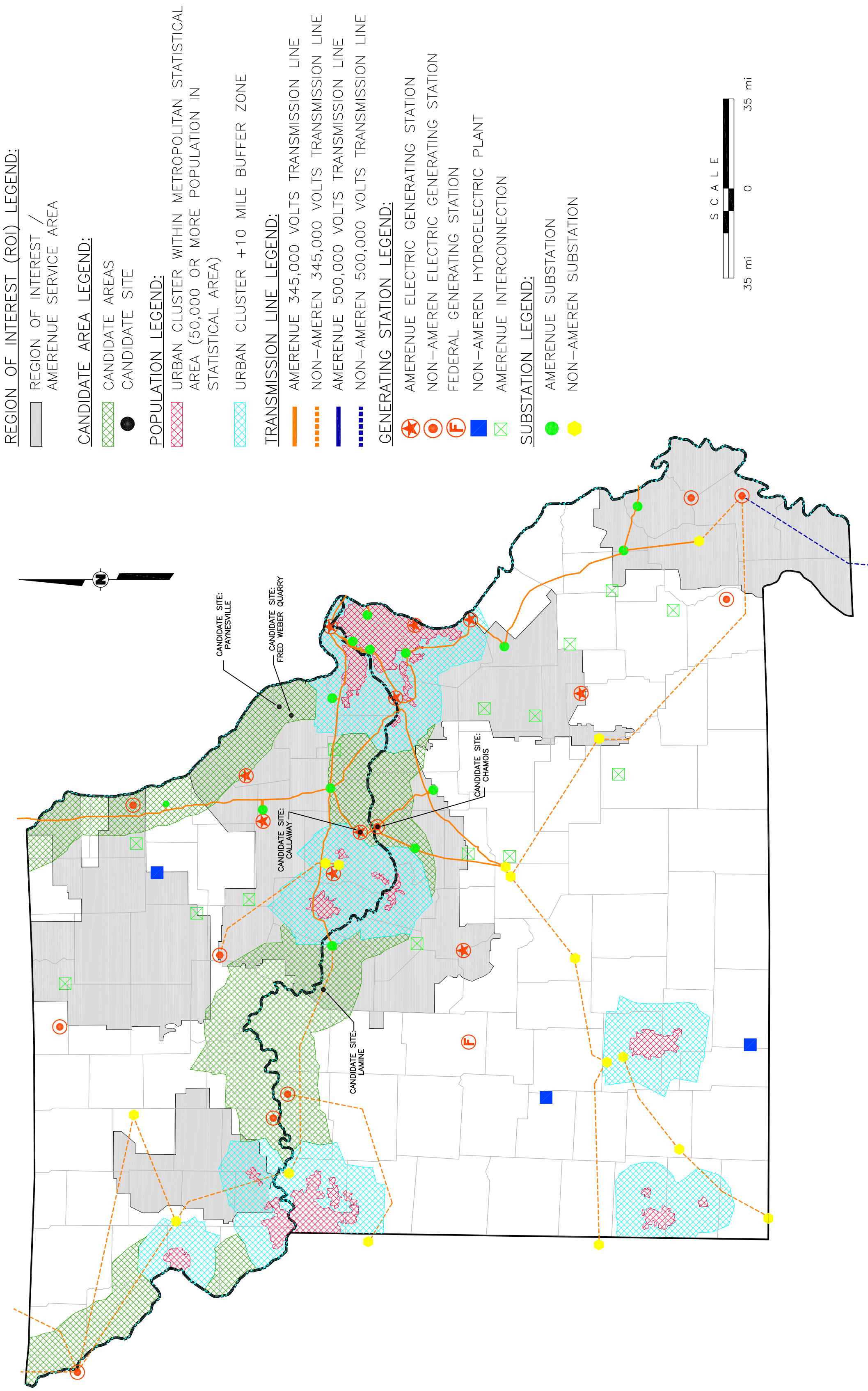

Figure 9.3-2—{Candidate Areas}

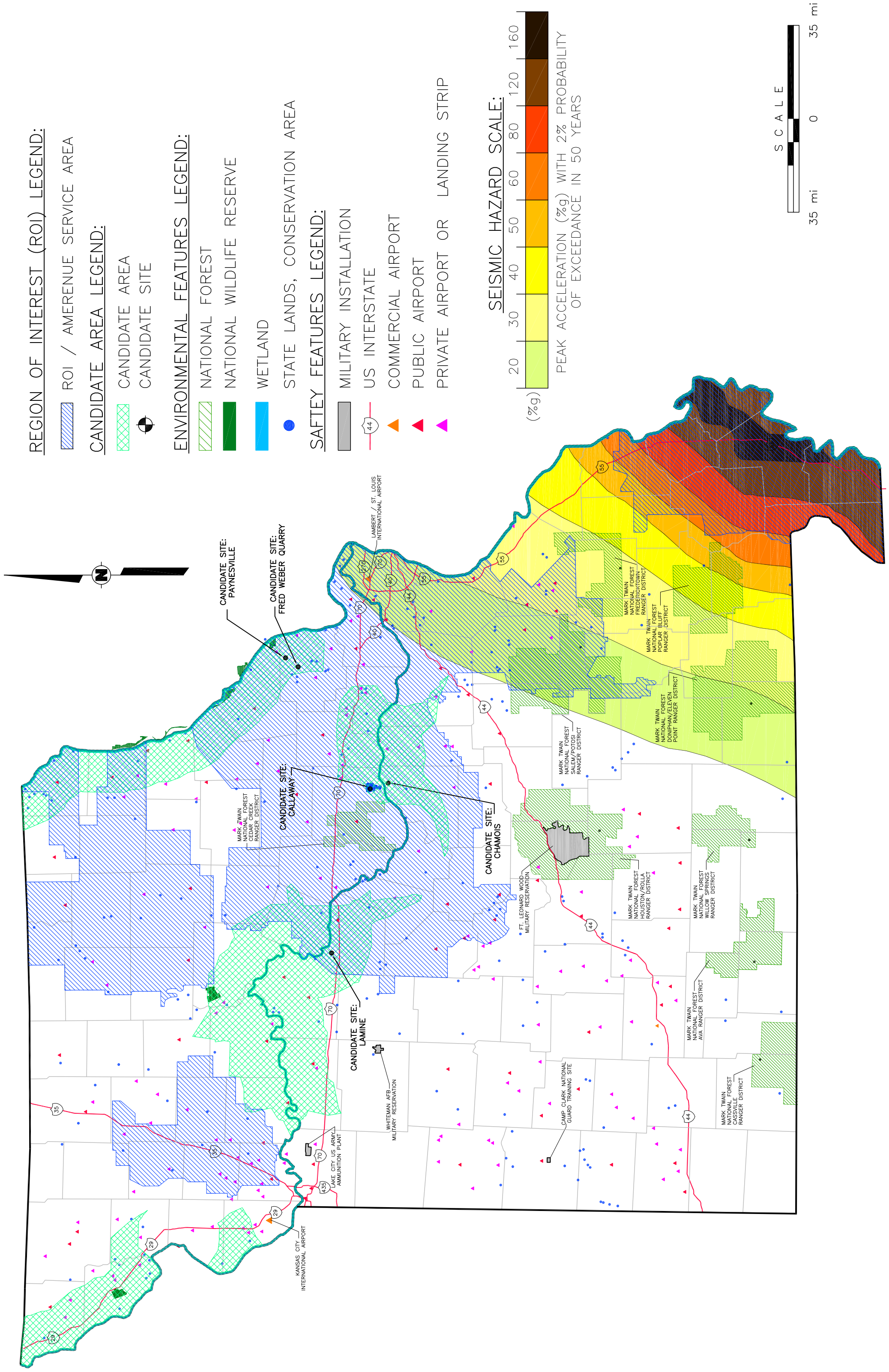

Figure 9.3-3—{Preferred and Candidate Site Locations Near Wabash Valley and New Madrid Seismic Sources}

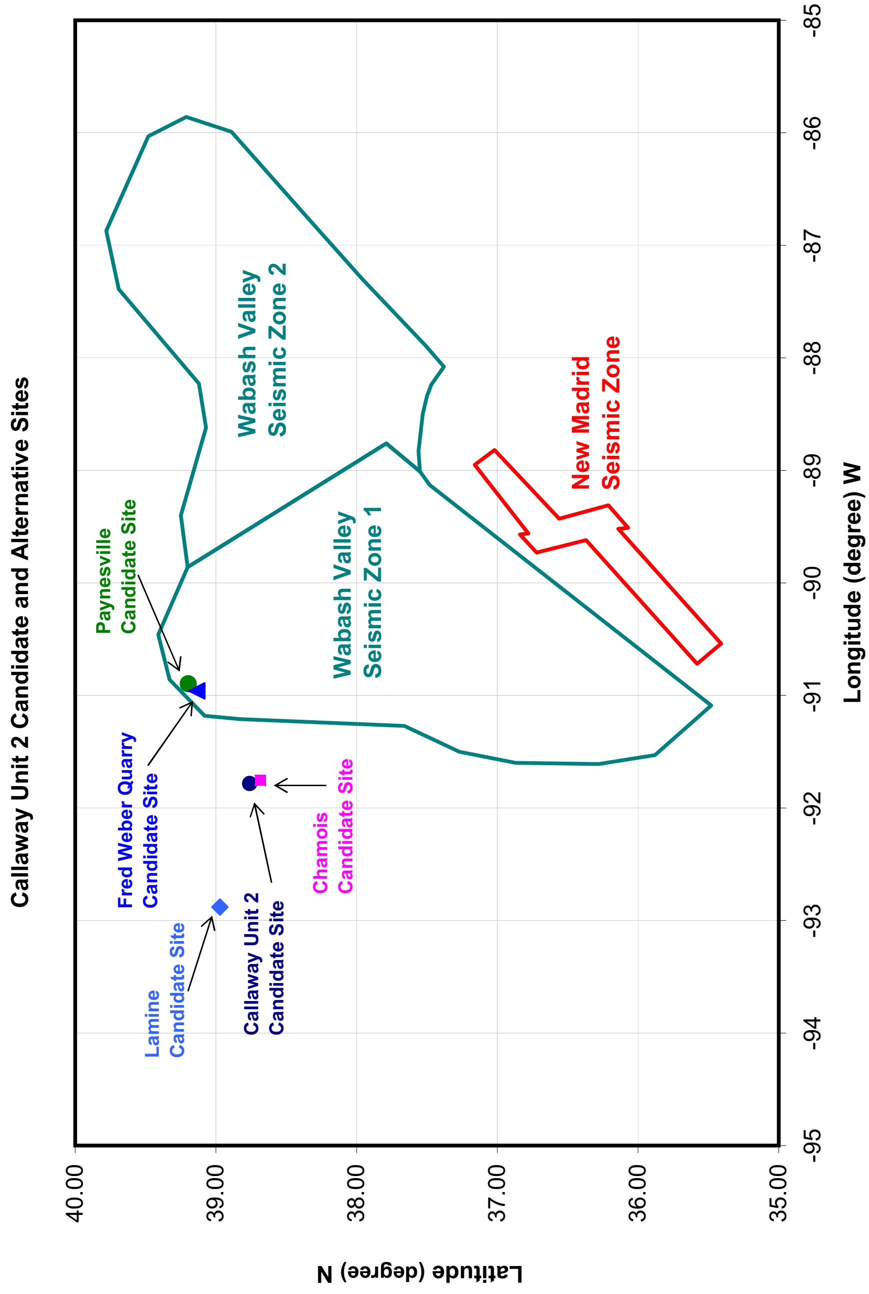

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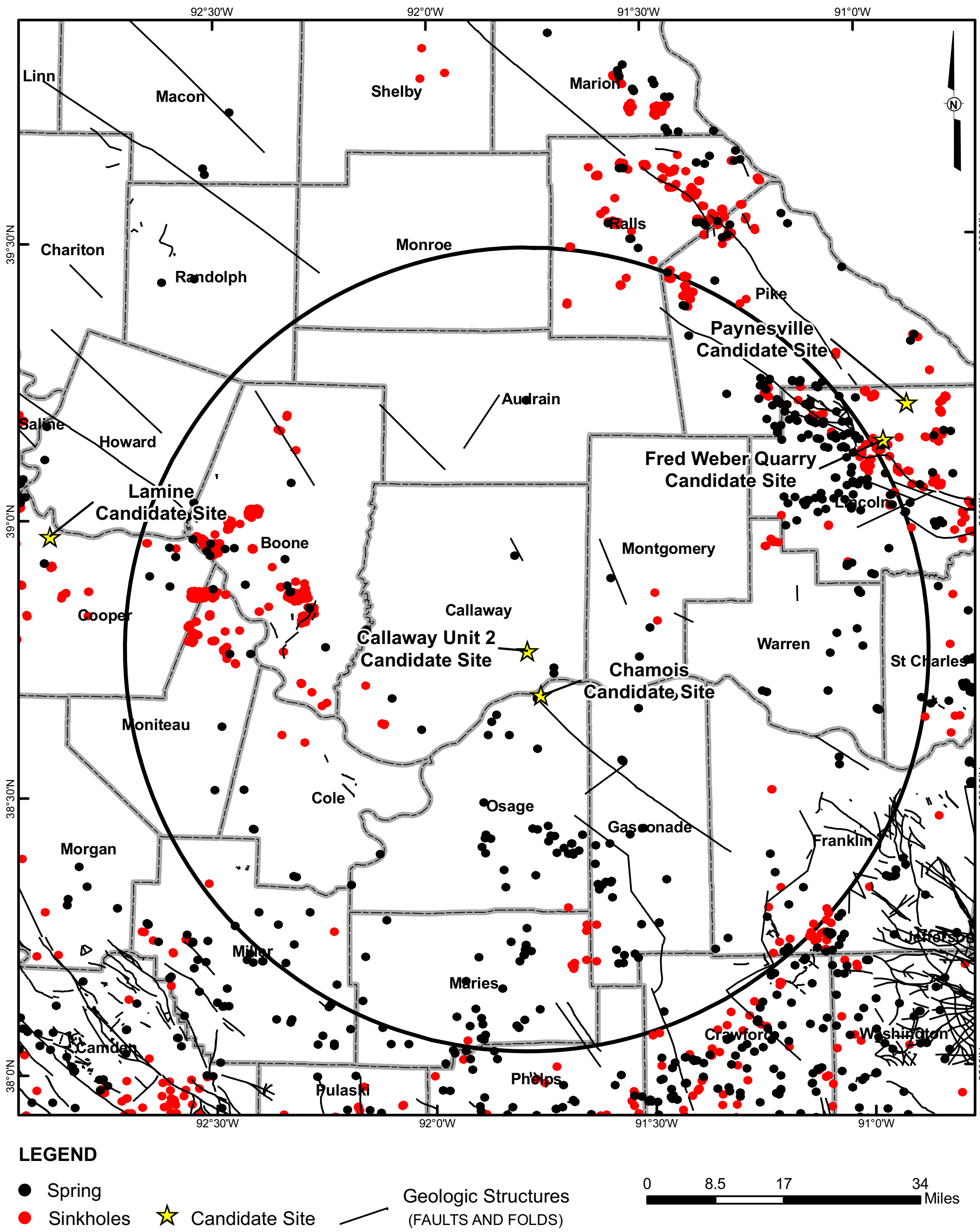
Figure 9.3-4—{Surface Faulting and Deformation Comparison}



NOTE:
REFERENCE CENTER POINT OF PLANT SITE IS DEFINED AS THE MIDPOINT BETWEEN EXISTING REACTOR FOR CALLAWAY PLANT UNIT 1 AND REACTOR FOR CALLAWAY PLANT UNIT 2.

REFERENCE: MODNR, 2007. Missouri Environmental Geology Atlas (MEGA 2007).

Figure 9.3-5—{Site Comparison Geologic Map}

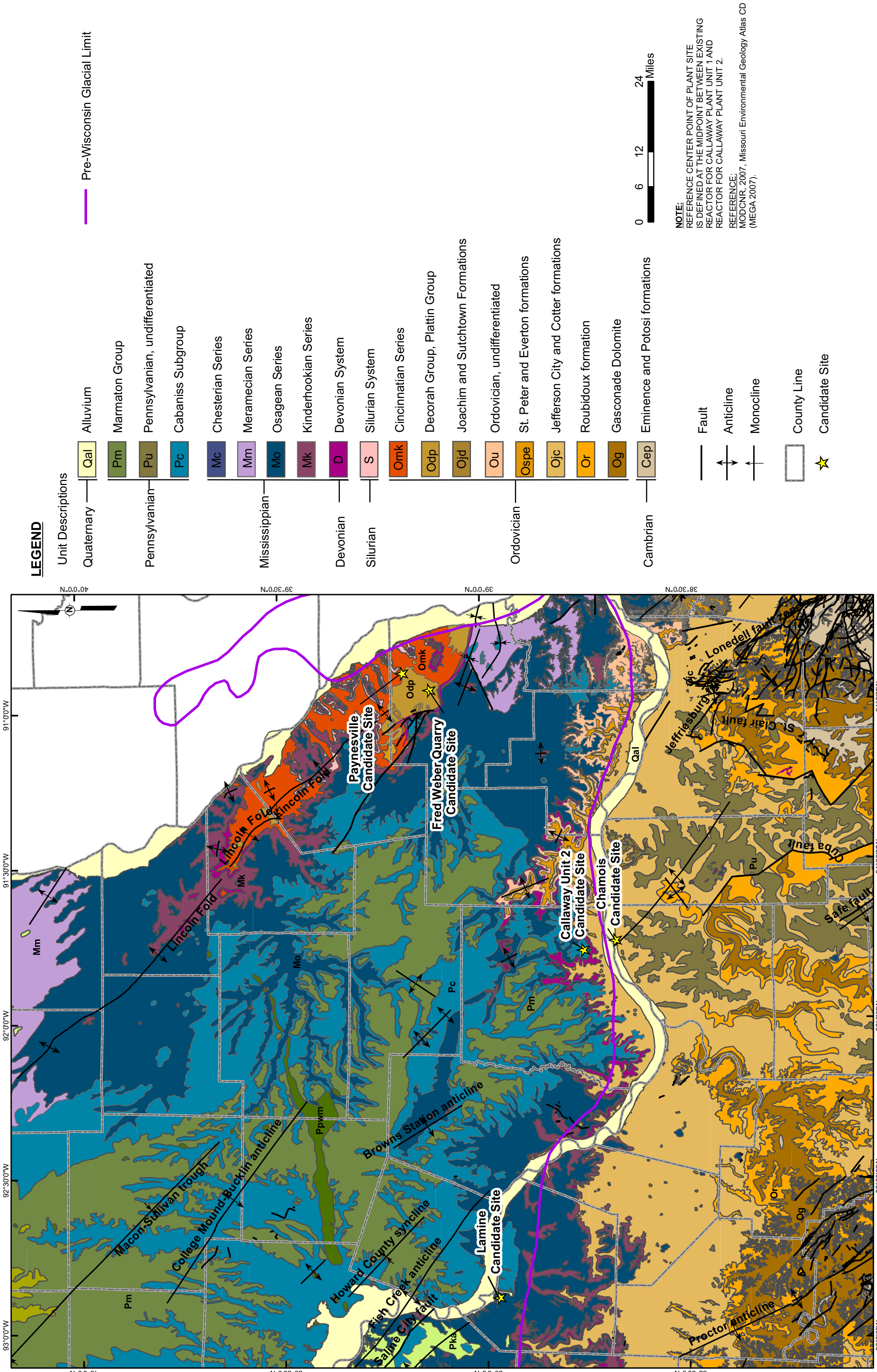


Figure 9.3-6—{Site Comparison Soils Map}

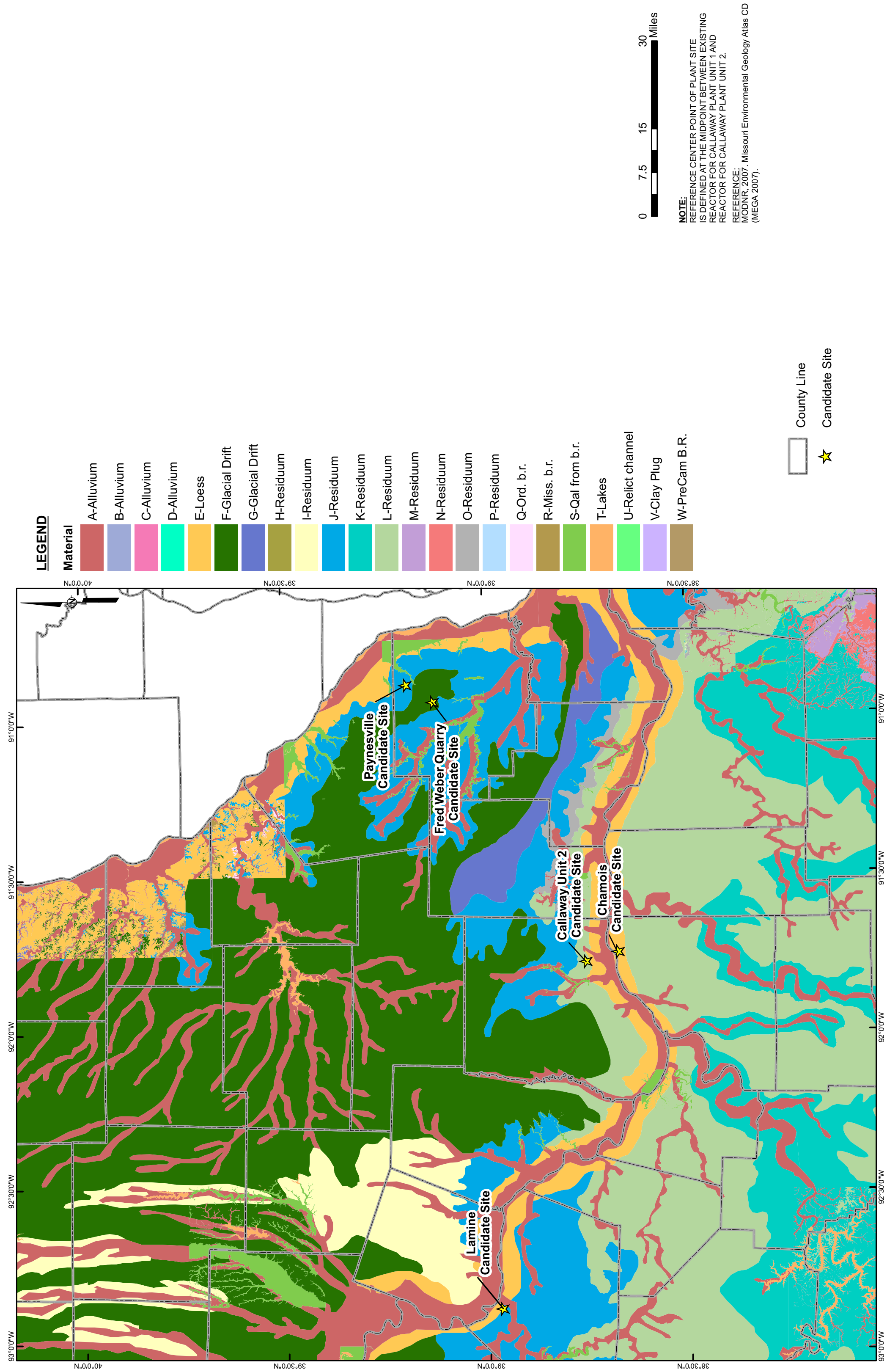
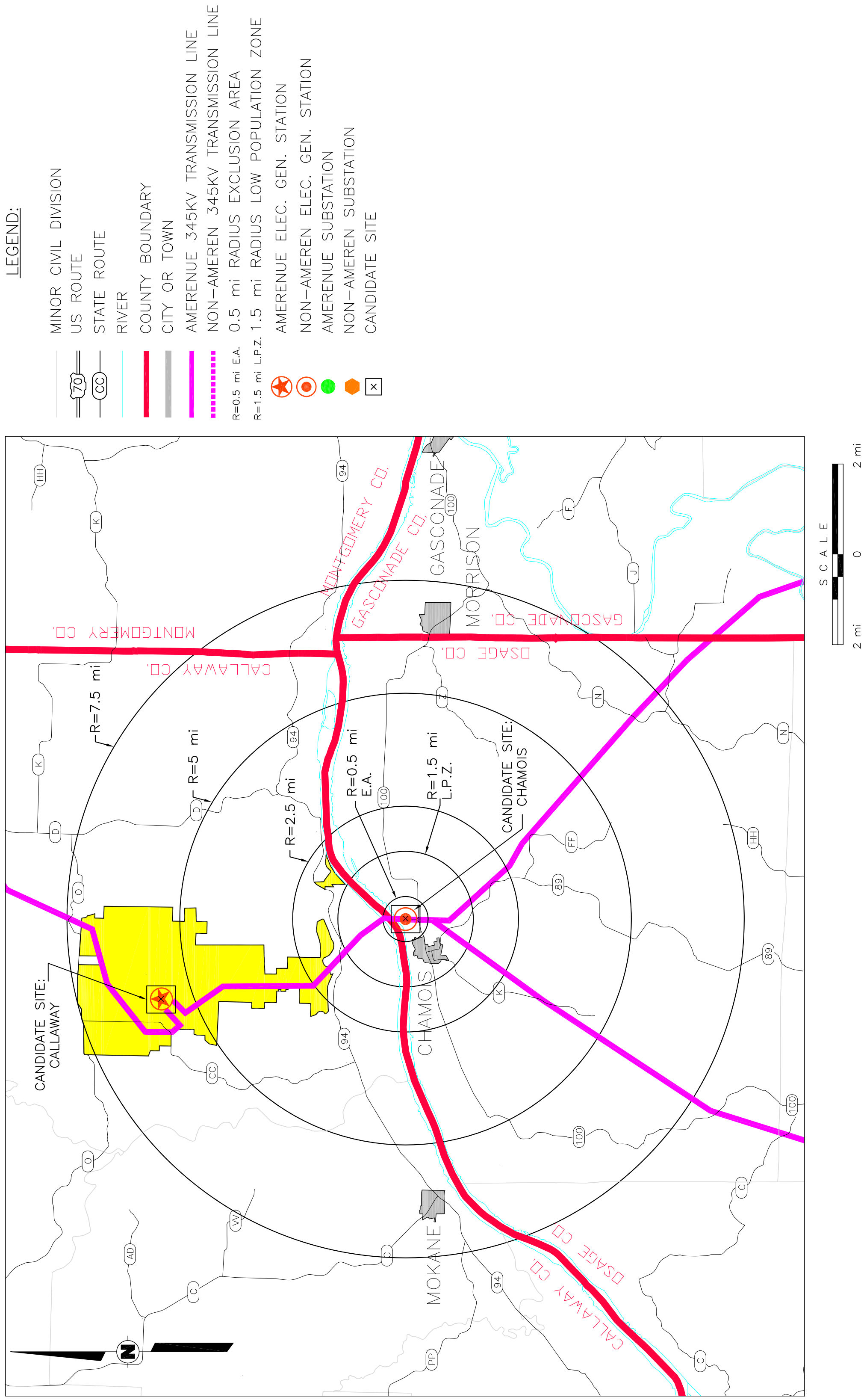


Figure 9.3-7—{Candidate Site – Chamois}



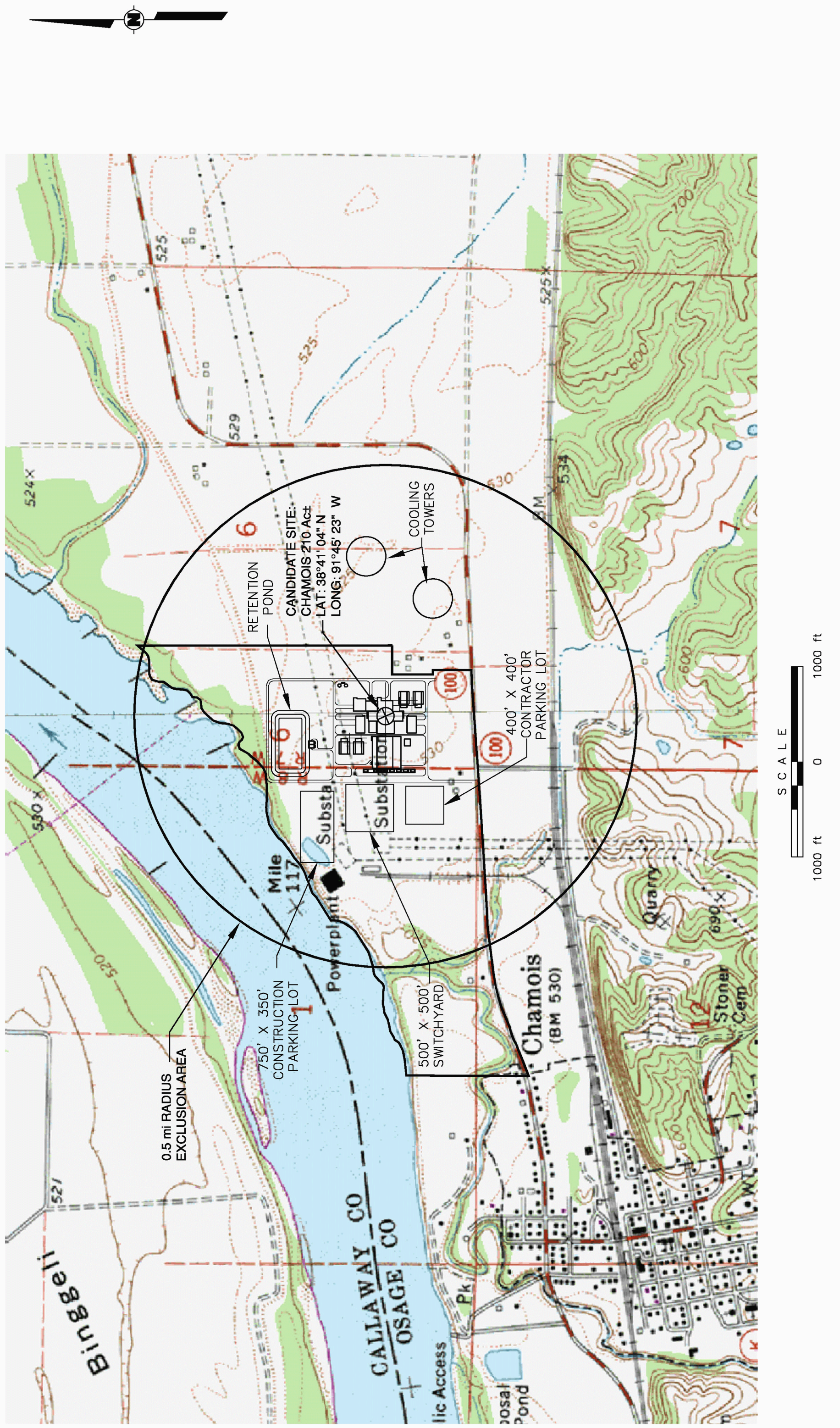
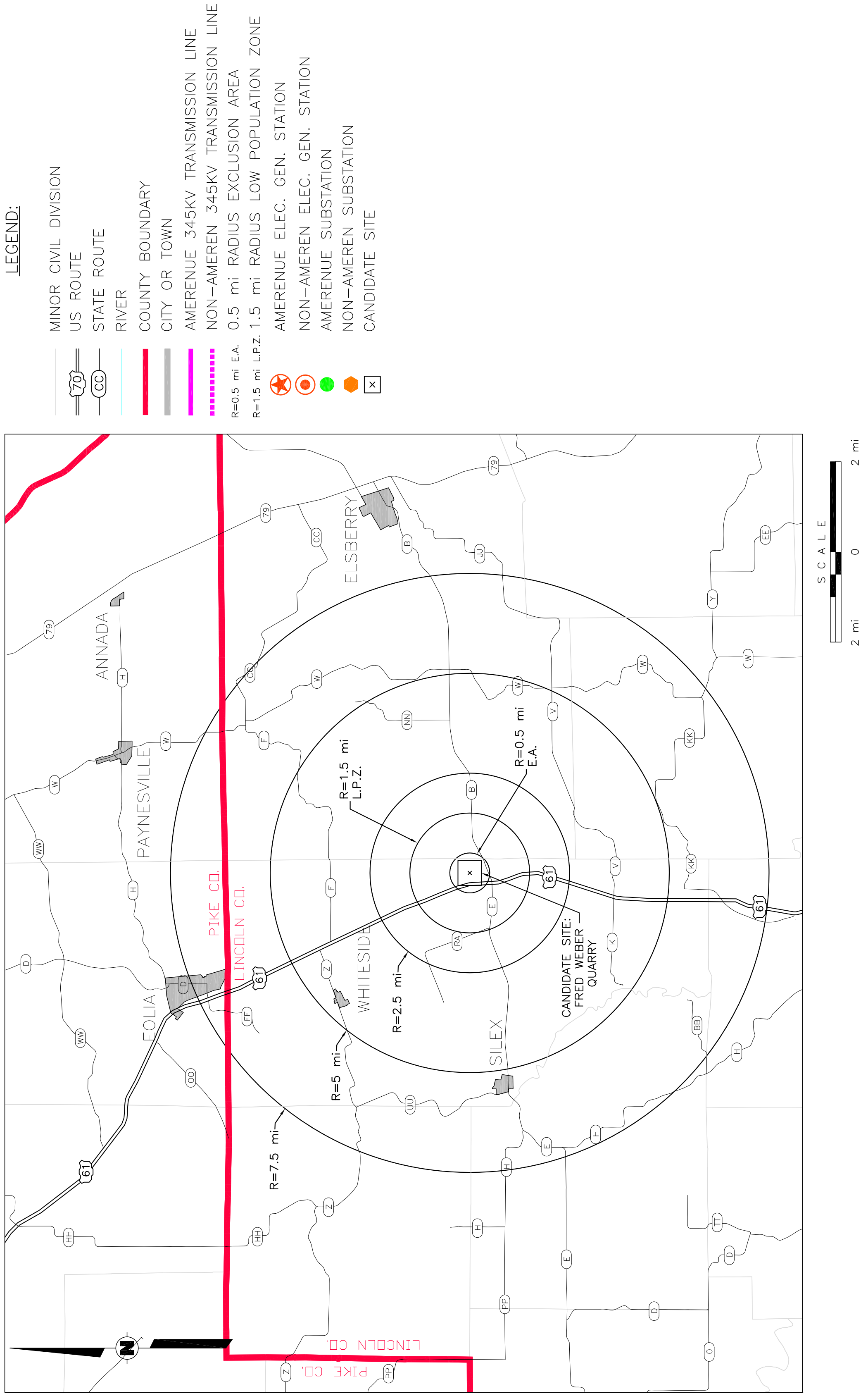


Figure 9.3-8—{Candidate Site – Chamois USGS}

Figure 9.3-9—{Candidate Site – Fred Weber Quarry}



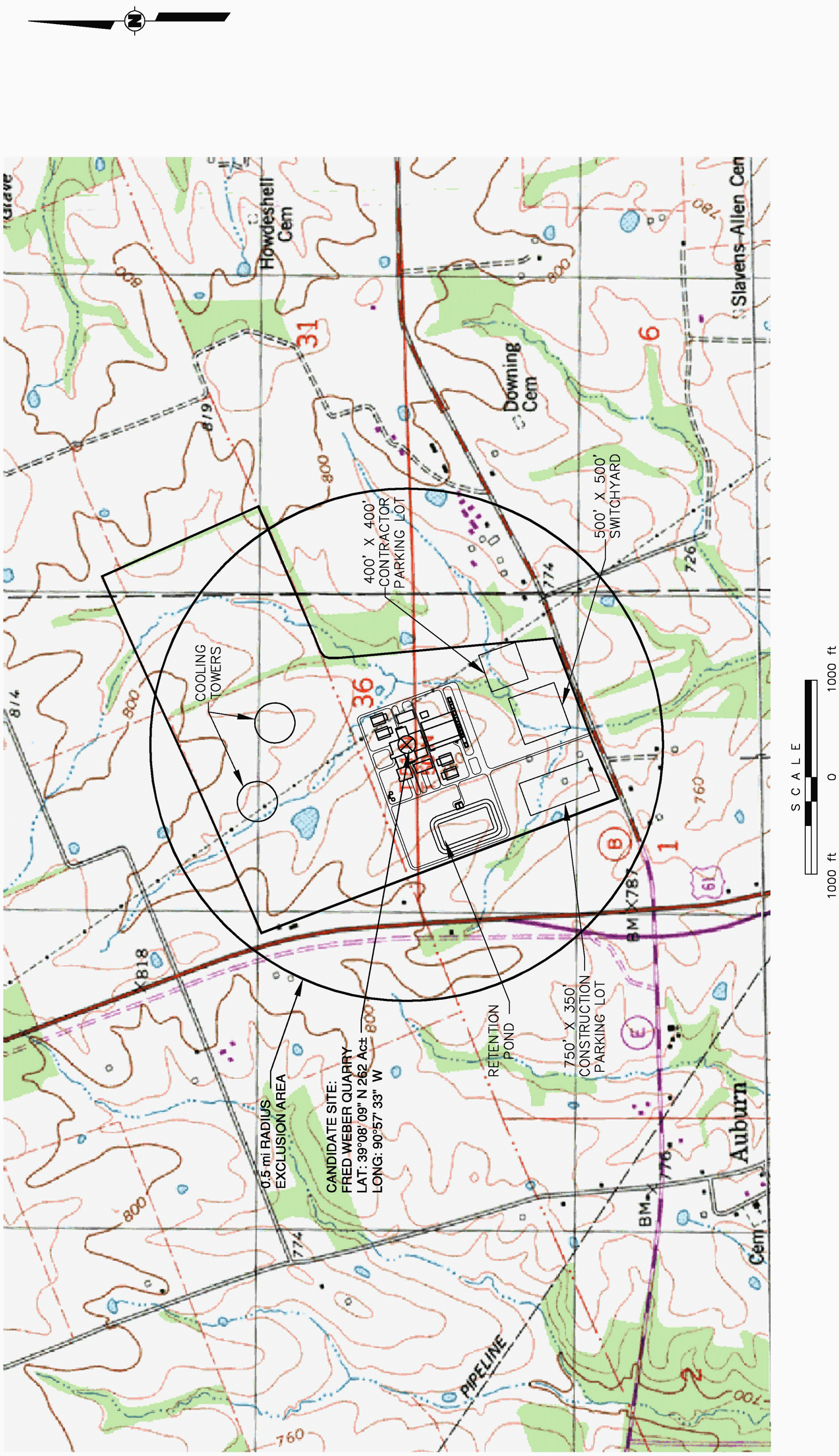


Figure 9.3-10—{Candidate Site – Fred Weber Quarry USGS}

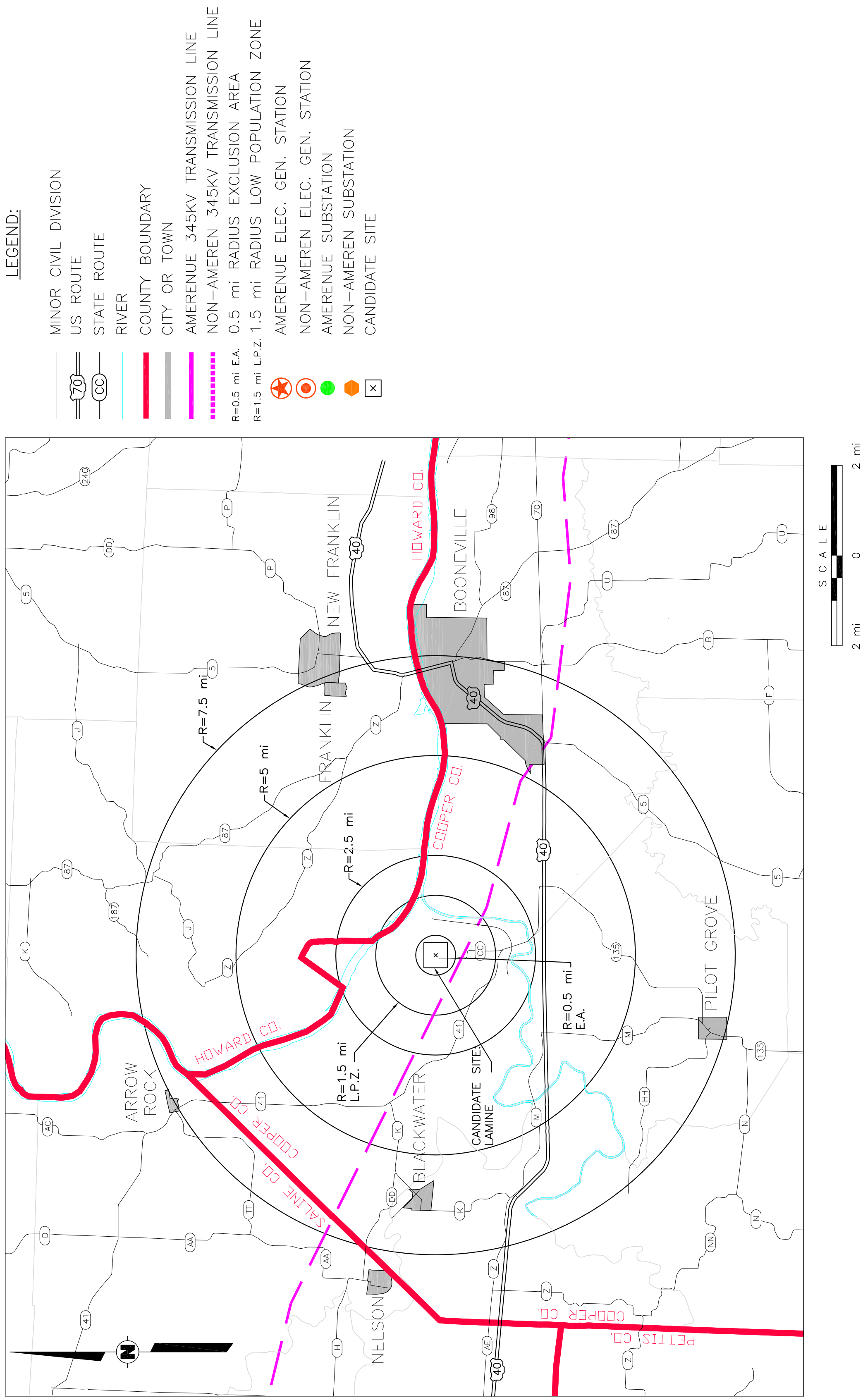


Figure 9.3-11—{Candidate Site – Lamine}

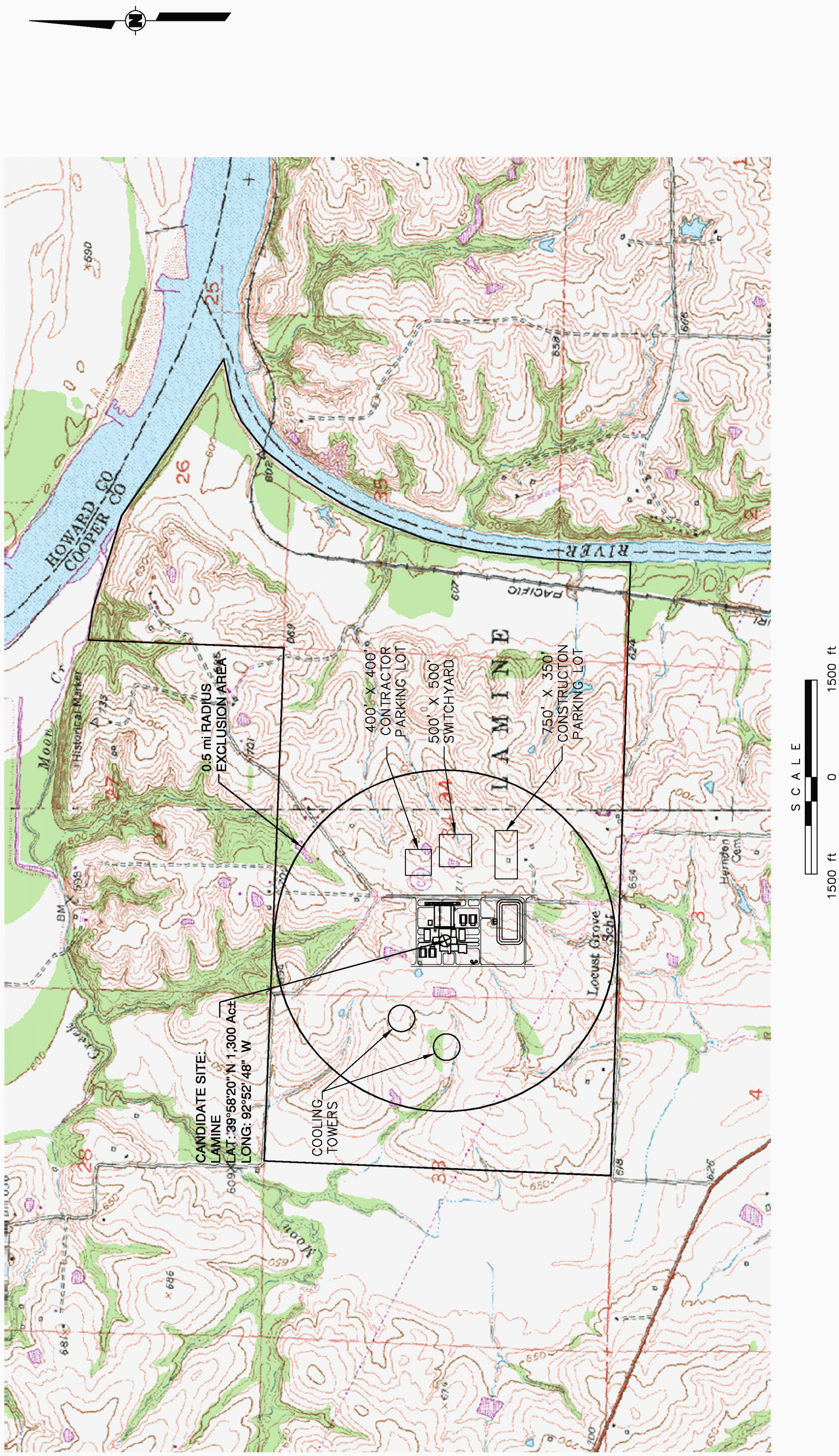
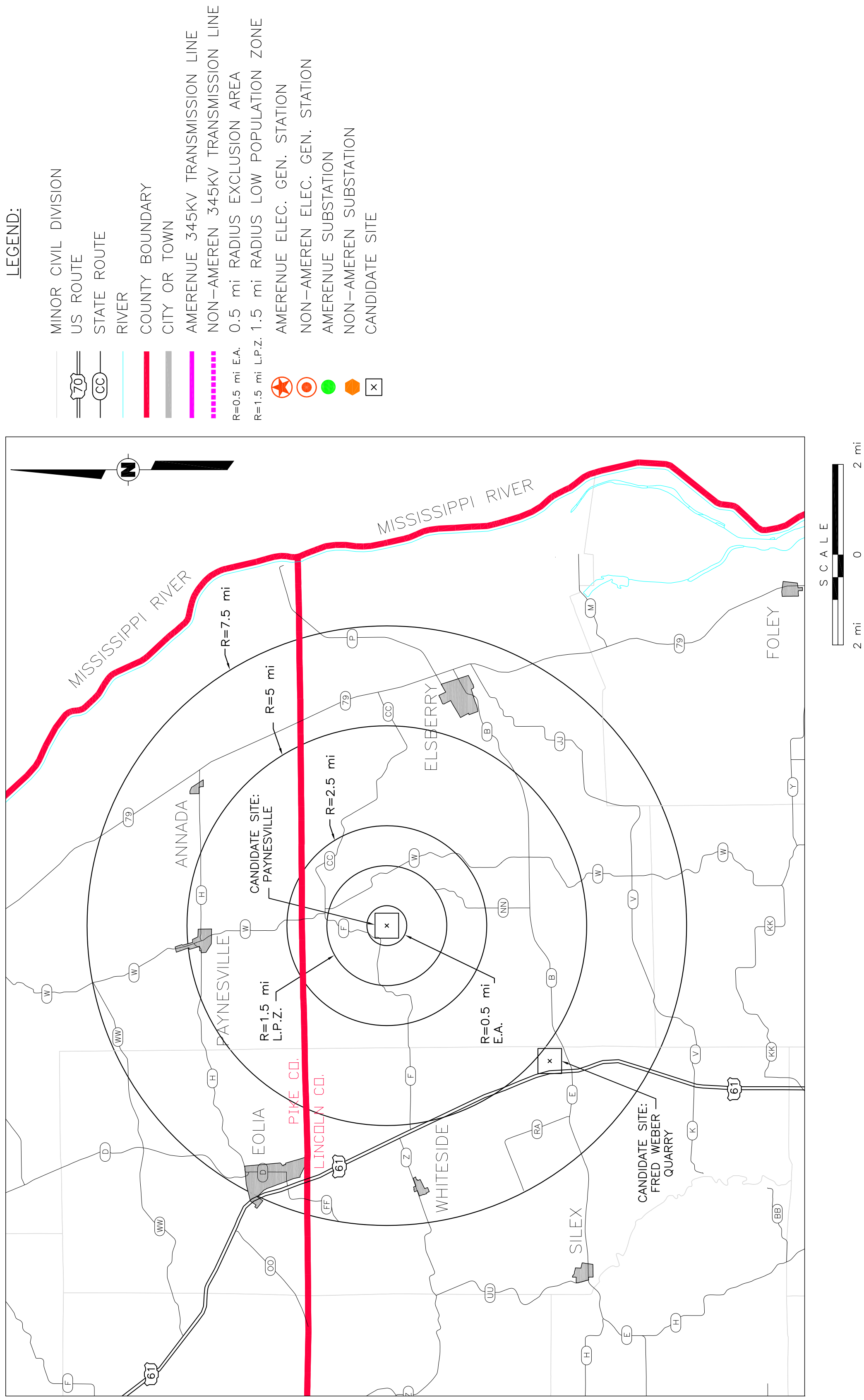


Figure 9.3-12—{Candidate Site – Lamine USGS}

Figure 9.3-13—{Candidate Site – Paynesville}



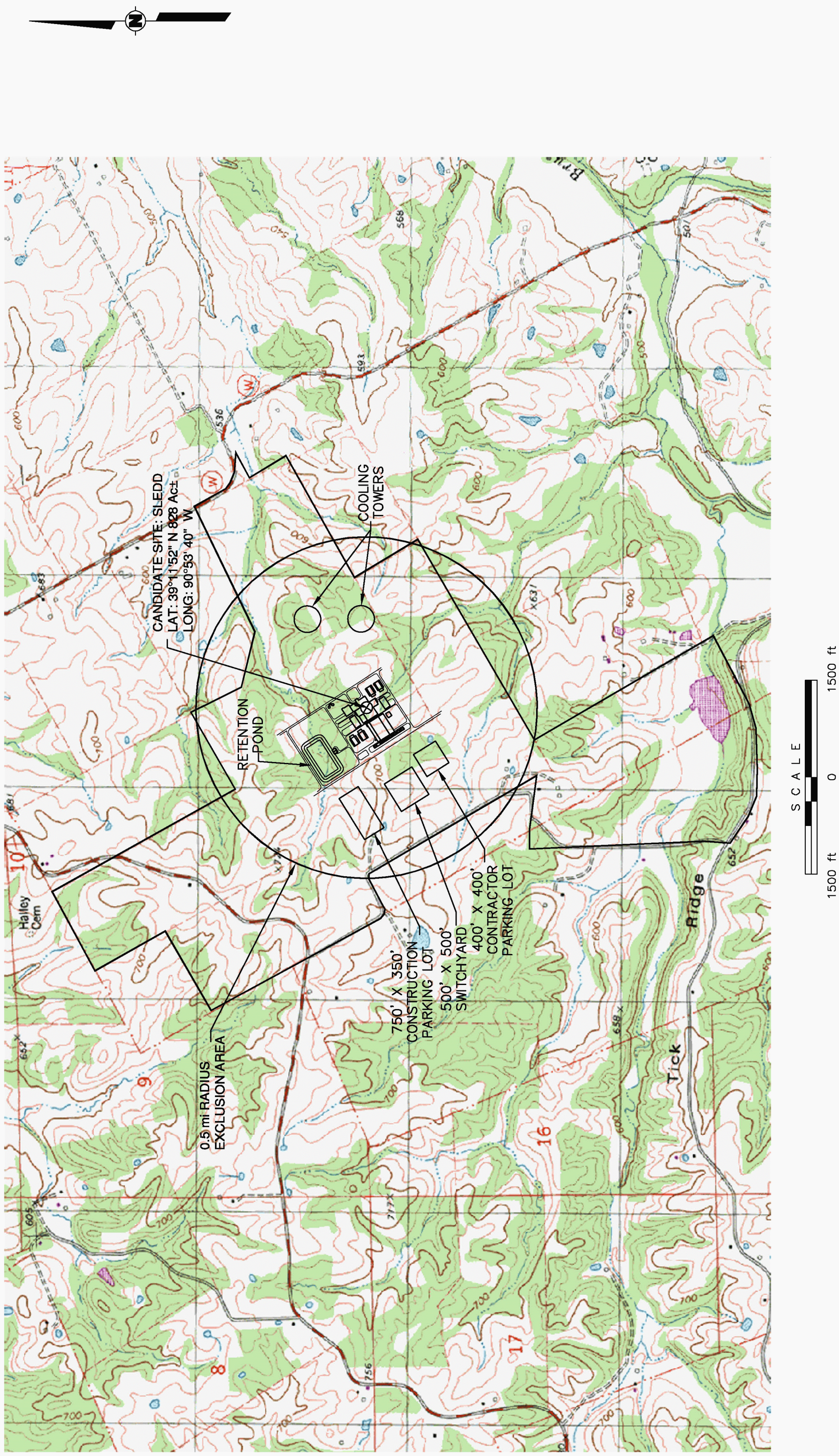


Figure 9.3-14—{Candidate Site – Paynesville USGS}

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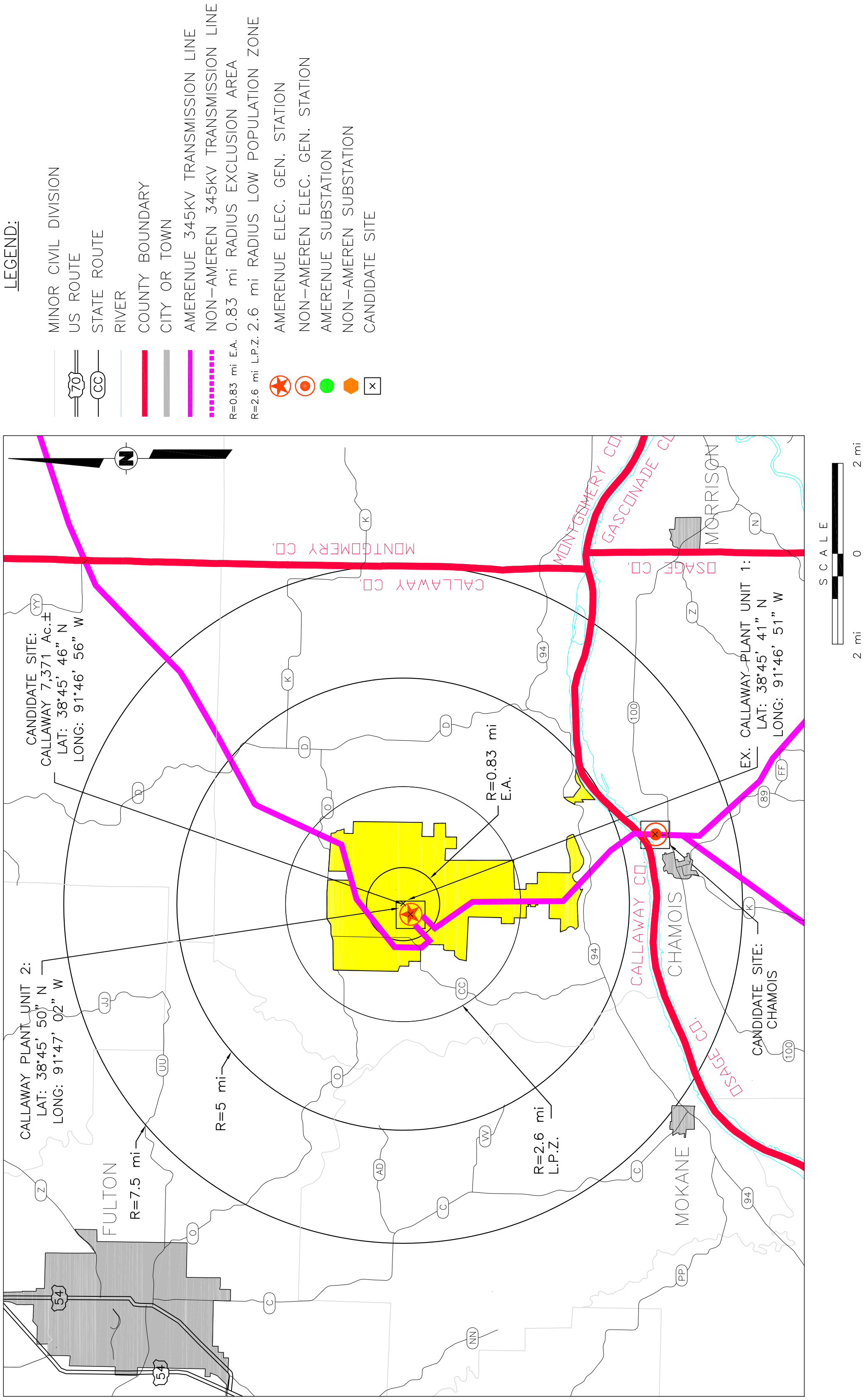
Figure 9.3-15—{Candidate Site – Callaway}



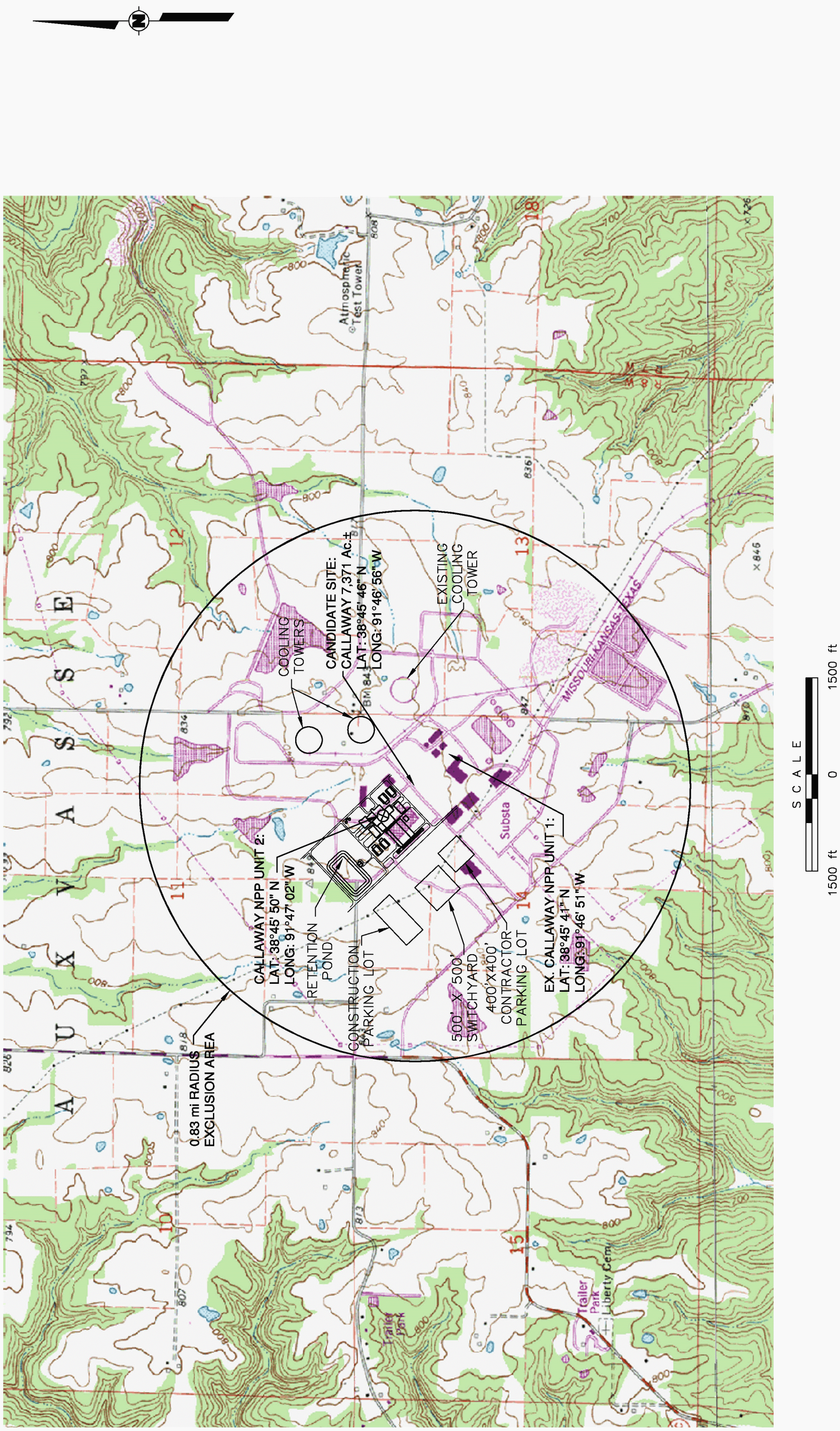


Figure 9.3-16—{Candidate Site – Callaway USGS}

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Figure 9.3-17—{Chamois Candidate Site Transmission Plan}

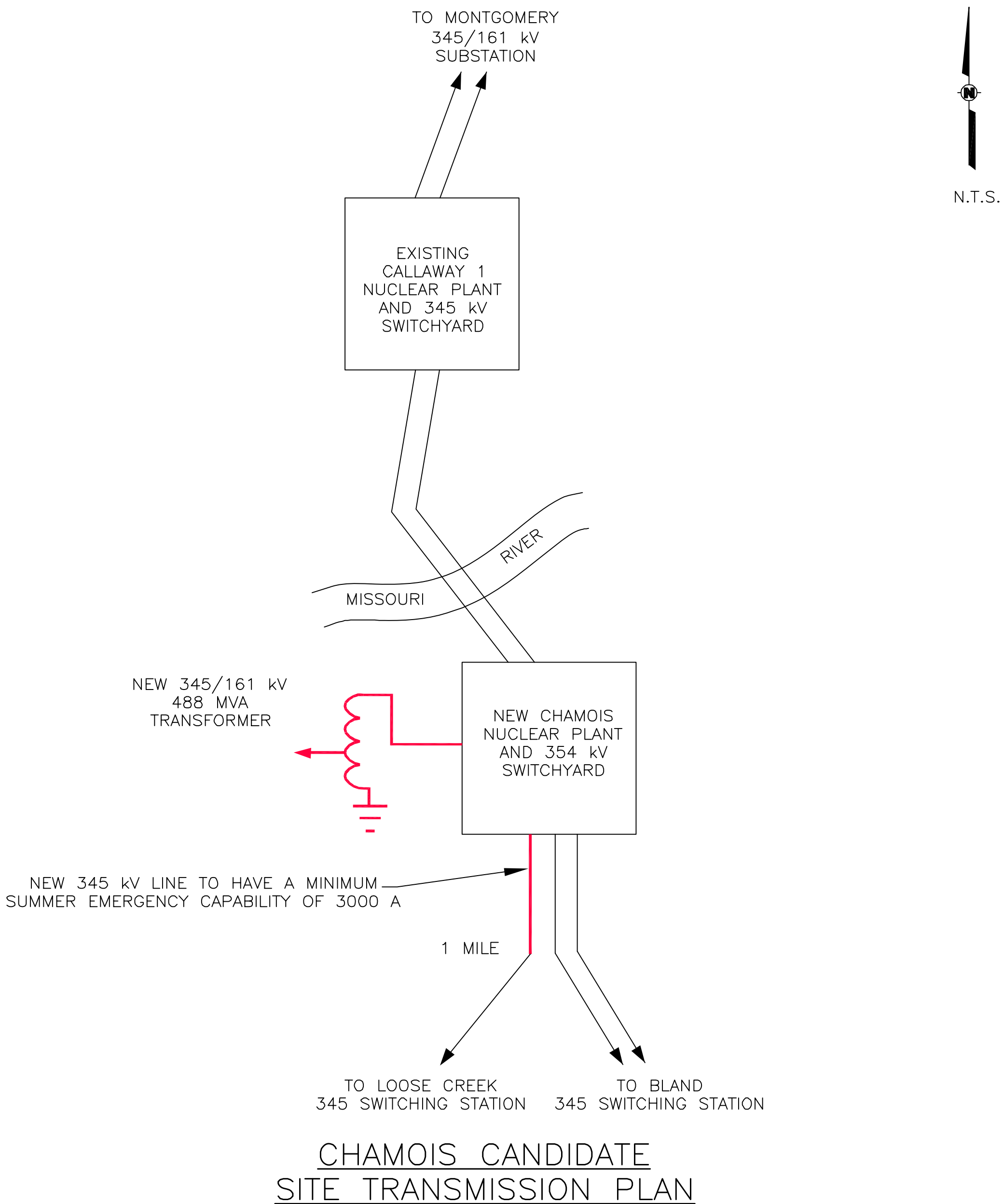


Figure 9.3-18—{Fred Weber Quarry Candidate Site Transmission Plan}

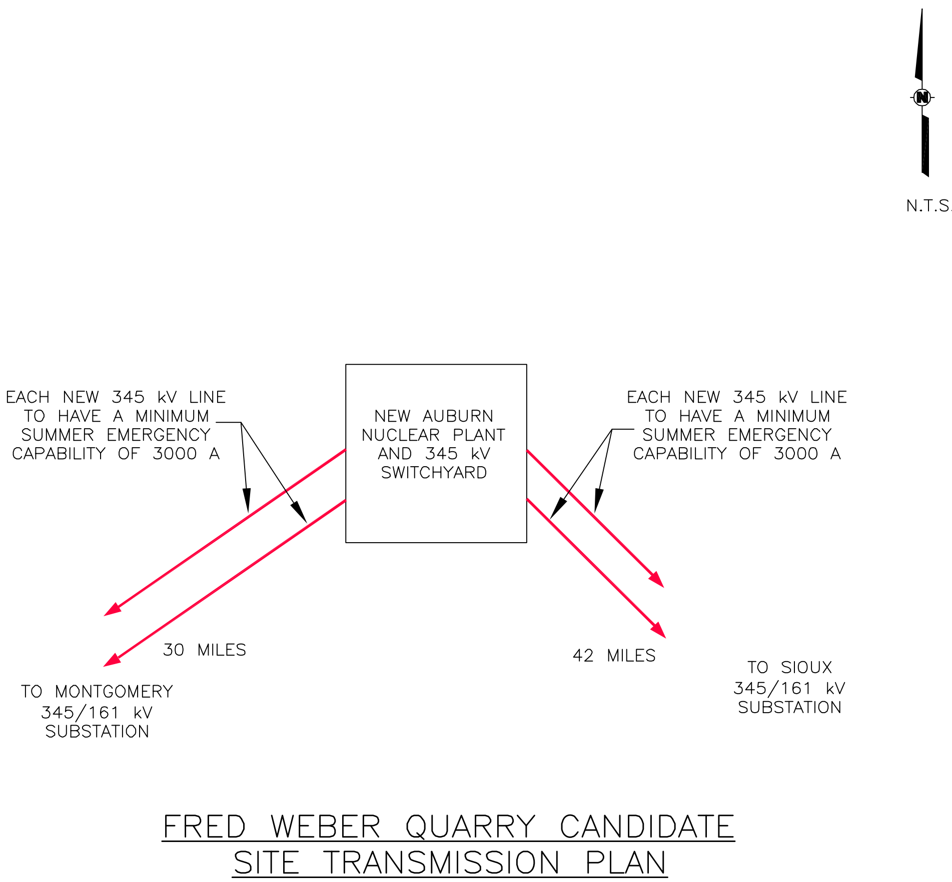


Figure 9.3-19—{Lamine Candidate Site Transmission Plan}

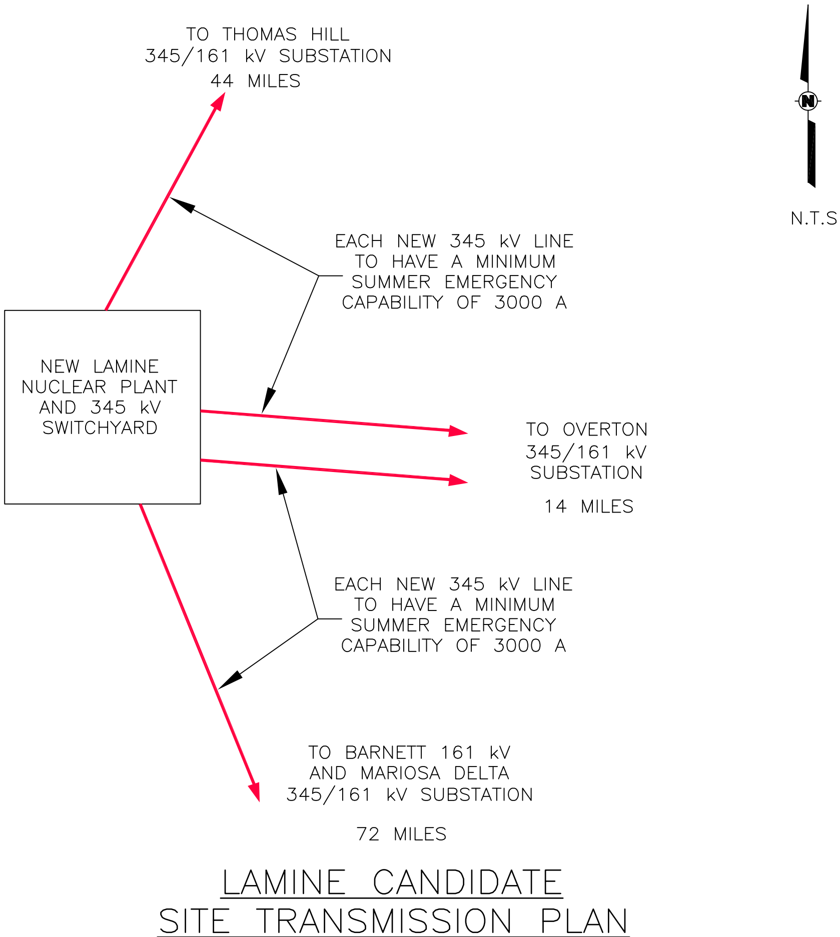
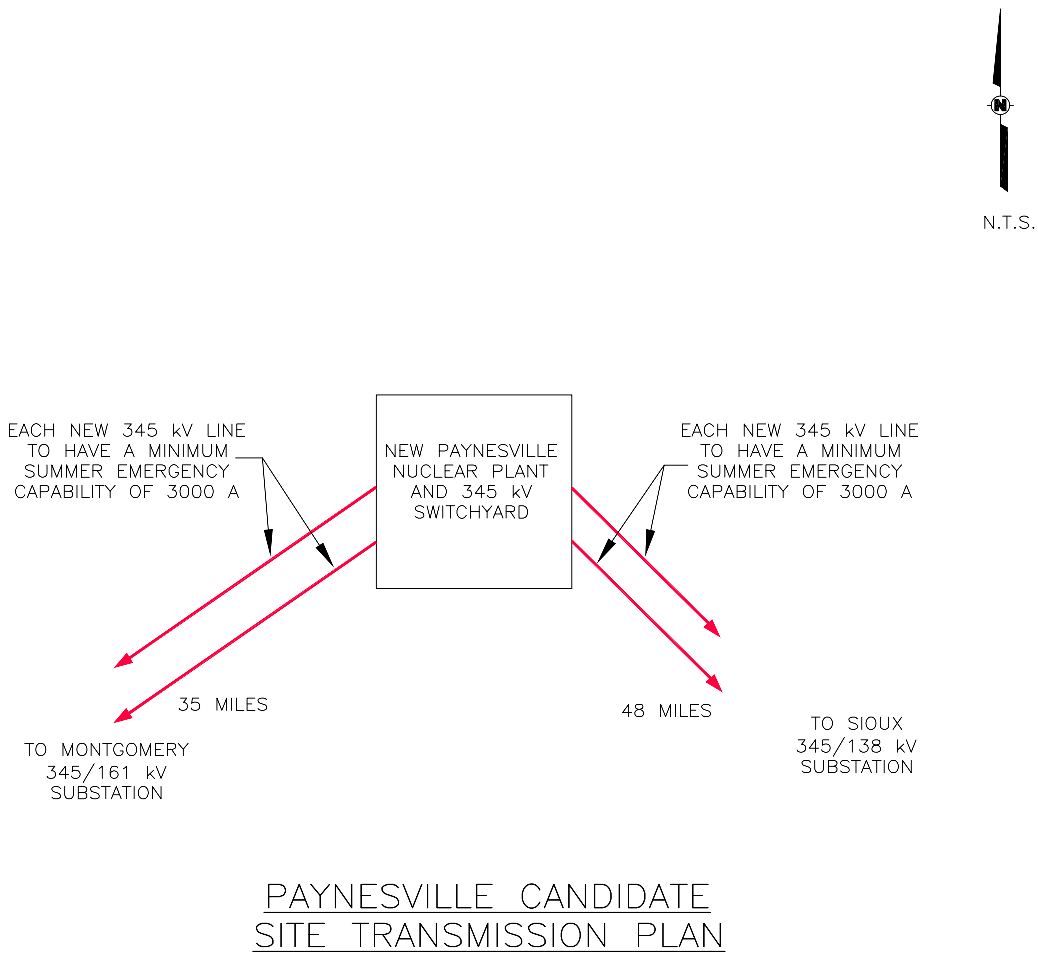


Figure 9.3-20—{Paynesville Candidate Site Transmission Plan}



9.4 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

The information presented in this section describes the evaluation of the alternative plant and transmission systems for heat dissipation, circulating water, and power transmission associated with the 1,600 MWe {Callaway Plant Unit 2} facility. The information provided in this section is consistent with the items identified NUREG-1555 (NRC, 1999).

Throughout this chapter, environmental impacts of the alternatives will be assessed based on the significance of impacts, with the impacts characterized as being SMALL, MODERATE, or LARGE. This standard of significance was developed using the guidelines set forth in the footnotes to Table B-1 of 10 CFR 51, Appendix B to Subpart A (CFR, 2007a):

- SMALL. Environmental effects are not detectable or are so minor they will neither destabilize, nor noticeably alter, any important attribute of the resource.
- MODERATE. Environmental effects are sufficient to alter noticeably but not to destabilize important attributes of the resource.
- LARGE. Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

The impact categories evaluated in this chapter are the same as those used in the "Generic Environmental Impact Statement for License Renewal of Nuclear Plants" (GEIS), NUREG-1437, (NRC, 1996).

Section 9.4.1 discusses alternative heat dissipation systems. Section 9.4.2 discusses alternative circulating water systems. Section 9.4.3 discusses the transmission systems.

9.4.1 HEAT DISSIPATION SYSTEMS

This section discusses alternatives to the proposed heat dissipation system that was described in Section 3.4, and is presented using the format provided in NUREG-1555 (NRC, 1999), Environmental Standard Review Plan (ESRP) 9.4.1. {The information provided in this section is based on a study conducted by Burns & McDonnell entitled "Closed-Cycle Cooling and Makeup Water Supply Options for Future Units at the Callaway Nuclear Plant, Fulton, Missouri." (Burns & McDonnell, 2007a).}

These alternatives are generally included in the broad categories of "once-through" and "closed-loop" systems. The once-through method involves the use of a large quantity of cooling water, withdrawn from a water source and returned to that source (receiving water body) following its circulation through the normal heat sink (i.e., main condenser). Closed-loop cooling systems use substantially less water because the water performing the cooling is continually recirculated through the normal heat sink (i.e., the main condenser), and only makeup water for evaporative losses and blowdown is required.

In closed-loop systems, two pumping stations are usually required—a makeup water system and a cooling water circulation system. Closed-loop systems include cooling towers, a cooling pond, or a spray pond. As a result of the evaporation process, the concentration of chemicals in the cooling water will increase. To maintain acceptable water chemistry, water must be discharged at a small rate (blowdown) and compensated by a makeup water source.

Heat dissipation systems are also categorized as wet or dry, and the use of either system depends on the site characteristics. Both wet and dry cooling systems use water as the heat exchange medium. Wet heat dissipation systems cool water by circulating it through a cooling tower. Heat from the water is dissipated by direct contact with air circulating through the tower. The heat transfer takes place primarily by evaporation of some of the water into the air stream (latent heat transfer).

Generally, a relatively minor amount of sensible heat transfer (heating of the air and cooling of the water) also occurs. During very cold weather, the amount of sensible heat transfer can be fairly substantial. On the other hand, during a warm, dry summer day, the amount of sensible heat transfer may be nil or even negative (when negative, the air discharged from the tower is cooler than the ambient dry bulb). This does not adversely affect the cold water performance of wet cooling towers, but does affect evaporation rate. The wet cooling tower is used widely in the industry and is considered a mature technology.

Because wet cooling towers provide direct contact between the cooling water and the air passing through the tower some of the liquid water may be entrained in the air stream and be carried out of the tower as "drift" droplets. The magnitude of drift loss is influenced by the number and size of the droplets produced within the cooling tower, which in turn are influenced by the fill design, the air and water patterns, and other interrelated factors. Tower maintenance and operation levels can influence the formation of drift droplets. For example, excessive water flow, excessive air flow, and water bypassing the tower drift eliminators can promote and/or increase drift emission.

To reduce the drift from cooling towers, drift eliminators are usually incorporated into the tower design to remove as many droplets as practical from the air stream before exiting the tower. The drift eliminators rely on inertial separation of the droplets, caused by direction changes, while passing through the eliminators. Types of drift eliminator configurations include herringbone, wave form, and cellular (or honeycomb) designs. The cellular units are generally the most efficient. Drift eliminators may include various materials, such as ceramics, fiber-reinforced cement, fiberglass, metal, plastic, and wood installed or formed into closely spaced slats, sheets, honeycomb assemblies, or tiles. The materials may include other features, such as corrugations and water removal channels, to enhance the drift removal further (USEPA, 1995).

Dry cooling systems transfer heat to the atmosphere without the evaporative loss of water. There are two types of dry cooling systems: direct dry cooling and indirect dry cooling. Direct dry cooling systems use air to directly condense steam, while indirect dry cooling systems use a closed-loop water cooling system to condense steam and air to cool the heated water.

The most common type of direct dry cooling system is a recirculated cooling system with mechanical draft towers. For dry cooling towers, the turbine exhaust steam exits directly to an air-cooled, finned-tube condenser. Because dry cooling systems do not evaporate water for heat transfer, dry cooling towers are quite large in comparison to similarly sized wet cooling towers. Also, because dry cooling towers rely on sensible heat transfer, a large quantity of air must be forced across the finned tubes by fans to improve heat rejection. This results in a larger number of fans being required for a mechanical draft dry cooling tower than would be needed for a mechanical draft wet cooling tower.

The key feature of dry cooling systems is that no evaporative cooling or release of heat to the surface water occurs. As a result, water consumption rates are very low compared to wet cooling. Because the unit does not rely in principle on evaporative cooling like the wet cooling tower, large volumes of air must be passed through the system compared to the volume of air used in wet cooling towers. As a result, dry cooling towers need larger heat transfer surfaces and therefore tend to be larger than comparable wet cooling towers.

Dry cooling towers require high capital and operating and maintenance costs that are sufficient to pose a barrier to entry to the marketplace for some facilities (USEPA, 2001b). Dry cooling technology has a detrimental effect on electricity production by reducing the energy efficiency of steam turbines. Dry cooling requires the facility to use more energy than would be required with wet cooling towers to produce the same electricity. This energy penalty is most significant in warmer southern regions during summer months, when the demand for electricity is at its peak. The energy penalty would result in an increase in environmental impacts because replacement generating capacity would be needed to offset the loss in efficiency from dry cooling.

9.4.1.1 Evaluation of Alternative Heat Dissipation Systems

Heat dissipation system alternatives were identified and evaluated. The alternatives considered were those generally included in the broad categories of "once- through" and "closed-loop" systems. The evaluation includes the following types of heat dissipation systems:

- Cooling ponds and spray ponds
- Once-through cooling
- Natural draft cooling tower
- Mechanical draft cooling tower
- Hybrid (plume abated) cooling towers
- Dry cooling systems (closed-loop cooling system)

An initial evaluation of the once-through cooling alternative and the closed-loop alternative designs was performed to eliminate systems that are unsuitable for use at {Callaway Plant Unit 2}. The evaluation criteria included aesthetics, public perception, space requirements, environmental effects, noise impacts, fog and drift, water requirements, capital and operating costs, and legislative restrictions that might preclude the use of any of the alternatives.

The screening process identified the {closed-loop natural draft cooling tower, as the preferred heat dissipation system for Callaway Plant Unit 2. The analysis of this alternative is discussed below. The discussion of non-preferred alternatives that were considered is provided below. Selection of the preferred heat dissipation alternative was supported by detailed net present value (NPV) analysis.

Table 9.4-1 provides a summary of the screening of Circulating Water Supply (CWS) System heat dissipation system alternatives, and Table 9.4-2 provides a summary of the environmental impacts of the heat dissipation system alternatives.}

Cooling Ponds and Spray Ponds

Cooling ponds are usually man-made water bodies that are used by power plants and large industrial facilities for heat dissipation. In a conventional static-type cooling pond, warmed cooling water exiting the main condenser and other plant heat loads would be routed to the cooling pond where some of the water would evaporate, and the remaining water would be cooled and recirculated to the plant. The primary heat transfer mechanism in a cooling pond is evaporation. If there is no vertical mixing in the pond, layers (or thermoclines) of warm and cold water can form causing horizontal flows which in turn, can restrict the movement of warmer water to the surface for evaporation and cooling. This can result in only portions of the pond cooling capacity being used.

Although the conventional static-type cooling pond is probably the oldest form of water cooling it is not preferred for several reasons. The modern spray pond offers the following advantages over a conventional cooling pond: (1) a spray pond requires less than 10% of the land area required for a conventional pond, and (2) they provide over 30 times the cooling capacity of a conventional pond on a BTU/ft^2 basis.

A spray pond is typically a bentonite-lined structure in the ground, and is typically long and narrow to improve efficiency. The spray pond structure contains a volume of water and consists of an intake structure that houses pumps to transfer the water from the pond through their respective loops and back to the pond through a network of sprays located in the pond. The spray pond size depends on the number of nozzles required. It is important that the long, narrow spray pond have its long side perpendicular to the prevailing summer wind direction in order to benefit from a better spray droplet surface area and air contact interface. Generally, a spray pond long side dimension would be in the range of two to four times that of the narrow side dimension.

The area of the pond is determined by the quantity of water which it can treat per hour per unit area of the pond. Accepted industry practice for sizing spray ponds is based on values that are typically between 120 lb/ft^2/hr (585 kg/m^2/hr) and 150 lb/ft^2/hr (732 kg/m^2/hr). In actual practice, a spray pond will only cool the water to a point approximately midway between the hot water and wet bulb temperatures. Because of the various factors in spray pond applications, it is virtually impossible to accurately calculate the expected cooled water temperature. The 50% design efficiency factor (cooling to halfway point between hot water and wet bulb temperature) is considered to be a reasonable value for a well designed and located, long and narrow, spray pond.

{Due to evaporation loss of water from the pond, the water levels are usually maintained by rainfall and augmented by a fresh water makeup system operating on pond level.

Given the relatively large amount of land that would be required for a cooling pond or spray pond option, and expected thermal performance, neither the spray pond, nor the cooling pond alternative is reasonable for Callaway Plant Unit 2.}

<u>Once-through Cooling System Using {Missouri River Water}</u>

In a once-through cooling system, water is withdrawn from a water body, passes through the heat exchanger, and is discharged back to the same water body. The discharged water temperature is higher than the intake by the temperature gained when passing through the heat exchanger.

{For Callaway Plant Unit 2, a once-through cooling system would require approximately 2.5 million gpm (9.5 million lpm) considering a 10°F (5.6°C) temperature rise across the condenser. As this flow exceeds 29% of the projected 10-year low flow in the Missouri River at Hermann, this option was not considered feasible for use at Callaway Plant Unit 2.}

{Additional discussion of Federal and State regulations under Section 316(b) governing cooling water intake structures for existing power plants is found in Section 9.4.2.1.}

Natural Draft Cooling Tower

Wet cooling towers predominantly rely on the latent heat of water evaporation to exchange heat between the water and the air passing through the tower. In a natural draft cooling tower, warm water is brought into direct contact with cooler air. When the air enters the cooling tower, its moisture content is generally less than saturation. When the air exits, it emerges at a higher temperature and with moisture content at or near saturation.

Even at saturation, cooling can take place because a temperature increase results in an increase in heat capacity, which allows more sensible heat to be absorbed. A natural draft cooling tower receives its air supply from natural wind currents that result in a convective flow up the tower. This air convection cools the water on contact.

Because of the significant size of natural draft cooling towers (typically 500 ft (152.4 m) high, 400 ft (121.9 m) in diameter at the base), their use is generally reserved for use at flow rates above 200,000 gpm (757,000 lpm) (Young, 2000). They are typically sized to be loaded at about 2 to 4 gpm/ft^2 (1.4 to 2.7 Lps/m^2). {Natural draft cooling towers are the preferred method of heat dissipation for Callaway Plant Unit 2. The two Circulating Water Supply System (CWS) cooling towers will have a concrete shell rising to a height of approximately 550 feet (168 meters). The CWS cooling towers will dissipate a maximum waste heat load of up to 1.108 E+10 BTU/hr (2.792 E+9 Kcal/hr) from the unit, operate with a 11°F (6.1°C) approach temperature, and maintain a maximum 90°F (32°C) return temperature at design ambient conditions. The cooling towers occupy an area of approximately 13 acres (5.3 hectares). This closed-loop system would receive makeup water from the Missouri River/Missouri River Alluvial Aquifer and transfer heat to the environment via evaporation and conduction. The natural draft cooling tower option was selected for the benefit of lower operation and maintenance costs compared to mechanical draft cooling towers. (Burns & McDonnell 2007b).}

Mechanical Draft Cooling Tower

A wet mechanical draft cooling tower system, operated completely as a wet-type cooling tower, would consist of multi-cell cooling tower banks, and associated intake/discharge, pumping, and piping systems. This closed-loop system would receive makeup water from the {Missouri River/Missouri River Alluvial Aquifer} and transfer heat to the environment via evaporation and conduction. These towers would have a relatively low profile of approximately 80 ft (24.4 m). Mechanical draft towers use fans to produce air movement.

A mechanical draft cooling tower would typically consist of a continuous row of rectangular cells in a side-by-side arrangement sharing a common cold water basin. Cold water is pumped from the basin through the condensers where it picks up heat from the condensing steam. The heated water to be cooled is returned to a hot water distribution system above the fill, and then falls over the fill to the cold water basin. Air is drawn through the falling water by fans, which results in the transfer of heat from the water to the air, and the evaporation of some of the water. The fill serves to increase the air-water contact surface and contact time, thereby promoting heat transfer.

A mechanical draft cooling tower employs large fans to either force or induce a draft that increases the contact time between the water and the air, maximizing the heat transfer. A forced draft tower has the fan mounted at the base, forcing air in at the bottom and discharging air at low velocity through the top. An induced draft tower uses fans to create a draft that pulls air through the cooling tower fill. {Based on a detailed net present value analysis, the operation and maintenance costs of the fans made the mechanical draft cooling tower a higher life-cycle cost alternative for cooling at Callaway Plant Unit 2 when compared to natural draft cooling towers.}

Hybrid Plume Abatement Cooling Tower

A cooling tower plume occurs when the heated and saturated air leaving a wet cooling tower mixes with the relatively cooler ambient air under atmospheric conditions, and a supersaturated condition occurs during the process of mixing and dispersion. The excess vapor condenses (the amount in excess of saturation vapor) and becomes a visible plume.

A cooling tower plume may be visually objectionable or may result in problems of fogging or icing. A plume abatement hybrid cooling tower (i.e., combination wet-dry tower) combines dry cooling and wet cooling to reduce the cooling tower plume. The dry cooling section adds heat to the discharge air without adding moisture (sensible heat transfer). This results in a subsaturated air stream leaving the tower (less than 100% relative humidity) and therefore reduced plume potential.

Although the hybrid plume abatement cooling tower results in reduced water consumption and no visible plume, construction costs, operating and maintenance costs, and land use requirements are significantly higher. {Therefore, the hybrid plume abatement cooling tower was not the preferred alternative for Callaway Plant Unit 2.}

Dry Cooling System

{There are specific environmental advantages that would be realized with dry cooling system including:

- Minimal makeup water requirements due to the elimination of cooling tower evaporation and drift losses.
- No environmental impacts to terrestrial or aquatic habitat due to presence of intake and discharge structure and flows.
- No environmental impacts to terrestrial or aquatic habitat due to cooling tower drift.
- No impact to the Missouri River due to effluent discharges.

Unfortunately, a dry cooling system affects plant performance so significantly that the net effect is an increased environmental impact. Dry cooling results in a significant reduction in plant output (approximately 25%). An objective comparison of dry versus wet cooling would therefore require the installation of a larger facility to compensate for the impact of dry cooling. The environmental impact of a larger facility far outweighs the environmental advantages of dry cooling.

Use of a dry system would also require a significant increase in dry cooling land use compared to wet cooling. An air-cooled condenser, where steam turbine exhaust is transported directly to a steam-to-air heat exchanger, has technical limitations due to its physical size. The distances from the main steam turbine condensers to the air-cooled condensers and the size of the steam ducting required would be uncommonly large and would far exceed the largest steam duct ever attempted.

Dry cooling material operation and maintenance costs would be significantly greater than wet cooling. Dry cooling land use would increase significantly, and the system would require periods of significant unit power output reduction during periods of high ambient air temperatures.

For the reasons stated above, the use of a dry tower was not considered as a feasible alternative for Callaway Plant Unit 2.}

9.4.1.2 Analysis of the Hybrid Cooling Tower Without Plume Abatement Alternative

{A hybrid cooling tower system without plume abatement has higher operating and maintenance costs than the natural draft towers. Therefore, this alternative is not preferred for Callaway Plant Unit 2.}

9.4.1.3 Summary of Alternative Heat Dissipation Evaluation

As discussed earlier in this section, {natural draft cooling towers provide a lower life-cycle cost due to the lower operational and maintenance costs}, and are therefore the preferred alternative to transfer heat loads from the CWS to the environment.

{Although the natural draft cooling towers and the mechanical draft cooling towers may be considered environmentally equivalent alternatives, the costs involved with the mechanical draft systems preclude them from being the viable alternative for Callaway Plant Unit 2. Although the mechanical draft cooling towers would have a lower capital cost, the fans involved would make Callaway Plant Unit 2 incur higher operational and maintenance costs. Additionally, a cooling lake is not a feasible option for Callaway Plant Unit 2 due to the substantial environmental impacts associated with construction of new cooling lakes of the size necessary for the proposed nuclear generating facilities, the high initial capital investment, and the 10-year critical path. (Burns & McDonnell, 2007a).}

9.4.2 CIRCULATING WATER SYSTEMS

In accordance with NUREG-1555 (NRC, 1999), ESRP 9.4.2, this section discusses alternatives to the following components of the CWS for {Callaway Plant Unit 2}. These components include the intake systems, discharge systems, water supply, and water treatment processes. {The information provided in this section is based on a Closed-Cycle Cooling and Makeup Water Supply Options study.} A summary of the environmental impacts of the circulating water intake and discharge system alternatives for {Callaway Plant Unit 2} are provided in Table 9.4-1 and Table 9.4-2.

The CWS is an integral part of the heat dissipation system. It provides the interface between (1) the normal heat sink (i.e., main steam turbine condenser) where waste heat is discharged from the steam cycle and is removed by the circulating water, and (2) the heat dissipation system where the heat energy is then dissipated or transferred to the environment.

Essentially, two types of CWSs are available for removing this waste heat: once-through (open-loop) and recycle (closed-loop) systems. In once-through cooling systems, water is withdrawn from a cooling source, passed through the condenser, and then returned to the source (receiving water body). In the recycle (closed-loop) cooling system, heat transferred in the condenser to the circulating water is dissipated through auxiliary cooling facilities, after which the cooled water is recirculated to the condenser.

As discussed in Section 9.4.1, the CWS for {Callaway Plant Unit 2 will be a closed-loop system, consisting of two (2) natural draft cooling towers with associated pumps, piping, and cold water retention basins that will be operated as wet cooling towers (i.e., without plume abatement) year-round.

The cooling water withdrawal rate for the CWS will normally be approximately 22,300 gpm (84,400 lpm), and maximum makeup will be approximately 30,500 gpm (115,500 lpm). These withdrawals include consideration of losses due to evaporation, drift and blowdown.

{Blowdown from the CWS cooling tower will be returned to the Missouri River. The blowdown water will enter the discharge pipe where it will mix with the blowdown from the Essential Service Water System cooling towers during its passage to the outfall. The normal circulating water system blowdown discharge is estimated to be approximately 4,700 gpm (17,700 lpm). The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of the Missouri River is expected.

A new collector well system serving both Callaway Plant Unit 1 and Callaway Plant Unit 2 will be installed in the subsurface and will draw water from the Missouri River/Missouri River Alluvial Aquifer (Aquifer). Use of this collector well system will eliminate any potential fish impingement and entrainment at the intake structure. Therefore, it is concluded that intake system modifications common to the closed-loop cooling systems at Callaway Plant Unit 1 and Callaway Plant Unit 2 will eliminate the existing impact on fish impingement and entrainment.}

9.4.2.1 Intake and Discharge System Alternatives

For both once-through and closed-loop cooling systems, the water intake and discharge structures can be of various configurations to accommodate the source water body and to minimize impact to the aquatic ecosystem. The intake structures are generally located along the shoreline of the body of water and are equipped with fish protection devices. The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Biocides and other chemicals used for corrosion control and for other water treatment purposes may be mixed with the condenser cooling water and discharged from the system.

Cooling water intake structures (CWIS) are typically regulated under Section 316(b) of the Federal CWA and its implementing regulations (FR, 2004). A federal court decision in January 2007 changed the regulatory process. The regulations that implement Section 316(b) were effectively suspended, and U.S. EPA recommended that all permits for Phase II facilities should include conditions under Section 316(b) developed on a best professional judgment basis (USEPA, 2007).

{Intake and discharge structures will be required to supply makeup water for the closed-loop operation of Callaway Plant Unit 2. Four alternative intake systems were considered. Each option is discussed in more detail below. For additional details, see Table 9.4-3.

<u>Modifications to the Existing Intake Structure</u>

Modifications to the existing intake structure, such as adding additional bays or replacing the existing makeup water pumps with larger pumps, were considered. The existing intake structure was designed to provide 41,000 gpm (155,200 lpm) with 3 x 33% makeup water pumps; however, the existing unit only requires 25,000 gpm (96,900 lpm). The intake would need to be capable of providing up to 50,000 gpm (193,800 lpm) of makeup water for two units. The current makeup water pumps were designed for 41,000 gpm (198,900 lpm) at 436 ft (133 m) total developed head (TDH), with 361 ft (110 m) of the TDH being elevation head. With a flow rate of approximately 50,000 gpm (193,800 lpm) for two units, the TDH the pumps would have to overcome is 473 ft (144 m). For three pumps running at 3 x 33%, each pump would need to have a capacity pf 16,666 gpm (64,600 lpm). Based on the manufacturer's pump curve, the TDH at 16,666 gpm (64,600 lpm) is approximately 400 ft (122 m), which is insufficient. Therefore, the existing pumps cannot be used to provide makeup water to Callaway Plant Unit

1 and Callaway Plant Unit 2. New pumps with the increased flow rate and head capacity could be installed, but only if the overall diameter of the bell housing remains the same as the existing pumps. This is due to the limiting hydraulic requirements in the bays. Hydraulic Institute 9.8-1998 recommends that the width of each bay be twice the diameter of the pump bell. While such an upgrade to the existing intake structure is possible and would allow the existing intake to supply makeup water for two units, no spare pump could be provided. This alternative also could have potential restrictions on operation during periods of extreme low flows in the Missouri River.

New Intake Structure

Construction of a new intake structure for providing makeup water for the existing Callaway Plant Unit 1 as well as Callaway Plant Unit 2 was considered. This intake could be located upstream of the existing intake and would be constructed as a separated structure rather than an expansion of the existing intake in order to minimize impacts on the plant during construction. The intake structure and associated traveling screen system would be designed with a maximum 0.5 ft per section (0.2 m per second) through-screen velocity to comply with the EPA Phase II 316 (b) requirements. Assuming that the new intake would be designed and constructed to supply cooling tower makeup water and service water for two units, a total flow of approximately 50,000 gpm (193,800 lpm) would be required. While technically feasible and offering the opportunity to include a spare pump and improve the reliability during low river flows, this option is not cost effective.

Vertical Wells near the Plant Site

The Callaway site lies near the southern limit of the Northeast Missouri Groundwater Province. Surface deposits consist of glacial drift which can supply small to moderate quantities of water for domestic use. Deeper bedrock formations of Ordovician and Cambrian age can supply relatively large quantities of good quality water for municipal, industrial, and irrigation use. In the Callaway site area, these formations have a total thickness of approximately 900 ft (270 m).

Reported well yields from the deeper bedrock units are in the range of 300 to 1,000 gpm (1,200 to 3,900 lpm). Wells are constructed with casing cemented in place down to the top of the aquifer. The well is then completed as an open-bore well to the base of the formation, with water entering the well through cracks, fractures, and voids in the bedrock. Well yields are variable, depending on the number of fractures encountered.

Recharge to the aquifer is vertical migration of water from the overlying Mississippian age formations and is relatively slow. Additionally, because drawdown caused by pumping the well can extend a large distance, well spacing would need to be about ¼ to ½ mile (0.4 to 0.8 km) to minimize the impacts of interference drawdown. With an estimated water demand of 25,000 gpm (96,600 lpm), 30 to 50 (or more) wells would be required, covering an area of 5 to 9 sq miles (13 to 23 sq km). Additional evaluations using groundwater modeling would be required to determine actual sustainable yield or the amount of water in storage that could safely be mined over the lifetime of the unit.

Collector Wells near the Existing Intake

Collector wells are large capacity wells constructed in river alluvial aquifers and are designed to maximize inducted infiltration from surface water sources. The Missouri River alluvium, due to its relatively thick sequence of saturated materials with good hydraulic conductivity, is quite suitable for the construction and operation of collector wells.

The capacity of collector wells in Missouri River alluvium ranges from 10 to 40 million gallons per day (MGD) (7,000 to 28,000 gpm) (27,100 to 108,500 lpm). Factors influencing well capacity include: saturated aquifer thickness, aquifer hydraulic conductivity (permeability of aquifer materials), riverbed permeability, proximity of well location to the river, river stage, and water temperature. Typically, 80% to 90% of the water pumped by the well is induced from the adjacent surface water source. The remaining 10% to 20% of the water pumped is groundwater that has recharged from precipitation in areas away from the river and is intercepted as it migrates toward the river.

Geologic maps of the river alluvium based on several borings and seismic soundings in the area generally indicate bedrock at approximately 90 to 95 ft (27 to 29 m) below ground surface, suggesting an adequate saturated thickness of aquifer materials. Based on hydrogeological investigations, yields from each collector well could be approximately 17,000 gpm (64,350 lpm) in the winter months and 26,000 gpm (98,400 lpm) in the summer.

Assuming typical Missouri River alluvial aquifer conditions, water demands of 25,000 gpm (96,900 lpm) per unit, and two generating units, it is anticipated that collector wells would be required to meet the water demands of the Callaway. The collector wells would need to be spaced apart to avoid significant interference drawdown during operation of adjacent wells.

Wells would be constructed with a 20-ft (6 m) diameter concrete caisson extending to bedrock, fourteen well-screen laterals extending 200 ft (61 m) or further from the caisson, and a pump house constructed on top of the caisson with 3 or 4 high-capacity pumps.

Based on a projected makeup flow of 25,000 gpm (96,900 lpm) per unit, the existing 48-inch (1.2 m) steel intake line that runs from the surface water intake to the plant should be adequate to provide the flow required for two units. Piping from the collector wells would tie into this line near Missouri Highway 94.}

9.4.2.2 {Selected Intake, Discharge, and Makeup Systems

Intake System

Collector wells are the environmentally preferable alternative for the new intake system. Collector wells will withdraw water from below the Missouri River, eliminating the potential for fish impingement and entrainment, reducing impact on the intake during periods of drought, and providing for reduced maintenance and operating costs.

The intake system for Callaway Plant Unit 2 consists of two collector wells. Wells are constructed with a 20 ft (6 m) diameter concrete caisson, fourteen well-screen laterals extending at least 200 ft (61 m) from the caisson, and a pump house on top of the caisson with 3 or 4 high-capacity pumps (Burns & McDonnell, 2008). The general site location of the new intake system is shown in Figure 3.4-2, while Figure 3.4-3 and Figure 3.4-4 show the intake structure and channel in more detail.

Section 316(b) of the federal CWA requires the U.S. EPA to ensure that the location, design, construction, and capacity of CWIS reflect the best technology available (BTA) for minimizing adverse environmental impact. The objective of any CWIS design is to have adequate sweeping flow past the screens to meet entrainment and impingement reduction goals established under Section 316(b) requirements. In addition to the impingement and entrainment losses associated with CWIS, there are the cumulative effects of multiple intakes, re-siting, or modification of CWIS disturbances to threatened and endangered species, keystone species, the thermal stratification of water bodies, and the overall structure of the aquatic system food web. Because Callaway Plant Unit 2 will be using collector wells as its intake system, fish impingement and entrainment as well as environmental impacts specific to aquatic life and surface water will not be an issue.

The new collector wells will be located approximately 9,000 ft (2,740 m) to 14,000 ft (4,270 m) upstream of the existing intake structure for the Callaway. The wells will be spaced a minimum of 1,500 feet apart of avoid interference and will be located to minimize wetland impacts.}

As noted in Chapters 4 and 5, the preferred water supply alternative (collector wells) would have SMALL construction and operational impacts. As a result, mitigation alternatives are not discussed in this section.

Discharge System

The final plant discharge consists of cooling tower blowdown from both the CWS and ESWS cooling towers and site wastewater streams, including the domestic water treatment and circulation water treatment systems. Only biocides or chemical additives approved by the U.S. EPA and the State of Missouri as safe for humans and the constituent discharged to the environment will meet requirements established in the NPDES permit.

{In 2007, a new discharge pipe was installed at the Callaway site. This pipe is capable of handling the discharge for both Callaway Plant Unit 1 and Callaway Plant Unit 2. Thus, no new discharge system will be required because Callaway Plant Unit 2 will be designed to tie into the existing discharge pipe.

Makeup System

Callaway Plant Unit 2 will require makeup water to the CWS and ESWS cooling towers to replace water inventory lost to evaporation, drift, and blowdown. As described in Section 9.4.2, fresh water makeup to the CWS cooling tower, the ESWS cooling towers, and the UHS pond will be provided directly from the non-safety related Missouri River/Missouri River Alluvial Aquifer collector wells. It has been determined that Callaway Plant Unit 2 will withdraw a limited quantity of groundwater for use at the site during operations, and will make limited groundwater withdrawals to support construction. During operations, groundwater will supply the plant demineralized water system, potable and sanitary water systems, and fire water system.}

9.4.2.3 Water Treatment

Evaporation of water from cooling towers leads to an increase in chemical and solids concentrations in the circulating water, which in turn increases scaling tendencies of the cooling water. {A water treatment system is required at Callaway Plant Unit 2 to reduce the iron concentrations, minimize bio-fouling, prevent or minimize growth of bacteria (especially *Legionella* in the case of cooling towers), and inhibit scale on system heat transfer surfaces.

The circulating water treatment system provides treated water for the CWS and ESWS and consists of three phases: makeup treatment, internal circulating water treatment, and blowdown treatment. Makeup treatment will consist of a biocide injected into the collector well water influent to minimize biological growth and control fouling on heat exchanger surfaces. Treatment also improves makeup water quality.

Similar to Callaway Plant Unit 1, an environmental permit to operate this treatment system will be obtained from the State. For prevention of *Legionella*, treatment for internal circulating water components (i.e., piping between the new intake structure and condensers) will include existing power industry control techniques consisting of either continuous chlorination or hyperchlorination (chlorine shock) in combination with intermittent chlorination at lower levels, biocide and scale inhibitor addition. Blowdown treatment will depend on water chemistry, but is anticipated to include application of a biocide dechlorinator to reduce residual chlorine at the outfall.

Well water will be treated by the demineralized water treatment system, which provides demineralized water to the demineralized water distribution system. During normal operation, demineralized water is delivered to power plant users. Treatment techniques will meet makeup water treatment requirements set by the Electric Power Research Institute and include the addition of a corrosion inhibitor.

The drinking water treatment system, which supplies water for the potable and sanitary distribution system, will treat well water so that it meets the State of Missouri potable (drinking) water program and U.S. EPA standards for drinking water quality under the National Primary Drinking Water Regulation and National Secondary Drinking Water Regulation. The system will be designed to function during normal operation and outages (i.e., shutdown).}

Liquid wastes generated by the plant during all modes of operation will be managed by the liquid waste storage and processing systems. The liquid waste storage system collects and segregates incoming waste streams, provides initial chemical treatment of those wastes, and delivers them to one or another of the processing systems. The liquid waste processing system separates waste waters from radioactive and chemical contaminants. The treated water is returned to the liquid waste storage system for monitoring and eventual release. Chemicals used to treat wastewater for both systems include sulfuric acid for reducing pH, sodium hydroxide for raising pH, and an anti-foaming agent for promoting settling of precipitates.

{Callaway Plant Unit 2 treats sewage using the existing Waste Water Treatment System. This treatment system removes and processes raw sewage so that discharged effluent conforms to environmental regulations as contained in the site NPDES permit.}

9.4.3 TRANSMISSION SYSTEMS

Section 9.4.3 of NUREG-1555 (NRC, 1999) provides guidelines for the preparation of summary discussion that identifies the feasible and legislatively compliant alternative transmission systems. {As discussed in Section 3.7, the existing Callaway Plant Unit 1 power transmission system consists of two 345 kilovolt (kV) circuits which connect Callaway Plant Unit 1 to the Montgomery Substation near New Florence, Missouri. Additionally, there is one 345 kV circuit that connects Callaway Plant Unit 1 to the Bland Substation near Owensville, Missouri. There is also a 345 kV circuit line connecting the Callaway Plant Unit 1 switchyard to a substation near Loose Creek. An extension of the Loose Creek 345kV transmission line from a tie point on the Loose Creek transmission line near Chamois to the Unit 1 switchyard will be required and will result in approximately 6.7 miles of new transmission line. The routes for the existing Callaway Plant Unit 1 circuits are presented in Figure 3.7-1.

The transmission lines to support Callaway Plant Unit 2 would be constructed in areas that are currently being used for other Callaway purposes or are contiguous with the current transmission lines. Thus, environmental impacts are limited to the Callaway Plant Unit 2 construction area on the Callaway site. There will be no impacts from land use changes. The impact to humans and animals resulting from increased transmission-line induced currents is minimized due to conformance with the national electric safety code (NESC), and is SMALL. Access to the existing corridors would be through existing access roads in compliance with existing negotiated easement agreements as well as through an additional easement of approximately 150 feet (45 meters) contiguous with the easement along the existing transmission line that will be required.

The transmission line work to support Callaway Plant Unit 2 will, however, require new towers and transmission lines on the Callaway site to connect the Callaway Plant Unit 2 substation to the existing Callaway Plant Unit 1 substation.

The power transmission needs of Callaway Plant Unit 2 can be satisfied with relatively minimal changes to the existing transmission corridor and power transmission system for Callaway. Based on this conclusion, and the small expected impact to the environment from utilizing the existing transmission corridor and equipment, no other alternatives were considered since all other alternatives were obviously less preferable.}

9.4.4 REFERENCES

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Table 9.4-1—{Comparison of Cooling Tower Evaluation Criteria}

Type of Cooling	Footprint per Plant Unit (1,562 MWe)	Maximum Height	Materials of Construction	Plant Efficiency Impact	Auxiliary Load	Water Makeup [a]	Drift Rate	Pump Head	Visible Plume	Noise	O&M Cost [b]	Capital Cost
	Diameter (ft)	Ft		%	MWe	gpm	% of Full Flow	Feet H_2O		dBA @ 1m	USD	USD
Natural Draft Wet Cooling Tower	414 x 2	550	Concrete	0.5	0	22,000	<0.005	51	Yes	82	171,539,000	132,842,000
Mechanical Draft (Wet)	277 x 3	66	Fiberglass (FRP)	0.5	9.6	22,000	0.005	41	Yes	85	234,435,000	115,963,000

Notes:

[a] Water total makeup includes drift, evaporation, and blowdown (at 4.8 cycles of concentration).

[b] O&M costs are expressed as net present value of operation and maintenance cost.

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Table 9.4-2—{Environmental Impacts of Alternative Cooling Tower Systems}
(Page 1 of 2)

Factors Affecting System Selection	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)
Land Use: Onsite Land Requirements	10.0 acres (4 hectares) Impacts would be small.	23 acres (10.1 hectares) for rectangular MDWCT and 11 acres for a round MDWCT. Impacts would be small.
Land Use: Terrain Considerations	Terrain features of the Callaway Plant site are suitable for a NDWCT system. Impacts would be small.	Terrain features of the Callaway Plant site are suitable for a MDWCT system. Impacts would be small.
Water Use	22,300 gpm (84,300 lpm) for water makeup. Total water makeup includes drift, evaporation, and blowdown (@ 4.8 cycles of concentration). Potential for small to moderate impacts to aquatic biota if a direct river intake option is used . Impacts would be small to moderate.	22,300 gpm (84,300 lpm) for water makeup for both a rectangular and round MDWCT. Total water makeup includes drift, evaporation, and blowdown (@ 4.8 cycles of concentration). Potential for small to moderate impacts to aquatic biota if direct river intake option is used. Impacts would be small to moderate.
Atmospheric Effects	Visible plume. NDWCT presents greater potential for fogging and salt deposition. Impacts would be small.	Short average and median visible plume. Drift eliminators minimize salt deposition. Impacts would be small.
Thermal and Physical Effects	Discharges associated with the NDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Missouri River is expected. Impacts would be small.	Discharges associated with the MDWCT would need to meet applicable water quality standards and be in compliance with applicable thermal discharge regulations. Cooling water will be sent to a retention basin, thus reducing thermal impacts to receiving waters. The discharge is not likely to produce tangible aesthetic or recreational impacts. No effect on fisheries, navigation, or recreational use of Missouri River is expected. Impacts would be small.
Noise Levels	NDWCT would emit broadband noise that is largely indistinguishable from background levels and would be considered unobtrusive at the site boundary. Impacts would be small.	MDWCT would emit more broadband noise than a natural draft wet cooling tower but would be considered unobtrusive at the site boundary. Impacts would be small.
Aesthetic and Recreational Benefits	NDWCT plumes resemble clouds and would not disrupt the viewscape.	MDWCT plumes resemble clouds and would not disrupt the viewscape.

Table 9.4-2—{Environmental Impacts of Alternative Cooling Tower Systems}
(Page 2 of 2)

Factors Affecting System Selection	Natural Draft Wet Cooling Tower (NDWCT)	Mechanical Draft Wet Cooling Tower (MDWCT)
Aesthetic and Recreational Benefits	The existing Unit 1 and new Unit 2 are located on more than 6,000 acres of land owned by Ameren, of which most is managed by agreement with MDC as publicly accessible conservation land, creating the Reform Conservation Area. The extensive amount of undeveloped and naturally vegetated open and green space surrounding the plant, and topographic features (i.e., location on plateau) provides a natural and aesthetic buffer between the Callaway Plant and the nearest residences approximately 1.2 miles (1.9 km) or more from the facility. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries navigation, or recreational use of Missouri River is expected. Impacts would be smal.l	The existing Unit 1 and new Unit 2 are located on more than 6000 acres of land owned by Ameren, of which most is managed by agreement with MDC as publicly accessible conservation land, creating the Reform Conservation Area. The extensive amount of undeveloped and naturally vegetated open and green space surrounding the plant, and topographic features (i.e., location on plateau) provide a natural and aesthetic buffer between the Callaway Plant and the nearest rural residences approximately 1.2 miles (1.9 km) or more from the facility. The cooling tower discharge is not likely to produce tangible aesthetic or recreational impacts; no effect on fisheries, navigation, or recreational use of Missouri River is expected. Impacts would be small.
Legislative Restrictions	Direct River Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. CWA 316(b) does not apply to Missouri River/Missouri River Alluvial Aquifer Collector Well System option. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Missouri River. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.	Direct River Intake structure would meet Section 316(b) of the CWA and implementing regulations, as applicable. CWA 316(b) does not apply to Missouri River/ Missouri River Alluvial Aquifer Collector Well System option. NPDES discharge permit thermal discharge limitation would address thermal load from blowdown to Missouri River. These restrictions would not negatively affect implementation of this heat dissipation system. Impacts would be small.
Environmental Impacts	Small to Moderate	Small to Moderate
Is this an environmentally acceptable alternative heat dissipation system?	Yes	Yes

Table 9.4-3—{Alternate Intake Systems}

Factors Affecting System Selection	New River Intake Structure	Vertical Wells Near Plant Site	Horizontal Collector Wells (Missouri River Alluvial Aquifer)
Construction Impacts	Some adverse impacts such as turbidity release while working in river. Impacts can be minimized through engineering controls. Small	Some surface disturbance and potential for erosion sedimentation in the vicinity of well locations and trenching to lay pipeline, conduit, etc. Impacts can be minimized through engineering controls. Small	Some surface disturbance and potential for erosion sedimentation in the vicinity of well locations and trenching to lay pipeline, conduit, etc. Impacts can be minimized through engineering controls. Moderate due to potential impact to wetlands.
Aquatic Impacts	Potential for some entrainment and impingement. Small to moderate	No aquatic impacts anticipated. None	No aquatic impacts anticipated. None
Water Use Impacts	No expected long term impacts; water consumption is sustainable. Small	No expected long term impacts; water consumption is sustainable. Small	No expected long term impacts; water consumption is sustainable. Small
Compliance with Regulations	Satisfies regulatory performance standards for CWA and Missouri regulations.	Satisfies regulatory performance standards for CWA and Missouri regulations.	Satisfies regulatory performance standards for CWA and Missouri regulations.
Environmental Preferability	Environmentally least preferable due to entrainment potential and impact on aquatic biota. Will require some disturbance in previously undisturbed areas.	Preferable to river extraction. May incur high energy cost depending on water aquifer level Will require some disturbance in previously undisturbed areas.	Most environmentally preferable. No entrainment potential, withdrawal from a more sustainable part of aquifer (closer to river recharge) Will require some disturbance in previously undisturbed areas.