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6.0 ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

6.1 THERMAL MONITORING

{This section presents the pre-application, pre-operational, and operational thermal monitoring programs for Callaway Plant Unit 2. The objective of thermal monitoring during each phase is to comply with state and federal water quality criteria and to assess potential and actual environmental impacts within the area of influence of the facility.

Pertinent site and plant features, including boundaries and bathymetry of the Missouri River adjacent to the site are described and shown in FSAR Section 2.1.1 and Section 2.3.1. The existing thermal monitoring station is shown in Figure 6.1-1. Additional information related to field water temperature measurement is described in Section 2.3.1. Data analysis is described in Section 2.3.1. Hydrological and biological monitoring stations are described in Sections 6.3 and 6.5. The extent of the predicted thermal plume is described in Section 5.3.2.1.

Temperature monitoring is described in each subsection below corresponding with the pre-application, pre-operational, and operational phases of the project.

Thermal program acceptance criteria are based on relevant federal, state, and local requirements.

Consultation with the NPDES authority, the Missouri Department of Natural Resources, has been initiated and will continue throughout pre-application, pre-operational, and operational phases of the project.

6.1.1 PRE-APPLICATION MONITORING

Pre-application thermal monitoring for Callaway Plant Unit 2 consists of past and present thermal monitoring activities conducted for Callaway Plant Unit 1. More than 20 years of thermal monitoring activities associated with the existing plant cooling tower outfall establishes the basis for the thermal description and baseline water temperature conditions for Callaway Plant Unit 2.

Modeling studies were undertaken in conjunction with the preparation of the Environmental Report-Construction Stage prior to Callaway Plant Unit 1 construction. These studies were designed to evaluate the thermal impact of the Callaway Plant Unit 1 plant on the Missouri River. Results of these studies were presented in Section 5.1.1 and Appendix SA of the Environmental Report-Construction Permit Stage (Callaway, 1979). These results were analyzed independently by the NRC Staff in Section 5.1.2.1 of the Construction Permit Stage Final Environmental Statement (NUREG-75/011, 1975). The staff concluded that the analysis presented by Union Electric (now dba AmerenUE) was reasonable and that the plume size would be very small. In Section 6.2.1 of the Construction Permit Stage Final Environmental Statement the NRC recommended operational temperature monitoring in the Missouri River upstream and immediately downstream of the outfall for a limited period of time to detect any entrapment of heat for its potential impact on aquatic biota. This recommendation was qualified by stating that the operational program would be evaluated in detail at the time of application for an operating license.

In the Summary and Conclusions section of the Final Environmental Statement related to the Operation of Callaway Plant, Unit No. 1 (NUREG-0813, 1982) NRC states:

"The chemical, thermal, and other waste discharges to the Missouri River will be rapidly assimilated, hence, no adverse impacts on downstream water users or aquatic biota are expected.

Although there was no NRC requirement to perform thermal monitoring during operations, temperature measurements continue to be taken to monitor Callaway Plant Unit 1 discharges from the site according to the site's National Pollutant Discharge Elimination System (NPDES) permit throughout the operational life of the facility (Callaway, 2003). The NPDES hydrological monitoring program parameters and limits including temperature for the cooling tower blowdown stream are given in Table 6.3-1.

Existing site features and the location of the existing monitoring station (Outfall 002) in the Circulating/Service Water Pumphouse are shown on Figure 6.1-1 and are further described in Section 6.6. Recent bathymetry characteristics in the Missouri River adjacent to the Callaway site are described in Section 2.3.1.

The Callaway Plant Unit 1 NPDES permit requires thermal monitoring of cooling tower blowdown discharged via Outfall 002 (Callaway, 2003). Cooling tower blowdown is piped to a submerged discharge point on the north bank of the Missouri River. The discharge pipe is equipped with a Tideflex check valve to prevent river water from traveling back up through the discharge line. The invert elevation of the 36-inch (0.91-m) discharge pipe is 492 ft (150 m) above mean sea level (msl) (AmerenUE, 2006). The discharge is projected to remain completely submerged in the Missouri River at river flows (discharge) above 25,000 cfs (708 cms) measured at the U.S. Geological Survey gauging station at Hermann, MO (AmerenUE, 2007a). Table 6.1-1 demonstrates that monthly mean flows this low occur infrequently, having last been recorded in December 1989, and occurring in approximately 2% of the months between October 1957 and September 2006.

The State of Missouri regulates ambient water quality criteria for the protection of aquatic life (AQL) through the Missouri Department of Natural Resources (MDNR), Division 20, Clean Water Commission, Chapter 7 Water Quality at 10 CSR 20-7.031. Specific criteria for temperature appear in Table A - Criteria for Designated Uses (MDNR, 2005a) as follows:

	Pollutant	AQL	
Temperature (maximum)		°F	°C
	Warm-water	90	32 2/9
	Cool-water	84	28 8/9
	Cold-water	68	20
Temperature (maximum change)			
	Warm-water	5	2 7/9
	Cool-water	5	2 7/9
	Cold-water	2	16/9

The temperature change (raising or lowering of water course temperature) and maximum temperature limitation appearing in Table A of 10 CSR 20-7 and given above apply in areas of a water body beyond a mixing zone (10 CSR 20-7.031(d)(1)). Thermal mixing zones are limited to 25% of the cross sectional area or volume of a river (10 CSR 20-7.031(D)(6)).

This reach of the Missouri River is designated a Limited Warm Water Fishery (MDNR, 2005b). These water temperature and temperature change criteria are identical to those used in performing the modeling studies presented in the Environmental Report – Construction Permit Stage (Callaway, 1974). As discussed above, NRC concurred with that analysis and concluded

that no adverse impacts on downstream water users or aquatic biota were expected (NUREG-0813, 1982).

Outfall 002 temperature is collected once per day on a grab sample taken from the outfall and reported to the DNR on a quarterly basis in accordance with the requirements of the site NPDES permit (Callaway, 2003). The NPDES permit limit established for Outfall 002 is 110 °F (43 °C). Monitoring results demonstrate consistent compliance with permit limits (AmerenUE, 2007b). Blowdown temperature data appears in Section 2.3.3.}

6.1.2 PRE-OPERATIONAL MONITORING

{Pre-operational thermal monitoring consists of a continuation of the pre-application monitoring program. Thermal monitoring of Outfall 002 collected during the pre-operational monitoring period together with Missouri River monitoring data collected by the USGS at Boonville (upstream) and the Hermann (downstream) gauging stations will supplement pre-application monitoring data and further serve to establish baseline river water temperature conditions for comparative purposes in assessing potential environmental impact from plant operations. Pre-operational monitoring will be conducted during site preparation and construction of Callaway Plant Unit 2.

Construction-related discharges will consist mainly of process water or rain runoff that collects at the bottom of excavations which will be pumped to one or more stormwater runoff ponds comprising the construction storm water discharge protection system. Therefore, no change in thermal discharges is expected during the pre-operational monitoring period.

The MDNR will be notified of pending construction activities and approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit as described in Section 1.3. The existing monitoring station location and temperature limitations for Outfall 002 are expected to remain the same as those for pre-application monitoring. Additional requirements for monitoring of discharges imposed by the MDNR or other agencies with jurisdiction will be met.

The addition of new generating capacity at the Callaway Plant site was considered in the design of the replacement discharge pipeline installed in 2008. As described in ER Section 3.4, the new discharge pipeline is adequately sized to handle the combined flow of Callaway Plant Unit 1 and Callaway Plant Unit 2.}

6.1.3 OPERATIONAL MONITORING

{Thermal monitoring will continue during operation of Callaway Plant Unit 2 to assess water temperature changes associated with effluents from the plant. Callaway Plant Unit 2 will utilize a closed-loop cooling water system. Blowdown from Circulating Water Supply System (CWS) cooling towers and the Essential Service Water System (ESWS) is combined with waste streams from other sources (i.e., the Water Treatment Plant, the Cooling Tower Bypass, etc.) to be discharged to the Missouri River. It is anticipated that cooling tower blowdown temperature limitations and monitoring requirements for the plant will be similar to the existing monitoring requirements (see description in Section 6.1.2 above). Additional requirements for monitoring of discharges that may be imposed by the MDNR or other agencies with jurisdiction will be met.

Thermal plume modeling performed to estimate the distribution of additional heat load entering the Missouri River indicates that the combined thermal discharges from the new and existing plants meet State of Missouri ambient water quality criteria for the protection of

aquatic life within a short distance of the discharge point. Analyses of thermal impacts and the extent of the estimated thermal plume are provided in Sections 5.2 and 5.3.2.

The extent and duration of the operational monitoring program will conform to requirements of the NPDES permit applicable to Callaway Plant Unit 2. Water temperatures from plant discharges will meet applicable federal and state environmental regulatory requirements. As described above, consultation with the MDNR has been initiated and will continue throughout pre-application, pre-operational, and operational phases of the project.}

6.1.4 REFERENCES

{**Callaway, 1979,** Callaway Plant Environmental Report, Operating License Stage, Volumes I – III, Union Electric Company, October 1979.

MDNR, 2005a, Table A-Criteria for Designated Uses, 10CSR20-7-Department of Natural Resources, Division 20-Clean Water Commission, November 30, 2005.

MDNR 2005b, 10CSR20-7-031-Water Quality Standards, Department of Natural Resources, Division 20-Clean Water Commission, November 30, 2005.

NUREG 75/011, 1975, Final Environmental Statement related to the proposed Callaway Plant Units 1 and 2, United States Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, March 1975.

NUREG-0813, 1982, Final Environmental Statement related to the operation of Callaway Plant, Unit No. 1, U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Regulation, January 1982.

Callaway, 2003, State of Missouri, Missouri Clean Water Commission Missouri State Operating Permit MO-0098001, October 2003.

AmerenUE, 2006, Burns & McDonnell Cooling Tower Blowdown Relocation, Phase 1 Report, June 2006.

AmerenUE 2007a, Burns & McDonnell Closed-Cycle Cooling and Makeup Water Supply Options for Future Units, February 2007.

AmerenUE, 2007b, Monthly NPDES Monitoring Reports for the years 2004 through 2006.}

Table 6.1-1—{USGS Missouri River at Hermann Monthly Mean Discharge, cubic feet per second}

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1957										46,830	33,610	34,430
1958	24,150	32,120	103,800	73,240	73,990	71,640	179,800	127,200	76,310	52,770	43,620	24,530
1959	25,120	58,860	71,550	72,320	95,020	77,380	59,770	55,200	49,690	96,820	37,970	32,180
1960	52,950	49,020	67,740	213,500	139,000	79,970	75,720	52,670	52,690	41,400	44,580	28,970
1961	22,340	29,710	107,000	124,500	196,600	78,950	80,490	55,280	137,700	80,410	144,300	45,110
1962	46,980	121,600	132,300	104,100	60,130	107,900	75,650	51,030	55,490	60,150	43,450	24,710
1963	17,350	25,620	69,170	45,800	75,080	52,660	45,250	40,760	37,800	36,680	38,780	17,060
1964	18,130	19,250	22,810	80,920	63,250	121,000	59,690	41,070	52,240	38,170	43,770	24,730
1965	43,740	37,940	99,460	137,300	61,870	111,400	147,100	56,540	159,500	84,050	54,990	44,980
1966	44,250	64,740	56,710	77,600	71,100	73,250	52,940	50,630	43,750	41,620	42,270	27,660
1967	21,570	27,480	29,910	83,480	66,590	228,800	118,900	57,520	52,460	73,050	84,520	65,110
1968	33,740	62,470	51,330	81,930	79,480	69,590	59,450	83,270	49,890	62,390	76,420	66,380
1969	69,980	94,530	109,000	175,800	126,100	140,100	195,200	78,510	95,790	140,700	76,030	47,840
1970	31,050	41,850	55,050	119,400	137,400	137,800	53,890	59,640	109,000	99,890	78,980	50,520
1971	50,860	84,590	108,400	64,920	89,330	106,300	76,630	60,600	58,170	60,120	74,050	86,050
1972	47,780	39,320	60,610	81,510	116,400	71,540	63,350	70,380	85,200	68,060	134,000	66,550
1973	129,000	135,300	267,500	333,400	192,100	113,400	92,290	72,910	84,410	221,900	127,600	127,400
1974	114,700	115,600	129,100	87,050	143,800	132,600	55,880	53,650	64,250	51,460	104,400	54,780
1975	58,920	103,100	108,300	124,000	88,110	112,500	82,570	80,750	92,730	79,590	81,530	68,900
1976	40,190	49,540	80,480	101,100	103,800	70,000	59,470	47,250	43,760	48,190	45,640	36,060
1977	21,560	34,150	42,840	50,660	53,720	83,470	77,150	58,670	128,400	93,350	125,100	47,200
1978	32,830	26,710	169,800	173,200	145,400	88,500	90,990	79,900	89,050	67,760	77,620	54,110
1979	32,390	67,340	192,800	158,500	116,600	94,390	99,200	70,260	63,340	50,900	70,920	54,960
1980	41,550	49,360	73,320	124,500	58,970	83,450	48,860	49,910	50,700	45,260	47,030	40,750
1981	26,230	30,030	30,910	51,390	97,480	117,900	153,300	89,730	54,830	52,730	59,750	49,080
1982	37,450	136,800	111,200	76,770	124,400	223,500	135,000	100,100	103,400	72,680	80,840	178,900
1983	77,940	90,670	119,100	233,600	204,200	156,000	109,300	63,470	56,770	61,360	103,100	84,000
1984	50,600	92,710	169,500	248,400	205,500	206,700	164,100	71,990	67,410	78,200	111,300	85,940
1985	96,820	124,400	171,700	122,800	106,400	152,700	71,770	81,990	68,530	156,000	152,700	116,300
1986	61,030	91,410	88,880	107,300	155,500	99,990	132,400	76,070	107,100	286,700	149,700	133,100
1987	71,280	80,110	146,800	177,800	123,600	105,900	99,330	77,300	72,110	53,730	63,930	98,760
1988	67,450	75,410	84,420	105,800	64,740	46,150	44,010	42,790	45,280	46,660	47,280	37,250
1989	36,850	39,120	52,970	57,540	47,710	57,020	48,900	56,410	97,110	44,860	34,260	21,740
1990	31,010	48,730	95,370	89,980	183,600	183,500	89,710	74,700	45,450	45,560	29,400	30,970
1991	48,930	48,920	42,310	80,810	115,900	92,640	52,840	39,540	40,720	40,810	35,130	44,960
1992	39,350	50,860	62,680	100,000	62,210	59,600	119,100	109,000	80,980	61,050	118,200	146,000
1993	108,000	96,640	149,200	197,800	194,900	176,000	376,300	306,600	243,500	169,000	127,900	91,390
1994	62,380	86,920	107,000	173,200	174,000	127,300	85,750	57,140	56,260	49,160	82,220	64,080
1995	67,750	66,510	63,900	109,400	313,000	282,300	178,000	118,900	83,030	79,190	85,280	58,130
1996	44,370	52,840	58,710	82,620	194,500	199,600	132,300	110,400	92,020	97,000	135,500	100,200
1997	61,600	126,600	146,700	193,800	154,800	155,800	107,700	90,260	91,420	93,950	96,170	103,000
1998	89,850	91,360	148,400	189,300	111,000	158,400	130,900	100,600	91,140	173,000	174,800	106,800
1999	77,160	124,000	107,100	172,200	220,400	172,800	147,200	83,940	69,700	66,650	63,820	57,860
2000	49,210	46,860	54,730	51,160	54,600	75,500	70,330	56,840	45,940	46,940	47,800	30,040
2001	32,830	84,590	123,700	118,700	116,400	206,200	97,450	61,240	59,410	57,830	44,680	43,600
2002	34,880	54,450	44,960	65,810	184,500	100,800	47,810	44,480	41,610	42,670	40,360	28,910
2003	25,540	29,000	38,130	47,170	81,730	65,030	53,390	37,920	50,850	38,500	44,660	48,240
2004	51,040	38,740	103,700	70,600	94,400	107,200	87,790	72,820	62,070	42,640	70,610	65,000
2005	119,500	102,700	47,200	65,800	73,500	128,000	56,580	57,680	55,420	49,250	26,790	28,190
2006	30,100	30,540	34,460	50,960	72,360	48,250	40,970	42,660	44,790	35,230	24,820	33,720
2007	39,460	51,950	80,230	106,700	200,900	130,300	107,000	80,280	55,930	35,200	24,800	33,700

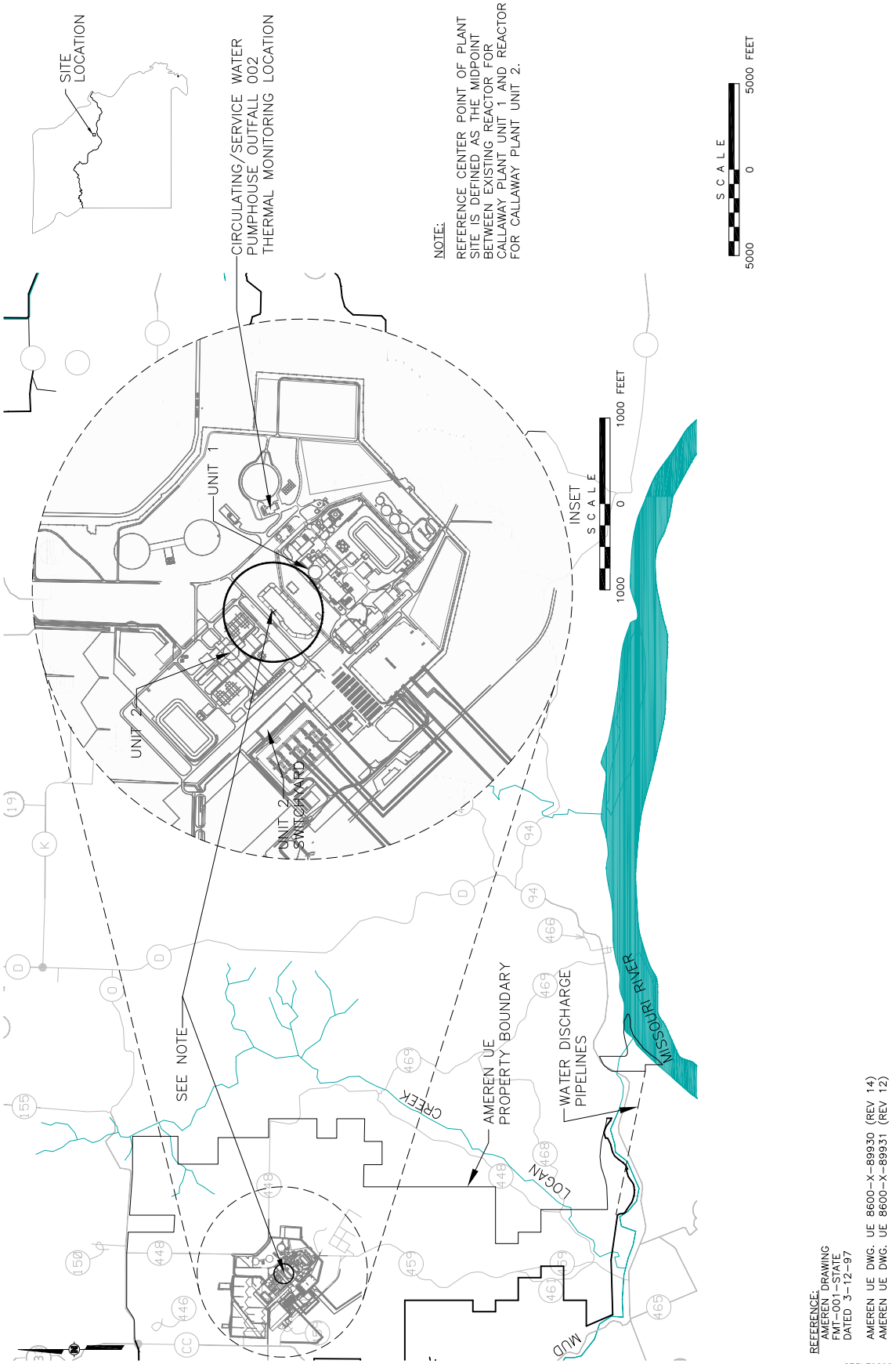

Figure 6.1-1—{Thermal Monitoring Station for Callaway Plant Unit 1}

6.2 RADIOLOGICAL MONITORING

{This section describes the objectives, basis, content, reporting and quality assurance aspects of the Callaway Plant Unit 1 site area Radiological Environmental Monitoring Program (REMP), as well as that for Callaway Plant Unit 2. The Callaway Plant Unit 2 REMP will build upon existing Callaway Plant Unit 1 site program where sample types, locations, collection frequencies, and analysis requirements are consistent with satisfying the program requirements (such as objectives, basis, and reporting) that are identified for Callaway Plant Unit 2. The data that are collected are used in both Callaway Plant Unit 1 and Callaway Plant Unit 2 REMPs. These data cover the entire Callaway site and environs surrounding the site and are used to provide baseline information in support of the pre-construction and pre-operational phase of Callaway Plant Unit 2.

Results of the monitoring program for the pre-construction, construction, pre-operational and operational periods to date have been reported to the Nuclear Regulatory Commission (NRC) in a series of annual reports. This reporting which includes radioactivity and plant related impacts will continue through construction and operation of Callaway Plant Unit 2.

The objectives of the REMP for Callaway Plant Unit 1 and Callaway Plant Unit 2 are:

a. To verify that radioactivity and ambient radiation levels attributable to plant operations are within the limits specified in 10 CFR Part 50, Appendix I for maintaining doses to members of the public "As Low As Reasonably Achievable (ALARA)" (CFR, 2007b) and within the Environmental Protection Agency Radiation Protection Standards as stated in 40 CFR Part 190 (CFR, 2007a);

b. To detect any measurable buildup of long-lived radionuclides in the environment;

c. To monitor and evaluate ambient radiation levels; and

d. To determine whether any statistically significant increase occurs in concentration of radionuclides in important pathways.

The environmental monitoring sampling program for the site is consistent with the guidance provided in standard radiological effluent technical specifications (CFR, 2007a) as described in Regulatory Guide 4.1 (NRC, 1975), NUREG-1301, (NRC, 1991), and NRC guidance (NRC, 1979b).

Changes to the Callaway Plant Unit 1 REMP to reflect Callaway Plant Unit 2 are noted in Section 6.2.6.}

6.2.1 PATHWAYS MONITORED

{Environmental exposure pathways to humans resulting from Callaway Plant Unit 2 radiological effluents are described in Section 5.4.1. These are the same environmental pathways that apply to effluents from Callaway Plant Unit 1. Radioactive liquid pathways include internal exposure due to ingestion of aquatic foods (fish and invertebrates) and external exposure due to recreational activities on the shoreline and in the water (swimming and boating). Radioactive gaseous pathways include external exposure due to immersion in airborne effluents and exposure to a deposited material on the ground plane. Internal exposures are due to ingestion of food products grown in areas under the influence of atmospheric releases, and inhalation from airborne effluents. In additional, direct radiation exposure from the facility structures is also considered a potential pathway. The REMPs for Callaway Plant Unit 1 and Callaway Plant

Unit 2 are designed to evaluate detectable levels of radioactive materials in environmental media associated with these exposure pathways.

The relationships between exposure pathways and environmental media included in the Callaway Plant Unit 1 sampling program are shown in Table 6.2-1 and are applicable to Callaway Plant Unit 2.

The exposure pathways being monitored are listed in Table 6.2-2 and Table 6.2-3 for the REMP. These same pathways and monitoring locations are applicable for the Callaway Plant Unit 2 REMP, except as noted in Section 6.2.6.}

6.2.2 LAND USE CENSUS

{A land use census for the Callaway Site area is conducted during the growing season. The same land use census requirement is applicable for Callaway Plant Unit 2}. The census identifies the following within each of the sixteen meteorological sectors in the 5 mile (8 km) vicinity:

- The nearest milk animal,
- {The nearest meat animal,}
- The nearest residence, and
- The nearest garden of greater than 500 sq ft (50 sq m) producing broad leaf vegetation.

The purpose of the land use census is to identify needed changes in the Radiological Environmental Monitoring Program. This ensures that sampling locations associated with media that have the highest dose potential are included in the REMP as changes in land use patterns occur over time. The implementation of the land use census satisfies the requirement of 10 CFR Part 50, Appendix I (CFR, 2007b).

6.2.3 ENVIRONMENTAL MONITORING PROGRAM SAMPLE TYPES

6.2.3.1 Direct Radiation Monitoring

{Thermoluminescent dosimeters (TLDs) or equivalent are used to measure ambient gamma radiation levels at many locations surrounding Callaway Plant Unit 1.}

TLDs are crystalline devices that store energy when they are exposed to radiation. They are processed after their exposure periods, with minimal loss of information, to read the amount of stored energy, or radiation, that they had accumulated during their exposure period in the field. This makes them well suited for quarterly environmental radiation measurements.

During TLD processing, stored energy is released as light, and is measured by a TLD reader. The light intensity is proportional to the radiation dose to which the TLD was exposed.

{Forty-three dosimeters are placed in 16 sectors around the plant. Dosimeters are read once per quarter. A summary of the environmental monitoring performed for Callaway Plant Unit 1 is shown in Table 6.2-2 through Table 6.2-3, and Figure 6.2-1 through Figure 6.2-2. Data collected as part of the Callaway Plant Unit 1 TLD program are included in the Callaway Plant Unit 2 REMP.}

6.2.3.2 Airborne Activity Monitoring

{Radioiodine and particulate samples are currently collected with continuously operating air pumps, particulate filters, and iodine collection cartridges. Filters have a 99% particulate removal efficiency at 1 micron at a volumetric sampling rate of one-half cubic foot (0.014 cubic meter) per minute. Filters and cartridges are collected weekly at indicator locations A1, A7, A8, A9, and B3. Samples are subjected to gross beta radioactivity analysis using a proportional counter. Iodine-131 is analyzed by proportional air filtering through a charcoal filter cartridge which is then counted using a germanium detector. Particulate filters are composited according to location and counted using a germanium detector coupled to a multi-channel analyzer. The spectrum produced identifies specific nuclides as noted shown in Table 6.2-4. Sampling frequencies are noted on Table 6.2-2. Airborne activity monitoring data collected as part of the Callaway Plant Unit 1 REMP will be included as part of the Callaway Plant Unit 2 monitoring program. Additions to the airborne monitoring program that are related directly to the Callaway Plant Unit 2 REMP are identified in Section 6.2.6.}

6.2.3.3 Waterborne Monitoring

{Summary Table 6.2-2 through Table 6.2-3, and Figure 6.2-1 through Figure 6.2-2 note sampling information for waterborne pathway monitoring.

Monthly composite samples of surface water from the Missouri River are collected from one indicator location (S02) and from one control location (S01). Samples are evaluated for tritium by scintillation counter and for other specific nuclides using gamma spectrometry.

Drinking/groundwater samples are collected quarterly from two deep sampling wells (F05 and F15) and two deep drinking water supply wells (D01 and PW1). Samples are evaluated for the presence of tritium using a scintillation counter and for other specific nuclides using gamma spectrometry. A chemical separation method followed by a gas flow proportional counting technique is used for Iodine-131 analysis.

Bottom and shoreline sediment samples are collected semi-annually in the same general area from two locations, one at indicator location (C) and one at control location (A). Shoreline samples are collected within 2 ft (0.6 m) of the shore. Bottom sediment locations are collected in the same general area in water that has a minimum depth of 7 ft (2 m). Samples are subjected to gamma spectroscopy analysis for identifying specific nuclides.

Wetlands soil samples are collected annually from 3 indicator locations at W2, W3, and W4 and at one control location at W1. These samples are subjected to gamma spectroscopy analysis for identifying specific nuclides.

Waterborne activity monitoring data collected as part of the Callaway Plant Unit 1 REMP are included as part of the Callaway Plant Unit 2 monitoring program.}

6.2.3.4 Ingestion Pathway Monitoring

{Table 6.2-2 through Table 6.2-3, and Figure 6.2-1 through Figure 6.2-2 provide a summary of the monitoring in 2007 for various ingestion pathways.}

For liquid effluent pathways, the five most abundant recreational or commercial fish species are collected semiannually from one indicator location (C) and one control location (A).

Monthly during the growing season, green leafy vegetation is collected from four indicator locations V9, V10, V11, and V13 and from one control location V12. Vegetation samples consist

of samples such as mustard greens, turnip greens, cabbage, lettuce, collards, radish greens, swiss chard, broccoli, and poke. Other broad leaved vegetation is requested and/or collected if primary varieties are not available.

The regional area in the vicinity of the Callaway site is both rural and agricultural. The presence of milk producing livestock warrants milk sampling. When available, one-gallon (3.8 L) milk samples are collected semi-monthly during the grazing season (typically April through September) and monthly during the winter from two indicator stations near the Callaway site at M6 and M13 and at one control location away from the Callaway site. Samples are analyzed for Iodine-131 using an ion exchange, extraction, precipitation technique followed by counting using a proportional counter. Gamma spectrometry is used to identify the presence of other specific nuclides.}

6.2.4 SAMPLE SIZES

Table 6.2-5 is an estimate of typical sample sizes for radiological analyses. These are approximations and may vary depending on such things as laboratory procedures and methods, available media obtained during sampling, lower limits of detection (LLDs), and split sampling, if applicable.

6.2.5 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM REPORTS

Routine REMP reports are submitted annually to the NRC. The annual REMP report for {Callaway Plant Unit 1 (and will include Callaway Plant Unit 2 as it becomes licensed and operated)} includes summaries, interpretations, and an analysis of trends of the results of the radiological environmental surveillance activities for the report period. The reports also include comparisons with preoperational studies and with operational controls, as appropriate, and with previous environmental surveillance reports, and an assessment of any observed impacts of the plant operation on the environment. The reports also include the results of the land use census for {the operating Units. Either a single joint report covering Callaway Plant Unit 1 and Callaway Plant Unit 2 or individual reports for each unit will be submitted annually and include all data collected and shared between sampling programs.}

6.2.6 QUALITY ASSURANCE PROGRAM

The REMP quality assurance program for {Callaway Plant Unit 2} will be conducted in accordance with Regulatory Guide 4.15, Revision 2 (NRC, 2007).

{The REMP quality assurance program at Callaway Plant Unit 1 is conducted in accordance with Regulatory Guide 4.15, Revision 1 (NRC, 1979a). Site area environmental sampling is conducted so as to be usable for both Unit 1 and Unit 2 REMPs. Therefore, if there is a difference in the quality assurance requirements between the different revisions of RG 4.15 that apply to each REMP, either the most limiting quality assurance requirement will be applied to that sample set, or separate samples will be collected and handled so as to maintain conformity of each REMP with its respective RG 4.15 quality assurance requirements.

The quality assurance program also involves the use of "Interlaboratory Comparison Program" samples and split samples for all parameters listed in Table 6.2-4 (NRC, 1977). The comparisons are reported in annual REMP reports. Since no NRC approved laboratory supplies TLDs as part of a comparison program, no TLDs are analyzed as part of the "Interlaboratory Comparison Program." The nature of TLDs precludes their use in the split sample program.}

6.2.7 REMP MODIFICATIONS FOR {CALLAWAY PLANT UNIT 2}

{The location of Callaway Plant Unit 2 is approximately 1350 ft (411.5 m) northwest of Callaway Plant Unit 1. The center point between the two reactors is 38° 45′ 45.53″ North by 91° 46′ 56.34″ West. Because of the proximity of the two installations, the current radiological monitoring program is adequate to comply with NRC requirements.

The Callaway Plant Unit 1 site REMP and NRC regulations contain no explicit requirements to routinely monitor groundwater onsite near plant facilities. By design, liquid effluents are not released to groundwater or structures that discharge to groundwater, and as such, there is no expected or intended human exposure pathway associated with groundwater for Callaway Plant Unit 2. However, recent nuclear industry initiatives by the Nuclear Energy Institute, the Electric Power Research Institute and NRC assessments (NRC, 2006) of existing nuclear reactors, indicates that guidance documents covering the implementation of NRC regulation 10 CFR 20.1406 (CFR, 2007c) relating to groundwater monitoring for both operating and future nuclear reactors is being developed. Groundwater monitoring near plant facilities will provide an early indication if unexpected releases through system leaks or failures has occurred and is impacting the environment beyond expected pathways. Development of these guidance documents concerning ground water protection are being followed and future requirements will be addressed, as applicable, for inclusion in the Callaway Plant Unit 2 REMP.}

6.2.8 REFERENCES

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CFR, 2007b. Title 10, Code of Federal Regulations, Part 50, Appendix I, Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion 'As Low as is Reasonably Achievable for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, January 2007.

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NRC, 1977. Performance, Testing, and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications, Regulatory Guide 4.13, Revision 1, Nuclear Regulatory Commission, July 1977.

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NRC, 1979b. Branch Technical Position, Revision 1, Radiological Assessment Branch Technical Position Regarding Radiological Environmental Monitoring Programs, Nuclear Regulatory Commission, November 27, 1979.

NRC, 1991. Offsite Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, NUREG-1301, Nuclear Regulatory Commission, 1991.

NRC, 2006. Liquid Radioactive Release Lessons Learned Task Force, Final Report, Nuclear Regulatory Commission, September 1, 2006.

NRC, 2007. Quality Assurance for Radiological Monitoring Programs (Inception Through Normal Operations to License Termination) – Effluent Streams and the Environment Regulatory Guide 4.15, Revision 2, Nuclear Regulatory Commission, July 2007.}

Table 6.2-1—{Effluent Exposure Pathways and Environmental Sampling Media in 2007}

Effluent Exposure Pathways	REMP Sampling Media
Liquid Effluents:	
Ingestion fish (internal indirect)	Commercial and recreational fish species
Ingestion drinking water (internal indirect)	Groundwater from deep well sampling
Shoreline exposure (external direct)	Shoreline Sediments
Ingestion fish/wildlife (internal indirect)	Wetlands soil
Ingestion milk (internal indirect)	Milk Sampling
Swimming & boating (external direct)	Missouri River Surface waters
Gaseous Effluents:	
Ground Radiation (external direct)	TLD
Inhalation (internal direct)	Air particulate sampling, Iodine sampling
Ingestion of agricultural products (internal indirect	Broadleaf vegetation

Table 6.2-2—{Radiological Environmental Monitoring Program for Callaway Plant in 2007}

Exposure Pathway And/Or Sample	Number of Representative Samples and Sample Locations	Sampling and Collection Frequency	Type and Frequency of Analysis
Direct Radiation	43 routine TLD monitoring stations as noted in Table 6.2-3. Three are control stations.	Quarterly – Collect Passive TLD's	TLD Analysis Quarterly
Airborne Radioiodine and Particulates	Samples from 5 locations (A1, A7, A8, A9, and B3) and one indicator location (A9).	Continuous 0.5 cubic feet per minute (0.014 cubic meters per minute) air sampler, using collection filters and adsorption cartridges that are collected weekly for analysis	Radioiodine Canister: I-131 analysis weekly Particulate Sampler: Gross beta radioactivity analysis following filter change. Gamma isotopic analysis of composite (by location) weekly.
Waterborne			
Surface	(Table 6.2-3) Sample collected at indicator location S02, sample at control location S01	Composite(1) Sample over one month period	Gamma Isotopic Analysis(1) monthly. Composite(2) for tritium analysis quarterly
Drinking/ Groundwater	Drinking/groundwater samples collected from two deep sampling wells (F05 and F15) and two deep drinking water supply wells (D01 and PW1).	Well water samples collected quarterly	Samples evaluated for tritium by scintillation counter. Specific nuclides by gamma spectrometry. A chemical separation method followed by a gas flow proportional counting technique is used for Iodine-131 analysis.
Sediment from shoreline	One sample from downstream area with existing or potential recreational value within 2 ft (0.6 m) from shoreline at indicator location (A) and control location (C)	Sediment cores sample -semiannually	Gamma Isotopic Analysis(1) semiannually
Sediment from bottom	One sample at 2-meters depth in general vicinity of shoreline sediment sample locations (A) and (C)	Sediment cores sample - semiannually	Gamma Isotopic Analysis(1) semiannually
Ingestion			
Fish	Samples of the 5 most commercially, and/or recreationally important species (in vicinity of plant discharge area) from one indicator location (C) and one control location (A)	Live samples collected semiannually	Gamma Isotopic Analysis(1) on edible portions.
Food Products	Samples collected in season at monitoring locations V9, V10, V11, and V13 and at control location V12 in season of broad leaf vegetation grown near the Site	As available during growing season: mustard greens, turnip greens, cabbage, lettuce, collards, radish greens, swiss chard, broccoli, and poke. Other broad leaf vegetation is requested and/or collected if the primary varieties are not available.	Gamma isotopic(1) and Iodine-131 analysis.
Milk	Samples collected at location M6 and M13 and at control location M8	As available (i.e. animals are producing milk), one gal (3.8 L) samples collected semimonthly during grazing season (typically April – September) and monthly during winter season.	Gamma isotopic(1) and Iodine-131 analysis.

Notes:

(1) A Gamma Isotopic Analysis is an analytical method of measurement used for the identification and quantification of gamma emitting radionuclides.

(2) A Composite Sample is a combination of individual samples obtained at intervals that are short (e.g., hourly) in relation to the compositing time interval (e.g., monthly) to assure obtaining a representative sample.

Table 6.2-3—{Environmental Monitoring Sites for Callaway Plant in 2007}

(Page 1 of 3)

Sample Site/Type[2]	Sector	Distance[1]		Description
		km	mi	
IDM, 1a	NW	17.4	10.8	City of Fulton on Hwy Z, 0.65 mi (1.06 km) East of Business 54, West of Campus Apartments
IDM, 3	NW	1.9	1.2	0.1 mi (0.16 km), West of Hwy CC on Gravel Road, 0.8 mi (1.3 m) South Hwy O, Callaway Electric Cooperative Utility Pole No. 18559
IDM, 5	ENE	2.1	1.3	Primary Meteorological Tower
IDM, 6	W	3.2	2.0	County Road 428, 1.2 mi (1.9 km) West of Hwy CC, Callaway Electric Cooperative Utility Pole No. 18609
IDM, 7	S	2.3	1.4	County Road 459, 2.6 mi (4.2 km) North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 35097
IDM, 9	S	6.1	3.8	NW Side of the County Road 459 and Hwy 94 Junction Callaway Electric Cooperative Utility Pole No. 06754
IDM, 10	SSE	6.3	3.9	Hwy 94, 1.8 mi (2.9 km) East of County Road 459, Callaway Electric Cooperative Utility Pole No. 12182
IDM, 11a	SE	7.6	4.7	City of Portland, Callaway Electric Cooperative Utility Pole No. 12110
IDM, 14	ESE	7.9	4.9	SE Side of Intersection D and 94, Callaway Electric Cooperative Utility Pole No. 11940
IDM, 17	E	6.1	3.8	County Road 4053, 0.3 mi (0.48km) East of Hwy 94, Kingdom Telephone Company Pole No. 3X12.
IDM, 18a	ENE	6.0	3.7	East side of Hwy D, 0.5 mi (0.81 km) South of O, Callaway Electric Cooperative Utility Pole No. 38579
IDM, 20	NE	7.6	4.7	City of Readsville, Callaway Electric Cooperative Utility Pole No. 12830
IDM, 21	NNE	6.1	3.8	County Road 155, 1.9 mi (3.1 km) North of Hwy O, Callaway Utility Pole No. 19100
IDM, 22a	NNE	3.1	1.9	North Side of Hwy O, 100 ft (45.7 m) East of County Road 150, Callaway Electric Cooperative Utility Pole No. 31094
IDM, 23	NNE	10.6	6.6	City of Yucatan, Callaway Electric Cooperative Utility Pole No. 12670
IDM, 26[3]	E	18.9	11.7	Town of Americus, Callaway Cooperative Utility Pole No. 11159
IDM, 27[3]	ESE	14.9	9.3	Town of Bluffton, Callaway Electric Cooperative Utility Pole No. 11496
IDM, 30a	SSW	7.1	4.4	City of Steedman, N side of Belgian Dr., 150 ft (45.7 m) East of Hwy CC, Callaway Electric Cooperative Utility Pole No. 06557
IDM, 31a	SW	12.6	7.8	City of Mokane, Junction Hwy C and County Road 400, 0.9 mi (1.4 km) North of Hwy 94, Callaway Electric Cooperative Utility Pole
IDM, 32	WSW	8.7	5.4	Hwy VV, 0.6 mi (0.97 km) West of County Road 447, Callaway Electric Cooperative Utility Pole No. 27031
IDM, 32a	WSW	8.0	5.0	County Road 447, Callaway Electric Cooperative Utility Pole No. 06354
IDM, 33	W	11.9	7.4	City of Hams Prairie, SE of Hwy C and AD Junction
IDM, 34	WNW	15.3	9.5	NE Side of Hwy C and County Road 408 Junction
IDM, 35	NNW	9.3	5.8	City of Toledo, Callaway Electric Cooperative Utility Pole No. 17684
IDM, 36	N	7.9	4.9	County Road 155, 0.8 mi (1.3 km) South of County Road 132, Callaway Electric Cooperative Utility Pole No. 19137

Table 6.2-3—{Environmental Monitoring Sites for Callaway Plant in 2007}

(Page 2 of 3)

Sample Site/Type[2]	Sector	Distance[1] km	Distance[1] mi	Description
IDM, 37	SSW	0.8	0.5	County Road 459, 0.9 mi (1.5 km) South of Hwy CC, Callaway Electric Cooperative Utility Pole No. 35077
IDM, 38	NNW	7.4	4.6	County Road 133, 1.5 mi (2.4 km) South of Hwy UU, Callaway Electric Cooperative Utility Pole No. 34708
IDM, 39	NW	8.7	5.4	County Road 111, Callaway Electric Cooperative Utility Pole No. 17516
IDM, 39a	NW	8.0	5.0	County Road 111, Callaway Electric Cooperative Utility Pole No. 17526
IDM, 40	WNW	6.8	4.2	NE Side of County Road 112 and Hwy O, Callaway Electric Cooperative Utility Pole No. 18145
IDM, 41	W	7.9	4.9	Hwy AD, 2.8 mi (4.5 km) East of Hwy C, Callaway Electric Cooperative Utility Pole No. 18239
IDM, 42	SW	7.1	4.4	County Road 447, 2.6 mi (4.2 km) North of County Road 463, Callaway Electric Cooperative Utility Pole No. 06326
IDM, 43	SW	0.8	0.5	County Road 459, 0.7 mi (1.1 km) South of Hwy CC, Callaway electric Cooperative Utility Pole No. 35073
IDM, 44	WSW	2.6	1.6	Hwy CC, 1.0 mi (1.6 km) South of County Road 459, Callaway Electric Cooperative Utility Pole No. 18769
IDM, 45	WNW	1.6	1.0	County Road 428, 0.1 mi (0.16 km) West of Hwy CC, Callaway Electric Cooperative Utility Pole No. 18580
IDM, 46	NNW	2.4	1.5	NE Side of Hwy CC and County Road 466 Intersection, Callaway Electric Cooperative Utility Pole No. 28242
IDM, 47	N	1.6	1.0	County Road 448, 0.9 mi (1.4 km) South of Hwy O, Callaway Electric Cooperative Utility Pole No. 28151
IDM, 48	NE	0.6	0.4	County Road 448, 1.5 mi (2.4 km) South of Hwy O, Plant Security Sign Post
IDM, 49	E	2.6	1.6	County Road 448, Callaway Electric Cooperative Utility Pole No. 06959, Reform Wildlife Management Parking Area.
IDM, 50	SSE	1.4	0.9	County Road 459, 3.3 mi (5.3 km) North of Hwy 94, Callaway Electric Cooperative Utility Pole No. 35086
IDM, 51a	SE	0.5	0.3	Owner Control Fence, SE of the Water Treatment Plant
IDM, 52	ESE	0.6	0.4	Light Pole Near the East Plant Security Fence
IDM, 60[3]	SW	21.7	13.5	Callaway Electric Cooperative Utility Pole No. 43744 just past Tebbetts City sign
APT, AIO, A1	ENE	2.1	1.3	Primary Meteorological Tower
APT, AIO, A7	NW	15.3	9.5	C. Bartley Farm
APT, AIO, A8	NNE	1.4	0.9	County Road 448, 0.9 mi (1.4 km) South of Hwy 0
APT, AIO, A9	NNW	3.1	1.9	Community of Reform
APT, AIO, B3	NNW	2.9	1.8	0.3 mi (0.48 km) East of the O and CC Junction, Callaway Electric Cooperative Utility Pole No. 50422
WWA, D01	SE	8.0	5.0	Holzhouser Grocery Store/Tavern (Portland, MO)
WWA, F05	SSE	1.4	0.9	Onsite Groundwater Monitoring Well
WWA, F15	NNE	0.6	0.4	Onsite Groundwater Monitoring Well
WWA, PW1		0.0	0.0	Callaway Cafeteria
MLK, M6	NW	4.1	2.6	Pierce's Farm (Cow's Milk)
MLK, M8[3]	WSW	30.1	18.7	Kissock's Farm, South of New Bloomfield, MO (Cow's Milk)
MLK, M13	SSE	4.07	2.53	Miller's Farm, located on Highway 448
SOL, V3[3]	SW	24.1	15.0	Beazley Farm, West of Tebbetts, MO

Table 6.2-3—{Environmental Monitoring Sites for Callaway Plant in 2007}

(Page 3 of 3)

Sample Site/Type[2]	Sector	Distance[1] km	Distance[1] mi	Description
FPL, V9	WNW	3.2	2.0	Meehan Farm
FPL, V10	SSW	5.5	3.4	Brandt Farm
FPL, V11	NW	5.1	3.2	Hickman Farm
FPL, V12[3]	WSW	30.1	18.7	Kissock's Farm, South of New Bloomfield, MO
FPL, V13[4]	W	3.3	2.02	Buchholz's Farm County Road 428, 1.2 mi (1.9 km) West of Hwy CC
AQS, AQF, A[3], [5]	SSE	7.9	4.9	0.6 River Miles (1 km) Upstream of Discharge North Bank
AQS, AQF, C[5]	SE	7.9	4.9	1.0 River Miles (1.6 km) Downstream of Discharge North Bank
SWA, S01[3]	SSE	7.6	4.7	105 feet Upstream of Discharge North Bank
SWA, S02	SE	7.9	4.9	1.1 River Miles (1.8 km) Downstream of Discharge North Bank
SOL, F2	SW	2.64	1.64	Callaway Plant Forest Ecology Plot F2
SOL, F6	NE	2.77	1.72	Callaway Plant Forest Ecology Plot F6
SOL, PR3	ESE	1.64	1.02	Callaway Plant Prairie Ecology Plot PR3
SOL, PR7	NNW	0.72	0.45	Callaway Plant Prairie Ecology Plant PR7
SOL, W4	SSE	1.09	0.68	Callaway Plant Wetlands, SW Bank
SOL, W2	SSE	0.97	0.60	Callaway Plant Wetland, Inlet Area
SOL, W1[3]	SE	0.98	0.61	Callaway Plant Wetlands, High Ground
SOL, W3	SSE	1.16	0.72	Callaway Plant Wetlands, Discharge Area
WWA, GWS[4]	N/A	0.0	0.0	Ground Water Sump, Plant East of containment and Spent Fuel Pool Bldg.
WWA, 936[4]	N/A	0.0	0.0	Diesel Fuel Remediation Well, Plant SE of Spent Fuel Pool Bldg.
WWA, 937C[4]	N/A	0.0	0.0	Monitoring Well, Plant East of Radwaste Building Drum Storage
WWA, 937D	N/A	0.0	0.0	Monitoring Well, Plant South of Discharge Monitor Tanks

Notes

(1) All distances are measured from the midpoint between Callaway Plant Unit 1 Reactor and Callaway Plant Unit 2 Reactor as described in Final Safety Analysis Report (FSAR) Section 2.1.1.1.

(2) AIO= Air Iodine, APT= Air Particulate, AQF = Fish, AQS = Sediment, FPL = Leafy Green Vegetables, GWS= Ground Water Sump, IDM= TLD, MLK = Milk, SOL= Soil, SWA = Surface Water, WWA=Ground Water.

(3) Control Location

(4) New REMP location starting in 2005.

(5) The fish collection area for location "A" is between 0.6 and 3.0 river miles (0.96 km and 4.8 km) upstream of the plant discharge on the north bank and for location "C" is between discharge area and 1.5 miles downstream of the discharge on the north bank. The expanded collection areas are needed to guarantee there is sufficient habitat for sampling to ensure the ability to collect the required number of fish species.

Table 6.2-4—{Lower Limits of Detection (LLD) for Environmental Media}

Direct Radiation	Parameter	Units	Frequency	LLD
Direct Radiation:	Gamma Dose	mR	At Least Quarterly	See Note (1)
Airborne Activity:				
Radioiodine Canister	I-131	pCi/m^3	At Least Weekly	0.07
Particulate Filter	Gross Beta Activity	pCi/m^3	At Least Weekly	0.01
	Cs-134	pCi/m^3	At Least Quarterly	0.05
	Cs-137	pCi/m^3	At Least Quarterly	0.06
Waterborne Activity:				
Surface Water Sample	H-3	pCi/l	At Least Quarterly	2000
	Mn-54	pCi/l	At Least Monthly	15
	Fe-59	pCi/l	At Least Monthly	30
	Co-58	pCi/l	At Least Monthly	15
	Co-60	pCi/l	At Least Monthly	15
	Zn-65	pCi/l	At Least Monthly	30
	Zr-95/Nb-95	pCi/l	At Least Monthly	15
	I-131	pCi/l	At Least Monthly	1
	Cs-134	pCi/l	At Least Monthly	15
	Cs-137	pCi/l	At Least Monthly	18
	Ba-140/La-140	pCi/l	At Least Monthly	15
Shoreline Sediment Sample	Cs-134	pCi/kg, dry	At Least Semiannually	150
	Cs-137	pCi/kg, dry	At Least Semiannually	180
Ingestible Activity:				
Fish and Invertebrates	Mn-54	pCi/kg, wet	See Note (2)	130
	Fe-59	pCi/kg, wet	See Note (2)	260
	Co-58	pCi/kg, wet	See Note (2)	130
	Co-60	pCi/kg, wet	See Note (2)	130
	Zn-65	pCi/kg, wet	See Note (2)	260
	Cs-134	pCi/kg, wet	See Note (2)	130
	Cs-137	pCi/kg, wet	See Note (2)	150
Milk	I-131	pCi/l	At Least Monthly(3)	1
	Cs-134	pCi/l	At Least Monthly(3)	15
	Cs-137	pCi/l	At Least Monthly(3)	18
	Ba-140/La-140	pCi/l	At Least Monthly(3)	15
Food Products	I-131	pCi/kg, wet	At Least Monthly(4)	60
	Cs-134	pCi/kg, wet	At Least Monthly(4)	60
	Cs-137	pCi/kg, wet	At Least Monthly(4)	80

Notes:

(1) LLD for Thermoluminescent Dosimeters (TLDs) used for environmental measurements shall be in accordance with the recommendations of Regulatory Guide 4.13 (NRC, 1977).
(2) The fish and invertebrates shall be sampled at least once per year in season, or semiannually if they are not seasonal.
(3) The milk samples need be collected and analyzed only if the milk is commercially available in quantities greater than 130 liters (34 gal) per year.
(4) The food products shall be sampled during the growing season.

Table 6.2-5—{Typical Sample Sizes for Environmental Media}

Media	Approximate Weight/Volume (1)
Air Particulate	142.7 m^3 (5040 ft^3) /weekly sample
Charcoal Filter	142.7 m^3 (5040 ft^3) /weekly sample
Surface Water (River)	1 gallon (3.8 liters) x 2 (Note (1))
Fish	5 species
Milk	1 gallon (3.8 liters)
Green Leafy Vegetation	0.5 – 1 kg (1.1 – 2.2 lbs)
Drinking/Groundwater	1 gallon (3.8 liters) x 2 (Note (1))
Sediment (shoreline and bottom)	2 each – 6″ diameter x 2″ deep sediment plugs
Soil	1 – 2 kg (2.2 – 4.4 lb)

Notes:

The sample sizes in this table are representative of the approximate sizes needed. These may vary depending on the LLD of the isotopes being measured and other laboratory and analysis specific quality assurance requirements.

(1) One gallon (3.8 liters) is needed for gamma spectrometry/tritium analysis ONLY. An additional gallon (3.8 liters) is required for a gross beta analysis.

Figure 6.2-1—{Distant Collection Locations}

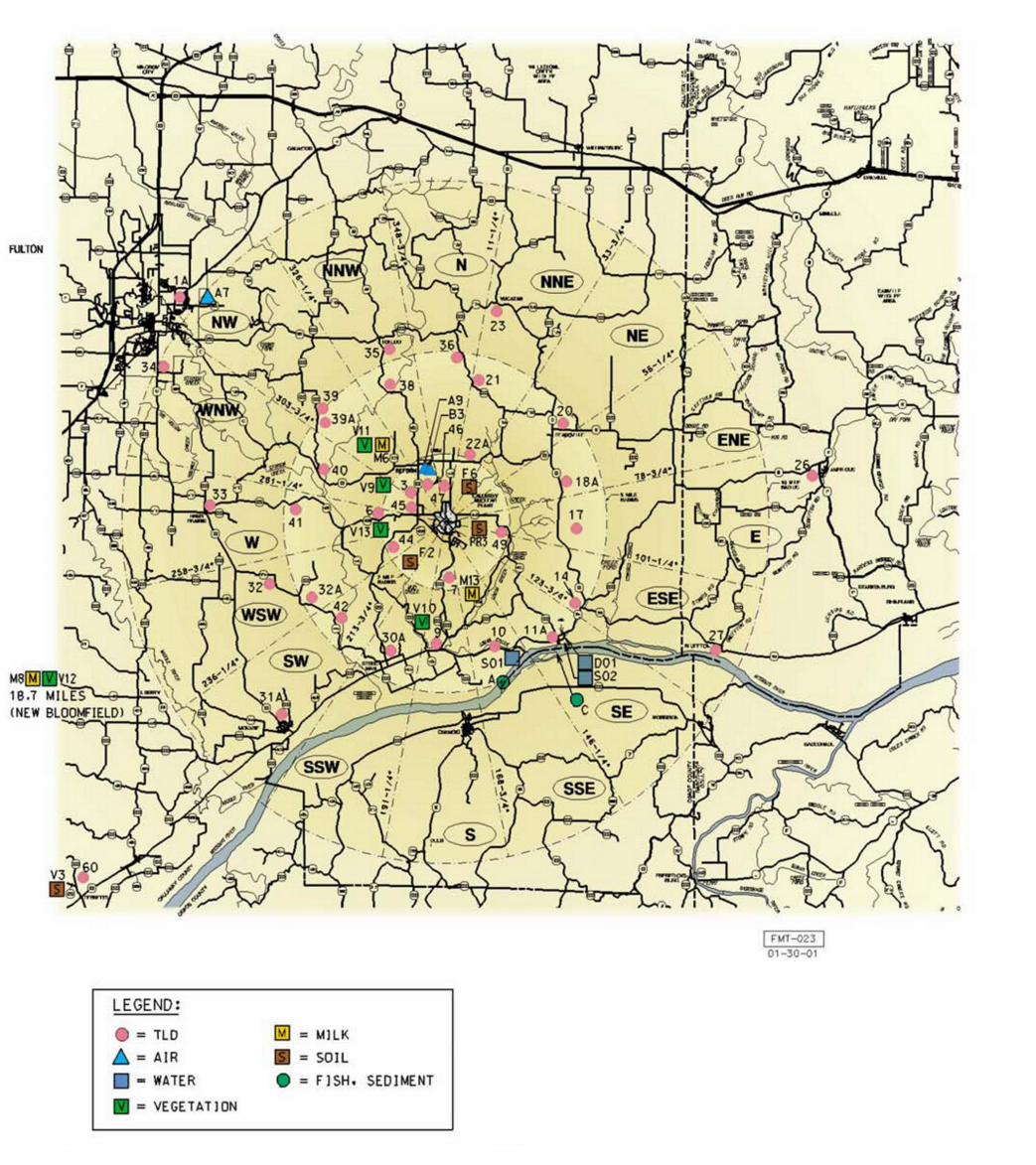
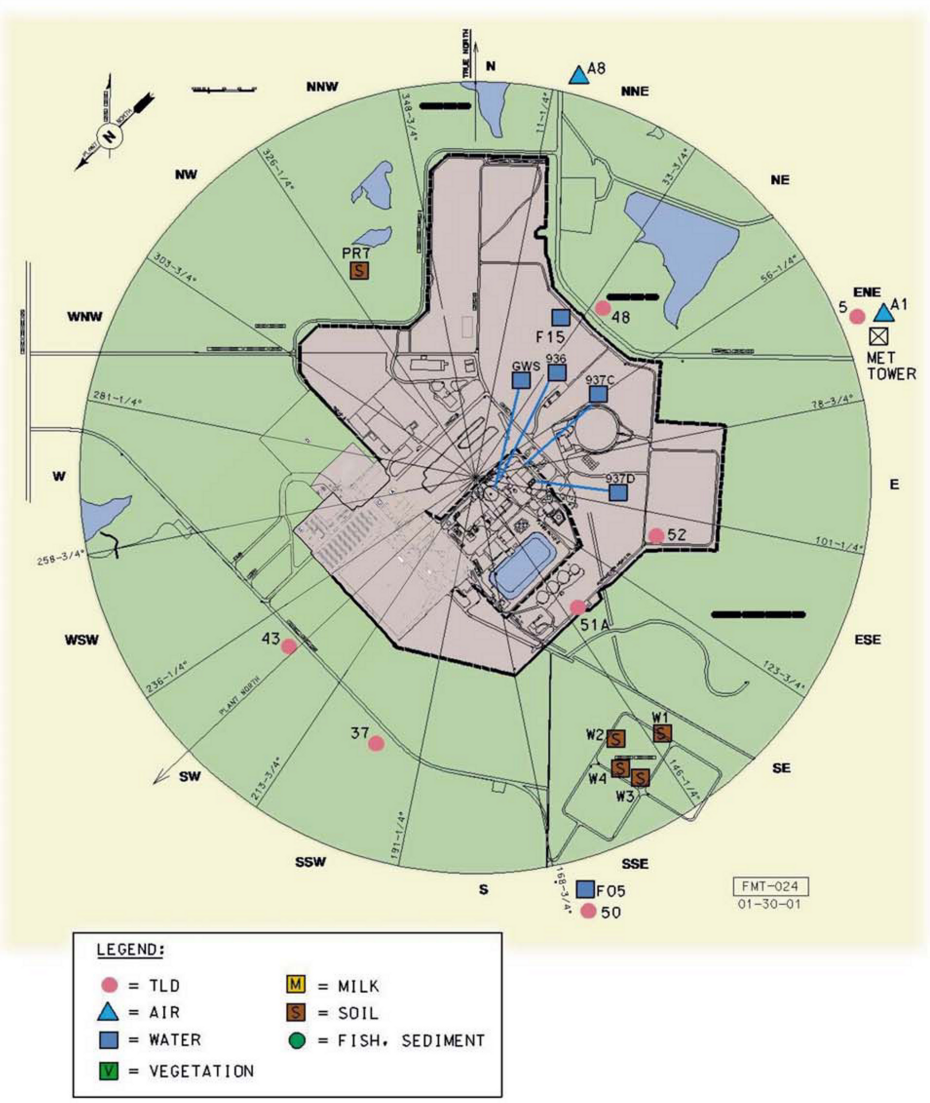


Figure 6.2-2—{Near Site Collection Locations}



4

6.3 HYDROLOGICAL MONITORING

This section describes the hydrological monitoring program that will be implemented to monitor the effects of the {Callaway Plant Unit 2}. Elements of the hydrological program relating to thermal, radiological, and chemical monitoring are described separately in Section 6.1, Section 6.2, and Section 6.6, respectively.

This section includes the pre-application monitoring program that discusses the {hydrological monitoring program at the Plant and the} programs to monitor {Callaway Plant Unit 2} during the construction/pre-operational and operational phases.

Section 2.3.1 describes the vicinity watershed and stream flow data collected by the U.S. Geological Survey, the {Missouri DNR, and AmerenUE}. Groundwater velocities, flow rates and sediment transport characteristics and shore erosion are discussed in Section 2.3.1. Section 2.3.2 describes surface and groundwater uses. Features of the {Callaway} site, including boundaries and bathymetry of all surface water bodies adjacent to the site are provided in FSAR Section 2.1.1 and Section 2.3.1. {The location of groundwater monitoring wells is provided onFigure 2.3-22 and Figure 2.3-23 (for the site investigation area). Figure 2.3-63 shows the locations of public and private wells within the hydrogeologic study area, including production wells onsite. Table 2.3-30 lists public, private and groundwater monitoring wells in Callaway and Osage Counties. Table 2.3-30 provides the MDNR monitoring well network. The thermal and biological monitoring stations are discussed in Section 6.1 and Section 6.6 for surface water.} No thermal or biological monitoring stations exist for groundwater and none are planned. Figures showing major geomorphic features and regional geology are shown in Section 2.3.1 and Section 2.6.

6.3.1 PRE-APPLICATION MONITORING

{Hydrological monitoring at the Callaway site includes both surface water and groundwater. Both monitoring programs comply with and are controlled by regulatory permit requirements and conditions as described below.}

6.3.1.1 Surface Water

{Callaway Plant Unit 1 conducts hydrological monitoring of surface water in accordance with the National Pollutant Discharge Elimination System (NPDES) program (MDNR, 2003). Flows from storm water and plant-associated activities such as equipment blowdown and various system effluents are measured at different monitoring locations. Table 6.3-1 lists the monitoring locations and the permit requirements. Refer to Section 6.6 for a description of the monitoring locations as well as the NPDES monitoring program data analysis and quality control procedures.

The field investigation for Callaway Plant Unit 2 was based on the local hydrogeological description and conceptual model developed for the Callaway Plant Unit 1 Final Safety Analysis Report (FSAR) (AmerenUE, 2003). The following text is summarized from that report. The site sits on a plateau at an approximate elevation of 840 ft to 850 ft (256 m to 259 m) mean sea level and serves as the headwater area for four sub-watersheds. Unnamed, upland dendritic streams drain away from the plateau toward Logan Creek, Mud Creek, Cow Creek and Auxvasse Creek, all of which ultimately drain to the Missouri River. The elevation of the Missouri River in the vicinity of the site is approximately 525 ft (160 m) msl, which indicates that the topographic relief of the area is approximately 315 ft to 325 ft (96 m to 99 m).

Twenty eight surface water locations were gauged for surface water elevation, flow velocity, depth, and flow rate, as well as field water quality parameters in conjunction with the Callaway Plant Unit 2 field investigation. These locations can be grouped as follows:

- Auxvasse Creek stream gauges (SG-A1 through SG-A5)
- Logan Creek stream gauges (SG-L1 through SG-L4)
- Mud Creek stream gauges (SG-M1 through SG-M5)
- Left Branch stream gauges (SG-L1 and SG-L2)
- Pond gauges (PG-1 through PG-10)
- Lake gauges (LG-1 through LG-3)

Locations of these surface water monitoring locations are shown on Figure 2.3-22 and Figure 2.3-23. The streams were monitored to evaluate the interaction of surface water with the Cotter-Jefferson City aquifer groundwater along the study area boundary. Many of these monitoring locations were monitored by utilizing surveyed reference points at bridge crossings. Pond gauges were installed to evaluate the interaction of surface water with the chert aquifer groundwater on the plateau. The lake gauges were installed to monitor surface water elevations in the large lakes north of the site. Results of the monitoring are discussed in Section 2.3.1}

6.3.1.2 Groundwater

{The Callaway site has three deep wells, of which one is in use to supply potable water within the Callaway Plant Unit 1 protected area. Section 2.3.2.2 describes the well locations and withdrawal volumes.

Thirty-six monitoring wells were installed for the Callaway Plant Unit 2 hydrogeological field investigation. The wells are divided into five groups:

- 11 shallow wells (designated with the suffix "S" if part of a well cluster) on the plateau are screened within or primarily within the Graydon chert. PW-1 and MW-18 are centrally located for Callaway Plant Unit 2; MW-8 through MW-12 are located radially outward from the central part of the plateau; and MW-2S, MW-3S, MW-5S, and MW-6S are located radially further outward near the perimeter of the plateau. At MW-2S, the well is screened above the chert due to saturated groundwater over a consistent section at this location. At MW-18, the top of the well screen is placed partially in glacial till for the same reason. A shallow well planned for the MW-4S location was not installed due to field conditions (refer to 2.3.1.2 for more detail).
- one intermediate well (designated with the suffix "I") as part of a cluster centrally located on the plateau is screened within the aquitard (MW-1I).
- 7 deep wells (designated with the suffix "D") on the plateau are screened within the Cotter-Jefferson City aquifer. MW-1D through MW-3D, MW-5D, and MW-6D are paired with shallow wells. MW-7D is located on a separate plateau northwest of the site.
- 7 shallow wells along the study boundary are screened within the Cotter-Jefferson City aquifer. MW-13 through MW-17, PW-2, and PW-3 are located downgradient of the

plateau near surface water boundaries. There are 6 additional piezometers (three each at the pumping wells PW-2 and PW-3) that were used as observation wells during pumping tests.

- 10 wells on the Missouri River floodplain are screened within the Missouri River alluvial aquifer. FMW-1S and FMW-1D is a cluster of two wells screened in the alluvial and Cotter-Jefferson City aquifers, respectively. FMW-5 through FMW-12 are screened in the deeper portion of the alluvial aquifer. There were 5 additional soil borings logged at FSB-2 through FSB-4, FSB-13, and FSB-14.

Locations of these groundwater monitoring locations appear on Figure 2.3-22 and Figure 2.3-23. Water levels in the monitoring wells were measured to characterize flow directions as well as seasonal trends. Monthly pre-application water level monitoring of these wells began in March 2007 and were concluded in February 2008. Field parameters for water quality were measured on a seasonal basis in June, August, and November 2007, and January 2008. Monitoring results are discussed in Section 2.3.1.}

6.3.2 CONSTRUCTION AND PRE-OPERATIONAL MONITORING

{Hydrological monitoring during Callaway Plant Unit 2 construction will include both surface water and groundwater. Both monitoring programs will comply with regulatory permit requirements and conditions described below. The objective of each program will be to establish a baseline for evaluating potential hydrologic changes, monitor anticipated impacts from site preparation and construction, and detect unexpected impacts.}

6.3.2.1 Surface Water

Surface water onsite will be monitored as part of the NPDES Construction General Permit as described in Section 1.3. Conditions of the permit will include compliance with erosion/sediment control and storm water management plans, which will be detailed in a required Storm Water Pollution Prevention Plan (SWPPP). The SWPPP also requires inspections as well as monitoring and record keeping.

In addition, {Missouri River} surface water will be monitored during {refurbishment of the Barge Unloading Facility, if required.} Monitoring will be part of the U.S. Corps of Engineers 401 permit as described in Section 1.3 to ensure compliance with applicable water quality (e.g., turbidity) and sediment transport requirements.

6.3.2.2 Groundwater

Groundwater monitoring during {Callaway Plant Unit 2} construction will include, as needed, data from groundwater observation wells installed across the {Callaway} site as part of COL pre-application studies described in Section 2.3.1.2. The purpose will be to monitor the potential effects of dewatering on groundwater levels.

{Some of the existing Callaway Plant Unit 2 area observation wells will be taken out of service prior to construction activities due to anticipated earth moving and construction requirements. Prior to construction activities, the observation well monitoring network will be evaluated in order to determine groundwater data gaps and needs created by the abandonment of existing wells. These data needs will be met by the installation of additional observation wells, if required. Revisions to the observation well network will be implemented as necessary to monitor changes in the local groundwater regime from construction activities.}

Disturbances to existing drainage systems will be avoided to the extent possible. {One existing stormwater runoff pond (P-4) along with three isolated ponds (C3-WT-02, C3-WT-03, and C4-WT-02) will be filled during the construction of the new Laydown Area as shown. Two new unlined stormwater runoff ponds, A and B, will receive discharge from the Laydown Area, as indicated on Figure 2.3-3, and will drain to the adjacent streams discharging to Cow Creek. Additional details of necessary changes to the storm water management system are discussed in Section 2.3-1. Existing and future stormwater runoff ponds are designed for the 100-yr flood. Environmental controls (i.e., silt screens, dams, settling basins, and spill containment measures), will be implemented to reduce potential pollutants in storm water runoff and to minimize construction impacts to aquatic habitats. Prior to the start of construction, approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit as described in Section 1.3. }

6.3.3 OPERATIONAL MONITORING

Hydrological monitoring during {Callaway Plant Unit 2} operation will be designed, as needed, to monitor the potential impacts from plant operation as well as detect unanticipated operational impacts.

{During Callaway Plant Unit 2 operation, the principal plant water supply will be from the Missouri River/Missouri River Alluvial Aquifer (Aquifer) using a Collector Well River Intake System. The existing deep well will provide water needs for Demineralizer System makeup, potable water and fire water. Discharge of effluents to the Missouri River from Callaway Plant Unit 2 operation will require monitoring as discussed in Section 6.6.

Sewage and cafeteria wastewater generated from the portions of the Callaway Plant Unit 2 plant outside the radiological control areas of the power block will be treated in the existing three cell lagoon system. These lagoons are designed to provide unaided natural biological activity for treating wastewater in compliance with State standards. The sewage from Callaway Plant Unit 2 will be combined with the sewage and miscellaneous waste water (i.e. cafeteria waste) from Callaway Plant Unit 1 and delivered to the sewage treatment lagoons via a common lift station. Segregation, administration, and engineering control measures in place at Callaway Plant Unit 1 will be implemented similarly throughout Callaway Plant Unit 2 to exclude materials that could impact the performance of the treatment system.

Effluent from the sewage treatment lagoons is pumped to sludge lagoon wetlands adjacent to the sewage lagoons via a separate lift station. Water quality discharged from the sludge lagoon wetland system is monitored in accordance with the current NPDES permit requirements. Permit requirements are presented in Table 6.3-1. No changes to the system capacity or limitation are anticipated as a result of the construction of Callaway Plant Unit 2.

Non-radioactive liquid effluents that could potentially drain to area water bodies are limited under the NPDES permit. It is anticipated that the list of permitted outfalls including Callaway Plant Unit 2 will be as shown in Table 6.3-1. Table 3.6-1 provides information on the various chemicals anticipated to be used for the various plant water systems. Chemical additives will have limiting discharge concentrations specified in the NPDES permit that will require monitoring. It is anticipated that the permitted concentrations will be unchanged from those provided in Table 6.3-1 for Callaway Plant Unit 1.}

Chemical monitoring will be performed at the {outfalls in accordance with NPDES permit requirements} to assess the effectiveness of effluent treatment systems, as well as to detect changes in water quality associated with plant operations. {Similar to Callaway Plant Unit 1,} chemical monitoring will also be performed at {storm water runoff} outfalls and at internal

monitoring points (i.e., sanitary waste effluents, wastewater retention basin influent and/or effluent). Effluent water chemistry will meet applicable Federal and State environmental regulatory requirements.

6.3.4 REFERENCES

{**Ameren 2003,** AmerenUE Final Safety Analysis Report (FSAR), Rev. OL-13, Section 2.4.1, May 2003.

MDNR, 2003, Missouri Department of Natural Resources, Missouri Clean Water Commission, Missouri State Operating Permit MO-0098001 Effective date October 3, 2003.}

Table 6.3-1—{Callaway Plant Unit 1 NPDES Hydrological Monitoring Program in 2007}

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Monitoring Station	Description	Parameter	Measurement	Sample Type	Units	Final Effluent Limits		
						Daily Max	Weekly Avg	Monthly Avg
001	Radwaste Treatment System	Flow	Once/daily each batch	Each batch total	MGD	*		*
		Boron, total recoverable	Once/daily each batch	Grab	mg/L	*		*
		Total Suspended Solids	Once/daily each batch	Grab	mg/L	45		30
		Oil and Grease	Once/month	Grab	mg/L	20		15
		BOD	Once/month	Grab	mg/L	*		*
		pH	Once/daily each batch	Grab	SU	**		**
		Total residual chlorine	Once/month	Grab	µg/L	190		*
002	Cooling Tower Blowdown	Flow	Once/day	24 hr total	MGD	*		*
		Total Suspended Solids	Once/week	Grab	mg/L	*		*
		Total Dissolved Solids	Once/week	Grab	mg/L	*		*
		Oil and Grease	Once/quarter***	Grab	mg/L	20		15
		Temperature	Once/day	Grab	F	110		*
		pH	Continuous	24 hr. recorder	SU	****		****
		Sulfate	Once/quarter***	Grab	mg/L	*		*
		Total residual chlorine	Once/day	Grab	µg/L	190		
003	Water Treatment Plant	Flow	Once/week	24 hr total	MGD	*		*
		Total Suspended Solids	Once/month	Grab	mg/L	100		30
		Oil and Grease	Once/month	Grab	mg/L	20		15
		Total residual chlorine	Once/month	Grab	µg/L	190		*
		pH	Once/month	Grab	SU	**		**
004	Demineralizer System Wastes	Included under Outfall 003						
007	3 Cell Flow Through Lagoon	Flow	Once quarter***	24 hr. estimate	MGD	*		*
		BOD	Once/quarter***	Grab	mg/L		65	45
		Total Suspended Solids	Once/quarter***	Grab	mg/L		110	70
		pH	Once/quarter***	Grab	SU	**		**
009	Intake Heater Blowdown	Flow	Once/week when discharging	24 hr total	MGD	*		*
		Total Suspended Solids	Once/week when discharging	Grab	mg/L	100		30
		Oil and Grease	Once/week when discharging	Grab	mg/L	20		15
		pH	Once/week when discharging	Grab	SU	**		**

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Table 6.3-1—{Callaway Plant Unit 1 NPDES Hydrological Monitoring Program in 2007}

(Page 2 of 2)

Monitoring Station	Description	Parameter	Measurement	Sample Type	Units	Final Effluent Limits		
						Daily Max	Weekly Avg	Monthly Avg
010 - 015	**Storm Water Runoff**	Flow	Calculated from rainfall records or measured	24 hr total	MGD	*		*
		Total Suspended Solids	Once/quarter***	Grab	mg/L	*		*
		Oil and Grease	Once/quarter***	Grab	mg/L	20		15
		COD	Once/quarter***	Grab	mg/L	*		*
		pH	Once/quarter***	Grab	SU	******		******
016	**Cooling Tower Bypass**	Flow	Once/quarter***	24 hr estimate	MGD	*		*
		Total Suspended Solids	Once/quarter***	Grab	mg/L	100		30
		Oil and Grease	Once/quarter***	Grab	mg/L	20		15
		Total residual chlorine	Once/quarter***	Grab	µg/L	190		*
		pH	Once/quarter***	Grab	SU	**		**
017	**Ultimate Heat Sink**	No Discharge Outfall						

Notes:

Annual Whole Effluent Toxicity Test on 24-hour composite of Outfalls 001, 002, 003, 007, 009, and 016

* Monitoring requirement only.

** pH is measured in pH units and is not to be averaged. The pH is limited to the range of 6.0 - 9.0 pH units.

*** Sample once per quarter in the months of February, May, August, and November.

**** Permittee shall maintain the pH between 6.0 – 9.0 except excursions from the range are permitted subject to the following limitations:

1. The total time during which the pH values are outside the required range of pH values shall not exceed 7 hours and 26 minutes in any calendar month; and
2. No individual excursion from the range of pH values shall exceed 60 minutes.

Monitoring reports shall show each excursion, the duration of the excursion, and the total excursion time for each month. Should the continuous monitor fail for any reason, daily grab samples shall be provided until repairs are completed.

***** Discharge quantities can be calculated from rainfall records for the reporting period or measured during each discharge event.

****** pH is measured in pH units and is not to be averaged. The pH is to be maintained at or about 6.0 pH units.

Additional Notes
Flow values shown as Daily Average/Daily Maximum
Values for Average Rainfall/10 year return storm event

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6.4 METEOROLOGICAL MONITORING

This section describes the meteorological monitoring programs implemented for the {Callaway Plant Unit 2}. It includes the {pre-application monitoring program, the} pre-operational meteorological monitoring program, and the operational monitoring program consisting of {a continuation of the existing meteorological monitoring program for Callaway Plant Unit 1}. There are no unusual circumstances anticipated during site preparation and construction that require additional meteorological monitoring, {however, meteorological data collection will continue during this period in support of Callaway Plant Unit 1 operations.}

{Callaway onsite meteorological data were used as described below.} The other source of meteorological data used was from the U.S. National Weather Service (NWS). These data are certified by the National Climatic Data Center (NCDC, 2007). {As such, a description of the data collection program is not included. No other sources of data were used.

The meteorological conditions of the Callaway site and the surrounding area are taken into account by using onsite (Callaway) and offsite (NWS) data sources. The onsite meteorological program, which has been collecting data since the 1970s, provides an extensive data base for pre-application monitoring.}

6.4.1 PRE-APPLICATION METEOROLOGICAL MEASUREMENT PROGRAM

{While meteorological data has been collected since the 1970s, data representing the most recent three years were used to define the pre-application program. The 2004 through 2006 pre-application meteorological measurement program described herein for Callaway Plant Unit 2 utilized the operational meteorological measurement program and equipment established for Callaway Plant Unit 1. Data from the Callaway Plant Unit 1 operational meteorological measurement program were used in this analysis for Callaway Plant Unit 2. Callaway Plant Unit 2 is to be located approximately 1,350 ft (410 m) northwest of Callaway Plant Unit 1.

This program was designed and maintained in accordance with the guidance provided in Safety Guide 23, "Onsite Meteorological Programs" (NRC, 1972). Deviations from Safety Guide 23 are discussed in Section 6.4.1.7.}

6.4.1.1 Tower Location

{The meteorological tower for the Callaway site is located in an open field approximately 1.4 miles (2.3 km) east-northeast of Callaway Plant Unit 1. The tower is on a plateau that has flat to undulating terrain. The elevation at the base of the tower is approximately 824 ft (251 m) above mean sea level.

Figure 6.4-1 shows the location of the meteorological tower as well as the topography of the Callaway site. The meteorological tower has been sited for Callaway Plant Unit 1 according to the guidance provided in Safety Guide 23 (NRC, 1972). Figure 6.4-2 shows the general topographic features within 5 miles (8 km) of the Callaway site.

The meteorological tower is located on level, open terrain at a distance equal to at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement. The tower is located far enough away from Callaway Plant Unit 2 structures and topographical features to avoid airflow modifications. The terrain height difference between the meteorological tower and the Callaway Plant Unit 2 reactor area is approximately 16 ft (5 m). The distance between the meteorological tower and the Callaway Plant Unit 2 reactor is

approximately 7,500 ft (2,290 m). Therefore, the terrain profile has a very gentle slope and has an insignificant impact on site dispersion conditions.}

6.4.1.2 Tower Design

{The meteorological tower is a Rohn Series 80, 195 ft (59 m) tall structure with a lattice frame. Data from instruments on the tower are sent to a meteorological shed which is located 92 ft (28 m) from the tower base.

The meteorological tower is designed to be capable of withstanding wind speeds of up to 70 mph (31.3 m per sec).}

6.4.1.3 Instrumentation

{The tower instrumentation formerly consisted of wind speed, wind direction, and aspirated temperature sensors located at 296 ft (90 m), 197 ft (60 m) and 33 ft (10 m) above ground level. A dew point temperature instrument was located at 33 ft (10 m) and 296 ft (90 m) and a tipping bucket rain gauge was located approximately 35 ft (10.6 m) east of the meteorological shed in a small fenced enclosure. See Section 6.4.2.3 for a description of modifications to the tower and associated instrumentation.

The specifications of the instrumentation met or exceeded the accuracy and resolution requirements of Safety Guide 23 (NRC, 1972). The instruments were positioned on the meteorological tower in accordance with the guidance in Safety Guide 23 (NRC, 1972). Table 6.4-1 provides the meteorological instrument accuracy and resolution and compares them with regulatory guidance provided in Safety Guide 23 (NRC, 1972).

To ensure the desired 90% data recovery, both analog and digital data recording systems were installed at the meteorological tower. Wind speed and direction from 33 ft, 197 ft and 296 ft (10 m, 60 m and 90 m) were recorded on strip chart recorders. Ambient temperature, dew point temperature, vertical temperature differences, shed temperature and precipitation were also recorded. Meteorological measurements (5-second values) were transmitted via telephone lines to the plant computer and averaged over 15-minute and hourly intervals. These 15-minute and hourly averages were displayed in the control room and stored in the plant computer.}

6.4.1.4 Instrument Maintenance and Surveillance Schedules

{The meteorological instruments were inspected and serviced at a frequency that assured at least a 90% data recovery rate for all parameters, including the combination of wind speed, wind direction, and delta temperature. The instrumentation specified in Safety Guide 23 (NRC, 1972) were channel checked on a daily basis and instrument calibrations were performed semi-annually.

System calibrations encompassed the entire data channel for each instrument, including recording devices and displays (those located at the tower, in emergency response facilities, and those used to compile the historical data set). The system calibrations were performed by either a series of sequential, overlapping, or total channel steps.}

6.4.1.5 Data Reduction and Compilation

{Wind and temperature data were averaged over 15-minute and hourly periods. The plant computer employs a validation that monitors the various sensors and activates flags as

necessary. The validation compared the data values from the 33 ft (10 m), 197 ft (60 m) and 296 ft (90 m) levels of the tower with an expected range of values for each parameter.

Averaged data values from the plant computer were collected by the meteorological software, along with wind direction variance (sigma-theta). Hourly data values were determined from the 15-minute averaged values. Output options included various functions and averages as well as graphical displays.

The 15-minute averaged data were available for use in the determination of magnitude and the continuous assessment of the impact of releases of radioactive materials to the environment during a radiological emergency (as required in 10 CFR 50.47 (CFR, 2007a) and 10 CFR 50 Appendix E (CFR, 2007b)). The hourly averaged data were available for use in:

1. Determining radiological effluent release limits associated with normal operations to ensure these limits are met for any individual located offsite.

2. Determining that radiological dose consequences of postulated accidents meet prescribed dose limits at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ).

3. Evaluating personnel exposures in the control room during radiological and airborne hazardous material accident conditions.

4. Determining compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable.

5. Determining compliance with dose limits for individual members of the public.

Annual summaries of meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class were maintained onsite and are available upon request.

A summary of the 2004 through 2006, onsite meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class is presented in Section 2.7.

Wind roses (graphical depictions of joint frequency distribution tables) summarizing data from 2004 to 2006, for five National Weather Service (NWS) sites are also presented in Section 2.7.

A comparison of the Callaway site and the Columbia, MO, data (of the five NWS sites, the Columbia, MO, site is closest to the Callaway site) reveals that both sites have the same general prevailing wind direction, southerly, with the actual prevailing wind direction of winds from the south-southeast at the Callaway site and winds from the south at Columbia. For the south-southeast wind direction, the wind speed is between 4.7 mph and 15.6 mph (2.1 mps and 7.0 mps) approximately 8% of the time at the Callaway site and the wind speed is between 4.7 mph and 15.6 mph (2.1 mps and 7.0 mps) approximately 11% of the time at the Columbia, Missouri site. The most prevalent wind speed class at the Callaway site, 11.4 mph to 15.6 mph (5.1 mps to 7.0 mps), occurs approximately 32% of the time. The most prevalent wind speed class at the Columbia, Missouri, site, 6.9 mph to 11.2 mph (3.1 mps to 5.0 mps), occurs approximately 47% of the time. These results indicate that the Callaway onsite data also represent long-term conditions at the site.}

6.4.1.6 NEARBY OBSTRUCTIONS TO AIR FLOW

{Downwind distances from the meteorological tower to nearby (within 0.5 mile (0.8 km)) obstructions to air flow were determined using U.S. Geological Survey topographical maps. There are no obstructions to the meteorological instrumentation within 0.5 mile (0.8 km).

From the information provided in Figure 6.4-1 and Figure 6.4-2 and with the knowledge that the base of the tower is at an elevation of approximately 824 ft (251 m), it can be seen that there are no significant nearby obstructions to airflow.}

6.4.1.7 Deviations to Guidance from {Safety Guide 23

The pre-application meteorological monitoring program for Callaway Plant Unit 2 complied with Safety Guide 23 (NRC, 1972). The meteorological tower is located on level, open terrain in an area where plant structures will have little or no influence on meteorological measurements (i.e., the tower is located far enough away from Callaway Plant Unit 1 structures and topographical features to avoid airflow modifications). Further discussion is provided in Section 6.4.1.1.

The data reduction and compilation methodology described in 6.4.1.5 for the pre-application meteorological monitoring program complied with the requirements of Safety Guide 23 in effect during the pre-application monitoring period.}

6.4.2 PRE-OPERATIONAL, AND OPERATIONAL METEOROLOGICAL MEASUREMENT PROGRAMS

{The pre-operational and operational meteorological measurement programs for Callaway Plant Unit 2 are based on the operational meteorological measurement program for Callaway Plant Unit 1 with new instrumentation as described in Section 6.4.2.3 and revised operational procedures as described in Section 6.4.2.5. This program was originally designed according to the guidance provided in Safety Guide 23 (NRC, 1972) and was upgraded in October 2007 to comply with Regulatory Guide 1.23, Revision 1 (NRC, 2007).}

6.4.2.1 Tower Location

{The meteorological tower for the Callaway site is described in Section 6.4.1.1.}

6.4.2.2 Tower Design

{The meteorological tower design is described in Section 6.4.1.2. The height of the existing tower was reduced from 305 ft (93 m) to 197 ft (60 m) in conjunction with instrumentation changes implemented in October 2007.}

6.4.2.3 Instrumentation

{The tower instrumentation was changed in October 2007, from that used during pre-application monitoring. It now consists of redundant wind speed, wind direction, and aspirated temperature sensors located at 197 ft (60 m) and 33 ft (10 m) above ground level. Dew point temperatures (converted from relative humidity sensors) are located at 33 ft (10 m) and 197 ft (60 m) and a tipping bucket rain gauge is located approximately 35 ft (10.7 m) east of the meteorological shed.

The instruments are positioned on the meteorological tower in accordance with the guidance in Regulatory Guide 1.23, Revision 1 (NRC, 2007). Table 6.4-1 presents meteorological instrument specifications and compares them with regulatory guidance provided in Regulatory Guide 1.23, Revision 1 (NRC, 2007).

Signals from the sensors are collected and processed by a data logger. The data logger collects 5-second samples of the data from the meteorological tower, and performs calculations of 15-minute and hourly average values of all parameters, wind direction (sigma theta), and temperature difference between the 197 ft (60 m) and 33 ft (10 m) levels of the meteorological tower. The data logger sends the averaged data values to a second data logger and personal computer located in the meteorological shed, to a personal computer located in the plant computer room and to the plant computer system. In addition, the averaged data values are transmitted to the appropriate locations for operational and emergency response purposes:

- For pre-operational monitoring:
  - Callaway Plant Unit 1 Control Room, Technical Support Center, and Emergency Operations Facility;
- For operational monitoring:
  - Callaway Plant Unit 1 Control Room, Callaway Plant Unit 2 Control Room, Technical Support Center, and Emergency Operations Facility.

In all cases, the averaged data will also be submitted to the NRC's Emergency Response Data System as provided for in Section VI of Appendix E to 10 CFR Part 50 (CFR, 2007b).}

6.4.2.4 Instrument Maintenance and Surveillance Schedules

{The meteorological instruments are inspected and serviced at a frequency that assures at least a 90% data recovery rate for all parameters, including the combination of wind speed, wind direction, and delta temperature. The instrumentation specified in Regulatory Guide 1.23, Revision 1 is channel checked on a daily basis and instrument calibrations are performed semi-annually.

System calibrations encompass the entire data channel for each instrument, including data logger devices and displays (those located at the tower and in emergency response facilities, and those used to compile the historical data set). The system calibrations are performed by either a series of sequential, overlapping, or total channel steps.}

6.4.2.5 Data Reduction and Compilation

{Wind and temperature 5-second data are averaged over 15-minute and hourly periods. The plant computer employs a validation that monitors the various sensors and activates flags as necessary. The validation compares the data values from the 33 ft (10 m) and 197 ft (60 m) levels of the tower with a set of ranges for each parameter. A daily channel check of all parameters is performed to determine if values are outside of specified limits.

Averaged data values from the data logger are collected by the plant computer along with wind direction variance (sigma-theta). Hourly data values are determined from the 15-minute averaged values. Output options include various functions and averages as well as graphical displays.

The 15-minute averaged data are available for use in the determination of magnitude and continuous assessment of the impact of releases of radioactive materials to the environment during a radiological emergency (as required in 10 CFR 50.47 (CFR, 2007a) and 10 CFR 50 Appendix E (CFR, 2007b)). The hourly averaged data are available for use in:

1. Determining radiological effluent release limits associated with normal operations to ensure these limits are met for any individual located offsite.

2. Determining that radiological dose consequences of postulated accidents meet prescribed dose limits at the EAB and LPZ.

3. Evaluating personnel exposures in the control room during radiological and airborne hazardous material accident conditions.

4. Determining compliance with numerical guides for design objectives and limiting conditions for operation to meet the requirement that radioactive material in effluents released to unrestricted areas be kept as low as is reasonably achievable.

5. Determining compliance with dose limits for individual members of the public.

Annual summaries of meteorological data in the form of joint frequency distributions of wind speed and wind direction by atmospheric stability class are maintained onsite and are available upon request.

As described in Section 6.4.1.5, comparison of the Callaway site and the Columbia, MO, data (of the five NWS sites, the Columbia, MO, site is closest to the Callaway site) revealed that both sites have the same general prevailing wind direction, southerly, with the actual prevailing wind direction of winds from the south-southeast at the Callaway site and winds from the south at Columbia. These comparisons will be repeated during the site preparation and construction, preoperational, and operational monitoring programs to confirm that the Callaway onsite data also represent long-term conditions at the site.}

6.4.2.6 Nearby Obstructions to Air Flow

{Downwind distances from the meteorological tower to nearby (within 0.5 mile (0.8 km)) obstructions to air flow were determined using U.S. Geological Survey topographical maps. There are no obstructions to the meteorological instrumentation within 0.5 mile (0.8 km).

From the information provided in Figure 6.4-1 and Figure 6.4-2 and with the knowledge that the base of the tower is at an elevation of approximately 824 ft (251 m), it can be seen that there are no significant nearby obstructions to airflow.}

6.4.2.7 Deviations to Guidance from Regulatory Guide 1.23

{The meteorological tower is not sited at the same elevation as finished plant grade. This was done in order to assure that the meteorological tower is located on level, open terrain at a distance at least 10 times the height of any nearby obstruction that exceeds one-half the height of the wind measurement; i.e., the tower is located far enough away from Callaway Plant Unit 1 and Callaway Plant Unit 2 structures and topographical features to avoid airflow modifications. The terrain height difference between the meteorological tower and the Callaway Plant Unit 2 reactor area is approximately 16 ft (5 m). The distance between the meteorological tower and the Callaway Plant Unit 2 reactor is approximately 7,500 ft (2,290 m). Therefore, the terrain profile has a very gentle slope and has an insignificant impact on site dispersion conditions. No specific timeframe for the frequency of inspection required by Regulatory Guide 1.23, Revision 1 (NRC, 2007) has been set for the tower, guy wires, and anchors.}

6.4.3 REFERENCES

{**CFR, 2007a.** Title 10, Code of Federal Regulations, Part 50.47, Emergency Plans, 2007.

CFR, 2007b. Title 10, Code of Federal Regulations, Part 50, Appendix E, Emergency Planning and Preparedness for Production and Utilization Facilities, 2007.

NRC, 1972. Onsite Meteorological Programs, Safety Guide 23 (Regulatory Guide 1.23 Revision 0), Nuclear Regulatory Commission, February 1972.

NRC, 2007. Meteorological Monitoring Programs for Nuclear Power Plants, Regulatory Guide 1.23, Revision 1, Nuclear Regulatory Commission, March 2007.}

Table 6.4-1—{Tower Instrument Specifications and Accuracies for Meteorological Monitoring Program (Pre-Application, Pre-Operational, and Operational)}

Characteristics	Requirements[2] *SG 23 requirements, if different*	Specifications	
		Operational[1]	Pre-Application[1][2]
Wind Speed Sensor			
Accuracy	±0.2 m/s (±0.45 mph) *+0.5 mph in SG 23* OR ±5% of observed wind speed threshold <0.45 m/s (1 mph)	±1% or 0.15 mph (0.07 m/s)	±0.07 m/s (0.16 mph)
Resolution	0.1 m/s OR 0.1 mph	0.1 mph (0.04 m/s)	0.01 m/s (0.02 mph)
Wind Direction Sensor			
Accuracy	±5 degrees	±3.0 degrees	±2.0 degrees
Resolution	1.0 degree	1.0 degree	0.1 degrees
Temperature Sensors			
Accuracy (ambient)	±0.5°C (±0.9°F)	±0.1°C (±0.18°F)	±0.24°C (±0.43°F)
Resolution (ambient)	0.1°C OR 0.1°F)	0.1°C (0.18°F)	0.01°C (±0.018°F)
Accuracy (vertical temperature difference)	±0.1°C (±0.18°F)	±0.05°C (±0.09°F)	±0.025°C (±0.045°F)
Resolution (vertical temperature difference)	0.01°C OR 0.01°F	0.01°C 0.018°F)	0.001°C (0.0018°F)
Precipitation Sensor			
Accuracy	±10% for a volume equivalent to 2.54 mm (0.1 in) of precipitation at a rate < 50 mm/hr (< 2 in/hr)	±1%	±1%
Resolution	0.25 mm OR 0.01 in	0.25 mm (0.01 in.)	0.25 mm (0.01 in.)
Time			
Accuracy	± 5 min	± 1 sec	NA
Resolution	1 min	1 sec	NA

Notes:

(1) Instruments replaced in October 2007 following completion of the pre-application monitoring period with new instruments meeting the Regulatory Guide 1.23, Revision 1 specifications

(2) Accuracy and resolution criteria from Regulatory Guide 1.23, Revision 1. *Resolution not specified in SG 23*

Figure 6.4-1—{Callaway Site with Meteorological Tower Location}

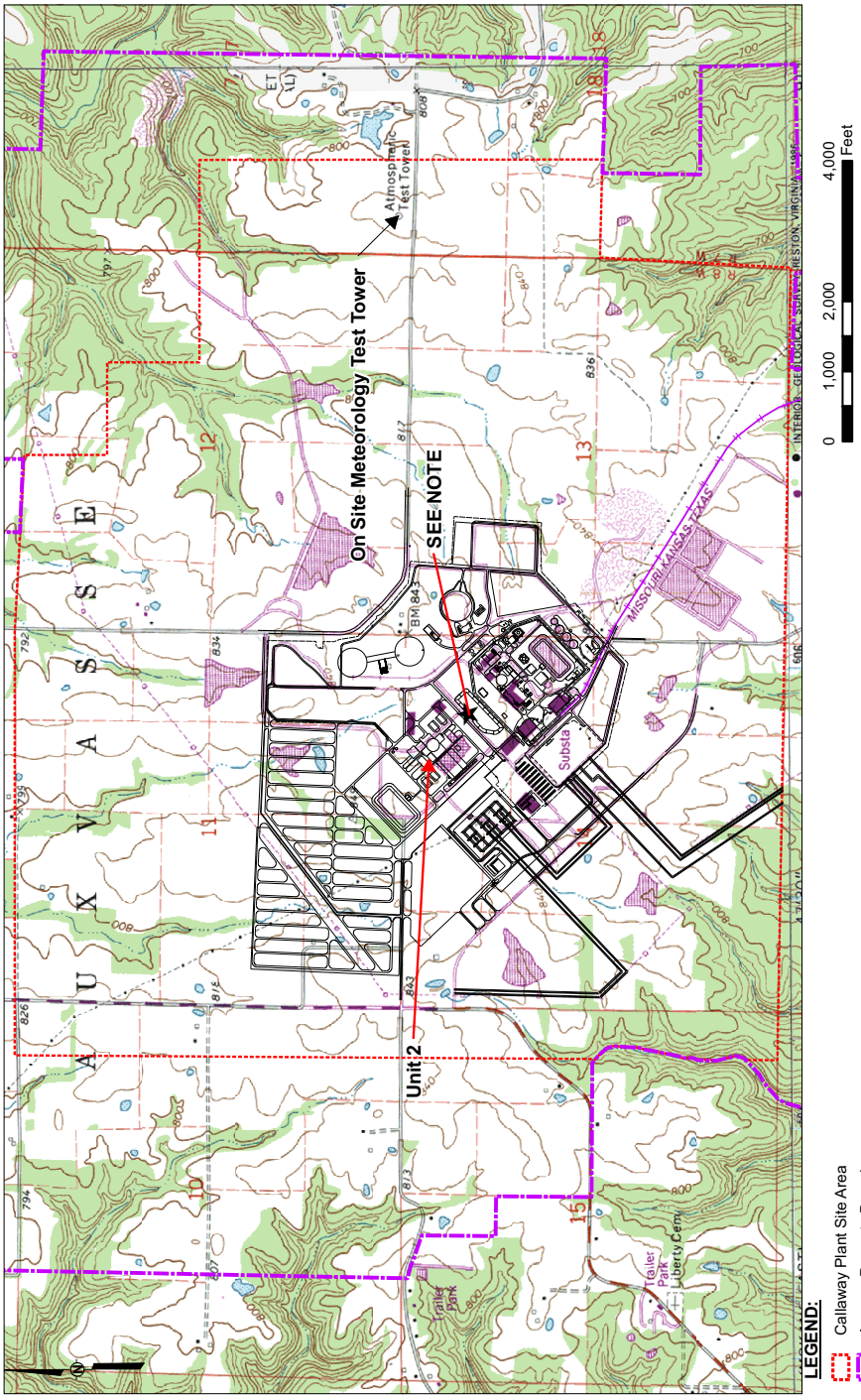
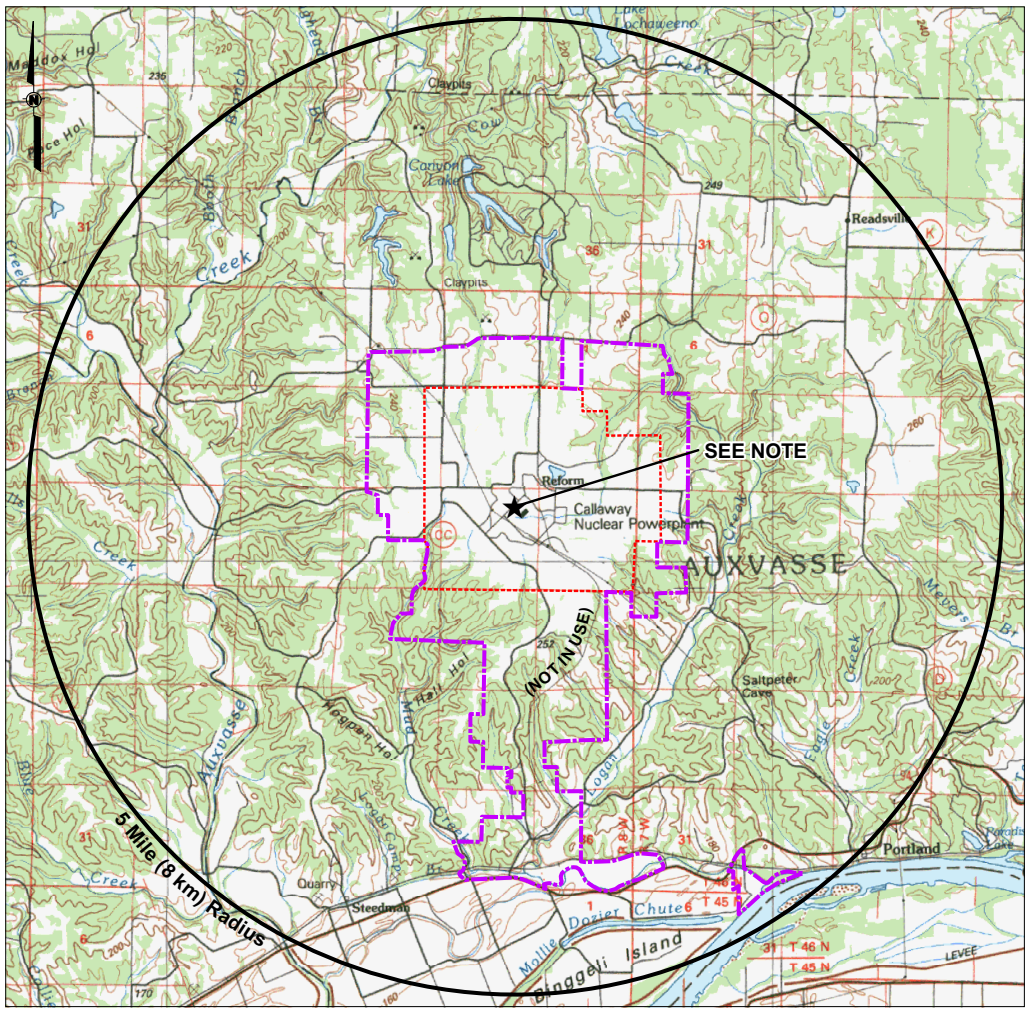


Figure 6.4-2—{Topography within 5-miles (8 km) of the Callaway Site}



6.5 ECOLOGICAL MONITORING

The following sections present information regarding ecological monitoring for terrestrial ecology, land use, and aquatic ecology of the {Callaway site} areas likely to be affected by site preparation, construction, and operation and maintenance of {Callaway Plant Unit 2}. The monitoring programs are designed based on anticipated environmental impacts through the various stages of {Callaway Plant Unit 2} project implementation. This section complies with NRC Regulatory Guide Sections 4.7 and 4.11 regarding general site suitability studies and environmental studies to allow reasonably certain predictions that there are no significant impacts to the ecology associated with the construction or operation of {Callaway Plant Unit 2}.

Monitoring programs to detect changes in the ecology begin before application submittal and continue during site preparation and construction and throughout station operation and maintenance. The monitoring programs cover elements of the ecosystem where a causal relationship between station construction and operation and adverse changes are established or strongly suspected. An evaluation of the standardization, adequacy and accuracy of data collection and analytical methods used in the monitoring programs is included.

6.5.1 TERRESTRIAL ECOLOGY AND LAND USE

The following sections present information on monitoring programs for terrestrial ecology and land use likely to be affected by site preparation, construction, or operation and maintenance of the facility. The monitoring programs are designed based on anticipated environmental impacts through the various stages of project implementation.

6.5.1.1 Pre-application Monitoring

Section 2.2.1 describes the site features and land use including a map showing these features. Section 2.2.2 describes the transmission line corridors and Section 2.4.1 describes the field studies performed to determine the major plant communities and important species and habitats. Note that the details of the type, frequency and duration of observations or samples taken at each location are contained in the individual reports for the field studies discussed in Section 2.4.1. The field studies and Section 2.4.1 discuss the distribution and abundance of important species and habitats. Critical life history information including parameters such as feeding areas, wintering areas and migration routes are also discussed in Section 2.4.1. Descriptions of modifications that may affect existing patterns of plant and animal communities including the development of cooling ponds and reservoirs, cooling towers, transmission line corridors and access routes are discussed in Section 4.3.1.

{Mitigation of unavoidable wetland impacts will be guided by the permit requirements of the U.S. Army Corps of Engineers according to the current regulations under Section 404 of the Federal Water Pollution Control Act. Section 1.3 contains a list of the permits required for this project as well as the applicable Federal and State regulations. Monitoring of mitigation success will be defined and executed with reference to these regulations. Wetlands likely to be affected by Callaway Plant Unit 2 site preparation and construction were evaluated to determine their functions and values by a methodology accepted by the U.S. Army Corps of Engineers (USACE) (USACE, 1995). Functions identified will be used as the basis of mitigating loss of wetlands during site development.}

As an essential record of overall project area baseline conditions, field surveys and aerial photography of the site and transmission line system were obtained prior to construction. The resulting map of vegetation types by structure (e.g., herbaceous, shrub-scrub, sapling/small trees) and moisture regime (e.g., emergent wetland, droughty outcrops) serve as a guide to identify suitable habitats of Federal and State-listed species of plants and animals. {Areas

impacted by construction of Callaway Plant Unit 2, including the transmission system rights-of-way have largely been previously cleared and developed. Forested areas will be somewhat impacted by construction activities. Periodic field observations will be performed following completion of construction to monitor re-growth of vegetation.} It would also provide evidence of any erosion around construction and other work areas, and indicate changes in vegetation that may call for corrective action (e.g., wind throws) or aid in the scheduling of routine transmission corridor right-of-way management.

{There are no continuous monitoring programs required for terrestrial ecology and land use in this phase of the project. The surveys and studies performed and described in Section 2.4 to establish baseline conditions follow generally accepted professional guidelines as referenced in the field study reports.}

6.5.1.2 Site Preparation, Construction and Pre-Operational Monitoring

{A description of site preparation and construction impacts on terrestrial resources, including wetlands, is discussed in Section 4.1. As noted in Section 4.3, modifications will be required to the storm water drainage in the lay down area, including the construction of two new sedimentation ponds to manage storm water runoff. Mitigating wetlands lost to Callaway Plant Unit 2 site development, including any lost to the construction of the Collector Well River Intake System, will commence concurrently with project construction. Any monitoring required during site preparation, construction and pre-operation will follow guidelines developed by the USACE in accordance with conditions specified in required permits listed in Table 1.3-1. Additional monitoring requirements including program elements, actions and reporting levels will be specified in the {Callaway Plant Unit 2} Construction Permit to be issued by the Missouri Department of Natural Resources (MDNR) regulating storm water discharges and the Callaway site Spill Prevention, Control, and Countermeasures Program. This plan and program will be implemented during this phase in order to minimize impacts to wetlands and groundwater.

In accordance with the baseline studies performed during the pre-application timeframe and existing plant experience at the Callaway site, no additional monitoring programs are proposed for:

- Bird collisions with plant structures, transmission lines and towers, and cooling towers;
- Salt deposition impacts on vegetation growth and habitat modifications; and
- Impacts to important species and habitats.

These parameters have all been determined to have a small impact on terrestrial ecology as discussed in Section 4.1.1, Section 4.1.2 and Section 4.3.1. Note that there is a commitment to reduced lighting on the large natural draft cooling towers to minimize bird collisions and to install flashing lights as air traffic warning devices once these structures are built.

There are no continuous monitoring programs required for terrestrial ecology and land use in this phase of the project.}

6.5.1.3 Operational Monitoring

{Operation and maintenance impacts of the transmission system are addressed in Section 5.6.1.

For the most part, areas occupied by Callaway Plant Unit 2 were previously disturbed and contained within the Owner Controlled Area. Land use in these areas was classified as

Impervious, High or Low Intensity Urban prior to construction of Callaway Plant Unit 2. No continuous monitoring programs required for terrestrial ecology and land use in this phase of the project.}

6.5.2 AQUATIC ECOLOGY

The following sections present information regarding ecological monitoring for aquatic ecology likely to be affected by site preparation, construction, or operation and maintenance of the facility. The monitoring programs are designed based on anticipated environmental impacts through the various stages of project implementation.

Section 2.3.3 documents the pre-existing water quality characteristics of {groundwater and surface water bodies near the plant, including the Missouri River.} The principle aquatic ecological features of the {Callaway} site and vicinity are described in Section 2.4.2, including freshwater systems on the {Callaway} site and the intake and discharge areas of the {Missouri River}. Impacts to aquatic systems from construction of the facilities are described in Section 4.3.2. Impacts to aquatic systems from operation of the cooling system are described in Section 5.3.1.2 and Section 5.3.2.2. Impacts from waste discharges are described in Section 5.5.

6.5.2.1 Pre-application Monitoring

{Pre-application monitoring has been conducted, consisting of a review of historical Callaway Plant Unit 1 data, and additional data collected for Callaway Plant Unit 2 and reported in Section 2.4.2. The data provides a sufficient basis for describing the ecological resources existing on and near the Callaway site. Sampling locations, sampling methods and quality control is discussed in these reports and in Section 2.4.2.

No Federally threatened or endangered aquatic species were identified during the pre-application surveys of nearby freshwater systems. Two species (Paddlefish and Blue Sucker) classified as vulnerable (S3) by the State of Missouri were found during the pre-application surveys. There was no significant difference reported in the abundance of the Blue Sucker with respect to sampling location in the Missouri River. Most of the aquatic species that occur onsite are ubiquitous, common, and easily located in nearby waters. The most abundant species reported were the Gizzard Shad, Red Shiner, and Emerald Shiner. Table 2.4-7, Table 2.4-8, Table 2.4-9, and Table 2.4-12 provide lists of fish species found in the Missouri River and area streams. Figure 2.4-1 is a map showing open water areas. The aquatic invertebrate species identified during the pre-application surveys are listed in Table 2.4-10, Table 2.4-11, and Table 2.4-13.

Critical life history information including parameters such as spawning areas, nursery grounds, food habits, feeding areas, wintering areas, and migration routes are discussed in Section 2.4.2. Descriptions of modifications that may affect existing patterns of plant and animal communities such as dams, impoundments, dredging, filling of wetlands, and clearing of stream banks is discussed in Section 4.3.2.

There are no additional monitoring programs required for aquatic ecology in this phase of the project. The surveys performed to establish baseline conditions follow generally accepted professional guidelines as referenced in the aquatic field study report.}

6.5.2.2 Construction and Pre-Operational Monitoring

{No aquatic ecology monitoring in addition to the current monitoring requirements for Callaway Plant Unit 1 are proposed during Callaway Plant Unit 2 site preparation, plant construction, and pre-operational periods. A new discharge line capable of handling the

combined flows from Callaway Plant Unit 1 and Callaway Plant Unit 2 was installed in 2007 and 2008. Construction of the new Collector Well River Intake System will be accomplished from on-shore locations and, therefore, will not cause stresses to the aquatic environment.

Approval of storm water management and erosion/sediment control plans will be obtained in accordance with the National Pollution Discharge Elimination System (NPDES) permit. The Missouri Department of Natural Resources will issue a new permit to include pollutants typically found at a construction site such as turbidity and petroleum hydrocarbons.

Storm water discharges from impervious surfaces at the new facility will be controlled and minimized by provisions of a Storm Water Pollution Prevention Plan. This plan includes periodic monitoring and record keeping of the engineered controls to ensure they are effective in minimizing silt runoff and evaluating the need to repair or replace the installed controls such as silt fences, hay bales, berms and settling ponds. The U.S. Army Corps of Engineers 404 Permit may contain requirements for aquatic monitoring as it relates to chemical spills or control of silt discharging into water bodies. Implementation of the Spill Prevention, Control and Countermeasures Plan includes periodic monitoring and record keeping ensuring spill controls are established and maintained to minimize impacts to the aquatic environment.

Details as to monitoring program elements, sampling procedures and equipment, data analysis, quality control and reporting will be contained in the various permits and approvals required for construction.}

6.5.2.3 Operational Monitoring

{Operational aquatic ecology monitoring will be performed as required to comply with a new Operating (NPDES) Permit to be issued by the MDNR for compliance with the Clean Water Act 316(b) (USC, 2002). The permit will require flow and temperature monitoring and monitoring of certain chemical constituents in the discharge. It is anticipated that annual Whole Effluent Toxicity (WET) testing of the combined Missouri River outfall will be required as a condition of the Operating Permit.

The Clean Water Act Section 316(b) requires that the location, design, construction and capacity of a cooling water intake structure reflect the best technology available (BTA) (CFR, 2007d) for minimizing adverse environmental impacts. The Collector Well River Intake System to be constructed to supply the water needs of both Callaway Plant Unit 1 and Callaway Plant Unit 2 combined with the abandonment of the existing intake structure will eliminate potential aquatic species impingement with the water intake structure. Callaway Plant Unit 1 currently operates under Missouri State Operating Permit No. MO-0098001 with a permit expiration date October 2, 2008. A common Operating Permit application will be prepared and submitted for Callaway Plant Units 1 and 2. The Operating Permit is required for the entire duration of plant operation. The permit is required to be renewed every five years with provisions for updating monitoring programs and parameters as necessary. The Operating Permit builds upon the methodology and informational outputs of the previous monitoring programs and studies. It is expected that the chemical concentration limits for the new Operating Permit will not be substantially different than those in the current permit as shown in Table 6.3-1.

As noted in Section 5.5.1.2, the discharges to surface waters from plant operations will include cooling water blowdown, permitted wastewater from auxiliary systems, and storm water runoff. Concentrations of chemicals in the outfalls will be controlled by the Operating Permit. Sanitary wastes from Callaway Plant Unit 2 operations will be accommodated by the existing sewage treatment system, with effluent discharge also controlled by the Operating Permit. Storm water discharges from the facility will be regulated by provisions of the Missouri

Operating Permit. A Spill Prevention, Control and Countermeasures Plan is required by U.S. EPA regulation 40 CFR 112 (EPA, 2007). The plan describes measures to prevent, contain and clean up oil, gasoline, and chemical spills. Plans are certified by a Professional Engineer and kept on site available for inspection by the U.S. EPA.

The State of Missouri does not regulate water withdrawals from groundwater or surface water bodies. Annual reporting of withdrawal volumes is required. A recent nuclear industry initiative by the Nuclear Energy Institute and NRC assessment (NRC, 2006) of existing nuclear reactors indicates that requirements related to groundwater monitoring during plant operation may change for present and future nuclear reactors. Therefore, this developing issue will continue to be followed and future requirements will be addressed, as applicable.}

6.5.3 REFERENCES

{**CFR, 2007d**. Title 40, Code of Federal Regulations, Section 125, Criteria and Standards for the National Pollutant Discharge Elimination System, 2007.

EPA, 2007. US Environmental Protection Agency, Title 40 CFR Section 112.3, Requirements to Implement a Spill Prevention, Control and Countermeasures Plan, 2007.

NRC, 2006. Liquid Radioactive Release, Lessons Learned Task Force - Final Report, Nuclear Regulatory Commission, September 1, 2006.

USACE, 1995. The Highway Methodology Workbook Supplement, Wetland Functions and Values: A Descriptive Approach, NEDEP-360-1-3a, U.S. Army Corps of Engineers, 1995.

USC, 2002. U.S. Code, Federal Water Pollution Control Act, Section 316(b), Thermal Discharges, as Amended, November 27, 2002.}

6.6 CHEMICAL MONITORING

Chemical monitoring of surface water and groundwater is performed to control and minimize adverse impacts to the {Missouri River and groundwater resources}, and will be implemented in three phases: pre-application, construction and pre-operational and operational monitoring. The scope for each monitoring phase will be predicated by the findings for the preceding phase.

Section 6.1 discusses discharged wastewater temperature requirements and Section 6.3 discusses flow sampling requirements.

6.6.1 PRE-APPLICATION MONITORING

{Pre-application monitoring provides a baseline for assessment of effects from "construction, pre-operational activities" and operation of Callaway Plant Unit 2 on the aquatic environment in the vicinity of the Callaway site. Information on past studies performed to determine thermal characteristics of the Missouri River is discussed in Section 6.1.

Surface Water

The following water quality databases, maintained by Federal agencies, State agencies, and AmerenUE contain water quality data relevant to the Missouri River in the vicinity of the Callaway site:

- United States Geological Service (USGS) Monthly Stream Flow Data,

- State of Missouri Water Quality Monitoring and Reporting under Sections 303(d) (USC, 2006a) and 305(b) (USC, 2006b) of the Federal Water Pollution Control Act (USC, 2006c),
- National Pollution Discharge Elimination System (NPDES) Discharge Monitoring and Reporting for Callaway Plant Unit 1 (MDNR, 2003),
- Pre-application field monitoring at surface water monitoring locations S-01 and S-02 immediately above and below existing Callaway site outfall area for Unit 1, and
- Pre-application field monitoring at new groundwater monitoring well locations.

Summaries of the available relevant data are provided below.

USGS Monthly Stream Flow Data

The USGS monthly stream flow data base is a compilation of data measured and collected at designated USGS stream flow gauging stations. There are both upstream and downstream monitoring stations on the Missouri River relative to the Callaway Site and outfall locations. These are shown on Figure 6.6-1. There are two limitations to the use of these data: the proximity of the monitoring stations relative to the site and the consistency of the analytical parameters measured at the various gauging stations. The USGS gauging stations on the Missouri River closest upstream and downstream to the Callaway Site are located at Boonville, MO (USGS 06909000) and Hermann, MO (USGS 06934500) respectively. These sites are more than 20 river miles (32 km) away in either direction. Further, not all gauging stations measure the same parameters. The upstream station at Boonville only measures a limited number of physical parameters, such as real time flow rate and water temperature. At the downstream station at Hermann, in addition to physical measurements, samples are collected for more extensive water quality chemical analysis.

Hydraulic stream flow data for these gauging stations are discussed in greater detail and summarized in Section 2.3.1. A summary of more than five years of chemical monitoring data reported for the downstream USGS monitoring station at Hermann is provided in Table 6.6-1 (USGS, 2008). The data summarized covers the period from February 2000 to September 2005 and provides a statistical summary of the minimum, maximum, mean, median, and standard deviation for the 34 parameters listed. The USGS collects more data than is presented. However, these parameters were selected as they represent the most common water quality constituents of concern. As noted in the paragraph below, the Missouri River in the vicinity of the Callaway site is not listed on the State of Missouri 303(d) water inventory list as impaired as a result of any chemical specific parameter (MDNR, 2007).

State of Missouri Water Quality Monitoring and Reporting under Sections 303(d) and 305(b) of the Federal Water Pollution Control Act

The Federal Water Pollution Control Act, Section 303, establishes the water quality standards and Total Maximum Daily Load (TMDL) programs which are implemented at the State level (USC, 2006a). The goal of the State Water Quality Monitoring program under Section 303 is to compile an inventory of water resources and identify those resources (e.g. lakes, stream and river segments, estuaries, bays, etc.) that have water quality impairments which limit appropriate designated uses. The State Water Quality inventory is conducted biennially and reported to the EPA. Water quality standards are set by States, Territories, and Tribes. They also identify and determine the appropriate and designated uses for each water body, for example, drinking water supply, contact recreation (swimming), and aquatic life support (fishing), and the scientific criteria to support that use.

The compilation of data under this program provides a comprehensive statewide water quality snapshot. The limitation of this data set is that monitoring is conducted only approximately every two years. As such, it reflects long-term trends and not short-term or seasonal variability within a water resource.

Based on the State Water Quality inventory, impaired water resources are then evaluated for developing TMDL limits. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point- and non-point sources discharging to the water resource. A calculation is then made allocating the allowable amount to each discharger or pollutant source. For point source discharges, this standard becomes a permit limit in a discharging facility's NPDES permit. The calculation must include a margin of safety to ensure that the water body can be used for the purposes the State has designated. The calculation must also account for seasonal variation in water quality (EPA, 2008).

The Federal Water Pollution Control Act, Section 305 establishes a requirement that States submit biennial reports on water quality (USC, 2006b). The Missouri State Water Quality 305(b) Report for 2006 identifies only 3 impaired water bodies within the 4-county area surrounding the Callaway facility (Boone, Callaway, Cole, and Osage Counties). These 3 listings are all located in Boone County and include a 1.5-mile (2.4 km) stretch of Grindstone Creek that is impaired due to elevated levels of bacteria, and two sections of Hinkson Creek, totaling 12.3 miles (19.7 km) that are impaired due to urban runoff. The source of the listed impairment in these 3 instances is not currently identified.

Other waters that were not on the final 2006 303(d) listing, but were identified as impaired or potentially impaired, are noted below. These include waters with approved TMDLs, waters where sufficient pollution control measures are in place, waters that are not impaired by discrete pollutants, waters that were not approved for listing by the Missouri Clean Water Commission, and waters that are potentially impaired which may require additional monitoring and evaluation. These waters include: in Boone County, 4.0 miles (6.4 km) of Cedar Creek and 6.0 miles (9.7 km) of Fowler Creek which are impaired due to low dissolved oxygen, and Lake of the Woods impaired due to mercury; In Osage County, two stations on Contrary Creek are impaired due to habitat degradation from rural non-point source runoff, and Ben Bridge Lake is impaired due to atmospheric deposition of mercury; and in Callaway County, 2.0 miles (3.2 km) of Manacle Creek are impaired due to pH and chloride discharge from the Cedar Creek Abandoned Mine Land, 2 miles (3.2 km) of Manacle Creek are impaired due to sediment from crop production, and a segment of the Missouri River has impaired habitat due to channelization. There were listed water resource impairments or potential impairments in 2006 for Cole County. The addition of Callaway Plant Unit 2 will have no contribution or impact on the current listed impairments for these listed resources.

NPDES Discharge Monitoring and Reporting for Callaway Plant Unit 1

Pursuant to the Federal Water Pollution Control Act (USC, 2006c), the water quality of effluent discharges to the Missouri River and its tributaries is regulated through the NPDES program (EPA, 1983). Callaway Plant Unit 1 maintains a current NPDES permit for all site outfalls. The current permit was last issued in October 2003 and is due to be renewed in October 2008. There have been no historic compliance issues that have prevented permit renewal. The following summary describes the nature of wastewater discharged from each permitted outfall location which leads directly or indirectly to the Missouri River. (MDNR, 2003)

Outfall #001 – Radwaste Treatment System

The daily average permitted flow for the Radwaste Treatment system is 0.082 million gallons per day (MGD) (310 cu m per day) and the daily maximum flow is 0.298 MGD (1,130 cu m per

day). The Radwaste system serves to collect, process, store, recycle and dispose of liquid radioactive waste generated at Callaway Plant Unit 1 by the five general sub-systems which include:

- The Boron Recycle System receives reactor coolant for the purpose of recovering the boric acid for reuse in the plant. Boric acid is used as a neutron absorber/moderator in the primary loop;

- The Liquid Radwaste System collects and processes floor and equipment drains from the containment, auxiliary building, fuel building and radwaste buildings during normal operation;

- The Laundry and Hot Shower System collects waste generated from washing radioactively contaminated protective gear and clothing and personnel decontamination shower wastewater. These wastes are then transferred to the liquid Radwaste system for treatment;

- The Secondary Liquid Waste System is used to process condensate and steam generator blowdown, demineralizer regeneration wastes, and potentially radioactive liquid waste collected from the turbine building. The condensate demineralizer regeneration waste is divided into two waste streams: High total dissolved solids (TDS) waste from the acid and caustic rinses used when chemically regenerating spent resin, and low TDS waste which results from the initial backflushing of unregenerated resin and the final rinsing of the regenerated resin to remove acid and caustic; and

- Steam Generator Blowdown System – system blowdown is normally recycled back to the main condenser for reuse in the secondary cycle. Provisions also exist to discharge the treated blowdown via Outfall #001. Various unit operations are used individually or collectively to treat the blowdown in compliance with NRC and NPDES permit requirements which include one or more of the following: evaporation, filtration, carbon adsorption, ion exchange, neutralization, reuse/recycle, Mixing, Filtration, and/or Carbon Absorption.

Treatment is performed on a batch basis except steam generator blowdown. After monitoring for radioactive content, release rates are controlled administratively to ensure the “as low as practicable” radioactive discharge criteria are met.

Outfall #002 – Cooling Tower Blowdown

This outfall consists of cooling tower blowdown from the Circulating Water System, the Service Water System, and the Essential Service Water System. Blowdown from the cooling tower is necessary to maintain the dissolved solids concentration in the recirculating water system within acceptable operating limits. The average daily permitted flow is 4.84 MGD (18,300 cu m per day) and the maximum daily permitted flow is 14.4 MGD (54,500 cu m per day).

Outfall #003 - Water Treatment Plant Wastes

The average daily permitted flow 0.421 MGD (1,600 cu m per day) and the daily maximum flow is 1.645 MGD (6,230 cu m per day). These flows represent wastewater discharged to the settling basin. The actual discharge will vary depending on recycle. Discharge consists of the supernatant from a wastewater treatment lagoon that treats wastewater to remove solids. The wastewater treated in the lagoon is mainly from the blowdown of accumulated river solids in the water treatment plant clarifiers. The sand and carbon filter backwash, oil water separator and demineralizer system wastewater is also routed to this treatment lagoon. The oil water

separator flow consists of wastewater from some plant sumps as well as flow from an oil recovery well that is being used to remediate a historic on-site release. Outfall #003 is normally recycled by routing it back to the head of the water treatment plant.

Outfall #004 - Demineralizer System Wastes

This discharge is now included under Outfall #003.

Outfall #007 – 3 Cell Flow Through Lagoon

The permitted daily average flow is 0.027 MGD (100 cu m per day) and the maximum permitted flow is 0.040 MGD (150 cu m per day). The design population equivalent is 400. This outfall consists of a 3-cell lagoon designed to receive only sanitary and on-site cafeteria waste from the plant. Sludge is stored in the lagoon and the effluent discharged to on-site constructed wetlands. The monitoring location is at the discharge from the wetland.

Outfall #009 - Intake Heater Blowdown

The permitted daily average flow is 0 MGD (0 cu m per day) and the daily maximum flow is 0.006 MGD (23 cu m per day). The river intake structure currently contains two recirculating electric heaters which are used to prevent ice formation on the intake bar screens during the winter months. Outfall #009 consists of discharges from the infrequent blowdown or drainage of these heaters.

Outfalls #010 through #015 - Storm Water Runoff

For the existing site area, the average rainfall event is 0.794 MGD (3,010 cu m per day). The once in 10 year rainfall event flow rate is permitted for 41.46 MGD (156,900 cu m per day). These six outfalls collect and subsequently discharge storm water runoff from plant and associated areas after treatment in settling ponds. During construction, it is anticipated that one or two of these ponds will be impacted by construction and will need to be replaced with new ponds. The revised storm water runoff pond system will have adequate capacity to accommodate stormwater flows from the new construction areas associated with Callaway Plant Unit 2. "Non-process" discharges that are also discharged to storm water runoff (SWR) include the discharge from quarterly testing of the fire protection drains, the periodic (infrequent) draining of the demineralized water storage tank, the pumping of manholes, and clean rainwater captured within environmental containments surrounding storage tanks and transformers.

Outfall #016 - Cooling Tower Bypass

The permitted daily average flow is 3.32 MGD (12,600 cu m per day) and the maximum permitted daily flow is 14.4 MGD (54,500 cu m per day). The outfall consists of clarified river water and wastewater that has been recycled through the water treatment plant. It is used to moderate flow through the water treatment plant and to provide carrier water in the discharge line when discharging from Outfall #001.

Outfall #017 – Ultimate Heat Sink

The daily average permitted flow is 0 MGD (0 cu m per day). The Ultimate Heat Sink is a cooling pond that can provide cooling water to various plant systems during other than normal conditions. No discharge is allowed from Outfall # 017.

The facility submits monthly NPDES monitoring reports to the Missouri Department of Natural Resources (MDNR) which includes monitoring results for these outfalls according to permit requirements and frequencies. There are no current compliance concerns and it is not anticipated that there will be future concerns associated with the operation of Callaway Plant Unit 2. Since the current permit is in the process of being renewed according to the standard

regulatory schedule, AmerenUE is consulting directly with MDNR on the best approach to anticipate permit requirements should Callaway Plant Unit 2 be constructed. Similar discharge conditions to those listed in the existing permit would be anticipated for any new outfalls that may be required.

A summary of current NPDES permit effluent limitations and monitoring requirements for each outfall is provided in Table 6.3-1.

Pre-application field monitoring at Surface Water Sampling locations S-01 and S-02

Since the spring of 2007, four rounds of pre-application field monitoring and sampling have been conducted for surface water in the Missouri River at locations upstream and downstream of the discharge from the Callaway site. Surface water is discussed in detail in Section 2.3.2.1. Table 6.6-2 summarizes the data collected from surface water sampling locations S-01 and S-02. The locations of these sampling points are shown on Figure 6.6-2.

Pre-application field monitoring at groundwater monitoring well locations

Groundwater monitoring (water level observation) of the Callaway Plant Unit 2 area is currently being implemented through the use of both groundwater observation wells installed in 2006 for the Callaway Plant Unit 2 area subsurface investigation and other wells that are monitored as part of the ongoing Callaway Plant Unit 1 Radiological Environmental Monitoring Plan (REMP). Thirty-six (36) groundwater monitoring wells were installed across the Callaway Plant Unit 2 site investigation area. They were installed in the shallow chert aquifer, the intermediate leaky, confining aquitard, and the deeper Cotter-Jefferson City aquifer. The wells were located in order to provide adequate distribution with which to determine site groundwater levels, subsurface flow directions, and hydraulic gradients beneath the Callaway Plant Unit 2 area and the surrounding area. Well pairs were installed at selected locations to evaluate vertical gradients. Field hydraulic conductivity tests (slug tests) and pumping tests were conducted. Monthly water level measurements from the groundwater monitoring wells were collected from March 2007 through February 2008. Water quality parameters (i.e., physical qualities and chemical constituents) were measured seasonally.

Twenty eight (28) surface water locations were gauged for surface water elevation, flow velocity, depth, and flow rate, as well as field water quality parameters. The streams were monitored to evaluate the interaction of surface water with the Cotter-Jefferson City aquifer groundwater along the study area boundary. Many of these monitoring locations were monitored by utilizing surveyed reference points at bridge crossings. Pond gauges were installed to evaluate the interaction of surface water with the chert aquifer groundwater on the plateau. The lake gauges were installed to monitor surface water elevations in the large lakes north of the site.

Hydrology, water quality, and water use are discussed in detail in Section 2.3.}

Well water quality data are described in Section 2.3.3.2 and summarized in Table 2.3-33.

6.6.2 CONSTRUCTION AND PRE-OPERATIONAL MONITORING

{Chemical monitoring during construction will aid in controlling adverse impacts to the Missouri River and will provide additional water quality data that can be used to measure water-quality changes from operation of Callaway Plant Unit 2. Accordingly, chemical monitoring of surface water during construction related activities for Callaway Plant Unit 2 will be an extension of more than 30 years of pre-application and REMP monitoring data that have been collected over the development, construction, and operational history for Callaway Plant

Unit 1. Construction and pre-operational chemical monitoring will be performed during the planned two year and four year periods for site preparation and plant construction, respectively. Sample collection, laboratory analyses, data evaluation and reporting practices will comply with NPDES permit modifications.

Although storm water discharges may potentially increase during construction, primarily due to water pumped from excavation sumps and increased impermeable surface cover, disturbance to existing drainage systems will be avoided by implementing best management practices. Environmental controls (i.e., silt screens, dams, settling basins, and spill containment measures) will be implemented to reduce potential pollutants in storm water runoff and to minimize construction impacts to aquatic habitats. Prior to the start of construction, approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Permit as discussed in Section 1.3. These controls will be incorporated into a Storm Water Pollution Prevention Plan (SWPPP).

Some of the existing Callaway Plant Unit 2 area observation wells may be taken out-of-service prior to construction activities due to anticipated earth moving and construction requirements in the vicinity where they are located. Prior to construction activities, the observation well monitoring network will be evaluated in order to determine if there are groundwater data gaps and needs created by the abandonment of existing wells. These data needs will be met by the installation of additional observation wells, if required. Additionally, the hydrologic properties and groundwater flow regimes of the shallow water and deeper water bearing units may be impacted by the proposed earthmoving, regrading, and construction of infrastructure (buildings, parking lots, etc.). Continued observation may result in revisions to the observation well network including the installation of new wells or closure of existing wells that may no longer be needed, or become damaged or otherwise unusable. The purpose of the ongoing observation well monitoring program is to identify any changes in the local groundwater regime as a result of construction activities and the presence of new structures and facilities. No chemical monitoring is planned at this time for groundwater other than the ongoing groundwater monitoring being performed under the Callaway Plant Unit 1 REMP.}

6.6.3 OPERATIONAL MONITORING

{Operational monitoring will continue as long as required by the NPDES permit or any future permit modifications applicable to the Callaway operation. Although operational monitoring elements will be developed in consultation with MDNR, it is anticipated that sampling locations, frequency and analyses will be similar to or identical to those for Callaway Plant Unit 1.

A Collector Well River Intake System in the Aquifer is used to supply cooling water makeup for the Callaway site. The use of collector wells limits the need for advanced water treatment to remove turbidity. Treatment is required to reduce iron concentrations in the makeup water. Treatment for iron removal is accomplished by the water treatment system. Following chemical addition, the water discharges to sludge lagoons for precipitation and settling of iron solids. Supernatant from the sludge lagoons is returned to the water treatment system.

The discharge from Callaway Plant Unit 2 is combined with the discharge from Callaway Plant Unit 1 and utilizes separate outfalls (the outfall location is the point of compliance where required NPDES permit monitoring or measurement is made or a compliance sample is collected). Sampling and monitoring is conducted and regulated under modified provisions of the existing facility NPDES permit as negotiated at the time of renewal or when an amendment is necessary.

Callaway Plant Unit 2 utilizes a closed-loop Circulating Water System (CWS). Fresh water required for uses other than cooling water for Callaway Plant Unit 2 is supplied by existing deep groundwater wells.

Non-radioactive liquid effluents that could potentially drain to the Missouri River are limited and regulated under the NPDES permit. Table 3.6-1 provides information on the various chemicals anticipated to be used for the various plant water systems. Where regulated or due to potential adverse environmental effects, these chemical additives may have limiting discharge concentrations specified in the NPDES permit that requires monitoring.

Chemical monitoring is performed at permitted outfalls to assess the effectiveness of retention methods and effluent treatment systems, as well as to detect changes in water quality associated with plant operations. Similar to Callaway Plant Unit 1, chemical monitoring is also performed at storm water runoff outfalls and at internal monitoring points (i.e., sanitary waste effluents, wastewater retention basin influent and/or effluent). Effluent water chemistry meets applicable federal and state environmental regulatory requirements.

The following discussion provides a basis for the type of data and information that is expected to be required by the NPDES permit for Callaway Plant Unit 2. The Callaway Plant Unit 1 NPDES permit specifies the monitoring conditions that the existing plant must meet to protect water quality. It is expected that NPDES permit requirements for Callaway Plant Unit 2 will be similar or identical. Table 6.3-1 summarizes the required water sampling protocol for the existing monitoring stations and permitted outfalls. Figure 6.1-1 and Figure 6.2-2 show the monitoring station locations.

Sampling for the Callaway Plant Unit 2 NPDES permit requirements will be performed in accordance with the Callaway Plant Procedures. These procedures provide instructions for chemical/reagent control, instrumentation control, program control (e.g., sampling methodologies, analysis), minimum quantifiable concentration control, use and evaluation of charts, and data reporting.

Samples representative of the system or stream will be collected and preserved as necessary to prevent contamination or deterioration. Sanitary wastewater from Callaway Plant Unit 2 operation will be combined with the Callaway Plant Unit 1 sanitary wastewater and transferred by lift station to the existing onsite waste treatment lagoons. Sampling will continue to be conducted at the currently designated NPDES lagoon outfall/sampling location. Non-radiological wastewater management is discussed in greater detail in Section 3.6.

Sampling and analytical methods will conform to procedures for the analysis of pollutants as identified in 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants." Toxicity testing will be conducted in accordance with procedures described in EPA/600/4-90/027F (EPA, 1993). To ensure accuracy of measurements, monitoring and analytical instrumentation is maintained and periodically calibrated in accordance with Callaway Plant Procedures which also provide instructions for calibration standards, prepared or purchased, used for preparing calibration curves and performing calibration checks. Statistical reliability will be achieved by calculating the mean and standard deviation of the data at a 95% confidence level. Data quality objectives include producing accurate, reliable and cost effective measurements and data, adequate for their intended use.

Periodic monitoring results will be summarized on Discharge Monitoring Reports and submitted to the MDNR as required. Sampling data collected during pre-application monitoring will serve to document existing water quality conditions so that any impacts from

operation can be ascertained (although substantial impacts are not expected and have not been observed as a result of the operation of Callaway Plant Unit 1.

There are currently no plans to monitor groundwater for chemicals during the operational phase of Callaway Plant Unit 2 other than to continue any measures ongoing under the Callaway Plant Unit 1 REMP at that time.}

6.6.4 REFERENCES

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Table 6.6-1—{Statistical Summary of USGS Water Quality Sampling Results, February 2000 to September 2005, USGS Station 06934500-Missouri River at Hermann, MO}

	Temperature, Water, °C	Instantaneous Discharge (cfs)	Specific Conductance unfiltered (µS/cm @ 25 °C)	Dissolved Oxygen (mg/l)	pH unfiltered (field, std units)	Ammonia filtered (mg/l as N)	Nitrite plus Nitrate unfiltered (mg/l)
Minimum	1.10	25,000	292	2.1	7.4	0.02	0.07
Maximum	30.30	340,000	813	16.0	8.7	0.31	3.27
Mean	17.00	83,393	576	8.9	8.0	0.12	1.24
Median	18.05	58,100	585	8.5	8.0	0.09	1.19
Standard Deviation	8.62	59,506	141	3.1	0.3	0.08	0.66

	Phosphorus filtered (mg/l)	Ortho-phosphate filtered (mg/l)	Calcium filtered (mg/l)	Magnesium filtered (mg/l)	Sodium filtered (mg/l)	Potassium filtered (mg/l)	Chloride filtered (mg/l)
Minimum	0.029	0.012	31.1	8.41	11.4	4.05	8.6
Maximum	0.171	0.147	72.4	24.70	76.6	8.08	37.8
Mean	0.097	0.080	53.8	17.77	41.8	5.53	20.3
Median	0.094	0.077	55.2	17.90	40.4	5.59	19.9
Standard Deviation	0.026	0.027	9.7	4.39	17.0	0.76	6.0

	Sulfate filtered (mg/l)	Lead filtered (µg/l)	Alkalinity filtered (fixed end pt. lab, mg/l as $CaCo_3$)	Fecal coliform (M-CF 0.7 u MF col/100 ml)	Fecal streptococci (KFMF col/100 ml)	Suspended sediment concentration (mg/l)	Turbidity unfiltered (NTU)
Minimum	33	0.14	91	25	14	23	11
Maximum	200	0.14	222	6,600	13,000	3,060	1,200
Mean	111	N/A	155	1,067	1,786	553	211
Median	110	N/A	157	240	442	209	78
Standard Deviation	44	N/A	29	1,457	2,959	738	298

	Arsenic filtered (µg/L)	Barium filtered (µg/l)	Beryllium filtered (µg/l)	Cadmium filtered (µg/l)	Chromium filtered (µg/l)	Manganese filtered (µg/l)	Nickel filtered (µg/l)
Minimum	1.1	70	0	0.04	0	0.4	0.67
Maximum	4.7	818	0	0.04	0	14.9	5.84
Mean	2.5	137	n/a	0.04	n/a	2.5	2.91
Median	2.3	94	n/a	0.04	n/a	1.4	2.73
Standard Deviation	0.8	148	n/a	0.00	n/a	3.0	1.21

	Silver filtered (µg/l)	Zinc filtered (µg/l)	Antimony filtered (µg/l)	Aluminum filtered (µg/l)	Selenium filtered (µg/l)	Alkalinity filtered (mg/l as $CaCO_3$	
Minimum	0	0.6	0.12	1.0	0.6	91	
Maximum	0	43.4	4.92	58.0	3.2	222	
Mean	n/a	4.8	0.67	9.8	1.8	156	
Median	n/a	1.4	0.39	3.0	1.7	157	
Standard Deviation	n/a	9.7	1.03	16.4	0.6	30	

Table 6.6-2—{Summary of Pre-Application Sampling Upstream and Downstream of Callaway Site Discharge}

(Page 1 of 2)

Analysis Type	Surface Water Parameter	Total/Dissolved	PRL	Units	May 2007		August 2007		November 2007		February 2008	
					S-01	S-02	S-01	S-02	S-01	S-02	S-01	S-02
Anion	Chlorides	T	1.0	mg/L	14.2	14.3	25.1	25.6	25.4	25.4	32.8	32.0
	Sulfate	T	1.0	mg/L	52.3	52.5	119	123	98.8	101	95.6	94.4
Biological	Fecal Coliform	N/A	10	cfu/100 ml	600	2500	140	110	220	300	50	40
	Total Coliform	N/A	1	mpn/100 ml	>2420	>2420	2420	1986	2420	1986.3	2400	2400
	Chlorophyl a	N/A	4	mg/m^3	4	8	4	4	52	75	170	210
	Fecal Streptococcus	N/A	10	cfu/100 ml	90	32	30	20	20	40	50	10
Field(1)	Conductivity	N/A	1	µmhos/cm 25 °C	257	255	639	652	516	510	715	660
	Dissolved Oxygen	N/A	0.1	mg/L	5.62	5.5	8.52	8.09	14.27	11.9	11.54	10.42
	pH	N/A	0.1	SU	7.22	7.49	8	7.83	8.08	8	7.83	7.6
	Temperature	N/A	0.1	°C	21.1	21.2	29.5	29.5	11.8	11.8	2.3	2.3
	Turbidity	N/A	1	NTU	999 (max)	999 (max)	184	220	150	133	160	136
Metals	Aluminum	D	75.0	µg/L	3630	2360	114	257	116	237	<75.0	<75.0
	Antimony	D	10.0	µg/L	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
	Arsenic	D	10.0	µg/L	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
	Barium	D	10.0	µg/L	394	276	118	114	129	132	106	102
	Beryllium	D	1.0	µg/L	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Cadmium	D	5.0	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Calcium	D	100	µg/L	65800	55700	56300	55400	76300	79300	61200	58900
	Chromium	D	5.0	µg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Lead	D	5.0	µg/L	17.1	10.6	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Magnesium	D	50.0	µg/L	15800	14000	17900	17300	24300	24700	16100	15600
	Manganese	D	5.0	µg/L	1380	738	11.4	15.5	25.2	35.2	<5.0	6.0
	Mercury	D	0.20	µg/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Nickel	D	5.0	µg/L	22.1	12.2	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Potassium	D	500	µg/L	6690	6350	7910	7730	6680	6850	5460	5260
	Selenium	D	15.0	µg/L	<15.0	<15.0	<15.0	<15.0	<15.0	<15.0	<15.0	<15.0
	Silver	D	7.0	µg/L	<7.0	<7.0	<7.0	<7.0	<7.0	<7.0	<7.0	<7.0
	Sodium	D	500	µg/L	16900	16900	48400	46200	35200	36300	38100	36600
	Thallium	D	20.0	µg/L	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
	Zinc	D	50.0	µg/L	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0

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Table 6.6-2—{Summary of Pre-Application Sampling Upstream and Downstream of Callaway Site Discharge}

(Page 2 of 2)

Analysis Type	Surface Water Parameter	Total/Dissolved	PRL	Units	May 2007		August 2007		November 2007		February 2008	
					S-01	S-02	S-01	S-02	S-01	S-02	S-01	S-02
Nitrogen	Nitrate as N	T	1.0	mg/L	4.6	3.1	1.5	1.5	3.4	3.4	1.9	1.8
	Nitrite as N	T	1.0	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	Total Organic Nitrogen	T	0.20	mg/L	3.9	3.4	0.28	0.47	0.40	0.27	<0.20	<0.20
	Nitrogen, Ammonia	T	0.10	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
	Nitrogen, Kjeldahl, Total	T	0.20	mg/L	3.9	3.4	0.28	0.47	0.40	0.27	<0.20	<0.20
Water Quality	Alkalinity, Total	T	20.0	mg/L	119	119	157	<20.0	204	215	173	174
	BOD_5	T	2.0	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	COD	T	10.0	mg/L	<10.0	15.1	59.0	72.6	35.2	41.7	39.0	26.8
	Apparent Color	N/A	2.0	units	64.0	110	150	120	80.0	95.0	70.0	60.0
	Total Hardness	T	1.0	mg/L	212	212	220	220	288	299	232	242
	Odor[2]	N/A	1	TON	<1.0	<1.0	[2]	[2]	[2]	[2]	[2]	[2]
	Oil and Grease	T	5.0	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.7
	Orthophosphate as P (dis)	T	0.10	mg/L	0.20	0.15	0.18	<0.10	0.17	<0.10	0.16	0.15
	Phosphorus (dis)	T	0.50	mg/L	1.3	1.2	<0.50	<0.50	0.23	0.22	0.13	0.13
	Total Suspended Solids	T	5.0	mg/L	2920	1700	151	160	111	124	160	62.0
	Total Dissolved Solids	D	5.0	mg/L	274	275	407	401	443	443	366	380

Notes:

(1) Missouri River flow was not recorded

(2) Odor discontinued after first round

N/A = Not Applicable

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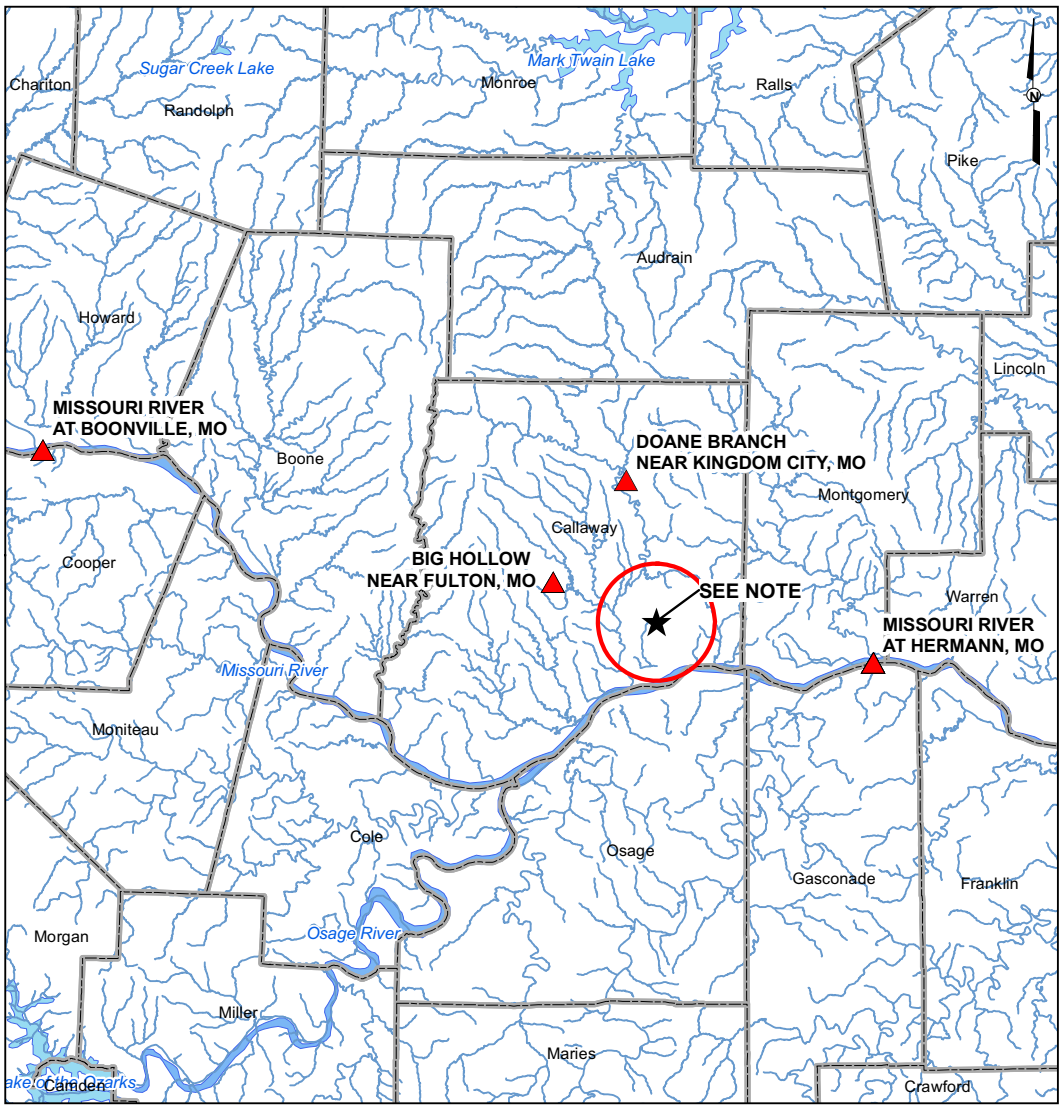
Figure 6.6-1—{USGS Gauging Stations Near the Callaway Plant Site}



REFERENCE:
ESRI StreetMap Pro [CD-ROM], 2007,
rivers, waterbodies, and county boundaries.
Missouri Spatial Data Information Service
http://www.msdis.missouri.edu

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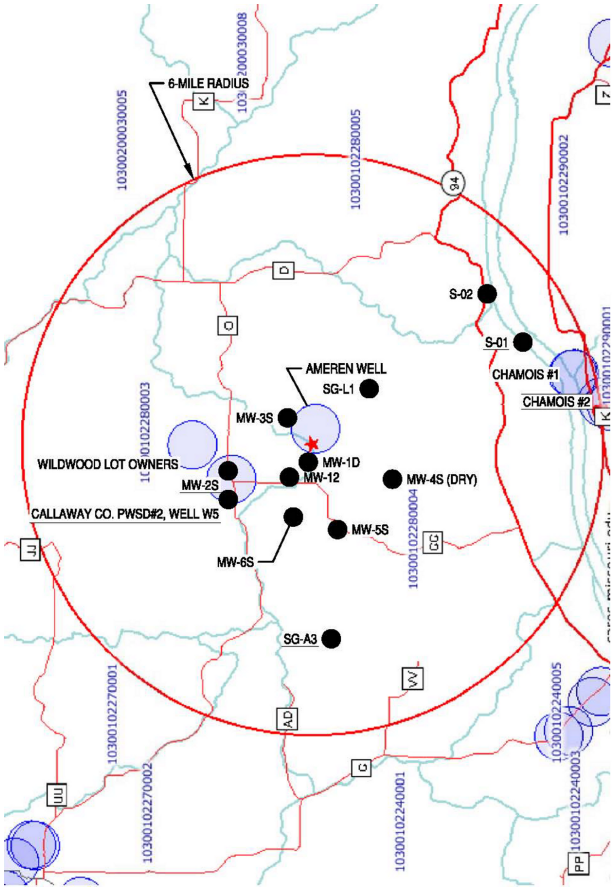
Figure 6.6-2—{Summary of Pre-application Surface Water Sampling Upstream and Downstream of Callaway Plant Site}



SUMMARY OF SAMPLE LOCATIONS

RESOURCE	DESCRIPTION	LOCATION
SURFACE WATER	AUXVASSE CREEK	SG–A3
	LOGAN CREEK	SG–L1
	MISSOURI RIVER	S–01
		S–02
GROUNDWATER	SHALLOW AQUIFER	MW–2S
		MW–3S
		MW–5S
		MW–6S
		MW–12
	BEDROCK AQUIFER	MW–1D
	DRINKING WATER	PWSD#2, WELL W5

6.7 SUMMARY OF MONITORING PROGRAMS

This section summarizes the monitoring environmental programs described in Chapter 6. The summary is divided into three sections:

- Pre-application monitoring
- Construction and Pre-Operational monitoring
- Operational monitoring

6.7.1 PRE-APPLICATION MONITORING

Pre-application monitoring for {Callaway Plant Unit 2} will be fulfilled by {the ongoing thermal, hydrological, radiological, and meteorological monitoring programs (Sections 6.1, 6.2, and 6.4) for the existing Callaway Plant Unit 1}. This represents {over 20} years of monitoring for the site. Pre-application {hydrological, ecological, and chemical} monitoring was provided through field studies. Summaries of the pre-application monitoring activities are included in Table 6.7-1 through Table 6.7-7.

6.7.2 CONSTRUCTION AND PRE-OPERATIONAL MONITORING

The ongoing monitoring programs will be continued through the construction and pre-operational phases of {Callaway Plant Unit 2. Hydrological monitoring during this period will include surface water monitoring in accordance with the NPDES Construction General Permit to be obtained from MDNR prior to the start of construction and continued data collection from groundwater monitoring observation wells installed in conjunction with the Pre-application field studies as modified to accommodate construction field conditions. Chemical monitoring during this period will consist of an extension of the ongoing NPDES monitoring program in place for Callaway Plant Unit 1. No additional chemical monitoring of groundwater is planned. No ongoing construction or pre-operational ecological monitoring programs beyond the aquatic ecology monitoring currently required for Callaway Plant Unit 1 are planned.} Summaries are included in Table 6.7-1 through Table 6.7-7.

6.7.3 OPERATIONAL MONITORING

While specific operational monitoring requirements and programs for {Callaway Plant Unit 2} have not yet been fully established, they will be similar to and tiered from or added to those monitoring programs described in the previous sections which currently monitor the impacts of {Callaway Plant Unit 1} on the surrounding environment. Summaries are included in Table 6.7-1 through Table 6.7-7.

The existing and future operational monitoring programs could be modified as a result of future consultations with state regulatory agencies. The need for modifications to established monitoring locations, parameters, collection techniques, or analytical procedures will be assessed prior to and during the course of operation, as is done now for {Callaway Plant Unit 1}.

6.7.4 REFERENCES

None

Table 6.7-1—{Thermal Monitoring}

Phase	Summary	Permit
Pre-Application	The National Pollutant Discharge Elimination System (NPDES) permit for Callaway Plant Unit 1 requires thermal monitoring of plant discharges via Outfall 002, and provides a maximum cooling water discharge temperature limit of 110 ^{O}F. Cooling water for Callaway Plant Unit 1 mixes with several other discharge streams and is piped to the Missouri River for release.	NPDES Permit issued for Callaway Plant Unit 1
Construction and Pre-Operation	Construction and pre-operational thermal monitoring will be a continuation of the pre-application program. Construction related discharges will mainly consist of surface drainage that collects in storm water collection ponds discharging to local streams without mixing with the cooling water. Consequently, no changes in thermal discharge monitoring from that provided during the pre-application phase is expected during the construction and preoperational periods. The Missouri Department of Natural Resources (MDNR) will be notified of pending construction activities. Approval of storm water management and erosion/sediment control plans will be obtained in accordance with the NPDES Construction General Permit.	NPDES Permit issued for Callaway Plant Unit 1 NPDES Construction General Permit issued for Callaway Plant Unit 2
Operation	Thermal monitoring for Callaway Plant Unit 2 will conform to the requirements of a revised NPDES permit to be issued to include Callaway Plant Unit 2. Callaway Plant Units 1 and 2 discharge to the Missouri River through a common outfall.	NPDES Permit issued to include Callaway Plant Unit 2 Operation

Table 6.7-2—{Radiological Monitoring}

Effluent Exposure Pathways	REMP Sampling Media	Frequency	Phase
Liquid Effluents			
Ingestion Fish	Commercial & Recreational Fish Species Bottom sediments	Semi-annual Semi-annual	All Phases All Phases
Ingestion Fish/Wildlife	Wetlands Soil Wells (non drinking water) and Ponds	Annual Quarterly	All Phases All Phases
Shoreline Exposure (External Direct)	Shoreline Sediments	Semi-annual	All Phases
Swimming & Boating (External Direct)	Missouri River Surface Waters	Monthly Composite	All Phases
Ingestion Drinking Water	Groundwater from Deep Well	Monthly	All Phases
Ingestion Milk	Cow's Milk	Semi-monthly when on pasture, monthly other times	All Phases
Gaseous Effluents			
Ground Plane (External Direct)	Thermoluminescence Dosimetry (TLD)	Quarterly	All Phases
Inhalation	Airborne Particulate and Iodine Sampling	Continuous sampler with weekly sample collection	All Phases
Ingestion of Agricultural Products	Broadleaf Vegetation	Monthly during growing season	All Phases

Pre-application Phase: monitoring for Callaway Plant Unit 2 is provided by the existing Radiological Environmental Monitoring Program (REMP) for Callaway Plant Unit 1. Existing sample locations, sampling frequency, and type of analysis are described further in Section 6.2-1 through 6.2-5.

Construction and Pre-Operational Phase: radiological monitoring will be a continuation of the pre-application monitoring program. An evaluation of the existing REMP will be made prior to commencing construction and, if necessary for construction worker exposure monitoring, additional air particulate and iodine and Thermoluminescence Dosimetry locations may be established closer to the construction impact area for Callaway Plant Unit 2 (see Figure 6.2-1 and Figure 6.2-2 for monitoring locations).

Operational Phase: No additional changes to the REMP are anticipated for the Callaway Plant Unit 2 operational phase.

Table 6.7-3—{Hydrological Monitoring}

Phase	Surface Water	Groundwater
Pre-Application	Hydrological Monitoring of 28 surface water locations performed in accordance with the field program specifically prepared for this application. Purpose was to evaluate surface water/groundwater interactions. Additional monitoring performed in accordance with the plant NPDES program summarized in Table 6.3-1.	Groundwater monitoring of 36 monitoring wells installed in accordance with the field program specifically prepared for this application. Monthly water level monitoring was conducted for a one year period. Purpose was to evaluate surface water/groundwater interactions.
Construction and Pre-Operation	Surface water on site is monitored as part of the NPDES Construction General Permit. Erosion/sediment control and storm water management is monitored by the Storm Water Pollution Prevention Plan (SWPPP). Missouri River surface water will be monitored during refurbishment of the barge unloading facility (if required) as part of the U.S. Army Corps of Engineers 404 permit.	Groundwater monitoring during construction of Callaway Plant Unit 2 will use selected wells from the groundwater observation well network installed as part of the COL pre-application studies. This network may be revised as necessary to appropriately monitor changes in the local groundwater regime from construction activities.
Operation	Plant makeup water for plant cooling is withdrawn from the Missouri River/Missouri River Alluvial Aquifer by a Collector Well River Intake System. Potable (fresh water) is provided from an existing deep well. Discharge to Missouri River and other permitted outfalls will be monitored as required by the site NPDES permit.	Groundwater monitoring is performed in accordance with a plan to be developed to monitor the potential impacts of Callaway Plant Unit 2 operations as well as to detect unanticipated operational impacts.

Table 6.7-4—{Meteorological Monitoring}

Phase	Primary Tower	Detailed Descriptions
Pre-Application [1]	Wind Speed Sensor, Wind Direction Sensor, Aspirated Temperature Sensors, (at 3 elevations), Dew Point Sensors (at 2 elevations), Tipping Bucket Rain Gauge.	Table 6.4-1
Pre-Operation [2]	Wind Speed Sensor, Wind Direction Sensor, Aspirated Temperature Sensors, Dew Point Sensors, (at 2 elevations), Tipping Bucket Rain Gauge.	Table 6.4-1
Operation[2]	Wind Speed Sensor, Wind Direction Sensor, Aspirated Temperature Sensors, Dew Point Sensors (at 2 elevations), Precipitation Sensor.	Table 6.4-1

Notes:

(1) Primary Tower – 296 ft (90 m), 197 ft (60 m) and 33 ft (10 m) elevations above ground level

(2) Primary Tower – Modifications made to original tower included 296 ft (90 m) elevation eliminated and tower shortened. Retained 197 ft (60 m) and 33 ft (10 m) elevations above ground level. Instruments replaced in October, 2007.

Table 6.7-5—{Terrestrial Ecology Monitoring}

Phase	Summary	Permits
Pre-Application	Seasonal field studies were performed for one year to identify terrestrial mammals, birds, reptiles and amphibians, and plant species present on the site and within 5 miles of the site, including Federally and State listed rare, threatened, and endangered species. Wetlands were delineated based on field studies.	Missouri Department of Conservation Wildlife Collector's Permit
Construction and Pre-Operation	There are no ongoing monitoring programs planned for terrestrial ecology during this phase. Mitigation of unavoidable wetlands impacts due to construction activities for Callaway Plant Unit 2 will be guided by permit requirements of the U.S. Army Corps of Engineers and the Missouri Department of Natural Resources. Monitoring will follow guidelines developed by the U.S. Army Corps of Engineers. State of Missouri permits will be obtained for storm water pollution prevention, and spill prevention, control and countermeasures.	U.S. Army Corps of Engineers Missouri Department of Natural Resources
Operation	There are no ongoing monitoring programs planned for terrestrial ecology during this phase.	None applicable

Table 6.7-6—{Aquatic Ecology Monitoring}

Phase	Summary	Permit
Pre-Application Monitoring	Historical data collected in conjunction with Callaway Plant Unit 1 was reviewed. Seasonal field studies were performed for one year to identify aquatic species present in water bodies potentially impacted by the site, including Federally and State listed rare, threatened, and endangered species.	Missouri Department of Conservation Wildlife Collector's Permit
Pre-Operation and Construction Monitoring	{No aquatic ecology monitoring in addition to the current monitoring requirements for Callaway Plant Unit 1 are planned during this period.	General NPDES Construction Permit, Army Corps of Engineers 404 Permit, Spill Prevention, Control and Countermeasures Plan
Operation Monitoring	Operational monitoring will be in accordance with a new or revised NPDES permit.	MDNR Operating (NPDES) permit issued or revised to include Callaway Plant Unit 2 Operations

Table 6.7-7—{Chemical Monitoring}

Phase	Summary	Permit
Pre-Application	Pre-application chemical monitoring includes a review of the Missouri River water quality data collected at the USGS monitoring station at Hermann, MO; monitoring data collected in accordance with Callaway Plant Unit 1 NPDES permit; and chemical data collected during one year of quarterly sampling at 13 surface water and 7 groundwater locations in accordance with a monitoring plan specifically prepared for this application.	Existing NPDES permit for Callaway Plant Unit 1
Construction and Pre-Operation	Sample collection, laboratory analyses, data evaluation and reporting practices will be comprised of an extension of the monitoring required under the Callaway Plant Unit 1 NPDES permit, and the General NPDES Construction Permit. A Storm Water Pollution Prevention Plan will be implemented for construction of Callaway Plant Unit 2.	MDNR Operating (NPDES) Permit; General NPDES Construction Permit
Operation	Chemical monitoring of the combined Callaway Plant Unit 1 and Callaway Plant Unit 2 to detect changes in water quality associated with Callaway Plant site operations.	NPDES permit issued or revised to include Callaway Plant Unit 2 Operations