LA CROSSE BOILING WATER REACTOR
LICENSE TERMINATION PLAN
CHAPTER 2
SITE CHARACTERIZATION

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	United States Atomic Energy Commission
ALARA	As Low As Reasonably Achievable
bgs	Below Ground Surface
CRD	Control Rod Drive
DCGL	Derived Concentration Guideline Levels
DQO	Data Quality Objective
EPA	United States Environmental Protection Agency
FCP	Forced Circulation Pump
FESW	Fuel Element Storage Well
FRS	Final Radiation Survey
FSS	Final Status Survey
G-1	Genoa 1 Coal/Oil Station
G-3	Genoa 3 Fossil Station
HSA	Historical Site Assessment
HTD	Hard-to-Detect
IR	Incident Reports
ISFSI	Independent Spent Fuel Storage Installation
LACBWR	La Crosse Boiling Water Reactor
LER	Licensee Event Reports
LSA	Low Specific Activity
LSE	LACBWR Site Enclosure
LTP	License Termination Plan
MARLAP	Multi-Agency Radiological Laboratory Analytical Protocols Manual
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	Minimal Detectable Concentrations
MDCR	Minimum Detectable Count Rate
MWe	Megawatt Electric
NIST	National Institute of Standards and Technology

NRC	United States Nuclear Regulatory Commission
ORC	Operational Review Committee
PSDAR	Post-Shutdown Decommissioning Activities Report
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCA	Radiologically Controlled Area
REMP	Radioactive Effluent Monitoring Reports
ROC	Radionuclides of Concern
RPV	Reactor Pressure Vessel
SRC	Safety Review Committee
STS	Source Term Survey
TSD	Technical Support Document
WDNR	Wisconsin Department of Natural Resources
WGTV	Waste Gas Tank Vault
WTB	Waste Treatment Building
ZNPS	Zion Nuclear Power Station

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2. Site Characterization

In accordance with the requirements of 10 CFR 50.82 (a)(9)(ii)(A) and the guidance of Regulatory Guide 1.179, *Standard Format and Contents for License Termination Plans for Nuclear Power Reactors* (1), this chapter provides a description of the radiological characterization performed at the La Crosse Boiling Water Reactor (LACBWR) site.

The purpose of site characterization is to ensure that the Final Radiation Survey (FRS) will be conducted in all areas where contamination existed, remains, or has the potential to exist or remain. The term “Final Radiation Survey” is from 10 CFR 50.82(9)(ii)(D) and is used in this License Termination Plan (LTP) in order to acknowledge the distinction between the two types of compliance surveys that will be performed at LACBWR. These surveys are; 1) a Final Status Survey (FSS) for open land areas and buried piping based on guidance provided in NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual* (MARSSIM) (2) and 2) a Source Term Survey (STS) for below ground structures to be backfilled prior to license termination. See LTP Chapter 5 for a description of the FRS.

The site characterization incorporates the results of investigations and surveys conducted to quantify the extent and nature of contamination at LACBWR. In addition, the results of site characterization surveys and analyses have been and continue to be used to identify areas of the site that will require remediation, as well as to plan remediation methodologies, develop waste classification and volumes, and estimate costs.

The characterization survey was designed and executed using the guidance provided in NUREG-1575 (MARSSIM) and NUREG-1757, Volume 2, Revision 1, *Consolidated Decommissioning Guidance - Characterization, Survey, and Determination of Radiological Criteria, Final Report,* (3). In addition, surveys were designed and executed in accordance with PG-EO-313196-SV-PL-001, *Characterization Survey Plan for the La Crosse Boiling Water Reactor* (4), and GP-EO-313196-QA-PL-001, *Quality Assurance Project Plan LACBWR Site Characterization Project* (QAPP) (5) which describes policy, organization, functional activities, the Data Quality Objective (DQO) process, and measures necessary to achieve quality data. The information obtained from the characterization provides guidance for decontamination and remediation planning. Materials which were shown to be contaminated with radioactive material at concentrations greater than the unrestricted release criteria have been and will continue to be removed and properly packaged for shipment and disposal.

The decommissioning approach for LACBWR requires the demolition, removal and disposal as waste of all LACBWR buildings, structures and components (with the exception of the LACBWR Administration building and Crib House) to a depth of at least 3 feet below grade. None of the buildings and structures associated with the Genoa 3 Fossil Station (G-3) are radiologically impacted such that they require remedial actions; therefore, no remediation is planned and these structures, including the G-3 Crib House, will remain intact and functional for G-3 power operations. The public roads and railways that traverse the site as well as several minor structures will also remain.

The major sub-grade structures that will be backfilled and remain at license termination are the basements of the Reactor Building, Waste Treatment Building (WTB), Waste Gas Tank Vault

(WGTV) and the remainder of the basement structures located below the 636 foot elevation (3 feet below grade). These remaining structures include the Piping and Ventilation Tunnel, Reactor/Generator Plant, the one foot thick portion of the Chimney Foundation, the Turbine sump and the Turbine pit.

In the Reactor Building, all internal structural surfaces, systems and components will be removed. All internal concrete will be removed to expose the steel liner, which will also be removed, leaving only the remaining structural concrete outside the liner below the 636 foot elevation (i.e., concrete "bowl" below 636 foot elevation, concrete pile cap and piles.) In the WTB, the only portion of the structure that will remain is the 630 and 635 foot floor, sump and concrete footers below the 636 foot elevation. In the WGTV and the other remaining basements, the remaining structure will consist of the floors and foundation walls as well as concrete piling cap and piles below the 636 foot elevation. The structural surfaces that will remain at LACBWR following the termination of the license are constructed of steel reinforced concrete which will be covered by at least 3 feet of soil and physically altered to a condition which would not allow the remaining backfilled structures to be plausibly occupied.

LTP Chapter 1, section 1.3.1 describes the site license boundary. The fenced area of the Independent Spent Fuel Storage Installation (ISFSI) Facility as located in Lot 7 of the site (and shown in Figure 2-1) is excluded from the scope of the LTP.

2.1. <u>Historical Site Assessment</u>

In accordance with the guidance provided in MARSSIM, section 3.0, a Historical Site Assessment (HSA) (6) was performed and documented in August of 1999. Historical information, including any 10 CFR 50.75(g) files, employee interviews, radiological incident reports, pre-operational survey data, spill reports, special surveys (e.g., site aerial surveys, marine fauna and sediment surveys), operational survey records, and Annual Radiological Environmental Reports to the Nuclear Regulatory Commission (NRC) were reviewed and compiled for this investigation.

2.1.1. Objectives

The HSA was a detailed investigation to collect existing information (from the start of LACBWR activities related to radioactive materials or other contaminants) for the site and its surroundings. The HSA focused on historical events and routine operational processes that resulted in contamination of plant systems, buildings, surface and subsurface soils within the Radiologically Controlled Area (RCA). It also addressed support structures, open land areas and subsurface soils outside of the RCA but within the owner controlled area. The current RCA and the 1.5 acre fenced LACBWR Site Enclosure (LSE) area share the same boundary. The information compiled by the HSA was used to establish initial survey units. This information may also be used as input into the development of remediation plans and the design of the FRS. The scope of the HSA included potential contamination from radioactive materials and hazardous materials.

The objectives of the HSA were to:

- Identify potential, likely, or known sources of radioactive and chemical contaminants based on existing or derived information,

- Distinguish portions of the site that may need further action from those that pose little or no threat to human health,
- Provide an assessment of the likelihood of contaminant migration,
- Provide information useful to subsequent continuing characterization surveys,
- Provide an initial classification of areas and structures as non-impacted or impacted,
- Provide a graded initial classification for impacted soils and structures in accordance with MARSSIM guidance, and
- Delineate initial survey unit boundaries and areas based upon the initial classification.

2.1.2. Methodology

The objective of the HSA records search and interview process was to identify those events that may have significantly impacted the hazardous material or radiological status of LACBWR site land areas and structures. These included system, structure, or area contamination from system failures resulting in airborne releases, liquid spills or releases, or the loss of control over solid material. Depending upon past site operations and processes, the potential for residual contamination varies by area. In order to facilitate effective characterization, and to guide future decontamination activities and FRS planning, land areas and structures are classified based upon their potential for contamination.

Each incident identified that posed a realistic potential to impact the characterization of the site was further investigated. This investigation focused on the scope of contaminant sampling and analysis, any remedial actions taken to mitigate the situation, and any post-remedial action sampling, survey, and analysis in an attempt to identify the "as left" condition of the incident location. Historical records provided the source of a vast majority of the documents inspected.

Relevant information that becomes available during any additional characterization and remediation phases of the license termination plan will be evaluated.

Also included in the research associated with the development of the HSA were:

- Relevant excerpts from written reports and correspondences,
- Personnel interviews, including the use of questionnaires, of current, former and retired plant personnel to confirm documented incidents and identify undocumented incidents, Site inspection, utilizing historic site drawings, photographs, prints, and diagrams to identify, locate, confirm, and document areas of concern.

Information from this research was used in the HSA development, including the compilation of data, evaluation of results, documentation of findings, and the identification of initial Survey Units.

2.1.2.1. <u>Preliminary Classification</u>

The HSA investigation was designed to obtain sufficient information to provide initial classification of the site land areas and structures as impacted or non-impacted. Impacted areas have a potential for contamination (based on historical data) or contain known contamination (based on past or preliminary radiological surveillance). Non-impacted areas are identified through knowledge of site history or previous survey information and are those areas where there is no reasonable possibility for residual radioactive contamination. Areas were classified as impacted from a radiological perspective. Potential chemical hazards incidents on owner-controlled areas were also documented.

If a land area or structure was classified as impacted, then a determination of the initial impacted area classification (e.g. Class 1, Class 2 or Class 3) in accordance with MARSSIM, section 2.2 was made based upon the information obtained.

Initial classification of LACBWR areas was based on historical information and available historical radiological survey data. Classifying a survey area has a minimum of two stages: (1) initial classification and (2) final classification. Initial classification of most areas is performed at the time of identification of the survey area using the information available when the HSA was prepared. Final classification is performed and verified as a DQO during characterization and FRS design. The characterization data was used to validate or update, as necessary, the initial classifications indicated in the HSA as described in this Chapter. Radiological survey data from continuing characterization surveys, operational surveys in support of decommissioning, routine surveillance, and any other applicable survey data may cause an increase in survey area classifications (for example, from Class 3 to Class 2 and from Class 2 to Class 1) until the time of commencement of the FRS.

2.1.2.2. Document Review

Records maintained to satisfy the requirements of 10 CFR Part 50.75(g)(1) provided a major source of documentation for the HSA records review process. During the conduct of the HSA for LACBWR, many record types were evaluated. A summary of the types of records reviewed include:

- Operational Review Committee (ORC) Meeting Minutes,
- Safety Review Committee (SRC) Meeting Minutes,
- Licensee Event Reports (LER) Summaries,
- Site Initiated Incident Reports (IR),
- Operator Logs including Reactor Operator and Health Physics entries,
- Annual Environmental Monitoring Reports,
- Environmental investigations performed by independent entities,
- Regulatory actions concerning the site,
- Documentation from interviews conducted with retired/separated site personnel,
- Health Physics surveys and sampling results associated with identified events,
- Site inspection and surveillance type documents associated with identified events,
- Radiological and environmental survey documents,

- Quality Control (QC) /Quality Assurance (QA) finding type documents.

2.1.2.3. Licenses, Permits and Authorizations

LACBWR was operated in accordance with several Federal and State of Wisconsin licenses and permits. The NRC Operating License for LACBWR and supporting Technical Specifications allowed Dairyland Power Cooperative (Dairyland) to use any quantity of radioactive material at the site, to support operations during its operating lifetime, and to implement decommissioning activities.

Several government and regulatory agencies have provided oversight at LACBWR during siting, licensing, construction, operations, and decommissioning. These agencies include:

- United States Atomic Energy Commission (AEC),
- United States Nuclear Regulatory Commission (NRC),
- United States Environmental Protection Agency (EPA),
- Wisconsin Department of Natural Resources (WDNR),
- Local/County Governments.

From August 28, 1973 to the present, the facility has been operated under NRC License DPR-45. This period includes power operations to 1987, permanent shutdown for decommissioning in 1987, and ISFSI construction and spent fuel off-load which was completed in 2012.

2.1.2.4. Personnel Interviews

Interviews with current or previous employees were performed to collect first-hand information about the site and to verify or clarify information gathered from the records that were reviewed. The personnel interviews included a combination of questionnaires completed by a majority of the participants as well as individual and group interviews with several of the participants. Key personnel were chosen due to their knowledge of and association with the systems and source terms being investigated for the assessment. A number of the personnel interviewed possessed site knowledge and experience that ranged from the site construction period to shutdown.

Between 2010 and 2011, approximately 40 recollections of interest were logged from the individuals contacted as part of the HSA questionnaire program. This consisted of a standardized personnel survey which was completed voluntarily by retired/separated staff and site personnel who worked at the LACBWR during its operational years. With few exceptions, the personnel observations documented on the questionnaire were corroborated either by logged memories of other questionnaire completers, current on-site working staff that had LACBWR operational period experience, or by documentation discovered during the records search.

2.1.2.5. Property Inspections

Several on-site property inspections were made over the course of the HSA development. Several site events of interest were identified which were subsequently documented in the HSA.

2.1.3. Operational History

LACBWR was a 50 Megawatt Electric (MWe) Boiling Water Reactor that is owned by Dairyland. This single unit, also known as Genoa Station #2, is located on the east shore of the Mississippi River south of the Village of Genoa, Vernon County, Wisconsin. The site is bordered on the north by the Mississippi River and a narrow strip of land between the Mississippi River and Highway 35. The licensed site comprises a total of 163.5 acres, with the LSE comprising approximately 1.5 acres of the licensed site. The LSE boundary is fenced and served as the RCA boundary during operations. Material leaving the LSE was surveyed and confirmed to be suitable for unrestricted use before release. The site is accessed by an access road on the south side of the plant. Other prominent features on the site include:

- the land north of the LACBWR plant, including the site switchyard and the site of the former Genoa Station #1 (G-1) coal (and later oil) fueled power plant (removed in 1989),
- an operational 350 MWe fossil generating station (G-3) located south and approximately 175 feet from the LSE,
- the fenced ISFSI facility that is located directly south of G-3, and
- a small parcel of land to the east of Highway 35, across from LACBWR that is part of the licensed site.

The plant was one of a series of demonstration plants funded in part by AEC. The Allis-Chalmers Company was the original licensee; the AEC later sold the plant to Dairyland and provided them with a provisional operating license.

LACBWR achieved initial criticality on July 11, 1967, and was operated for approximately 19 years until it was permanently shut down by Dairyland on April 30, 1987. Final reactor defueling was completed on June 11, 1987. The Dairyland authority to operate LACBWR under Operating License DPR-45, pursuant to 10 CFR 50, was terminated by License Amendment No. 56, dated August 4, 1987; and a possess but not-operate status was granted by NRC. The 333 irradiated fuel assemblies, which were in Fuel Element Storage Well (FESW), were placed into five (5) dry casks and transferred to the site's ISFSI by September 2012.

Limited dismantlement of shutdown and unused systems and waste disposal operations has been ongoing at LACBWR since 1994. Waste stored in the FESW and other Class B/C waste was shipped for disposal in June 2007. The Reactor Pressure Vessel (RPV) with head installed, internals intact, and 29 control rods in place was filled with concrete, removed from the Reactor Building, and shipped for disposal in June 2007. Other systems and components have been removed, including the spent fuel storage racks, Gaseous Waste Disposal System (except for the underground gas storage tanks); Condensate system and Feedwater system (except for the Condensate Storage Tank and condenser); Turbine and Generator; and Component Cooling Water System pumps, heat exchangers, piping and components that were located in the Turbine Building.

2.1.4. Incidents

Based on the review of existing plant records (e.g. annual and semi-annual reports, licensee notifications, occurrence reports, and questionnaires), incidents with radiological or hazardous material implications occurred between the commencement of plant operation in 1967 and placing the reactor in a SAFSTOR condition in 1987. All of these incidents took place within the LSE and, while contributing to the radiological contamination and potential contamination of the structures and soils directly related to the operation of the reactor, were contained within the LSE, which is already known to be "impacted".

Special emphasis was placed on obtaining and reviewing the annual Radioactive Effluent Monitoring Reports (REMP), focusing on gaseous and liquid releases since 1967, including reports covering the periods of SAFSTOR and decommissioning activities after the plant shutdown in 1987. Available sampling results associated with soil and groundwater within or around the plant site were also reviewed. The objective was the identification of those events posing a significant probability of impacting the radiological status or hazardous material status of LACBWR site land areas and structures. These included system, structure, or area contamination from system failures resulting in airborne releases, liquid spills or releases.

2.1.4.1. Radiological Spills

The historical review indicated that between 1967 and 1987, there were several incidents involving system leakages, radiological spills, and/or radioactive liquid effluent releases with the potential to affect the classification of LACBWR structures or soils. The incidents are listed in chronological order as follows;

- The stainless steel liner in the FESW had a history of leakage to the Reactor Building floor. Incidents involving leakage of the FESW were noted from 1967 to 2012.
- Incidents involving leakage from the resin regeneration waste system to the Circulating Water Discharge line were noted from 1967 to 1973.
- In 1970, potentially contaminated Control Rod Drive (CRD) oil was used for dust suppression on the licensed site roads.
- In September, 1977, removable alpha contamination was detected during decontamination of a Forced Circulation Pump (FCP) during maintenance involving a steam cleaning tank in the Reactor Building 701 foot elevation. (ORC, 09/27/77)
- On November 5, 1980, partial blockage of drain lines under Turbine Building resulted in the potential for leakage of drain water into the soil under the Turbine Building. (DPC-80-84 Incident Report, ORC-80-71, ORC-80-75, ORC-80-87, ORC-80-97)
- On November 24, 1980, residual radioactive contamination was detected in soils under the Turbine Building. (DPC-80-93 Incident Report, ORC-80-71, ORC-80-75, ORC-80-87, ORC-80-97, LER 80-12)
- On December 6, 1980, the Turbine Building Waste Water Tank overflowed approximately ½ gallon of waste water to the Turbine Building floor. (DPC-80-102 Incident Report, ORC-80-71, ORC-80-75, ORC-80-87, ORC-80-97)
- On December 15, 1980, the Turbine Building Waste Water Tank overflowed waste water into the Turbine Building Basement Tunnel. (DPC-80-106 Incident Report)

- Incidents involving leakage of potentially contaminated liquid from the Turbine Building waste water tanks through the normal effluent release pathway to the Circulating Water Discharge line were noted from 1980 to 1986.
- On January 30, 1981, the Turbine Building Waste Water Tank overflowed and unspecified volume of water into the laundry room. (DPC-81-10 Incident Report)
- On May 31, 1982, a lid seal failed on a spent resin liner which resulted in the spill of contaminated water and spent resin onto the floor of the Spent Resin Liner Room and into the basement. (DPC-82-51 Incident Report)
- On July 02, 1982, approximately 1,200 gallons of condensate water was released from a sight flow seal rupture to the Turbine Building floor, and approximately 20 gallons of contaminated water flowed into the soils outside the Turbine Building door and Truck Bay door. In addition, approximately 25 gallons of contaminated liquid was discharged to an unrestricted area. (DPC-82-58 Incident Report, LER 82-016)
- On July 16, 1983, a leak in the Seal Water Injection System leak at 1A FCP caused approximately 15,000 gallons of reactor coolant to be discharged to the Reactor Building basement floor. (LER 83-07)

2.1.4.2. Chemical Spills

Between 1967 and 2014, the HSA documented several incidents involving the unplanned spill or release of chemicals and/or potentially hazardous liquids to the environment. These incidents ranged from spills of acids and caustics used in the plant's various systems to the spill of diesel and fuel oil from systems and storage tanks. A majority of the incidents occurred inside of impacted buildings. These spills were controlled and remediated in accordance with the station policies and procedures for identification, control and remediation of hazardous material releases.

2.1.5. Findings and Conclusions

LACBWR was designed with multiple boundaries to control and contain the radioactive contents within its many systems, components, and structures. Many of these systems and structures have been impacted due to routine operations and maintenance activities during the operational and post operational history of the plant. Dairyland LAC-TR-138, *Initial Site Characterization Survey for SAFSTOR* (7) identified historical failed fuel incidents at LACBWR and the potential for fission products to enter and impact reactor and support systems.

Structures classified as "impacted" by the operation of the facility include Reactor Building, Turbine Building, WTB, Low Specific Activity (LSA) Building, WGTV, and the Ventilation Stack. In addition to the structures, the soils surrounding these buildings have also been deemed to be directly impacted by the operation of this facility. This area is defined by the LSE fence.

An area surrounding the LSE has also been designated as impacted. This area includes ancillary support buildings such as the LACBWR Crib House, LACBWR Administration Building and various warehouses and storage buildings.

In addition to the area within the LSE and the open land areas surrounding the LACBWR support buildings, the open land immediately surrounding the LSE fence is designated as impacted to provide a buffer zone between the LSE and the G-3 land and facilities south of the LSE which is considered non-impacted. The licensed site comprises a total of 163.5 acres with the LSE areas comprising approximately 1.5 acres of the owner controlled area.

2.1.6. Initial Survey Areas/Units and Classification

As part of the HSA process, the impacted LACBWR structures and open land areas were divided into preliminary survey areas and assigned area classifications based on the operational history and existing survey data.

2.1.6.1. Survey Areas

The entire 163.5 acres licensed site was divided into survey areas. Survey areas are typically larger physical sections of the site that may contain one or more survey units depending on their classification. Survey area size was determined based upon the specific area and the most efficient and practical size needed to bound the lateral and vertical extent of contamination identified in the area. Survey areas that have no reasonable potential for residual contamination were classified as "non-impacted". These areas have no radiological impact from site operations and are identified in the HSA. Survey areas with reasonable potential for residual contamination were classified as "impacted." Figure 2-1 provides an illustration of the LACBWR site and the current classifications by area.

2.1.6.2. Survey Units

The survey areas were further divided into survey units. A survey unit is a portion of a structure or open land area that is surveyed and evaluated as a single entity following FRS. Survey units were delineated to physical areas with similar operational history or similar potential for residual radioactivity to the extent practical. To the extent practical, survey units were established with relatively compact shapes and highly irregular shapes were avoided unless the unusual shape was appropriate for the site operational history or the site topography.

The survey units established by the HSA were used as initial survey units for characterization. Prior to characterization, survey unit sizes for Class 1 open land survey units were adjusted in accordance with the guidance provided in MARSSIM, section 4.6 for the suggested physical area sizes for survey units for FSS.

The decommissioning approach that will be implemented at LACBWR calls for the complete segmentation, removal and disposal of all impacted systems and above-grade structures. With the exception of structure basement floors and walls that reside 3 feet below grade, no portion of any structure will remain at site closure and consequently, be subjected to FRS. However, survey units have been established for structures to facilitate other characterization objectives. These objectives include providing survey data for remediation planning, estimating the waste volume contained onsite, and disposition options for the waste.

In addition, the survey units established for structures that are 3 feet below grade are intended for the purpose of characterization planning and do not correspond to the survey units that will be used for the FRS of remaining below grade structures (designated as STS and discussed in section 5.5.2 of Chapter 5).

Tables 2-1 and 2-2 provide a detailed list of the survey units for both the open land areas and impacted structures respectively. Figure 2-2 provides a detailed inventory of the building and site structures. A summary of the survey unit classifications are presented as follows.

2.1.6.3. Class 1 Open Land Areas

The following open land areas have been classified as impacted Class 1:

- Reactor Building, WTB, WGTV, Ventilation Stack Grounds (L1010101),
- Turbine Building, Turbine Office Building, 1B Diesel Generator Building Grounds (L1010102),
- LSA Building, Maintenance Eat Shack Grounds (L1010103),
- North LSE Area (L1010104).

The basis for this classification is due to a series of documented incidents of the contamination of soil by radioactive material in these areas during facility operations. These incidents include spills of radioactive liquids and resins, radioactive system leakage, and storage of radioactive packages and containers.

Based on an assessment of historical incidents and events, it was anticipated that the surface and subsurface soils in these areas could possibly contain residual radioactive material in excess of the unrestricted use criteria. Class 1 open land survey units are shown on Figure 2-1.

2.1.6.4. Class 2 Open Land Areas

The following open land areas were classified as impacted Class 2:

- LACBWR Administration Building, LACBWR Crib House, Warehouse Grounds (L2011101),
- G-3 Crib House, LACBWR Circ. Water Discharge Line, Area South of LSE Fence Grounds (L2011102).

Based upon a review of the historical information and operational radiation and contamination surveys performed in these areas as documented in the HSA, there was a potential for residual radioactive contamination to exceed the unrestricted release criteria.

Class 2 open land survey units are shown on Figure 2-1.

2.1.6.5. Class 3 Open Land Areas

The following open land areas were classified as Class 3:

- North End of Licensed Site (L3012101),
- Transmission Switchyard Area (L3012102),
- Plant Access, ISFSI Haul Road Grounds (L3012109).

Historical information contained in the HSA indicated that the presence of residual radioactivity in concentrations in excess of the unrestricted release criteria was not expected.

Class 3 open land survey units are shown on Figure 2-1.

2.1.6.6. Non-Impacted Open Land Areas

Based on a review of the operating history of the facility and historical incidents as documented in the HSA, the balance of the 163.5 acre licensed site has no reasonable potential for residual contamination and has been designated as non-impacted.

- G-3 Coal Plant Grounds (L4012103)
- Coal Pile Grounds (L4012105)
- Capped Ash Impoundment Grounds (L4012106)
- Grounds East of Highway 35 (L4012107)
- Hwy 35/Railroad Right of Way Grounds (L4012108)

The non-impacted open land survey units are shown on Figure 2-1.

2.1.6.7. Class 1 Structures

The following is a list of the major buildings that were initially classified as impacted Class 1 structures. The complete list of all impacted structural survey units is provided in Table 2-2. These structures contain the nuclear reactor, primary reactor systems, reactor support systems, radioactive waste systems, and nuclear fuel handling and storage systems. During operations, radioactive material was routinely handled, transferred, and stored within these buildings. A majority of the current radioactive material inventory at LACBWR resides in these structures:

- Reactor Building (B1010001)
- Waste Treatment Building (B1010002)
- Ventilation Stack (B1010003)
- Waste Gas Tank Vault (B1010004)
- Turbine Building (B1010005)
- Diesel Generator Building (B1010006)
- LSA Building (B1010007)
- Maintenance Eat Shack (B1010008)

Throughout facility operations, these structures were subjected to spills of radioactive liquids, the spread of loose surface contamination, and airborne radioactive material. Structural surfaces were routinely posted as contaminated areas. The decommissioning approach for these structures involves the complete segmentation, removal, and disposal of all systems and structural material as waste. With the exception of structural floors and walls that reside 3 feet below grade, no portion of these structures will remain at site closure and are therefore not subjected to FRS. The Class 1 structural survey units are depicted in Figure 2-1.

2.1.6.8. Class 2 and 3 Structures

The following is a list of some of the major buildings that were initially classified as impacted Class 2 or 3 structures. All are located within the licensed site but outside of the LSE. The complete list of all impacted structural survey units is provided in Table 2-2.

- LACBWR Crib House (B2010101)
- G-3 Crib House (B2010102)
- LACBWR Administration Building (B2010103)
- LACBWR Warehouse #1 (B2010104)
- LACBWR Warehouse #2 (B2010105)
- LACBWR Warehouse #3 (B2010106)
- Back-up Control Center (B3012101)
- Transmission Sub-Station Switch House (B3012102)
- G-1 Crib House (B3012103)
- Barge Washing Break Room (B3012104)

These structures did not routinely house radioactive systems or materials during operations. The structures associated with LACBWR listed above are outside of the LSE but were used by LACBWR workers and therefore considered Class 2 or 3. The G-1 Crib House and Barge Washing Break Room were not associated with LACBWR operations but are considered Class 3 structures because they reside in a Class 3 land area. With the exception of the LACBWR Administration building, the G-3 Crib House and the Transmission Sub-Station Switch House, the decommissioning approach calls for the complete segmentation, removal, and disposal of all LACBWR Class 2 or 3 systems and structural material as waste or salvage. No portion of these structures will remain at site closure and therefore will not be subjected to FRS.

The LACBWR Administration building, the G-3 Crib House and the Transmission Sub-Station Switch House will not be subjected to FRS. Instead, these structures will be surveyed for unrestricted release using a graded survey approach using the guidance of NUREG-1575, Supplement 1, *Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual* (MARSAME) (8). The Class 2 and Class 3 structural survey units for buildings are depicted in Figure 2-1.

Based on a review of the operating history of the facility and historical incidents as documented in the HSA, coupled with the results of characterization surveys (as summarized in section 2.3.5), the buildings associated with the G-3 station have no reasonable potential for residual contamination and have been designated as non-impacted. The G-3 station, including the G-3 Crib House, will remain intact and functional for G-3 power operations.

2.2. Characterization Approach

From October 2014 through August 2015, site characterization of LACBWR was performed in accordance with the Characterization Survey Plan. The Characterization Survey Plan incorporated the previous historical operational and radiological information collected and documented in the survey areas from the HSA and previous site characterization efforts. It was developed to provide guidance and direction to the personnel responsible for implementing and executing characterization survey activities. The Plan worked in conjunction with implementing procedures and survey unit specific survey instructions (sample plans) that were developed to safely and effectively acquire the requisite characterization data.

Characterization data acquired through the execution of the Plan was used to meet three primary objectives:

- Provide radiological inputs necessary for the design of FRS,
- Develop the required inputs for LTP, and
- Support the evaluation of remediation alternatives and technologies and estimate waste volumes.

The decommissioning approach for LACBWR calls for the demolition and removal of all on-site buildings, structures, and components to a depth of at least 3 feet below grade. Consequently, characterization efforts focused on open land areas and remaining structures that will be subjected to FRS. Extensive characterization of equipment, systems or structures that will be removed prior to the performance of final surveys is not required in accordance with NUREG-1757, Appendix O.

The characterization surveys focused on general open land areas including: site surface and subsurface soils, paved surfaces, and concrete pads. Concrete core samples were taken from the structural basements that will remain in the end-state condition. In addition, characterization surveys were performed in the LACBWR Administration Building and several of the G-3 station structures. Upon completion, the data was assessed for quality and adequacy. The data was then used to make determinations on whether additional characterization data is required, primarily of above grade or subgrade structures, surface and subsurface soils, or beneath the concrete floors of the expected end-state structures at LACBWR. Continuing characterization surveys will be planned, executed and documented with the same data quality and the results included in FRS planning.

A significant question that must be answered by the characterization is whether or not a survey unit is classified correctly. The appropriate classification of a survey unit is critical to the survey design for FRS. A classification which underestimates the potential for contamination could result in a survey design that does not obtain adequate information to demonstrate that the survey unit meets the release criteria. In some cases, this can increase the potential for making decisions errors.

As site-specific Derived Concentration Guideline Levels (DCGLs) were not yet established for LACBWR at the time the characterization survey was performed, alternate action levels were selected. The screening DCGLs presented in NUREG-1757 and the concentration values found in NUREG/CR-5512 Volume 3, *Residual Radioactive Contamination from Decommissioning Parameter Analysis* (9), Table 6.91 ($P_{crit} = 0.10$) for soils were used as alternate action levels to assess the correct classification of impacted open land or soil survey units.

For structures, the gross screening level that was used during characterization as an action level to evaluate the classification of survey units was the nuclide-specific screening value of 7,100 dpm/100cm^2 total gross beta-gamma surface activity based on Co-60 from NUREG-1757, Appendix H. Use of the Co-60 screening value was conservative as it was anticipated that the radionuclide distribution for surface contamination would be principally Co-60 and Cs-137 and the conservative approach was to assume a distribution of 100% Co-60 since the screening value for Cs-137 is significantly greater.

2.2.1. Data Quality Objectives

DQOs were implemented for characterization surveys in a similar manner as anticipated for the FRS. However, the goal of characterization is to quantify and delineate contaminated areas and to determine the radionuclide mixture, whereas the FRS goal is comparison of data against the unrestricted use criteria to demonstrate compliance with 10 CFR 20.1402. Characterization inspections and surveys of sufficient quality and quantity were performed to determine the nature, extent and range of radioactive contamination in each applicable survey unit, including applicable structures, residues, soils and surface water.

Characterization surveys were designed to gather the appropriate data using the DQO process as outlined in MARSSIM, Appendix D. The seven steps in the DQO development process are:

1) State the problem,
2) Identify the decision,
3) Identify inputs to the decision,
4) Define the study boundaries,
5) Develop a decision rule,
6) Specify limits on decision errors, and
7) Optimize the design for obtaining data.

The DQOs for site characterization included identifying the types and quantities of media to collect. No structures located above 3 feet below grade will remain following decommissioning and will therefore not be subjected to FRS. Consequently, sample collection was focused on the assessment of concrete in basements and surrounding soils. Building concrete was sampled by obtaining core samples. Soils were sampled volumetrically. Sufficient measurements were obtained to determine the mean and maximum activity as well as the sample standard deviation. Direct measurements and scans of surface soils were made using the same instruments and Minimal Detectable Concentrations (MDC) as will be employed for FSS. Volumetric samples that exhibited the highest activity were sent to an off-site laboratory for analysis of Hard-to-Detect (HTD) radionuclide(s).

2.2.2. Survey Design

Characterization surveys were designed and performed in accordance with all applicable approved procedures and the Characterization Survey Plan. Survey design incorporated a graded approach based upon the DQOs for each survey unit. For example, an open land survey unit was designated as Class 1 because it may contain levels of radiological contamination greater than the unrestricted release criteria. Therefore, the characterization surveys that were performed in a Class 1 survey unit focused on bounding the contamination where contamination was potentially present. The survey design was based upon the number of measurements and samples required to identify the lateral and vertical extent of the contamination. Areas classified as non-impacted, Class 2 or Class 3 received surveys developed to include a combination of random and biased survey measurement locations and scan areas. Biased survey designs used known information to select locations for static measurements and/or samples. Random survey design selected static measurement and/or sample locations at random. The decision of whether to use primarily a biased survey design or a random approach was addressed by the DQO process for each survey unit. A biased approach was warranted when the characterization effort was designed to delineate the extent of an area that requires remediation. Alternatively, a random approach was warranted if the characterization effort was designed to verify the basis for the classification of a survey unit.

The areas and materials surveyed and/or sampled in and around the licensed area as part of the characterization survey included:

- Surface scans and random and biased surface and subsurface soils samples were taken in all Class 1, 2, 3, and non-impacted open land area survey units with the exception of survey unit L3012102 (i.e., the switchyard).
- Biased subsurface soil samples were taken alongside and underneath underground piping systems of concern in Class 1 and 2 areas including the piping systems as shown on Figure 2-3.
- Random samples were taken from asphalt and concrete from pads and paved areas. In addition, soil samples were obtained directly below the asphalt to a one meter depth.
- Scans and samples were taken on accessible roof surface areas of the LACBWR Administration Building and the G-3 Coal Plant.
- Samples were taken from the septic tanks.
- Scans and samples were taken on LACBWR Administration Building surfaces and drain areas.
- Scans and samples were taken on G-3 Building access and heavily traveled surfaces.
- Concrete samples were taken in the basement areas of the Reactor Building, WTB, and Piping and Ventillation tunnels.
- A background radiation study was performed on materials similar to those found at LACBWR including: asphalt, concrete, and soil.

2.2.2.1. Number of Static Measurements and/or Samples

The number of measurements and/or samples that were taken in each survey unit was determined by assessing the sample size necessary to satisfy the DQOs.

For the characterization of impacted Class 1 and Class 2 open land areas (paved and unpaved) that will be subjected to FSS, the minimum number of random or biased direct measurements and/or samples taken in the survey units were commensurate with the probability of the presence of residual radioactive contamination in the survey unit.

For the characterization of Class 1 structures that will remain and be subjected to FRS, the sample size was based upon the necessary number of samples needed to assess the lateral and vertical extent of the contamination.

For non-impacted and Class 3 open land survey units, the primary characterization DQO was to validate the basis of the classification. Consequently, the number of systematic static measurements and/or samples was sufficient to ensure with reasonable confidence that only trivial levels of licensee-generated radionuclides are present in Class 3 areas and no licensee-generated radionuclides are present in non-impacted areas.

2.2.2.2. Determination of Static Measurement and Sample Locations

For the characterization of non-impacted and impacted open land areas and Class 2 structural survey units that will be subjected to FRS, sample locations were primarily chosen at random. Sample locations were determined by generating random pairs of coordinates that corresponded to specific locations within the survey unit. The location of biased measurements and/or samples that were taken in each survey unit was determined by the professional judgment of the responsible Radiological Protection Supervisor and/or the Project Health Physicist during the survey design process. Consideration was given to locations that exhibit measurable radioactivity, depressions, discolored areas, cracks, low point gravity drain points, actual and potential spill locations, or areas where the ground has been disturbed. Historical information from the HSA aided in the selection of biased locations.

2.2.2.3. Scan Coverage

Survey units were scanned to the extent practical in accordance with their classification. The area to be scanned in each survey unit was determined during the survey design process. The area scanned was contingent upon the professional judgment of the Radiological Protection Supervisor and/or the Project Health Physicist during the survey design process. Consideration was given to information from the initial walk downs and the ambient radiation levels in the survey unit.

2.2.2.4. Types of Measurements and Samples

The characterization survey of building surfaces consisted of a combination of surface scans (beta and gamma); static beta measurements, material samples and smears. The characterization survey of any concrete and/or asphalt-paved open land areas that will remain and be subjected to FRS consisted of a combination of surface scans (beta and gamma), static beta measurements, and volumetric samples. The survey of the open land areas consisted of gamma scans and the sampling of surface and subsurface soil, sediment and surface water for isotopic analysis. The following is a description of the different types of measurements and samples that were utilized.

2.2.2.4.1. Gamma Surface Scans

Gamma scans were performed over open land surfaces to identify locations of residual surface activity. Sodium iodide (NaI) gamma scintillation detectors (typically 2" x 2") were typically used for these scans. Energy*Solutions* Technical Support Document (TSD) RS-TD-313196-006, *Ludlum Model 44-10 Detector Sensitivity* (10) examines the response and scan MDC of the Ludlum Model 44-10 NaI detectors to Co-60 and Cs-137 when used for scanning surface soils.

Scanning was performed by moving the detector in a serpentine pattern, while advancing at a rate not to exceed 0.5 m (20 in) per second. The distance between the detector and the surface was maintained within 15 cm (6 in) of the surface if possible. Audible signals were monitored; and, locations of elevated direct levels were flagged for further investigation and/or sampling.

2.2.2.4.2. Beta Surface Scans

Scanning was performed in order to locate areas of residual activity above the 7,100 dpm/100cm^2 action level. Beta scans were performed over accessible structural surfaces including, but not limited to; floors, walls, ceilings, roofs, asphalt and concrete paved areas. Hand-held beta scintillation and/or gas-flow proportional detectors (typically 126 cm^2) were used.

Beta scanning was performed with the detector position maintained within 1 cm of the surface and with a scanning speed of one detector active window per second. If surface conditions prevented scanning at the specified distance, the detection sensitivity for the alternate distance was determined, and the scanning technique adjusted accordingly. Scanning speed was calculated *a priori* to ensure that the MDC for scanning was appropriate for the stated objective of the survey.

If not impacted by high ambient noise levels, technicians monitored the audible response of the instrument to identify locations of elevated activity that require further investigation and/or evaluation. Any identified areas of elevated contamination were marked or flagged for further investigation and potential decontamination.

2.2.2.4.3. Direct Measurements

Direct measurements were performed to detect total levels of contamination on structural surfaces of the buildings or on concrete or asphalt paved areas. These measurements were typically performed using ~100 cm^2 or larger sized scintillation or gas-flow proportional detectors.

Direct measurements were conducted by placing the detector near the surface to be counted and acquiring data over a pre-determined count time. A count time of one to two minutes was typically used for surface measurements and generally provided detection levels well below the designated investigation level or MDC under consideration. The instrument count times were adjusted as appropriate to achieve an acceptable MDC for direct measurements.

2.2.2.4.4. Removable Surface Contamination

If applicable, removable beta and/or alpha contamination or smear surveys were performed to verify loose surface contamination is less than the applicable action level. A smear for removable activity was usually taken at each direct measurement location on non-asphalt type surfaces. A 100 cm^2 surface area was sampled with a circular cloth or paper filter, using moderate pressure. Smears were then analyzed for the presence of gross beta and/or gross alpha activity as appropriate.

2.2.2.4.5. Concrete and Asphalt Core Sampling

Concrete core boring and the sampling of concrete were used to assess the depth of surficial contamination and the presence of volumetric contamination in concrete walls and floors that will remain and be subjected to FRS. Core bore sampling of concrete was accomplished using a diamond bit core drill. The concrete sample produced by the coring was typically sliced into ½-inch wide "pucks", representing a certain depth into the surface. Concrete pucks were pulverized and analyzed for isotopic content.

2.2.2.4.6. Material Sampling

Samples of soil, sediment, and sludge were obtained from designed biased and random sample locations as well as other locations in areas exhibiting elevated activity that were identified by scanning. Surface soil is defined as the top 15 cm (6-inch) layer of soil while subsurface soil is defined as soil below the top 15 cm layer in 1 m increments. Surface soil was collected using a split spoon sampling system or, by using hand trowels, bucket augers, or other suitable sampling tools.

Subsurface soil was sampled by direct push sampling systems (e.g. GeoProbe®) or by manual hand augers. Subsurface soil sampling was performed as necessary to address the DQOs for the survey unit.

2.2.3. Instrumentation Selection, Use and Minimum Detectable Concentrations (MDCs)

The radiation detection and measurement instrumentation for characterization was selected to provide both reliable operation and adequate sensitivity to detect the initial suite of radionuclides identified for the decommissioning of LACBWR at levels sufficiently below the established action levels. Detector selection was based on detection sensitivity, operating characteristics, and expected performance in the field. In all cases, the instruments and detectors selected for static measurements and scanning were capable of detecting the anticipated Radionuclides of Concern (ROC) at a MDC of 50% of the applicable action level.

Commercially available portable and laboratory instruments and detectors were typically used to perform the three basic survey measurements: 1) surface scanning; 2) static measurements; and 3) analysis of material samples.

Instrumentation and nominal MDC values that were employed during characterization are listed in Table 2-3.

2.2.3.1. <u>Calibration</u>

All data loggers, associated detectors, and all other portable instrumentation that were used for characterization were calibrated on an annual basis using National Institute of Standards and

Technology (NIST) traceable sources. The calibration of instruments used for characterization is addressed in the QAPP.

2.2.3.2. Instrument Use and Control

The receipt, inspection, issue, control, and accountability of portable radiological instrumentation used for characterization was performed in accordance with issue and control procedures for portable radiological instrumentation. The issue and control of instruments used for characterization is addressed in the QAPP.

2.2.4. Laboratory Instrument Methods and Sensitivities

Gamma spectroscopy was primarily performed by the on-site radiological laboratory. Gas proportional counting and liquid scintillation analysis was performed by an approved vendor laboratory in accordance with approved laboratory procedures. Energy*Solutions* ensured that the quality programs of the contracted off-site vendor laboratories that were used for the receipt, preparation and analysis of characterization samples provided the same level of quality as the on-site laboratory under the QAPP.

In all cases, analytical methods were established to ensure that required MDC values were achieved. The analysis of radiological contaminants used standard approved and generally accepted methodologies or other comparable methodologies. Table 2-4 provides the typical analytical methods employed and the laboratory MDC achieved by the off-site vendor laboratories used for characterization.

2.2.5. Quality Assurance

MARSSIM, section 2.2 discusses the need for a quality system to ensure the adequacy of data used to demonstrate that site conditions are acceptable for unrestricted release. Laboratory quality for sample analysis taken to support characterization and FRS is discussed in NUREG-1576, *Multi-Agency Radiological Laboratory Analytical Protocols Manual* (MARLAP) (11) and Regulatory Guide 4.15, *Quality Assurance of Radiological Monitoring Programs (Inception through Normal Operations to License Termination) - Effluent Streams and the Environment* (12). Further, MARSSIM and MARLAP both indicate that a Quality Assurance Project Plan may be used in addition to, or in lieu of, existing quality systems to ensure data quality is achieved.

The QAPP was prepared and implemented to ensure the adequacy of data being developed and used during the site characterization and FRS process. The QAPP describes policy, organization, functional activities, the DQO process, and measures necessary to achieve quality data.

All characterization activities essential to data quality were implemented and performed using approved procedures. The effective implementation of characterization was verified through audit and surveillance activities, including field walk-downs by Energy*Solutions* Characterization staff and program self-assessments, as appropriate. Corrective actions were prescribed, implemented, and verified when deficiencies were identified. These measures applied to any applicable services provided by off-site vendors, as well as on-site sub-contractors.

The Characterization Survey Plan was developed according to the essential elements of the quality assurance and quality control (QA/QC) program for the decommissioning of LACBWR and is subject to the QAPP. The QA/QC program elements applicable to characterization are as follows:

- Establishment/implementation of plans, procedures, and protocols for the field operations.
- Actions to ensure that the procedures are understood and followed by the implementing staff.
- Documentation of the data collected.

Details of the QA/QC elements specific to characterization are presented in the QAPP, as well as the procedures and sample plan instructions. The characterization operations and the associated data acquisition and recording was guided and conducted in compliance with these QA/QC requirements. The specific QA/QC program components for site characterization are as follows:

- Personnel qualifications, experience, and training.
- Execution in accordance with approved procedures.
- Proper documentation of survey data and sample analyses.
- Selection of appropriate instruments to perform the surveys.
- Proper instrument calibration and daily functional checks.
- Management oversight of characterization activities relative to the adherence to procedures, protocols, and documentation requirements.

All characterization activities were conducted in accordance with the Characterization Survey Plan, the QAPP, all applicable implementing procedures, and approved sample plan instructions.

2.3. Summary of Characterization Survey Results

In October of 2005, Dairyland performed a limited characterization survey of the LSE prior to placing the unit into a SAFSTOR condition. This survey is documented in Reference 7. In October of 2014, Dairyland contracted Energy*Solutions* to perform a more detailed characterization of LACBWR in anticipation of the development of this LTP and the anticipated acceleration of decommissioning activities. Characterization activities, performed by Energy*Solutions* in accordance with Energy*Solutions* characterization procedures commenced on October 9, 2014. The scheduled Energy*Solutions* site characterization effort concluded on August 6, 2015. The results of the site characterization surveys performed by Energy*Solutions* is documented in two separate reports, GG-EO-313196-RS-RP-001, *LACBWR Radiological Characterization Survey Report for October and November 2014 Field Work* (13) and LC-RS-PN-164017-001, *LACBWR Radiological Characterization Survey Report for June thru August 2015 Field Work* (14).

Radioactive systems that remain at LACBWR affected the ability to acquire meaningful characterization data in certain areas due to ambient radiation levels. In these cases, characterization has been deferred until such time that radiological or physical conditions would allow the survey of these survey units. Solutions intends to continue characterization throughout the decommissioning process, including following the submittal of this LTP. In the case where significant additional characterization data is obtained, this chapter of the LTP will be updated by revision or addendum as a part of the required 2 year update of the approved LTP.

2.3.1. Background Study

During the initial characterization survey performed in October 2005, Dairyland performed a background study for soils at LACBWR. Reference 7 states that a series of soil samples were acquired from various locations outside of the owner controlled area. The result of this background study is summarized in Table 2-5.

As part of the 2014 characterization effort, Energy*Solutions* performed a limited assessment of background levels at LACBWR. The purpose of the study was to assess if background at LACBWR fell within nominal expected levels for soils, concrete, and asphalt.

Normally, background reference areas should be reasonably close to the decommissioning site to be representative. However, no suitable off-site location was identified. Consequently, an on-site area was chosen. The Energy*Solutions* Project Health Physicist and the Radiation Protection Supervisor selected an area outside of the LSE but on the licensed LACBWR site that seemed appropriate for obtaining background measurements based upon the previous radiological survey results. Although the selected sample locations were inside the LACBWR licensed area, they were considered unaffected by past LACBWR operations.

Concrete samples and direct measurements were taken in Class 3 survey unit L3012101, which is located north of the LSE. Asphalt samples and direct measurements were also collected in non-impacted survey unit L4012106. Surface soil samples were acquired from a small area of approximately 100 square meters of undisturbed non-drainage soil within non-impacted survey unit L4012108. Soil samples from non-impacted survey units L4012107 and other areas within L4012108 were also evaluated for use as background reference soils. Analysis results for these samples are provided in sections 2.3.3 and 2.3.5.3.

The analysis of the background soil samples in 2014 compared favorably with the 2005 background study for soils. The results did report Cs-137 at levels slightly above MDC. This can be attributed to global fallout. For the two background studies performed at LACBWR, the mean Cs-137 concentration of surface samples taken on or around the site produced a mean of 0.135 pCi/g with a maximum observed concentration of 0.268 pCi/g. The standard deviation was 0.070 resulting in the upper range for this data set at a 95% confidence level of 0.275 pCi/g.

Relevant to LACBWR is a study performed for the decommissioning of the Zion Nuclear Power Station (ZNPS) titled Zion*Solutions* TSD 13-004, *Examination of Cs-137 Global Fallout in Soils at Zion Station* (15). This document was prepared to compare site soil sample Cs-137 results at Zion to Cs-137 levels anticipated from worldwide fall out. The LACBWR and Zion sites are geographically similar. The document predicted ranges for background concentrations of Cs-137 for disturbed soils as well as undisturbed soils and is presented in Table 2-6. The observed background Cs-137 levels for the site specific background studies performed at LACBWR fall within the expected range of disturbed soils in non-drainage areas. As there were various categories of soil in the non-impacted areas at LACBWR, the upper 95th percentile levels for drainage and non-drainage, disturbed and undisturbed soil from the Zion background study were considered appropriate background concentration levels for the evaluation of non-impacted areas, and Class 2 and 3 open land area survey units at LACBWR.

2.3.2. Potential Radionuclides of Concern

Energy*Solutions* TSD RS-TD-313196-001, *Radionuclides of Concern During LACBWR Decommissioning* (16) establishes the basis for an initial suite of potential ROC for the decommissioning of LACBWR. Industry guidance was reviewed as well as the analytical results from the sampling of various media from past plant operations. Based on the elimination of some of the theoretical neutron activation products, noble gases and radionuclides with a half-life less than 2 years, an initial suite of potential ROC for the decommissioning of LACBWR was prepared. The list of potential radionuclides is listed in Table 2-7.

2.3.3. Non-Impacted Open Land Areas

Based upon the information compiled in the HSA, a large portion of the open land areas on the 163.5 acre licensed site surrounding the LSE and ISFSI received a classification as "non-impacted." The non-impacted areas have no reasonable potential to contain residual contamination given that historical information provides no indication of impact from LACBWR operations. The determination that the contiguous open land areas surrounding the LSE and ISFSI were not impacted by licensed operations was based on the location(s) of licensed operations (i.e., within the LSE), site use, topography, site discharge pathways, and other site physical characteristics. The areas designated as non-impacted are not required to be surveyed for compliance beyond the characterization surveys and sampling performed to provide a basis for the classification.

The non-impacted open land area is approximately 352,360 square meters in size. This area was segregated into five survey units. Non-impacted open land survey unit L4012109 is located inside of survey unit L4012108 in a vegetated area with minimal ground disturbance east of Highway 35. This survey unit was formed during characterization to facilitate a background study for soils. The non-impacted survey units are shown in Figure 2-1. The G-3 station resides within survey unit L4012103. A majority of the surface area in survey unit L4012105 is covered in coal from the G-3 station and survey unit L4012106 completely surrounds the LACBWR ISFSI facility, which has not been characterized and is not addressed by this LTP.

From October 2014 to August 2015, characterization surveys were performed in the non-impacted open land areas of the site. The survey units were originally classified as Class 3 survey units and were characterized as such in Reference 13. Based upon a review of the HSA and the initial results of the 2014 characterization, these survey units were reclassified as non-impacted as it was determined that there is no reasonable potential for residual contamination. To support this conclusion, additional characterization was performed in 2015. A major objective of the additional characterization surveys performed in 2015 was to evaluate certain open land survey units given an initial Class 3 classification for re-classification as non-impacted by performing additional soil sampling and gamma walkover surveys.

The 2015 characterization campaign was designed in accordance with Reference 4. One of the primary objectives of the additional characterization was to perform sufficient radiological surveys and sampling to support the "non-impacted" classification and to provide reasonable assurance that the non-impacted survey units do not contain plant-derived radioactivity. The 2015 characterization survey focused primarily on soils and asphalt. The sample locations were based on a random design to ensure an unbiased survey.

During the 2015 characterization survey, a minimum of 1% of the surface soil area in survey units L4012103, L4012105, L4012106 and L4012108 was scanned with a Model 2350-1 data logger with a 2” by 2” NaI detector. In survey unit L4012107, less than 1% of the surface area was scanned due to inaccessibility from the presence of tall, thick vegetation and steep terrain. Gamma surface scanning focused on undisturbed soils with minimal vegetation or disturbed soils or gravel. Alarm set-points for the instrument were set at the observed background plus the Minimum Detectable Count Rate (MDCR) of the instrument. A total of four alarms were evaluated during the performance of the gamma scan, one in survey unit L4012106, two in survey unit L4012107 and one in survey unit L4012108. All scan alarms were investigated using an Exploranium GR-135. The results of the investigation indicated the elevated scan results were due to the presence of natural background activity.

Thirty-two surface soil samples were collected from non-impacted areas at locations biased toward discolored areas or areas where the ground had been disturbed. The sample locations are shown in Figure 2-5. Cs-137 was positively identified in concentrations greater than the instrument MDC in 26 of the 32 samples. No other potential plant-derived radionuclides were positively identified by gamma spectroscopy. The average Cs-137 concentration observed in the surface soil samples was 0.131 pCi/g with a maximum observed concentration of 0.463 pCi/g. These values are within the expected background range for Cs-137 surface samples as discussed in section 2.3.1. Only one Cs-137 result exceeded the maxium result of 0.268 pCi/g in the site-specific background data set. This sample was the maximum 0.463 pCi/g value and was located in the grounds east of Highway 35. The mean of the non-impacted and site-specific data sets were very close at 0.135 pCi/g and 0.131 pCi/g, respectively.

Seventeen subsurface soil samples were taken at randomly selected locations to a depth of one meter. Of the 17 subsurface soil samples taken, Cs-137 was positively identified in concentrations greater than the instrument MDC in eight samples. No other potential plant-derived gamma-emitting radionuclides were positively identified by gamma spectroscopy. The average Cs-137 concentration observed in the subsurface soil samples was 0.087 pCi/g with a maximum observed concentration of 0.409 pCi/g. These values are within the expected background range for Cs-137 as discussed in section 2.3.1. Only one subsurface sample had Cs-137 concentrations that exceeded the maximum Cs-137 concentration found in the site-specific surface soil background. This sample was the maximum 0.409 pCi/g value that was located in the Hwy 35/Railroad Right of Way Grounds.

Two asphalt samples were collected from random locations in paved areas in non-impacted survey units. The asphalt surface was first scanned with a beta-gamma detector. All scan results were less than the MDC of 1,938 dpm/100cm^2. No plant derived radionuclides were positively identified by gamma spectroscopy in any of the asphalt samples.

A summary of the gamma spectroscopy results for each non-impacted open land survey unit is presented in Table 2-8.

A coal ash sample from survey unit L4012105, six surface soil samples and five subsurface soil samples were sent to Test America Laboratories for gamma spectroscopy and HTD analyses. The results of the analysis are presented in Table 2-9.

The laboratory analysis sporadically identified several plant-derived radionuclides at concentrations exceeding the MDC, including H-3, C-14, Fe-55, Ni-63, and Sr-90. Cs-137 was also positively detected but at levels that are consistent with natural background. In all cases, the concentrations of the positively identified radionuclides were close to the detection limits and are considered to very likely be the result of counting uncertainty as opposed to the actual presence of the plant-derived radionuclides. This conclusion was supported by a review of expected radionuclide mixture fractions. For example, sample L3012105-CR-GS-002-SS indicates positive results for Cs-137, Sr-90 and Fe-55. However, the Sr-90/Cs-137 and Fe-55/Cs-137 ratios are 118 and 16, respectively. When the ratios from L3012105-CR-GS-002-SS are compared to the site-specific mixture fractions in Chapter 6, Table 6-3, it is seen that they are higher than expected by factors of 4,800 and 10,700, respectively. In conclusion, based on operational history, the radionuclide ratios, and primarily the concentrations of Cs-137 which are consistent with natural background and comprise 88% of the site-specific radionuclide mixture, the sporadic positive analytical results are very unlikely to represent the actual presence of plant-derived radionuclides in these survey units.

In survey unit L4012108, a representative sample of the rail road bed gravel was analyzed by gamma spectroscopy. In addition, gamma scan readings were taken of the rail road bed gravel area to determine if there is a significant difference from site background (which averaged approximately 7,000 to 8,000 cpm). The analysis of the railroad bed gravel indicated natural uranium and thorium series nuclides with no plant derived radionuclides. The gamma scan readings conducted during the walkover survey averaged 7,000-8,500 cpm.

2.3.4. Impacted Open Land Areas

The HSA identified the open land area inside the fenced LSE as “impacted” by reactor operations. The approximate area is 1.5 acres. All open land survey units inside the LSE have been classified as Class 1. An approximately 3.46 acre area that surrounds the LSE has also been identified as “impacted” by reactor operations. This open land area has been segregated into two Class 2 survey units. Three impacted Class 3 survey units were designated for the area north of the LSE, the transmission switchyard and the area encompassing the site access off Highway 35 and the haul road used to transport dry fuel casks to the ISFSI. The area of the three Class 3 survey units combined is approximately 16.5 acres.

The characterization of the impacted open land areas began in October 2014. A sample plan was prepared for each survey unit in accordance with Reference 4. Survey techniques were employed to determine the lateral and vertical extent of any contamination identified and the radionuclide concentrations in the soil. Characterization inspections and surveys were performed of sufficient quantity and quality to quantify the potential volumetric contamination of accessible surface and subsurface soils in each open land survey unit. Limited soil information was obtained from below the structures due to interferences and inaccessibility.

Survey techniques were employed to determine the lateral and vertical extent of any contamination identified and the radionuclide concentrations in the soil. A combination of random and biased survey locations were established in each survey unit in accordance with the survey package. The locations of biased measurements and/or samples were determined by the professional judgment of the Energy*Solutions* Project Health Physicist and the Radiological Protection Supervisor. Consideration was given to locations that exhibited measurable radioactivity, depressions, discolored areas, low point gravity drain areas, actual and potential spill locations, or areas where the ground had been disturbed. The number of random-based survey locations was also determined by area classification. Random-based measurements were not required for soils in an open land areas designated as Class 1. Random measurement locations were selected on asphalt in Class 1 survey units where there was no history of radiological contamination.

A surface soil sample was taken at each selected biased and random-based survey location. Sub-surface soil samples were acquired at several random locations or if surface soil sample analysis or surface scans indicated elevated activity. Depending on the location, subsurface soil samples were taken from 0.15 cm to depths ranging from 1 to 3 m below grade and composited over 1 m intervals.

Each surface soil, composite subsurface soil sample or asphalt sample was analyzed by the on-site radiological laboratory by gamma-spectroscopy. Analysis count times were adjusted as necessary to achieve an isotopic MDC equal to or less than 0.10 pCi/g for Cs-137 and Co-60. All surface and subsurface composite samples were analyzed after drying the sample media. Several soil samples were selected at random and were shipped to Test America Laboratories for full isotopic analysis (HTD radionuclides). Duplicate samples and concrete were collected by survey unit per Reference 4.

2.3.4.1. Class 1 Open Land Areas

There are four (4) open land survey units classified as Class 1 at LACBWR totaling 8,443 m^2. The Class 1 open land survey units are shown in Figure 2-1. A significant portion of the surface area in the Class 1 open land survey units is obstructed by the presence of buildings, namely the Reactor Building, the Turbine Building, the WTB and the LSA Building. The presence of radioactively contaminated building and systems, as well as stored radioactive material in these areas, prevented the ability to perform surface scanning due to high background.

Twenty-two (22) surface soil samples were taken at locations biased toward sites that exhibited measurable radioactivity, discolored areas, buried pipe locations, actual and potential spill locations, or areas where the ground had been disturbed. The locations of surface soil samples taken in Class 1 open land survey units are shown in Figure 2-6. Of the 22 surface soil samples taken, Co-60 was positively identified in concentrations greater than the MDC in two (2) samples and Cs-137 was positively identified in concentrations greater than the MDC in 13 samples. No other potential plant-derived gamma-emitting radionuclides were positively identified by gamma spectroscopy. The average Co-60 concentration observed in the analysis of the surface soil samples was 0.058 pCi/g with a maximum observed concentration of 0.287 pCi/g. The average Cs-137 concentration observed in the analysis of the surface soil samples was 0.096 pCi/g with a maximum observed concentration of 1.07 pCi/g.

Seventy-nine (79) subsurface soil samples were taken at 10 surface soil locations to a depth of one meter, two (2) locations biased to areas on the south and west side of the WGTV and five (5) locations that accessed the soils under the Turbine Building through angled Geoprobe sampling. The samples at the two WGTV locations were acquired to a depth of five meters in order to evaluate the subsurface soils alongside and underneath the vault. The samples under the Turbine Building were taken and composited at depths of 10, 15 and 20 feet. Of the 79 subsurface soil samples taken, Cs-137 was positively identified in concentrations greater than the MDC in 15 samples. No other potential plant-derived gamma-emitting radionuclides were positively identified by gamma spectroscopy. The average Cs-137 concentration observed in the analysis of the subsurface soil samples was 0.055 pCi/g with a maximum observed concentration of 0.161 pCi/g. The assessment of potential subsurface soil contamination in the Class 1 open land areas is not currently complete. Soil in difficult to access areas such as under building foundations and surrounding buried structures and piping has been deferred until later in the decommissioning process, when access will be more readily available.

Ten samples were taken of asphalt from paved areas in Class 1 survey unit L1010104. The asphalt was taken from the same location selected for the surface and subsurface soil samples in this survey unit. The asphalt surface was first scanned with beta-gamma detector with scan results ranging from the instrument MDC of 2,771 dpm/100cm^2 to a maximum of observed scan measurement of 3,095 dpm/100 cm^2. Of the 10 asphalt samples taken, Cs-137 was positively identified in concentrations greater than MDC in only one sample at a concentration of 0.057 pCi/g.

A summary of the findings of the survey for each individual Class 1 open land survey unit are presented in Table 2-10.

Nine surface soil samples, 11 subsurface soil samples, one concrete sample and two asphalt samples taken from Class 1 open land survey units were sent to Test America Laboratories for gamma spectroscopy and HTD analyses. The results of the analysis are presented in Table 2-11. In addition to detecting Co-60 and Cs-137, H-3, C-14, Fe-55 and Ni-63 were also positively detected at concentrations greater than the instrument MDC.

One sediment sample was taken from the sanitary solids tank that is located in Class 1 survey unit L1010103. This sample was also sent to Test America Laboratory for gamma spectroscopy and HTD analyses. Co-60 and C-137 were detected in this sample, both at a concentration of 0.136 pCi/g.

2.3.4.2. Class 2 Open Land Areas

The impacted Class 2 open land areas total approximately 13,996 m^2 and are located in the immediate area surrounding the LSE. The Class 2 impacted open land area was segregated into two survey units. These are shown in Figure 2-1. The LACBWR Administration Building, the LACBWR Crib House, the G-3 Crib House and the LACBWR warehouses are all located in these two survey units.

Approximately 1% of the surface soil area in survey unit L2011101 was scanned with a Model 2350-1 data logger with a 2” by 2” NaI detector. This area included asphalt paved surfaces. Alarm set-points for the instrument were set at the observed background plus the MDCR of the instrument. No scan alarms were observed.

Twenty-three surface soil samples were taken at locations biased toward sites that exhibited measurable radioactivity, discolored areas, buried pipe locations, actual and potential spill locations, or areas where the ground had been disturbed. The locations of surface soil samples taken in Class 2 open land survey units are shown in Figure 2-7. Of the 23 surface soil samples taken, Cs-137 was positively identified at concentrations greater than MDC in 14 samples. No other potential plant-derived radionuclides were positively identified by gamma spectroscopy. The average Cs-137 concentration observed in the analysis of the surface soil samples was 0.077 pCi/g with a maximum observed concentration of 0.200 pCi/g.

Twenty-three subsurface soil samples were taken at 14 random locations to a depth of one meter and three locations biased to areas alongside and underneath the Storm Sewer Water pipe that resides in survey unit L2011101. The biased samples were acquired to a depth of five meters. Of the 23 subsurface soil samples taken, Co-60 was positively identified at concentrations greater than MDC in one sample and Cs-137 was positively identified at concentrations greater than MDC in four samples. No other potential plant-derived radionuclides were positively identified by gamma spectroscopy. The single sample with detectable Co-60 had a concentration of 0.112 pCi/g. The average Cs-137 concentration observed in the analysis of the subsurface soil samples was 0.043 pCi/g with a maximum observed concentration of 0.088 pCi/g. The assessment of potential subsurface soil contamination in the Class 2 open land areas is not currently complete. Soil in difficult to access areas such as under building foundations and surrounding buried structures and piping has been deferred until later in the decommissioning process, when access will be more readily available.

Twelve samples were taken of asphalt from paved areas in Class 2 survey units. The asphalt was selected randomly. The asphalt surface was first scanned with beta-gamma detector with scan results ranging from the instrument MDC of 2,529 dpm/100cm^2 to a maximum of 2,748 dpm/100cm^2. Of the 12 asphalt samples taken, Cs-137 was positively identified in concentrations greater than the instrument MDC in three samples. The average Cs-137 concentration observed in the analysis of the asphalt samples was 0.049 pCi/g with a maximum observed concentration of 0.055 pCi/g.

A summary of the findings of the survey for each individual Class 2 open land survey unit are presented in Table 2-12.

Three surface soil samples, five subsurface soil samples, three asphalt samples and two sediment samples taken from an accessible storm sewer basin manhole located in front of the Administration Building were sent to Test America Laboratories for gamma spectroscopy and HTD analyses. The results of the analysis are presented in Table 2-13. In addition to detecting Co-60 and Cs-137, H-3, C-14, Fe-55 and Cm-243/244 were also positively detected at concentrations greater than MDC. As discussed in section 2.3.3 for non-impacted areas, the HTD radionuclides exceeding MDC are likely to be false positives.

2.3.4.3. Class 3 Open Land Areas

The impacted Class 3 open land areas total approximately 66,765m^2. The Class 3 impacted open land area was segregated into three survey units. The Class 3 survey units are shown in Figure 2-1. The Class 3 impacted open land survey units include the north end of the licensed site, the transmission switchyard for the LACBWR and G-3 facilities, the LACBWR plant access and right-of-way area and the haul road to the ISFSI facility. The north end of the licensed site was deemed impacted by LACBWR due to the presence of a septic system that services the LACBWR Administration Building and the presence of concrete from impacted structures (the Crib House). The transmission yard was deemed as impacted as it was part of the LACBWR facility during operations. The plant access area, Highway 35 right-of way and ISFSI haul road were deemed as impacted by the transit of packaged radioactive material through these areas. These areas were conservatively classified as impacted. However, it should be noted that Solutions maintains that classifying these areas as non-impacted would have been appropriate.

A minimum of 1% of the surface soil area in survey units L3012101 and L3012109 were scanned with a Model 2350-1 data logger with a 2" by 2" NaI detector. Survey unit L3012102 was excluded from gamma surface scanning for safety reasons. Gamma surface scanning focused on undisturbed soils with minimal vegetation or disturbed soils or gravel. Alarm set-points for the instrument were set at the observed background plus the MDCR of the instrument. No scan alarms were observed in these survey units.

Thirty-two surface soil samples were taken at locations biased toward discolored areas or areas where the ground had been disturbed. The locations of surface soil samples taken in Class 3 open land survey units are shown in Figure 2-8. Of the 32 surface soil samples taken, Cs-137 was positively identified in concentrations greater than MDC in 26 samples. No other potential plant-derived gamma-emitting radionuclides were positively identified by gamma spectroscopy. The average Cs-137 concentration observed in the analysis of the surface soil samples was 0.131 pCi/g with a maximum observed concentration of 0.463 pCi/g.

Seventeen subsurface soil samples were taken at randomly selected locations to a depth of one meter. Of the 17 subsurface soil samples taken, Cs-137 was positively identified in concentrations greater than MDC in eight samples. No other potential plant-derived radionuclides were positively identified by gamma spectroscopy. The average Cs-137 concentration observed in the analysis of the subsurface soil samples was 0.087 pCi/g with a maximum observed concentration of 0.409 pCi/g.

Two samples were taken of asphalt from paved areas in Class 3 survey units. The asphalt was selected randomly. The asphalt surface was first scanned with beta-gamma detector. All scan results were less than instrument MDC of 1,938 dpm/100cm^2. No plant derived radionuclides were positively identified by gamma spectroscopy in any of these samples.

A summary of the findings of the survey for each individual Class 3 open land survey unit are presented in Table 2-14.

As part of the characterization of survey unit L3012101, samples were taken from several pieces of concrete located in the north section of the survey unit that originated from the LACBWR Crib House. In addition, a sample was taken from a sanitary tank that services the LACBWR Administration Building and two sediment samples were taken from a storm sewer basin in survey unit L3012109. These samples were sent off-site for isotopic analysis.

Three concrete samples from survey unit L3012101, the sanitary tank sample from survey unit L3012101, the two sediment samples taken from the storm sewer basin in survey unit L3012109, three surface soil samples and two subsurface soil samples were sent to Test America Laboratories for gamma spectroscopy and HTD analyses. The results of the analysis are presented in Table 2-15. The analysis of these samples positively identified several plant-derived ROC at residual concentrations greater than the instrument MDC, including H-3, Fe-55 and Ni-63. As discussed in section 2.3.3 for non-impacted areas, the HTD radionuclides exceeding MDC are likely to be false positives. Cs-137 was also positively detected but at levels consistent with natural background.

2.3.5. Non-Impacted Structures

Based upon the information compiled in the HSA, Solutions concluded that the structures associated with the G-3 Coal Plant may be classified as “non-impacted”. Historical information indicated that there was no reasonable potential for residual contamination from site operations. A full list of G-3 structures that have been designated as “non-impacted” is provided in Table 2-2.

The primary basis for the “non-impacted” classification for the G-3 station structures is the information documented in the HSA that the G-3 structures were not used for LACBWR-related operations. Additionally, the potential for windborne migration of airborne effluent released from the LACBWR Stack during operations to structure roofs was evaluated by the characterization of the LACBWR Administration Building roof and the G-3 Coal Plant roof. The results are provided in Reference 13. Additional surveys of the G-3 structures were conducted during the 2015 characterization campaign where the surfaces subjected to high foot traffic in the major station buildings were surveyed.

The G-3 station resides in non-impacted survey unit L4012103. There are no documented incidents of radioactive contamination of soils, asphalt or concrete in this survey unit. The results of the characterization surveys performed in the G-3 station are summarized as follows:

A scan survey was performed of the mid-level roof of the G-3 Coal Plant building using a beta-gamma detector. In addition, six (6) locations were selected at random for direct measurements using an alpha/beta-gamma proportional detector. A smear sample for removable contamination was also taken at the location of each direct measurement. The results of the beta scan identified gross beta-gamma activity ranging from 2,302 dpm/100cm^2 to 2,816 dpm/100cm^2 with a scan MDC of 2,816 dpm/100cm^2. The results of the direct beta-gamma and alpha measurements identified gross beta-gamma activity ranging from 1,603 dpm/100cm^2 to 2,072 dpm/100cm^2 and gross alpha activity ranging from 142 dpm/100cm^2 to 258 dpm/100cm^2. No removable contamination was identified at concentrations greater than MDC by the analysis of the smear samples. The roof material itself was sampled on June 30, 2015. Cs-137 was the only plant derived ROC that was positively identified by gamma spectroscopy at a concentration of 0.061 pCi/g. Based on the fact that no other plant derived ROC was detected, it was concluded that the elevated direct alpha measurements were due most likely to the presence of coal ash material on the roof.

Direct and removable contamination surveys were performed of representative high personnel traffic areas of the G-3 Coal Plant. Scan measurements were performed using the Ludlum Model 2360 instrument with 43-93 detector. Approximately 5% of the concrete surfaces in the areas of interest were scanned, including floors and lower wall surfaces. The average scan MDC ranged from 2,540 dpm/100cm^2 to 2,617 dpm/100cm^2. No observed scan measurement exceeded the MDC during the course of this survey. Ten (10) locations were chosen at random, primarily from the main lobby area and the maintenance area. The results of all direct measurements for gross activity was less than the MDC of 74 dpm/100cm^2 for alpha and 875 dpm/100cm^2 for beta-gamma. No removable contamination was identified at concentrations greater than MDC by the analysis of the smear samples.

2.3.6. Impacted Structures and Systems

The decommissioning approach for LACBWR requires the demolition and removal of all impacted buildings, structures, systems and components to a depth of at least 3 feet below grade. In addition, all systems and exposed metal below 3 feet below grade will also be removed. The accepted elevation for grade at LACBWR is the 639 foot elevation. The only structures that will remain and be subjected to STS are the remaining reinforced concrete walls and floors of the Reactor Building that will be exposed by the removal of the interior concrete and steel liner, the remaining reinforced concrete walls floors of the WTB, the remaining reinforced concrete walls and floors of the WGTV, and the remainder of the Piping and Ventilation Tunnels, Reactor/Generator Plant basement, the one foot thick portion of the Chimney Foundation, the Turbine sump and the Turbine pit. Consequently, all systems and components and structural surfaces above the 636 foot elevation will be remediated, disassembled and/or demolished, segregated by waste classification and disposed of as clean demolition debris, clean salvage or radioactive waste. No extensive characterization was or will be performed of equipment, systems or structures that will be removed prior to the performance of FRS.

Radiological surveys of the interiors of structures at LACBWR are routinely performed to ensure compliance with 10 CFR 20 requirements regarding the posting of areas and to identify radiological conditions for the implementation of controls for the protection of workers in these areas. The radiological information from these surveys will provide the basis for the disassembly and removal of systems and the demolition of impacted structures at the site. When remediation has adequately reduced radiological conditions to levels suitable for controlled demolition, the impacted structures will be demolished, packaged and properly disposed of as waste.

After commodity removal is complete, the structures that will remain at license termination, i.e., 3 feet below grade, will be re-surveyed to determine the concentrations of the residual radioactivity and the extent of additional remediation required, if any, to meet the unrestricted use criteria.

2.3.6.1. Basement Structures Below 636 Foot Elevation

Characterization of the structural surfaces of basements that will remain in the "end-state" consisted primarily of the acquisition and radiological analysis of concrete core samples from the walls and floors of the Reactor Building, WTB and the balance of the basement structures (primarily the Piping Tunnels). In June and July of 2015, a series of concrete core samples were taken from the 615 foot elevation concrete floor and the concrete floor and east wall on the 621 foot elevation in the Reactor Building, the 630 foot elevation concrete floor of the WTB and the 633 foot elevation concrete floor of the Piping Tunnels. A total of twelve (12) concrete core samples were collected, six (6) in the Reactor Building, three (3) in the WTB and three (3) in the Piping Tunnel. The locations where the core samples were taken are shown in Figures 2-9.

The locations selected for concrete core sampling were biased toward locations where physical condition or observed radiological measurements indicated the presence of fixed and/or volumetric contamination of the concrete. When possible, locations were determined based upon elevated observed contact dose rates or count rates. In addition, visual observations of floor and wall surfaces were used to identify potential locations of surface contamination, such as discoloration or standing water. The goal was to identify, to the extent possible, the locations that exhibited the highest potential of representing the worst case bounding radiological condition for concrete in each survey unit. This judgmental sampling approach also ensured there was sufficient source term in the cores to achieve the sensitivities required to determine the radionuclide fractions of gamma emitters as well as HTD radionuclides.

The concrete pucks representing the first ½ inch of concrete at each sample location was sent to Test America Laboratory for gamma spectroscopy and HTD analyses for beta and alpha emitting ROC. In addition, the concrete pucks representing the concrete deeper than ½ inch deep at Reactor Building sample locations #001, #003, #005 and #006 and WTB sample locations #001 and #002 were also sent for isotopic analysis. A summary of the analytical results for the concrete cores is presented in Table 2-16. Significant HTD radionuclides identified by the analysis of the concrete core samples include Ni-63, H-3 and Sr-90. The other radionuclides positively detected at concentrations greater than their respective MDC include; C-14, Fe-55, Ni-59, Tc-99, Pu-238, Pu-239/240, Pu-241, Am-241 and Am-243. An analysis of the results of the concrete core samples is presented in Reference 16.

2.3.6.2. Turbine Building Tunnel

A concrete core was obtained as part of the 2014 characterization survey from the floor of the Turbine Building Tunnel to attempt to evaluate the possible extent of a radioactive contamination event cited in the HSA pertaining to the discovery of cracked drain system piping in the Turbine Building and the potential radiological contamination of surrounding soils. Analysis of this sample indicated detectable concentrations of Cs-137 at 0.352 pCi/g, Co-60 at 0.106 pCi/g and H-3 at 1.71 pCi/g.

2.3.6.3. LACBWR Administration Building

As stated previously, the LACBWR Administration Building and G-3 Crib House will not be subjected to FRS. Instead, these two structures will be surveyed for unrestricted release using a graded survey approach in accordance with MARSAME guidance.

As reported in the HSA, there was no past history of the use of unsealed radioactive materials, radioactive spills or radioactive contamination in the LACBWR Administration Building. The building has primarily been used for office space and records storage. An environmental lab was located in the building that supported both LACBWR and G-3 operations. The LACBWR Administration Building was initially classified as a MARSSIM Class 2 structure due to its proximity to the LSE, occupancy by LACBWR personnel and the presence of the environmental laboratory.

Characterization surveys of the LACBWR Administration Building included a scan for gross beta-gamma/alpha activity of interior floors surfaces and the roof. Direct measurements for gross beta-gamma/alpha activity were also performed on the roof, on floor tiles and around floor drain openings. A smear sample for removable contamination was also taken at the location of each direct measurement.

The results of the beta scans of the interior surfaces ranged from 1,420 dpm/100cm^2 to 4,915 dpm/100cm^2 with a scan MDC of 2,100 dpm/100cm^2. During the scan of the north end of the second floor hallway, a discrete radioactive particle was discovered. The particle was imbedded in a floor tile. The contaminated portion of the tile was removed and analyzed by gamma spectroscopy. The analysis of the tile identified 0.005 uCi of Cs-137. An investigation was then performed involving the acquisition of ten (10) biased direct measurements on the first and second floor laminated wood, carpet, and floor tile. Direct beta-gamma readings ranged from less than MDC of 329 dpm/100cm^2 to a maximum observed reading of 5,743 dpm/100cm^2 and direct alpha readings ranged from less than MDC of 39 dpm/100cm^2 to a maximum observed reading of 72 dpm/100cm^2.

Beta scans of the roof area indicated results ranging from 1,872 dpm/100cm^2 to 2,261 dpm/100cm^2 with a scan MDC of 2,261 dpm/100cm^2. Direct alpha measurements ranged from less than MDC of 113 dpm/100cm^2 to a maximum observed reading of 152 dpm/100cm^2. Direct beta-gamma measurements taken on the floor drain openings ranged from less than MDC of 243 dpm/100cm^2 to a maximum observed reading of 333 dpm/100cm^2 and direct alpha measurements were all less than MDC of 42 dpm/100cm^2. No removable contamination was identified concentrations greater than MDC by the analysis of the smear samples.

2.3.7. Surface and Groundwater

Section 8.5 in Chapter 8 of this LTP contains a summary description of the geology, hydrogeology and hydrology of ZNPS and environs. The information contained in this section was derived directly from Haley & Aldrich, *Hydrogeological Conceptual Site Model* (17). Haley & Aldrich, *Hydrogeological Investigation Report for the LaCrosse Boiling Water Reactor* (18) supplements the preliminary findings in Reference 17.

2.3.7.1. <u>Area Groundwater Use</u>

For a distance of 40 miles downstream of the site, virtually all municipal water supplies for towns and cities along the Mississippi River are obtained from ground water. The nearest use of river water for industrial purposes, excluding the adjacent G-3 plant, is the coal-fired plant in Lansing, Iowa, about 15 miles downstream of the site. There are no other known users of river water for industrial purposes between the LACBWR site and Prairie du Chien, WI, approximately 40 miles downstream.

The LACBWR site has its own potable water supply, provided through a single ground water well at the site. Sanitary wastes are collected in a solids holding tank and pumped off by a local state permitted sanitary wastes hauler. This includes a sanitary holding tank that services the LACBWR Administration Building and a sanitary holding tank that services the Turbine Building. Storm water runoff is diverted directly to the Mississippi River at outfalls. Release areas are periodically monitored for oil sheen and discoloration. Roof drains discharge directly to the ground area surrounding the facility via downspouts or enter the normal effluent release pathway after passing through an oil separator located inside the LSE.

2.3.7.2. Groundwater Flow

Regionally, groundwater flows in a westerly direction from the bluffs on the east towards the Mississippi river. Closer to the shore, groundwater may also have a flow component that parallels the river. Under typical river stage, groundwater gradients near the river are slightly upward; however, the vertical gradient reverses during flood stages. The geological and historic river stage data compared to water table elevations measure in LACBWR site monitoring wells demonstrates that the shallow aquifer is in direct hydraulic communication with the river and the river stage impacts the water table elevation.

Groundwater beneath the site is first encountered at an average depth of 20 feet below ground surface (bgs) and the groundwater is in direct hydraulic communication with the adjacent river. Groundwater in the shallow deposits and fill material flows towards the west and discharges into the Mississippi River. The deeper groundwater is also likely to flow towards the west but then may turn and flow parallel to the river. Because the potential releases of radiological or chemical constituents would occur at or near the surface, the releases would likely be confined to the shallow system.

Based on a review of the groundwater elevation measurements collected during routine sampling of the G-3 Ash Landfill area groundwater monitoring wells (# B2/B3/B9A/B9/B7/B8), which are located in the south side of the LACBWR site, and associated background groundwater monitoring wells (B11AR/B11R) to the east of and up gradient of LACBWR, there appears to be a slightly downward vertical gradient. During times of normal and low river stage, groundwater has a downward gradient at well pairs B11R/B11AR and B2/B3, with an upward vertical gradient at well pair B9/B9A. This is expected as groundwater flows generally from the bluffs towards the river basin with a localized influence at B9/B9A from the adjacent inlet. However, there are some periods where the gradients are reversed; and this is likely due to high river stages. Groundwater flow through the LACBWR site is impacted by deeper structures (i.e., the Reactor Building basement shell) as well as the deep pilings that support the structures, which are below the water table during high and low river stage conditions.

During plant construction, and more specifically the installation of the support pilings, the soil was compacted, reducing the effective porosity and permeability of the soils. This reduction in permeability can decrease the hydraulic conductivity of the aquifer within the footprint of the buildings. The resulting impact to groundwater flow is that groundwater within the compacted soils will flow at a slower velocity, and regionally, a significant percentage of the flow regime will circumnavigate the area, effectively bypassing these soils. The implications of these localized flow regimes on contaminant fate and transport are that potential releases that occurred outside the footprint of these structures will likely be deflected and flow around them. On the other hand, potential releases that occurred within the footprint of the buildings, via floor drains or buried piling, will likely take much longer to migrate both in the vadose zone as well as the underlying groundwater. This is further compounded as the overlying structures isolate the shallow soils from precipitation, creating an area that will likely retain any potentially released contamination. The average shallow aquifer hydraulic conductivity is 313 feet per day. For the soils within the support pilings, the hydraulic conductivity would be expected to be one to two orders of magnitude lower.

The velocity of groundwater is directly related to both the hydraulic conductivity and the gradient. The gradient of the water table is influenced by the topography; and, with the flat areas across the site, groundwater monitoring has shown that the water table has a very low gradient. Therefore, it is likely that the groundwater velocity across the site is also relatively slow (i.e., in the inches and feet/day range). Groundwater elevation data from the G-3 Coal Plant Environmental Monitoring Program wells agree with the regional groundwater flow, and also show seasonal variation on upward and downward gradients that are influenced by the river stage. These wells are not sufficient to characterize the groundwater flow below and around the LACBWR site structures or areas where potential releases associated with LACBWR (i.e., in the vicinity of suspect broken drain lines) could have occurred. In these areas, pilings, deep structures/foundations or variations in fill materials could locally influence groundwater flow directions.

2.3.7.3. Previous Investigations

Historically, the LACBWR Licensed Site has had several potable water wells and groundwater monitoring wells. Figure 2-11 illustrates the current location of potable water and groundwater monitoring wells located on the LACBWR site. There is no potable water or groundwater monitoring wells off the LACBWR site that are or have been monitored by Solutions or Dairyland for radiological purposes.

Of the wells shown on Figure 2-11, only Potable Water Wells Nos. 3 and 4 which serviced LACBWR facilities were historically monitored by Dairyland for radiological conditions on a routine basis. The groundwater monitoring wells and background groundwater monitoring wells designated as B-2, B-3, B-7, B-8, B-9, B-9A, B11AR, and B11R are monitored by the Environmental Monitoring staff on a routine basis for non-radiological parameters to support the G-3 Fossil Station operational requirements. During LACBWR operations, Potable Water Wells Nos. 3, 4 and 5 were routinely monitored for gross beta activity. Typical gross beta activity levels reported during this monitoring period was less than or equal to MDC (ranging from 3.0E-08 μCi/ml to 9.0E-08 μCi/ml).

During the recovery of a probable spill incident in 1983, a temporary well-point was established to the south of the Turbine Building. This incident concerned the potential leakage of radioactive liquids from suspect broken drain lines in the Turbine Building to sub-building soils. The well-point shown on Figure 2-11 was established down gradient and below the grade of the suspected leakage. The well-point was sampled once on May 3, 1983. The analysis results for that sample are presented in Table 2-17. This well-point has since been abandoned.

As noted in the *LACBWR Decommissioning Plan and Post-Shutdown Decommissioning Activities Report* (D-Plan/PSDAR) (19), Dairyland recently installed groundwater monitoring wells to support groundwater evaluation. In November 2012, five (5) pairs of groundwater monitoring wells (10 wells total) were installed within the LACBWR licensed site to determine if groundwater quality had been impacted by plant operations. The well pairs which were located nominally within five (5) feet of one another consist of one shallow well with a screened interval of 15 to 25 feet below grade and one deep well with a screened interval of 45 to 55 feet below grade. These wells are show on Figure 2-11 as MW 200A and B through MW-204A and B.

Two (2) rounds of groundwater samples were collected in 2013, during the seasonal high water in June 2013 and then during a seasonal low groundwater level in November 2013. These groundwater samples were sent to an off-site laboratory for radiological analysis for Co-60, Sr-90 and Cs-137. Analysis for H-3 was performed on site.

In June of 2014, a third round of groundwater samples was collected from: MW-200A and B through 204 A and B; Potable Water Wells #3, 4, 5, and 7; and Monitoring Wells B2, B-3, B11R and B11AR. These collected groundwater samples were sent off for radiological analysis of several radionuclides including HTD and transuranic radionuclides. In September of 2014 a fourth round of groundwater were collected from: MW 200A and B through 204A and B, Potable Well #5, and Monitoring Wells B11R and B11AR. These collected groundwater samples were sent off for radiological analysis of several radionuclides including HTD and transuranic radionuclides. Tables 2-18 and 2-19 provides a summary of the radiological analysis of the groundwater samples and results.

Additional details, including the off-site analytical laboratory reports are provided in Reference 18.

2.3.7.4. On-Going Investigations

The LACBWR Site groundwater monitoring program consists of obtaining groundwater samples twice per year for radiological analysis purposes only from existing monitoring wells when groundwater is at relatively higher and lower elevations. The monitoring wells sampled include the MW-200A/B thru MW-204A/B wells as shown on Figure 2-11.

The collected information during each monitoring interval includes:

- Depth to ground water in the respective monitoring well.
- Monitoring well groundwater pH/specific conductance/oxidation and reduction potential/turbidity/dissolved oxygen/temperature.
- Radiological sample information including a completed chain of custody following groundwater sample collection.

2.3.7.5. Summary of Groundwater Analytical Results

Groundwater characterization efforts commenced through the installation of 10 monitoring wells (5 pairs) within the LSE area in November 2012 and the commencement of groundwater sampling in 2013. H-3 was positively detected at concentration greater than MDC in monitoring wells MW-201A and B, MW-202-A and B, MW-203A and B and MW-204A and B in June and November of 2013 at concentrations ranging from 150 pCi/L to 660 pCi/L. Sr-90 was also positively detected in the same wells during the June 2013 sampling period at concentrations ranging from 1.43 pCi/L to 2.18 pCi/L; however, it was not positively detected during the November 2013 sampling period. Co-60 and Cs-137 were not positively detected in any well during the 2013 sampling period.

During the June 2014 sample period, H-3 was positively detected in four (4) wells (MW-B11R, MW-202A, MW-203A and MW-203B) at concentrations ranging from 245 pCi/L to 336 pCi/L. Sr-90 was also positively detected in wells MW-202A, MW-203A and MW-204A with concentrations ranging from 1.12 pCi/L to 2.01 pCi/L. C-14, Tc-99, Eu-152, Pu-239/240 and Am-241 were also positively detected at residual concentrations in several wells.

During the September 2014 sample period, H-3 was not positively detected at concentrations greater than MDC in any well. Sr-90 was positively detected in one (1) well, MW-200A at a concentration of 1.14 pCi/L. Co-60, Ni-63, Cs-137, Eu-152, Eu-154, Pu-239/240 and Am-241 were also positively detected at residual concentrations in several wells.

2.4. Continuing Characterization

The survey of many inaccessible or not readily accessible subsurface soils or surfaces has been deferred. Examples of areas where surveys are deferred include soils under structures, soils under concrete or asphalt coverings, structural wall and floor surfaces in some of the basements that will remain and be subjected to FRS, the underlying concrete in the Reactor Building basement after liner removal and the interiors of buried pipe that may remain. Figure 2-3 illustrates buried piping systems that may remain in the end-state condition. The decision to defer the characterization of a soil or structure was based on one or more of the following conditions:

ALARA considerations (e.g., the area is either a radiation or contamination area and additional data would likely not change the survey area or area classification of the location or surrounding areas),

- Safety considerations,
- Historical data shows that the area could be classified without further characterization,
- Access for characterization would require significant deconstruction of adjacent systems, structures or other obstacles where the removal could result in an unsafe condition or interfere with continued operation of operating systems, or
- The ability to use engineering judgment in assigning the area a classification based on physical relationship to surrounding areas and the likelihood of the area to have radiological conditions represented by the conditions in these adjacent areas.

As access is gained to areas that were previously inaccessible, additional characterization data will be collected, evaluated and stored with-other radiological survey data in a survey history file for the survey unit. This data will be used along with existing data to update the types of radionuclides present and update the variability in the radionuclide mix for both gamma-emitting and HTD radionuclides. In addition, as the decommissioning progresses, data from operational events caused by equipment failures or personnel errors, which may affect the radiological status of a survey unit(s) will be recorded. These events will be evaluated and, when appropriate, stored in the characterization database. This additional characterization data will be used in validating the initial classification and in planning for the FRS.

As decommissioning proceeds, areas will, as necessary, be decontaminated to remove loose surface decontamination (as well as fixed contamination) to levels that will meet the conditions for open air demolition or unrestricted release. When a structure is ready for demolition, a documented survey and a formal turnover will be made by the Radiological Protection group for the company preforming demolition, validating that the radiological conditions in the structure are suitable.

Following the demolition and/or remediation, and when an area is believed to be ready for FRS, a "turnover assessment" will be performed. If the results of this assessment indicate that the FRS acceptance criteria will be met, then physical and administrative control of the area will be transferred to Characterization/License Termination group personnel for preparation, design, and performance of the FRS. Otherwise, additional remediation may be required. This assessment may include a "turnover survey," primarily for Class 1 and 2 areas within the LSE.

The "turnover survey" process, together with any additional characterization and remediation survey performed, represent at least one, but possibly several, opportunities to collect additional survey data prior to conducting the FRS. For each type of survey (characterization, remediation, turnover, and FRS), a documented survey plan will be developed using the DQO process. These survey plans will contain the appropriate data assessment to ensure that several objectives are met. These objectives include:

- Appropriate instrument selection to ensure the proper sensitivity relative to the applicable action level and/or release criteria,
- Appropriate instrument quality control measures to ensure operability,
- Appropriate survey techniques to ensure that the field measurement techniques are consistent with the calibration methodologies,
- Appropriate sample collection and analysis to determine spatial variability and variability in radionuclide ratios,
- Data analysis criteria to identify follow-up actions such as remediation and the collection of additional samples and,
- Appropriate classification of the survey area.

2.5. References

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Table 2-1 LACBWR Open Land Survey Units

Survey Unit ID #	Survey Unit Description	Initial Classification	Approximate Survey Unit Area (m^2)
LACBWR Site Enclosure Grounds			
L1010101	Reactor Building, WTB, WGTV, Ventilation Stack Grounds	Class 1	1,992
L1010102	Turbine Building, Turbine Office Building, 1B Diesel Generator Building Grounds	Class 1	2,315
L1010103	LSA Building, Maintenance Eat Shack Grounds	Class 1	1,749
L1010104	North LSE Grounds	Class 1	2,387
LSE Buffer Zone Grounds			
L2011101	LACBWR Administration Building, LACBWR Crib House, Warehouse Grounds	Class 2	7,211
L2011102	G-3 Crib House, LACBWR Circ. Water Discharge Line, Area South of LSE Fence	Class 2	6,785
Class 3 Grounds			
L3012101	North End of Licensed Site	Class 3	24,042
L3012102	Transmission Switchyard Area	Class 3	11,711
L3012109	Plant Access, ISFSI Haul Road Grounds	Class 3	31,012
Non-Impacted Grounds			
L4012103	G-3 Coal Plant Grounds	Non-Impacted	66,869
L4012105	Coal Pile Grounds	Non-Impacted	82,894
L4012106	Capped Ash Impoundment Grounds	Non-Impacted	111,899
L4012107	Grounds East of Highway 35	Non-Impacted	81,254
L4012108	Hwy 35/Railroad Right of Way Grounds	Non-Impacted	9,444

Table 2-2 LACBWR Structural Survey Units

Survey Unit	Survey Area Description	Classification
B1010001	Reactor Building	Class 1
B1010002	Waste Treatment Building	Class 1
B1010003	LACBWR Ventilation Stack	Class 1
B1010004	Waste Gas Tank Vault	Class 1
B1010005	LACBWR Turbine Bldg./Turbine Office Bldg.	Class 1
B1010006	LACBWR 1B Diesel Generator Structure	Class 1
B1010007	LSA Building	Class 1
B1010008	Maintenance Eat Shack	Class 1
B1010009	Pipe Tunnel	Class 1
B2010101	LACBWR Crib House	Class 2
B2010102	G-3 Crib House	Class 2
B2010103	LACBWR Administration Building	Class 2
B2010104	LACBWR Warehouse #1	Class 2
B2010105	LACBWR Warehouse #2	Class 2
B2010106	LACBWR Warehouse #3	Class 2
B3012101	Back-up Control Center	Class 3
B3012102	Transmission Sub-Station Switch House	Class 3
B3012103	G-1 Crib House	Class 3
B3012104	Barge Washing Break Room	Class 3

Table 2-2 (continued) LACBWR Structural Survey Units

Non Impacted Structures	
G-3 Reclaim Building	G-3 Annex Building
G-3 Stock Out Transfer Building	G-3 Boiler Fuel Oil Pump Building
G-3 Coal Unloading Tower	G-3 Explosive Gas Storage Room
G-3 Transfer Tower A	G-3 Gas Room
G-3 Electrical Room	G-3 Sub Station Shed
G-3 Crusher Tower	G-3 Sub Station Shed
G-3 Conveyor #6 (2)	G-3 Lime Storage Silo
G-4 Warehouse and Electrical Room	G-3 Weigh Station
G-3 LRAPB Building	G-3 Active Reclaim Buildings/ Tunnel
G-3 Lime Silo Electrical Building	G-3 Ash Coordinator's Office
G-3 CAT Building	G-3 Bag Houses (5)
G-3 Coal Plant	G-3 Flammable Storage Shed
G-3 Vehicle Storage Building	#7 Well House
G-3 Train Shed	G-3 Coal Scale
G-3 Bottom Ash Dewatering Buildings	G-3 Sample Building
G-3 Fly Ash Silo	G-3 Stock Out Transfer Building
G-3 Fly Ash Electrical Building	G-3 Grid Shed
G-3 Waste Silo	G-3 Ash handling Blower Building
G-3 Surge Tank	Main Pollution Control Electrical Building
G-3 Settling Tank	S03 Tank Building
#6 Well House	

Table 2-3 Instrument Types and Nominal MDCs

Detector Model [b]	Meter Model	Application	Typical Detection Sensitivity	
			MDC_{scan} (dpm/100cm^2)	MDC_{static} [a] (dpm/100cm^2)
Ludlum 44-9	Ludlum 3	β scan	1,000 to 2,000	N/A
Ludlum 43-68 β mode	Ludlum 2350-1	β static & scan	1,800 to 2,000	600 to 700
Ludlum 43-68 α mode	Ludlum 2350-1	α static	N/A	80 to 90
Ludlum 43-93 β mode Ludlum 43-89 β mode	Ludlum 2360	β static & scan	1,800 to 2,000 2,000 to 2,200	800 to 900 800 to 900
Ludlum 43-93 α mode Ludlum 43-89 α mode	Ludlum 2360	α static	N/A	90 to 100 90 to 100
Ludlum 44-10	Ludlum 2350-1	γ scan	3.5 pCi/g ^{60}Co 6.5 pCi/g ^{137}Cs	N/A
Ludlum 43-37	Ludlum 2350-1	β scan	2,000 to 2,200	N/A
Ludlum 43-10-1	Ludlum 2929	α and/or β smear	N/A	α -14-15 β - 75-80
Gamma Spectroscopy System	N/A	γ Analysis	N/A	~0.10 pCi/g for Co-60 and Cs-137

a Based on 1-minute count time; and default values for surface efficiencies (ε_s) as specified in International Standard, ISO 7503-1 (20).
b Functional equivalent instrumentation may be used

Table 2-4 Off-Site Laboratory Analytical Methods and Typical MDCs

Analysis / Analytes	Technique	Method and Sensitivity	
		Soils (pCi/g)	Water (pCi/L)
Gamma Radionuclides	Gamma Spec	DOE EML HASL 300 < 0.1pCi/g	EPA Method 901.1 10.0 pCi/L
Isotopic Neptunium (Np-237)	Alpha Spec	DOE EML HASL 300 < 0.04 pCi/g	
Isotopic Plutonium (Pu-238/239/240)	Alpha Spec	DOE EML HASL 300 < 0.05 pCi/g	EML Pu-02 Modified 1.0 pCi/L
Isotopic Thorium (Th-228/230/232)	Alpha Spec	DOE EML HASL 300 < 0.05 pCi/g	
Isotopic Uranium (U-234/235/238)	Alpha Spec	DOE EML HASL 300 < 0.06 pCi/g	
Isotopic Curium (Cm-243/244)	Alpha Spec	DOE EML HASL 300 < 0.03 pCi/g	
Isotopic Americium (Am-241/243)	Alpha Spec	DOE EML HASL 300 < 0.04 pCi/g	
C-14	LSC	EPA EERF C-01 < 5.0 pCi/g	ENIC Modified 50.0 pCi/L
Tritium	LSC	EPA 906.0 < 10.0 pCi/g	EPA 906.0 300.0 pCi/L
Sr-90	GFPC	DOE EML HASL 300 < 1.0 pCi/	EICHROM Modified Method 2.0 pCi/L
Pu-241	LSC	DOE EML HASL 300 < 10.0 pCi/g	EML Pu-01 50.0 pCi/L
Tc-99	LSC	DOE EML HASL 300 < 2.0 pCi/g	EICHROM Tc-01 15.0 pCi/L
Gross Alpha / Beta	GFPC		EPA 900.0 5.0 pCi/L
Fe-55	LSC	DOE EML HASL 300 < 10.0 pCi/g	EML Fe-01 Modified 100.0 pCi/L
Ni-63	LSC	DOE EML HASL 300 (SRW01) < 2.0 pCi/g	EML Ni-01 Modified 15.0 pCi/L
Ni-59	LSC	DOE EML HASL 300 (SRW01) < 50.0 pCi/g	EML Ni-01 Modified 100.0 pCi/L

Table 2-5 2005 Dairyland Background Study for Soils

Location	Co-60 (pCi/g)	Cs-137 (pCi/g)
(on Licensed Site)		
Area West of #2 Warehouse	<MDC	0.077
Area South of Parking Lot	<MDC	0.026
Area North of LACBWR Admin Building	<MDC	0.149
Area at G-3 Gas Silo	<MDC	0.038
Area Outside G-3 Offices	<MDC	0.076
Area at G-3 Outfall	<MDC	0.017
(off Licensed Site)		
33 miles South at Bad Axe Boat Landing	0.023	0.381
Pedretti Farm Substation East of LACBWR	<MDC	0.227
Radio Tower Northeast of LACBWR	<MDC	0.035
Junction of Hwy O and Hwy K	<MDC	0.188
East of Stoddard at Hwy O Junction	<MDC	0.065

Table 2-6 Investigative Levels for Cs-137 Based on Background Studies

Condition and Depth	Measured Range (pCi/g)	Range for 95% Distribution (pCi/g)
Drainage Areas Surface 0-10 cm		
Undisturbed	0.00 to 2.80	0.45 to 3.63
Disturbed	0.00 to 1.67	0.35 to 2.86
Non-Drainage Areas Surface 0-10 cm		
Undisturbed	0.23 to 0.66	0.15 to 0.77
Disturbed	0.27 to 0.34	0.23 to 0.42

Table 2-7 Initial Suite of LACBWR Site-Specific Radionuclides

Radionuclide	Half Life (Years)
H-3	1.24E+01
C-14	5.73E+03
Fe-55	2.70E+00
Ni-59	7.50E+04
Co-60	5.27E+00
Ni-63	9.60E+01
Sr-90	2.91E+01
Nb-94	2.03E+04
Tc-99	2.13E+05
Cs-137	3.00E+01
Eu-152	1.33E+01
Eu-154	8.80E+00
Eu-155	4.76E+00
Np-237	2.14E+06
Pu-238	8.78E+01
Pu-239	2.41E+04
Pu-240	6.60E+03
Pu-241	1.44E+01
Am-241	4.32E+02
Cm-243/244*	1.81E+01

*Listed half life is the shortest half life for the radionuclides in the pair

Table 2-8 Non-Impacted Open Land Survey Units – Characterization Survey Summary

Survey Unit	Survey Unit L4012103		Survey Unit L4012105		Survey Unit L4012106		Survey Unit L4012107	
Surface Area	66,869 m^2		82,894 m^2		111,899 m^2		81,254m^2	
Description	G-3 Coal Plant Grounds		Coal Pile Grounds		Capped Ash Impoundment Grounds		Grounds East of Highway 35	
Surface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	3	3	3	3	3	3	3	3
# >CL	0	1	0	1	0	2	0	3
Mean (pCi/g)	0.070	0.082	0.071	0.061	0.082	0.100	0.080	0.264
Median (pCi/g)	0.075	0.083	0.072	0.060	0.084	0.099	0.079	0.263
Max (pCi/g)	0.078	0.092	0.084	0.068	0.090	0.121	0.089	0.463
Min (pCi/g)	0.057	0.071	0.057	0.055	0.072	0.079	0.072	0.065
SD	0.011	0.011	0.014	0.006	0.009	0.021	0.009	0.199
Subsurface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	4	4	3	3	4	4	3	3
# >CL	0	1	0	1	0	2	0	2
Mean (pCi/g)	0.060	0.048	0.061	0.042	0.081	0.088	0.081	0.068
Median (pCi/g)	0.056	0.038	0.063	0.040	0.083	0.084	0.069	0.057
Max (pCi/g)	0.084	0.081	0.068	0.056	0.102	0.130	0.106	0.091
Min (pCi/g)	0.047	0.036	0.052	0.030	0.056	0.054	0.068	0.056
SD	0.016	0.022	0.008	0.013	0.021	0.037	0.022	0.020
Asphalt	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	None Taken		None Taken		2	2	None Taken	
# >CL					0	0		
Mean (pCi/g)					0.073	0.062		
Median (pCi/g)					0.073	0.062		
Max (pCi/g)					0.082	0.084		
Min (pCi/g)					0.065	0.040		
SD					0.012	0.031		
Surface Scans								
% Scanned	1%		1%		1%		1%	
Mean Scan (cpm)	5,550		5,050		8,340		8,000	
Max Scan (cpm)	6,700		8,800		12,000		9,080	

Table 2-8 (continued) Non-Impacted Open Land Survey Units – Characterization Survey Summary

Survey Unit	**Survey Unit L4012108**		**Survey Unit L4012109**	
Surface Area	9,444 m^2		100 m^2	
Description	Hwy 35/Railroad Right of Way Grounds		Background Soils Test Area (inside L4012108)	
Surface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	3	3	17	17
# >CL	0	2	0	17
Mean (pCi/g)	0.079	0.119	0.087	0.160
Median (pCi/g)	0.075	0.108	0.086	0.161
Max (pCi/g)	0.095	0.156	0.101	0.268
Min (pCi/g)	0.068	0.093	0.077	0.059
SD	0.014	0.033	0.007	0.059
Subsurface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	3	3	None Taken	
# >CL	0	2		
Mean (pCi/g)	0.086	0.189		
Median (pCi/g)	0.092	0.091		
Max (pCi/g)	0.107	0.409		
Min (pCi/g)	0.060	0.067		
SD	0.024	0.191		
Asphalt	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	None Taken		None Taken	
# >CL				
Mean (pCi/g)				
Median (pCi/g)				
Max (pCi/g)				
Min (pCi/g)				
SD				
Surface Scans				
% Scanned	1%		No Scanning Performed	
Mean Scan (cpm)	8,124			
Max Scan (cpm)	9,200			

Table 2-9 Non Impacted Coal Pile and Soil Samples – Test America Laboratory Analysis (pCi/g)

Radionuclide	H-3	C-14	Fe-55	Ni-59	Co-60	Ni-63	Sr-90	Nb-94	Tc-99	Cs-137	Pm-147	Eu-152	Eu-154	Eu-155	Np-237	Pu-238	Pu-239/240	Pu-241	Am-241	Am-243	Cm-243/244
L3012103-QJ-GS-001-SB	**4.390**	**1.230**	**3.430**	*1.470*	*0.026*	*2.140*	*0.321*	*0.018*	*0.820*	*0.024*	*0.714*	*0.071*	*0.190*	0.095	*0.025*	*0.046*	*0.015*	*1.730*	*0.032*	*0.022*	*0.010*
L3012103-QJ-GS-001-SS	**3.570**	*0.671*	**2.790**	*1.870*	*0.027*	*3.380*	*0.391*	*0.022*	*0.628*	*0.018*	*0.847*	*0.060*	*0.167*	0.096	*0.024*	*0.040*	*0.021*	*1.650*	*0.025*	*0.024*	*0.019*
L3012105-Genoa Coal Pile					*0.018*			*0.022*		*0.019*		*0.052*	*0.152*	*0.048*					*0.041*		
L3012105-CR-GS-002-SS	*0.533*	*0.675*	**2.130**	*1.730*	*0.025*	*2.950*	**0.289**	*0.016*	*0.587*	*0.018*	*0.698*	*0.051*	*0.137*	*0.056*	*0.023*	*0.036*	*0.029*	*1.670*	*0.018*	*0.025*	*0.006*
L3012105-QJ-GS-001-SB					*0.026*			*0.020*		*0.023*		*0.049*	*0.166*	*0.055*					*0.048*		
L3012105-QJ-GS-001-SS					*0.030*			*0.020*		*0.028*		*0.072*	*0.199*	*0.074*					*0.061*		
L3012106-QJ-GS-001-SB	**14.600**	*0.713*	*2.300*	*2.370*	*0.037*	**3.950**	*0.348*	*0.030*	*0.611*	**0.319**	*1.500*	*0.115*	*0.223*	*0.080*	*0.035*	*0.036*	*0.014*	*2.550*	*0.019*	*0.034*	*0.006*
L3012106-QJ-GS-001-SS	**0.813**	*0.713*	**3.550**	*2.560*	*0.037*	*3.580*	*0.338*	*0.028*	*0.616*	**0.096**	*0.826*	*0.079*	*0.232*	*0.112*	*0.027*	*0.044*	*0.026*	*2.740*	*0.025*	*0.013*	*0.019*
L3012107-QJ-GS-001-SB					*0.019*			*0.013*		*0.021*		*0.045*	*0.115*	*0.038*					*0.034*		
L3012107-QJ-GS-001-SS	**1.420**	*0.719*	**3.610**	*2.800*	*0.025*	*3.940*	*0.293*	*0.019*	*0.593*	**0.018**	*1.450*	*0.049*	*0.156*	*0.048*	*0.040*	*0.021*	*0.024*	*2.580*	*0.020*	*0.035*	0.006
L3012108-QJ-GS-001-SB	**2.350**	*0.705*	*1.920*	*3.110*	*0.018*	*4.440*	*0.278*	*0.016*	*0.604*	**0.033**	*1.310*	*0.041*	*0.128*	*0.044*	*0.030*	*0.026*	*0.021*	*2.670*	*0.017*	*0.036*	*0.017*
L3012108-QJ-GS-001-SS	**6.490**	*0.728*	*2.260*	*3.200*	*0.030*	**4.710**	*0.271*	*0.020*	*0.576*	**0.182**	*0.770*	*0.059*	*0.176*	*0.060*	*0.020*	*0.028*	*0.029*	*2.740*	*0.015*	*0.024*	*0.015*

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value
b Survey units originally classified as Class 3 at time of sample

Table 2-10 Impacted Class 1 Open Land Survey Units – Characterization Survey Summary

Survey Unit	Survey Unit L1010101		Survey Unit L1010102		Survey Unit L1010103		Survey Unit L1010104	
Surface Area	1,992 m^2		2,315 m^2		1,749 m^2		2,387 m^2	
Description	Reactor Building, WTB, WGTV, Ventilation Stack Grounds		Turbine, Office, Diesel Generator Building Grounds		LSA Building, Maintenance Eat Shack Grounds		North LSE Grounds	
Surface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	12	12	2	2	7	7	1	1
# >CL	2	12	0	0	0	1	0	0
Mean (pCi/g)	0.080	0.215	0.049	0.050	0.059	0.069	0.045	0.049
Median (pCi/g)	0.058	0.100	0.049	0.050	0.050	0.054	0.045	0.049
Max (pCi/g)	0.287	1.070	0.054	0.051	0.099	0.161	0.045	0.049
Min (pCi/g)	0.048	0.032	0.044	0.050	0.048	0.048	0.045	0.049
SD	0.066	0.296	0.007	0.001	0.019	0.041	N/A	N/A
Subsurface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	18	18	22	22	25	25	14	14
# >CL	0	8	0	4	0	0	0	3
Mean (pCi/g)	0.078	0.066	0.058	0.064	0.046	0.049	0.048	0.041
Median (pCi/g)	0.052	0.054	0.058	0.065	0.046	0.049	0.048	0.042
Max (pCi/g)	0.516	0.161	0.080	0.130	0.055	0.054	0.050	0.051
Min (pCi/g)	0.047	0.033	0.043	0.044	0.025	0.042	0.043	0.027
SD	0.109	0.035	0.010	0.017	0.005	0.003	0.002	0.009
Asphalt							**Co-60**	**Cs-137**
# of Samples	None Taken		None Taken		None Taken		10	10
# >CL							0	1
Mean (pCi/g)							0.053	0.051
Median (pCi/g)							0.054	0.053
Max (pCi/g)							0.062	0.057
Min (pCi/g)							0.042	0.037
SD							0.006	0.006
Surface Scans								
% Scanned	No Scanning Performed		No Scanning Performed		No Scanning Performed		No Scanning Performed	
Mean Scan (cpm)								
Max Scan (cpm)								

a MDC value used for analytical results less than MDC.

Table 2-11 Class 1 Concrete, Asphalt, Sediment and Soil Samples – Test America Laboratory Analysis (pCi/g)

Radionuclide	H-3	C-14	Fe-55	Ni-59	Co-60	Ni-63	Sr-90	Nb-94	Tc-99	Cs-137	Pm-147	Eu-152	Eu-154	Eu-155	Np-237	Pu-238	Pu-239/240	Pu-241	Am-241	Am-243	Cm-243/244
L1010101-CJ-GS-002-SS					**0.024**			*0.020*		**0.233**		*0.056*	*0.161*	*0.066*					*0.058*		
L1010101-CJ-GS-009-SS					*0.040*			*0.020*		**0.185**		*0.056*	*0.181*	*0.050*					*0.042*		
L1010101-CJ-GS-010-SS					*0.286*			*0.025*		**0.413**		*0.062*	*0.247*	*0.057*					*0.051*		
L1010101-QJ-GS-001-SB	*0.364*	**0.896**	**2.430**	*1.850*	*0.024*	*3.040*	*0.335*	*0.015*	*0.579*	*0.020*	*0.800*	*0.050*	*0.143*	*0.044*	*0.019*	*0.046*	*0.023*	*1.970*	*0.015*	*0.023*	*0.021*
L1010101-QJ-GS-001-SS	**0.441**	*0.676*	*2.190*	*1.900*	*0.018*	*3.040*	*0.440*	*0.012*	*0.587*	**0.147**	*3.170*	*0.034*	*0.112*	*0.044*	*0.006*	*0.039*	*0.023*	*1.830*	*0.016*	*0.021*	*0.019*
L1010101-QJ-GS-002-SB	*0.377*	*0.679*	*2.150*	*1.750*	*0.017*	*2.930*	*0.338*	*0.011*	*0.620*	**0.149**	*0.772*	*0.040*	*0.109*	*0.040*	*0.019*	*0.041*	*0.022*	*1.950*	*0.017*	*0.029*	*0.014*
L1010101-QJ-GS-002-SS	**1.380**	*0.677*	*4.190*	*2.010*	*0.015*	*3.320*	*0.357*	*0.010*	*0.521*	**0.059**	*0.978*	*0.033*	*0.096*	*0.036*	*0.016*	*0.040*	*0.016*	*2.090*	*0.020*	*0.017*	*0.022*
L1010102-CJ-FC-001-CV	**1.710**	*0.727*	*1.650*	*2.630*	**0.106**	*3.920*	*0.292*	*0.022*	*0.536*	**0.352**	*1.290*	*0.061*	*0.239*	*0.062*	*0.029*	*0.041*	*0.028*	*2.490*	*0.018*	*0.019*	*0.021*
L1010102-CJ-GS-013-SB					*0.030*			*0.016*		*0.021*		*0.044*	*0.170*	*0.041*					*0.036*		
L1010102-QJ-GS-001-SB	**8.740**	*0.726*	*2.120*	*2.620*	*0.015*	**4.000**	*0.310*	*0.011*	*0.539*	*0.012*	*0.961*	*0.030*	*0.101*	*0.028*	*0.028*	*0.040*	*0.026*	*2.780*	*0.015*	*0.020*	*0.021*
L1010102-QJ-GS-001-SS					*0.022*			*0.015*		*0.018*		*0.036*	*0.113*	*0.042*					*0.039*		
L1010102-QJ-GS-002-SB	**24.700**	*0.715*	*2.230*	*2.760*	*0.021*	*3.920*	*0.316*	*0.014*	*0.537*	*0.016*	*0.722*	*0.043*	*0.139*	*0.042*	*0.032*	*0.042*	*0.029*	*2.660*	*0.015*	*0.021*	*0.018*
L1010103-CJ-GS-002-SB					*0.011*			*0.017*		*0.021*		*0.044*	*0.181*	*0.046*					*0.044*		
L1010103-QJ-SL-001-SM	*0.354*	**0.453**	*0.689*	*0.711*	**0.136**	*1.090*	*0.132*	*0.018*	*0.432*	**0.136**	*0.360*	*0.054*	*0.199*	*0.049*	*0.018*	*0.015*	*0.015*	*0.867*	*0.008*	*0.019*	*0.008*
L1010103-QJ-GS-001-SB	**3.260**	*0.715*	*1.830*	*2.850*	*0.017*	*4.240*	*0.333*	*0.011*	*0.606*	*0.015*	*0.740*	*0.036*	*0.117*	*0.039*	*0.026*	*0.029*	*0.017*	*1.430*	*0.009*	*0.024*	*0.005*
L1010103-QJ-GS-001-SS					*0.025*			*0.015*		*0.020*		*0.046*	*0.174*	*0.047*					*0.043*		
L1010103-QJ-GS-002-SB	**0.649**	*0.702*	*2.100*	*2.620*	*0.014*	*3.710*	*0.325*	*0.012*	*0.645*	*0.012*	*0.838*	*0.029*	*0.103*	*0.034*	*0.020*	*0.034*	*0.024*	*2.570*	*0.018*	*0.024*	*0.014*
L1010103-QJ-GS-002-SS					*0.019*			*0.017*		*0.017*		*0.040*	*0.139*	*0.045*					*0.024*		
L1010103-QJ-GS-003-SB	**0.654**	*0.717*	*2.340*	*2.630*	*0.012*	*3.660*	*0.300*	*0.009*	*0.557*	*0.011*	*0.713*	*0.029*	*0.092*	*0.034*	*0.040*	*0.028*	*0.028*	*2.470*	*0.018*	*0.022*	*0.005*
L1010103-QJ-GS-003-SS					*0.023*			*0.019*		**0.091**		*0.057*	*0.186*	*0.063*					*0.052*		
L1010104-CJ-GS-003-SB					*0.015*			*0.008*		*0.013*		*0.032*	*0.078*	*0.036*					*0.034*		
L1010104-CR-PA-007-AV					*0.021*			*0.014*		*0.016*		*0.042*	*0.141*	*0.044*					*0.040*		
L1010104-QQ-PA-001-AV					*0.025*			*0.025*		*0.028*		*0.058*	*0.218*	*0.061*					*0.050*		
L1010104-QR-GS-001-SB					*0.017*			*0.011*		*0.012*		*0.038*	*0.132*	*0.032*					*0.032*		

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value.

Table 2-12 Impacted Class 2 Open Land Survey Units – Characterization Survey Summary

Survey Unit	**Survey Unit** L2011101		**Survey Unit** L2011102	
Surface Area	7,211 m^2		6,785 m^2	
Description	LACBWR Administration Building, LACBWR Crib House, Warehouse Grounds		G-3 Crib House, LACBWR Circ. Water Discharge Line, Area South of LSE Fence	
Surface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	13	13	10	10
# >CL	0	8	0	6
Mean (pCi/g)	0.073	0.090	0.064	0.065
Median (pCi/g)	0.077	0.100	0.064	0.054
Max (pCi/g)	0.106	0.139	0.081	0.200
Min (pCi/g)	0.053	0.041	0.052	0.030
SD	0.016	0.030	0.009	0.049
Subsurface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	16	16	7	7
# >CL	1	2	0	2
Mean (pCi/g)	0.052	0.049	0.049	0.038
Median (pCi/g)	0.046	0.048	0.048	0.033
Max (pCi/g)	0.112	0.088	0.055	0.052
Min (pCi/g)	0.040	0.034	0.042	0.029
SD	0.018	0.012	0.004	0.009
Asphalt	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	6	6	6	6
# >CL	0	0	0	3
Mean (pCi/g)	0.051	0.051	0.056	0.048
Median (pCi/g)	0.051	0.051	0.057	0.051
Max (pCi/g)	0.054	0.054	0.059	0.055
Min (pCi/g)	0.047	0.047	0.049	0.009
SD	0.002	0.003	0.003	0.008
Surface Scans				
% Scanned	50%		50%	
Mean Scan (cpm)	7,500 to 8,000		7,500 to 8,000	
Max Scan (cpm)	11,500 to 12,000		11,500 to 12,000	

Table 2-13 Class 2 Asphalt, Sediment and Soil Samples – Test America Laboratory Analysis

Radionuclide	H-3	C-14	Fe-55	Ni-59	Co-60	Ni-63	Sr-90	Nb-94	Tc-99	Cs-137	Pm-147	Eu-152	Eu-154	Eu-155	Np-237	Pu-238	Pu-239/240	Pu-241	Am-241	Am-243	Cm-243/244
L2011101-CJ-GS-001-SM					**0.096**			*0.011*		**0.137**		*0.041*	*0.098*	*0.033*					*0.031*		
L2011101-CR-PA-003-AV					*0.023*			*0.016*		*0.017*		*0.039*	*0.131*	*0.039*					*0.038*		
L2011101-QJ-GS-001-SB	*0.518*	*0.727*	*2.290*	*2.660*	*0.016*	*4.030*	*0.273*	*0.014*	*0.643*	*0.015*	*0.705*	*0.033*	*0.108*	*0.040*	*0.022*	*0.028*	*0.025*	*2.470*	*0.015*	*0.022*	*0.019*
L2011101-QJ-GS-001-SM	**2.040**	*0.707*	*2.240*	*2.950*	**0.049**	*4.140*	*0.523*	*0.018*	*0.585*	**0.107**	*0.615*	*0.048*	*0.178*	*0.049*	*0.026*	*0.045*	*0.021*	*3.100*	*0.037*	*0.036*	**0.034**
L2011101-QJ-GS-001-SS					*0.012*			*0.020*		**0.080**		*0.060*	*0.188*	*0.091*					*0.042*		
L2011101-QQ-GS-001-SB					*0.017*			*0.012*		*0.013*		*0.040*	*0.127*	*0.037*					*0.031*		
L2011101-QQ-GS-001-SS	**11.810**	*0.726*	*2.590*	*2.600*	*0.035*	*3.720*	*0.255*	*0.035*	*0.532*	**0.103**	*0.779*	*0.097*	*0.205*	*0.102*	*0.023*	*0.037*	*0.024*	*2.800*	*0.019*	*0.015*	*0.015*
L2011101-QQ-GS-002-SB	**2.500**	*0.731*	**1.940**	*2.680*	*0.017*	*3.870*	*0.314*	*0.014*	*0.616*	*0.016*	*0.697*	*0.037*	*0.119*	*0.041*	*0.019*	*0.039*	*0.016*	*2.920*	*0.020*	*0.028*	*0.016*
L2011101-QQ-PA-001-AV					*0.022*			*0.015*		*0.015*		*0.046*	*0.135*	*0.042*					*0.040*		
L2011102-QQ-GS-001-SB	**1.370**	**1.560**	*2.260*	*3.040*	*0.007*	*4.390*	*0.291*	*0.018*	*0.537*	*0.021*	*0.672*	*0.044*	*0.173*	*0.055*	*0.031*	*0.026*	*0.018*	*2.680*	*0.029*	*0.028*	*0.024*
L2011102-QQ-GS-001-SS	*0.533*	*0.713*	*2.330*	*2.820*	*0.019*	*4.300*	*0.361*	*0.014*	*0.595*	*0.014*	*0.772*	*0.039*	*0.111*	*0.045*	*0.017*	*0.036*	*0.026*	*2.880*	*0.026*	*0.034*	*0.021*
L2011102-QQ-GS-002-SB	*0.525*	*0.702*	*3.890*	*2.880*	*0.031*	*3.950*	*0.327*	*0.016*	*0.568*	*0.018*	*0.717*	*0.052*	*0.183*	*0.051*	*0.022*	*0.028*	*0.020*	*1.710*	*0.010*	*0.028*	*0.006*
L2011102-QQ-PA-001-AV					*0.027*			*0.017*		*0.018*		*0.051*	*0.142*	*0.038*					*0.036*		

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value.

Table 2-14 Impacted Class 3 Open Land Survey Units – Characterization Survey Summary

Survey Unit	Survey Unit L3012101		Survey Unit L3012102		Survey Unit L3012109	
Surface Area	24,042 m^2		11,711 m^2		31,012 m^2	
Description	North End of Licensed Site		Transmission Switchyard Area		Plant Access, ISFSI Haul Road Grounds	
Surface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	3	3	None Taken		5	5
# >CL	0	0			0	5
Mean (pCi/g)	0.070	0.073			0.063	0.152
Median (pCi/g)	0.076	0.072			0.064	0.143
Max (pCi/g)	0.077	0.083			0.078	0.267
Min (pCi/g)	0.058	0.065			0.053	0.075
SD	0.011	0.009			0.010	0.078
Subsurface Soil	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	3	3	None Taken		4	4
# >CL	0	0			0	0
Mean (pCi/g)	0.051	0.051			0.072	0.066
Median (pCi/g)	0.053	0.052			0.072	0.059
Max (pCi/g)	0.054	0.052			0.100	0.101
Min (pCi/g)	0.046	0.051			0.046	0.045
SD	0.004	0.001			0.023	0.025
Concrete/Asphalt	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**	**Co-60**	**Cs-137**
# of Samples	3	3	None Taken		7	7
# >CL	0	0			0	0
Mean (pCi/g)	0.031	0.029			0.062	0.059
Median (pCi/g)	0.031	0.027			0.055	0.052
Max (pCi/g)	0.035	0.033			0.080	0.079
Min (pCi/g)	0.028	0.026			0.047	0.028
SD	0.003	0.004			0.013	0.019
Surface Scans						
% Scanned	1%		No Scanning Performed		1%	
Mean Scan (cpm)	9,000				5,890	
Max Scan (cpm)	10,000				6,400	

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Table 2-15 Class 3 Asphalt, Sediment and Soil Samples – Test America Laboratory Analysis (pCi/g)

Radionuclide	H-3	C-14	Fe-55	Ni-59	Co-60	Ni-63	Sr-90	Nb-94	Tc-99	Cs-137	Pm-147	Eu-152	Eu-154	Eu-155	Np-237	Pu-238	Pu-239/240	Pu-241	Am-241	Am-243	Cm-243/244
L3012101-CR-GC-001-CV					*0.028*			*0.030*		*0.026*		*0.043*	*0.221*	*0.059*					*0.053*		
L3012101-CR-GC-002-CV					*0.035*			*0.026*		*0.033*		*0.062*	*0.271*	*0.056*					*0.055*		
L3012101-CR-GC-003-CV		*0.669*	*2.180*	*2.020*	*0.031*	*3.590*	*0.374*	*0.027*	*0.521*	*0.027*	*1.480*	*0.056*	*0.249*	*0.069*	*0.025*	*0.046*	*0.018*	*1.690*	*0.019*	*0.021*	*0.006*
L3012101-CR-GS-003-SS					*0.025*			*0.017*		**0.113**		*0.052*	*0.157*	*0.059*					*0.052*		
L3012101-QQ-GS-001-SB	**18.400**	*0.717*	*2.390*	*2.870*	*0.016*	**5.640**	*0.309*	*0.014*	*0.550*	*0.015*	*0.899*	*0.036*	*0.128*	*0.036*	*0.039*	*0.035*	*0.022*	*2.590*	*0.023*	0.029	*0.027*
L3012101-QQ-GS-001-SS	**15.500**	*0.708*	**2.330**	*2.660*	*0.020*	*3.890*	*0.295*	*0.017*	*0.603*	**0.059**	*1.090*	*0.047*	*0.116*	*0.054*	*0.028*	*0.028*	*0.022*	*2.640*	*0.019*	0.021	*0.006*
L3012101-QQ-SL-001-SM	*0.364*	*0.342*	**2.710**	*0.739*	*0.022*	**1.090**	*0.152*	*0.017*	*0.360*	*0.020*	*0.333*	*0.042*	*0.153*	*0.034*	*0.009*	*0.016*	*0.013*	*0.797*	*0.009*	*0.009*	*0.011*
L3012104-CR-GS-002-SM					*0.015*			*0.013*		**0.066**		*0.035*	*0.128*	*0.047*					*0.036*		
L3012104-QJ-GS-001-SB	**2.160**	*0.670*	**1.950**	*1.750*	*0.021*	*3.060*	*0.325*	*0.018*	*0.469*	*0.025*	*0.818*	*0.053*	*0.160*	*0.054*	*0.022*	*0.027*	*0.021*	*1.610*	*0.016*	*0.018*	*0.016*
L3012104-QJ-GS-001-SM	**2.890**	*0.672*	**2.720**	*1.990*	*0.037*	*3.500*	*0.298*	*0.020*	*0.651*	**0.094**	*0.818*	*0.074*	*0.217*	*0.071*	*0.006*	*0.031*	*0.017*	*1.560*	*0.016*	*0.016*	*0.015*
L3012104-QJ-GS-001-SS	**2.190**	*0.676*	**4.240**	*1.880*	*0.029*	*3.300*	*0.329*	*0.020*	*0.631*	**0.138**	*0.667*	*0.068*	*0.181*	*0.080*	*0.020*	*0.043*	*0.026*	*1.580*	*0.019*	*0.019*	*0.021*

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value

Table 2-16 Concrete Core Isotopic Analysis Results

	B1001101-CJ-FC-001-CV 0-1/2			B1001101-CJ-FC-001-CV 1/2-1			B1001101-CJ-FC-002-CV 0-1/2		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	3.950	1.590	1.350	9.720	1.560	1.950	3.640	1.620	1.330
C-14	-0.162	1.400	0.793	-0.346	1.440	0.806	-0.270	1.410	0.794
Fe-55	9.130	16.000	7.880	10.400	21.300	10.200	11.300	9.950	5.540
Ni-59	0.000	0.254	0.325	0.000	0.264	0.151	0.000	0.289	0.183
Co-60	11.500	0.377	1.250	0.082	0.168	0.078	0.800	0.117	0.172
Ni-63	39.300	0.402	4.110	3.850	0.425	0.474	4.860	0.492	0.581
Sr-90	6.910	0.043	0.680	0.162	0.051	0.041	11.600	0.046	1.130
Nb-94	-0.120	0.312	0.189	0.001	0.139	0.078	-0.017	0.165	0.095
Tc-99	0.024	0.566	0.330	0.076	0.526	0.310	-0.104	0.564	0.322
Cs-137	7500	7.090	781.000	9.660	0.152	1.100	450.000	0.597	46.900
Eu-152	2.580	9.020	5.230	-0.039	0.511	0.055	0.173	2.150	0.924
Eu-154	0.266	2.410	0.398	0.025	1.260	0.171	-0.008	1.460	0.820
Eu-155	0.369	4.440	1.140	0.071	0.376	0.118	0.145	0.837	0.503
Np-237	0.009	0.042	0.021	-0.002	0.045	0.017	-0.010	0.042	0.009
Pu-238	0.176	0.056	0.065	-0.017	0.066	0.026	0.575	0.617	0.436
Pu-239/240	0.132	0.048	0.055	-0.006	0.049	0.018	0.715	0.466	0.413
Pu-241	0.902	2.700	1.660	-1.510	2.500	1.360	13.200	23.500	15.100
Am-241	0.407	0.048	0.107	0.011	0.037	0.020	0.550	0.401	0.419
Am-243	0.028	0.046	0.030	0.014	0.030	0.019	-0.036	0.433	0.140
Cm-243/244	0.0579	0.0302	0.0371	-0.0081	0.0478	0.0094	0.1540	0.4670	0.2600

	B1001101-CJ-FC-003-CV 0-1/2			B1001101-CJ-FC-003-CV 1/2-1			B1001101-CJ-FC-004-CV 0-1/2		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	7.240	1.360	1.580	12.600	1.570	2.240	4.490	1.590	1.420
C-14	-0.492	1.460	0.806	-0.566	1.390	0.765	-0.555	1.450	0.795
Fe-55	9.450	9.040	4.950	6.160	14.300	6.960	7.600	7.070	4.040
Ni-59	0.000	0.365	0.806	0.000	0.257	0.157	0.000	0.276	0.467
Co-60	57.700	0.333	5.880	0.435	0.057	0.096	28.100	0.190	2.950
Ni-63	202.000	0.593	21.100	2.990	0.400	0.392	88.300	0.467	9.200
Sr-90	34.500	0.040	3.330	0.304	0.051	0.052	11.000	0.045	1.070
Nb-94	0.191	0.392	0.203	-0.001	0.153	0.086	-0.016	0.264	0.155
Tc-99	-0.189	0.586	0.330	-0.129	0.596	0.339	0.153	0.592	0.352
Cs-137	614.000	0.732	64.000	2.450	0.113	0.348	213.000	0.439	22.200
Eu-152	0.768	2.870	1.300	0.045	0.346	0.154	0.162	1.570	0.611
Eu-154	0.335	5.460	0.536	0.179	1.020	0.383	0.557	3.070	0.863
Eu-155	-0.429	1.510	0.914	-0.007	0.282	0.164	0.108	0.850	0.138
Np-237	0.000	0.041	0.016	-0.010	0.051	0.018	-0.020	0.060	0.020
Pu-238	0.528	0.058	0.111	-0.005	0.064	0.029	0.413	0.426	0.320
Pu-239/240	0.491	0.030	0.104	-0.004	0.047	0.017	0.336	0.325	0.265
Pu-241	7.470	2.640	2.160	-1.320	2.660	1.480	-7.720	26.000	14.400
Am-241	1.450	0.047	0.250	0.018	0.038	0.024	0.614	0.441	0.436
Am-243	0.052	0.027	0.033	0.009	0.030	0.016	0.052	0.292	0.136
Cm-243/244	0.0879	0.0408	0.0496	0.0000	0.0168	0.0047	-0.0547	0.4320	0.0776

Table 2-16 (continued) Concrete Core Isotopic Analysis Results

	B1001101-CJ-FC-005-CV 0-1/2			B1001101-CJ-FC-005-CV 1/2-1			B1001101-CJ-WC-006-CV 0-1/2		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	2.960	1.520	1.200	4.180	1.850	1.520	4.210	1.700	1.440
C-14	-0.077	1.410	0.810	-0.701	1.350	0.733	0.077	1.440	0.832
Fe-55	8.070	9.770	5.230	8.170	9.870	5.340	11.700	9.320	5.530
Ni-59	2.590	0.267	0.813	0.000	0.270	0.165	0.000	0.263	0.230
Co-60	73.900	0.372	7.510	0.075	0.171	0.080	2.040	0.047	0.264
Ni-63	221.000	0.427	23.000	4.870	0.430	0.570	13.400	0.420	1.430
Sr-90	32.800	0.043	3.170	0.423	0.051	0.063	7.150	0.034	0.703
Nb-94	-0.089	0.531	0.317	-0.015	0.128	0.074	0.026	0.154	0.090
Tc-99	0.178	0.562	0.336	-0.124	0.540	0.307	0.083	0.580	0.341
Cs-137	65.700	0.569	6.970	0.801	0.117	0.172	1490	0.721	155.000
Eu-152	0.395	1.240	0.746	0.001	0.373	0.005	0.031	3.660	2.210
Eu-154	0.637	5.650	0.831	0.119	0.923	0.245	0.128	1.190	0.679
Eu-155	0.011	0.699	0.414	0.013	0.255	0.148	0.737	1.470	0.896
Np-237	0.005	0.015	0.010	-0.017	0.054	0.016	-0.013	0.044	0.010
Pu-238	0.706	0.065	0.134	-0.003	0.053	0.023	0.029	0.037	0.027
Pu-239/240	0.489	0.035	0.106	-0.008	0.038	0.008	0.035	0.025	0.026
Pu-241	9.090	2.540	2.270	0.337	2.530	1.510	-1.380	2.650	1.470
Am-241	1.590	0.045	0.273	0.012	0.018	0.017	0.048	0.052	0.041
Am-243	0.048	0.031	0.034	-0.002	0.054	0.022	0.003	0.029	0.011
Cm-243/244	0.1160	0.0443	0.0590	0.0000	0.0176	0.0049	-0.0053	0.0419	0.0075

	B1001101-CJ-WC-006-CV 1/2-1			B1008101-CJ-FC-002-CV			B1008101-CJ-FC-003-CV		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	3.590	1.640	1.350	0.382	0.940	0.559	1.300	1.020	0.713
C-14	-0.246	1.490	0.836	0.053	1.370	0.794	-0.296	1.440	0.810
Fe-55	6.030	14.500	7.050	1.610	6.550	3.370	6.460	14.500	7.050
Ni-59	0.000	0.257	0.147	0.000	0.234	0.151	0.000	0.241	0.171
Co-60	-0.026	0.207	0.240	0.662	0.065	0.131	0.974	0.142	0.162
Ni-63	2.310	0.396	0.335	2.730	0.353	0.355	4.400	0.356	0.510
Sr-90	0.146	0.038	0.034	0.154	0.053	0.041	0.235	0.035	0.041
Nb-94	0.019	0.141	0.060	0.000	0.211	0.066	0.016	0.141	0.081
Tc-99	0.024	0.556	0.324	-0.010	0.579	0.335	-0.005	0.592	0.343
Cs-137	1.410	0.153	0.258	16.000	0.177	1.780	10.000	0.154	1.130
Eu-152	0.021	0.434	0.113	0.034	0.633	0.056	0.291	0.470	0.270
Eu-154	0.055	1.270	0.137	0.060	1.200	0.239	0.019	1.410	0.052
Eu-155	0.003	0.336	0.196	0.140	0.357	0.215	0.101	0.348	0.208
Np-237	0.003	0.045	0.021	0.003	0.048	0.022	-0.024	0.068	0.025
Pu-238	-0.004	0.043	0.016	0.018	0.060	0.033	0.042	0.057	0.038
Pu-239/240	0.035	0.033	0.028	-0.011	0.054	0.019	0.008	0.034	0.017
Pu-241	-1.890	2.360	1.270	-1.120	2.710	1.480	-0.194	2.550	1.470
Am-241	0.006	0.036	0.017	0.020	0.042	0.027	0.019	0.051	0.029
Am-243	-0.002	0.031	0.005	-0.002	0.044	0.017	-0.001	0.052	0.023
Cm-243/244	-0.0036	0.0287	0.0052	0.0062	0.0187	0.0125	-0.0056	0.0444	0.0080

Table 2-16 (continued) Concrete Core Isotopic Analysis Results

	B1008101-CJ-FC-004-CV			B1002101-CJ-FC-001-CV 0-1/2			B1002101-CJ-FC-001-CV 1/2-1		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	1.200	0.990	0.685	0.820	0.985	0.637	0.275	0.931	0.543
C-14	0.077	1.430	0.829	0.505	1.410	0.850	-0.018	1.440	0.824
Fe-55	6.520	11.500	5.820	15.400	13.800	7.430	0.547	5.510	2.840
Ni-59	0.000	0.229	0.162	65.500	0.310	8.690	0.000	0.245	0.170
Co-60	1.390	0.095	0.255	95.000	0.420	9.600	1.010	0.149	0.168
Ni-63	4.260	0.339	0.492	817.000	0.472	85.000	5.640	0.367	0.633
Sr-90	0.216	0.040	0.041	99.800	0.045	9.600	0.253	0.053	0.049
Nb-94	0.001	0.143	0.081	0.098	0.475	0.149	0.029	0.102	0.054
Tc-99	0.043	0.599	0.350	0.113	0.564	0.333	-0.101	0.507	0.289
Cs-137	19.800	0.166	2.150	4710	1.690	491.000	3.870	0.137	0.496
Eu-152	-0.119	0.580	0.344	0.815	5.940	1.410	0.039	0.444	0.107
Eu-154	-0.061	1.370	0.296	1.250	5.460	1.980	-0.260	1.480	0.859
Eu-155	0.006	0.376	0.220	0.073	2.120	1.280	0.077	0.272	0.162
Np-237	0.014	0.065	0.035	-0.012	0.060	0.023	-0.022	0.064	0.023
Pu-238	0.020	0.052	0.030	0.920	0.620	0.511	0.017	0.059	0.033
Pu-239/240	0.025	0.042	0.028	1.280	0.469	0.537	-0.005	0.042	0.013
Pu-241	-1.610	2.610	1.430	5.240	26.700	16.200	-0.984	2.680	1.510
Am-241	0.052	0.034	0.035	3.200	0.428	0.989	0.035	0.037	0.031
Am-243	-0.004	0.032	0.006	0.406	0.296	0.310	-0.018	0.054	0.013
Cm-243/244	0.0100	0.0150	0.0142	0.2020	0.4200	0.2670	-0.0046	0.0366	0.0066

	B1002101-CJ-FC-001-CV 1-1.5			B1002101-CJ-FC-001-CV 1.5-2			B1002101-CJ-FC-002-CV 0-1/2		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	0.763	1.000	0.638	0.094	0.917	0.512	1.710	1.180	0.846
C-14	-0.776	1.410	0.763	0.372	1.380	0.819	15.400	1.510	2.310
Fe-55	3.540	5.670	3.150	7.770	25.000	11.400	8.960	5.860	3.640
Ni-59	0.000	0.228	0.159	0.000	0.259	0.188	423.000	0.446	55.200
Co-60	0.742	0.069	0.148	0.872	0.138	0.161	300.000	0.762	30.200
Ni-63	3.360	0.333	0.407	5.730	0.388	0.646	2360	0.661	245.000
Sr-90	2.410	0.050	0.250	0.106	0.041	0.032	220.000	0.052	21.100
Nb-94	0.035	0.149	0.066	-0.034	0.142	0.083	-0.350	0.935	0.567
Tc-99	0.259	0.564	0.342	0.032	0.528	0.308	0.792	0.562	0.373
Cs-137	3.630	0.150	0.493	2.440	0.146	0.343	25400	4.140	2650
Eu-152	0.156	0.420	0.236	0.125	0.383	0.195	0.510	13.700	0.956
Eu-154	0.119	1.400	0.382	0.271	0.956	0.406	4.650	7.170	4.390
Eu-155	0.159	0.335	0.204	0.099	0.326	0.196	1.060	7.370	0.988
Np-237	0.000	0.045	0.018	-0.007	0.052	0.019	0.024	0.042	0.027
Pu-238	0.023	0.061	0.035	0.004	0.061	0.030	3.200	0.497	0.825
Pu-239/240	0.000	0.049	0.021	0.009	0.041	0.021	2.580	0.287	0.713
Pu-241	-0.052	2.820	1.640	-2.090	2.700	1.460	36.900	24.000	17.100
Am-241	0.020	0.015	0.020	0.017	0.041	0.025	9.080	0.682	2.030
Am-243	0.013	0.029	0.018	0.029	0.029	0.026	0.305	0.388	0.286
Cm-243/244	0.0048	0.0143	0.0096	0.0059	0.0331	0.0154	0.4280	0.5450	0.4200

Table 2-16 (continued) Concrete Core Isotopic Analysis Results

	B1002101-CJ-FC-002-CV 1/2-1			B1002101-CJ-FC-003-CV 0-1/2		
	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)	Result (pCi/g)	MDC (pCi/g)	σ (pCi/g)
H-3	0.846	1.120	0.716	0.836	0.962	0.624
C-14	6.180	1.420	1.340	-0.405	1.440	0.803
Fe-55	5.270	25.300	11.400	8.430	17.000	8.210
Ni-59	0.000	0.269	0.616	0.000	0.334	0.484
Co-60	8.270	0.114	0.907	8.570	0.148	0.940
Ni-63	175.000	0.442	18.300	70.600	0.548	7.370
Sr-90	3.520	0.047	0.356	7.000	0.050	0.691
Nb-94	-0.041	0.230	0.135	0.038	0.211	0.060
Tc-99	0.165	0.522	0.312	0.062	0.543	0.318
Cs-137	208.000	0.362	21.700	1240	0.817	129.000
Eu-152	-0.280	1.580	0.950	0.176	2.600	0.514
Eu-154	0.255	1.900	0.259	0.090	2.320	0.202
Eu-155	0.116	0.864	0.205	-0.004	1.710	1.030
Np-237	-0.019	0.056	0.017	-0.011	0.044	0.009
Pu-238	0.059	0.064	0.046	0.105	0.056	0.051
Pu-239/240	0.056	0.049	0.040	0.126	0.039	0.051
Pu-241	-0.965	2.970	1.690	1.500	2.560	1.640
Am-241	0.238	0.048	0.080	0.339	0.044	0.099
Am-243	0.005	0.060	0.028	-0.001	0.037	0.012
Cm-243/244	0.0018	0.0438	0.0179	0.0175	0.0175	0.0203

Table 2-17 1983 Groundwater Analysis from Temporary Well-Point South of Turbine Building

Radionuclide	Activity (pCi/L)
Mn-54	63.4
Co-57	6.4
Co-60	508
Nb-95	21.4
Cs-137	21.7
Ce-141	18.9

Table 2-18 2013 Groundwater Monitoring Results

June 2013

	MW-201-A	MW-201-B	MW-202-A	MW-202-B	MW-203-A	MW-203-B	MW-204-A	MW-204-B
	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)
H-3	**572**	**506**	**660**	**484**	N/A	**420**	**397**	**420**
Co-60	*4.00*	*5.01*	*4.76*	*4.51*	*4.95*	*4.12*	*4.36*	*4.26*
Sr-90	**2.05**	**2.00**	**1.82**	**1.43**	**2.06**	**2.06**	**2.18**	**2.08**
Cs-137	*3.97*	*3.84*	*4.05*	*3.91*	*4.52*	*4.31*	*4.11*	*3.96*

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value.

November 2013

	MW-201-A	MW-201-B	MW-202-A	MW-202-B	MW-203-A	MW-203-B	MW-204-A	MW-204-B
	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)
H-3	**235**	**150**	**257**	**278**	**449**	**235**	**193**	**171**
Co-60	*4.64*	*3.80*	*5.26*	*5.41*	*4.43*	*3.89*	*4.52*	*8.24*
Sr-90	*1.18*	*3.73*	*1.18*	*1.61*	*1.87*	*2.40*	*1.18*	*1.51*
Cs-137	*4.64*	*1.90*	*6.54*	*4.70*	*4.41*	*3.98*	*4.77*	*7.92*

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value.

Table 2-19 2014 Groundwater Monitoring Results (pCi/L)

JUNE 2014

	MW-DW3	MW-DW4	MW-DW5	MW-DW7	MW-B11R	MW-B11AR	MW-B2	MW-B3	MW-200-A	MW-200-B	MW-201-A	MW-201-B	MW-202-A	MW-202-B	MW-203-A	MW-203-B	MW-204-A	MW-204-B
Gross Alpha	1.26E-01	-1.33E-01	4.44E+00	-3.78E-01	0.00E+00	**7.33E-01**	-2.13E+00	**6.46E-01**	**4.04E+00**	-2.26E-01	3.84E-01	-1.04E+00	**1.06E+00**	4.07E-01	**1.74E+00**	-2.29E-01	**7.58E-01**	**1.27E+00**
Gross Beta	1.48E+00	**3.13E+00**	1.93E+00	0.00E+00	**3.59E+00**	-2.70E-01	**1.12E+01**	**4.14E+00**	**8.66E+00**	-1.79E+00	**7.26E+00**	-1.04E+00	**4.34E+00**	1.49E+00	2.27E+00	**5.53E+00**	2.69E+00	2.57E-01
H-3	1.05E+02	1.59E+02	1.94E+02	1.23E+02	**2.45E+02**	1.61E+02	1.60E+02	1.94E+02	5.23E+01	1.24E+02	7.03E+01	1.05E+02	**3.36E+02**	1.06E+02	**2.79E+02**	**2.79E+02**	1.06E+02	3.49E+01
C-14	2.79E+00	0.00E+00	-3.97E+00	-5.08E+00	9.06E+00	6.83E+00	1.94E+00	-2.05E+00	9.26E+00	4.84E+00	4.84E+00	4.51E+00	0.00E+00	4.70E+00	4.54E+00	4.55E+00	4.66E+00	**1.30E+01**
Fe-55	-2.00E+01	-3.12E+01	-2.66E+01	-3.86E+01	-3.19E+01	-3.75E+01	-9.20E+00	-4.39E+01	1.93E+01	-4.16E+01	-3.20E+01	1.58E+01	-3.26E+00	-4.54E+01	-4.95E+01	-4.96E+01	-4.03E+01	-3.98E+00
Ni-59	1.83E+01	3.96E+01	-4.75E+01	2.60E+01	-4.16E+00	2.53E+00	-7.13E+00	3.15E+01	-2.18E+01	3.32E+01	-1.67E+01	-7.11E+01	2.49E+01	-1.05E+01	-2.71E+01	-4.66E+00	-6.22E+00	-2.47E+01
Co-60	1.02E+00	3.94E-01	2.50E+00	-2.42E+00	8.76E-01	-1.94E+00	-1.39E+00	-1.13E+00	1.01E+00	-1.27E+00	-6.04E-02	1.73E+00	-8.91E-01	1.02E+00	3.48E-02	-9.55E-01	1.91E-01	-2.31E-01
Ni-63	-1.78E+00	-6.14E+00	-7.40E+00	-4.38E+00	-3.57E+00	0.00E+00	-7.94E+00	1.50E+00	-1.97E+00	-4.69E+00	1.82E+00	-1.91E+00	-1.94E+00	-3.73E+00	-3.70E+00	-3.80E+00	0.00E+00	-1.97E+00
Sr-90	6.09E-01	8.99E-02	8.99E-02	1.78E-02	7.34E-01	6.11E-01	6.52E-01	6.12E-01	9.86E-01	9.98E-01	6.86E-02	1.02E+00	**1.12E+00**	6.05E-01	**1.17E+00**	8.23E-01	**2.01E+00**	6.11E-01
Nb-94	4.40E-01	1.43E-01	-1.26E+00	7.49E-01	-6.99E-01	1.53E+00	1.77E+00	6.65E-01	1.08E+00	8.47E-01	3.73E-01	1.80E+00	-3.55E-01	1.04E-01	1.59E+00	1.50E+00	2.26E-01	1.28E+00
Tc-99	-8.28E+00	-7.37E+00	-8.26E+00	-9.36E+00	-5.52E+00	-8.46E+00	-7.41E+00	-8.10E+00	3.55E+00	**5.08E+00**	3.92E+00	1.17E+00	3.88E-01	2.73E+00	4.36E+00	4.17E+00	**6.95E+00**	**6.31E+00**
Cs-137	-5.97E-01	-3.47E-01	-7.45E-01	-1.83E+00	1.24E+00	1.84E+00	1.37E+00	2.14E+00	1.77E-01	-3.64E-01	3.10E-01	-6.21E-01	-4.64E-01	2.86E+00	1.48E+00	1.39E+00	-3.04E-01	1.93E+00
Eu-152	**9.48E+00**	2.34E+00	-7.43E+00	-5.51E+00	-9.93E-01	1.48E+00	1.07E-01	**1.42E+01**	**9.71E+00**	-1.16E+01	4.15E+00	**1.12E+01**	4.11E+00	**1.08E+01**	-9.59E-01	4.99E+00	2.12E+00	7.68E+00
Eu-154	-5.24E+00	3.16E+00	1.35E+00	-4.73E+00	1.63E+00	-2.61E+00	2.36E+00	1.69E+00	5.77E-01	5.60E-01	-2.39E+00	-2.43E+00	-1.12E+00	-1.18E+00	1.93E+00	-3.69E+00	2.36+00	6.06E-01
Eu-155	-2.67E+00	1.46E+00	-1.54E-01	-1.07E+02	1.60E+00	-4.47E+00	1.60E+00	-3.17E+00	-3.63E+00	-3.44E+00	-2.92E+00	-2.60E+00	-1.59E+00	-3.49E+00	-4.91E+00	4.05E+00	-4.34E-01	1.66E+00
Pu-238	2.83E-02	-4.77E-02	-2.22E-02	8.22E-02	0.00E+00	4.09E-02	5.40E-02	8.29E-02	-1.38E-02	1.51E-02	5.33E-02	-5.02E-02	-8.46E-03	1.48E-01	-5.67E-02	-5.87E-02	-5.12E-02	-9.28E-03
Pu-239/240	-9.61E-02	3.36E-02	3.13E-02	**4.07E-01**	-2.54E-02	-3.39E-02	3.40E-02	1.46E-01	2.68E-02	-1.57E-02	-6.86E-03	2.36E-02	-2.27E-02	-4.54E-02	-2.27E-02	-3.95E-02	-2.49E-02	6.28E-02
Pu-241	3.51E+00	2.70E+00	-8.39E+00	2.62E+00	-5.72E+00	8.38E-01	0.00E+00	-7.39E-01	0.00E+00	4.49E+00	-4.85E-01	-1.42E+00	2.20E+00	2.72E+00	4.07E+00	1.03E+01	4.07E+00	-1.89E+00
Am-241	5.39E-02	3.42E-02	4.65E-03	-1.01E-02	1.22E-02	8.37E-02	3.98E-03	2.28E-02	**1.72E-01**	**9.71E-01**	9.46E-02	3.99E-03	**1.16E-01**	3.92E-02	2.94E-02	7.64E-02	**1.56E-01**	8.24E-02

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value.

Table 2-19 (continued) 2014 Groundwater Monitoring Results (pCi/L)

September 2014

	MW-DW5	MW-B11R	MW-B11AR	MW-200-A	MW-200-B	MW-201-A	MW-201-B	MW-202-A	MW-202-B	MW-203-A	MW-203-B	MW-204-A	MW-204-B
Gross Alpha	**8.47E-01**	**3.09E+00**	*2.07E-01*	**2.42E-01**	**2.01E+00**	**1.18E+00**	**1.43E+00**	**1.04E+00**	*-2.10E-01*	**1.37E+00**	*-6.68E-01*	**6.00E-01**	**3.53E+00**
Gross Beta	*2.96E+00*	**1.45E+01**	*3.04E-01*	*2.41E+00*	**9.11E+00**	**7.36E+00**	**3.67E+00**	*4.86E-01*	*2.30E+00*	*1.52E+00*	*1.00E+00*	**5.28E+00**	*0.00E+00*
H-3	*3.43E+01*	*0.00E+00*	*3.44E+01*	*6.86E+01*	*5.17E+01*	*8.67E+01*	*-3.42E+01*	*-5.18E+01*	*1.04E+02*	*-3.44E+01*	*1.21E+02*	*6.88E+01*	*-1.21E+02*
C-14	*-9.44E-01*	*-2.70E+00*	*0.00E+00*	*-4.56E-01*	*-4.98E+00*	*2.69E+00*	*9.28E-01*	*4.94E+00*	*-2.72E+00*	*-3.95E+00*	*4.89E-01*	*4.73E-01*	*9.46E-01*
Fe-55	*9.39E+00*	*-3.10E+01*	*-3.49E+01*	*-3.35E+01*	*-4.56E+01*	*-2.18E+01*	*2.77E+01*	*-5.43E+01*	*3.37E+01*	*-4.95E+01*	*4.32E+01*	*3.45E+01*	*-9.25E+01*
Ni-59	*3.13E+00*	*1.64E+01*	*-8.49E+00*	*7.84E+00*	*2.37E+01*	*-1.99E+01*	*3.09E+01*	*-1.18E+01*	*-4.46E+01*	*5.30E+01*	*-4.34E+01*	*-3.13E+01*	*-1.87E+01*
Co-60	*2.17E+00*	*1.32E+00*	*1.22E+00*	**3.56E+00**	*6.20E-01*	*-7.23E-02*	*9.50E-01*	*9.72E-01*	*1.18E+00*	**3.67E+00**	*1.99E+00*	*-3.77E-01*	*2.05E+00*
Ni-63	*2.79E+00*	*2.48E+00*	*-4.14E-01*	*3.62E+00*	*-7.87E-01*	**5.00E+00**	*2.15E+00*	*8.25E-01*	*-8.30E-01*	*1.62E+00*	*-1.77E+00*	*-1.84E-01*	*3.94E-01*
Sr-90	*-1.06E+00*	*5.90E-01*	*2.80E-01*	**1.14E+00**	*5.10E-01*	*-1.19E-01*	*-4.99E-01*	*6.70E-01*	*5.40E-01*	*4.80E-01*	*8.70E-01*	*9.00E-01*	*2.30E-01*
Nb-94	*-9.45E-01*	*-1.39E+00*	*-1.29E-01*	*-1.43E+00*	*-2.68E-01*	*6.56E-01*	*6.44E-01*	*-6.48E-02*	*-1.02E+00*	*8.53E-02*	*2.16E+00*	*1.18E-01*	*-1.88E+00*
Tc-99	*-1.54E+00*	*-4.00E-01*	*-1.56E+00*	*-1.57E+00*	*-1.54E+00*	*-7.94E-01*	*-1.95E+00*	*7.97E-01*	*-1.95E-01*	*-1.24E+00*	*-3.32E+00*	*-1.96E+00*	*3.89E-01*
Cs-137	**3.97E+00**	*-7.24E-01*	*9.72E-01*	**2.17E+01**	*1.94E+00*	*-1.09E+00*	*1.84E+00*	*-4.34E-01*	*2.31E+00*	*1.56E+00*	*6.84E-01*	*-1.14E+00*	*1.24E+00*
Eu-152	*2.48E+00*	*3.00E+00*	*6.42E+00*	*-2.39E+00*	*-1.34E+01*	*4.79E+00*	*2.53E+00*	**9.40E+00**	*6.51E+00*	*4.06E+00*	*-1.15E+00*	*-1.92E+01*	*2.23E+00*
Eu-154	*-3.31E+00*	*-3.93E+00*	*1.10E+00*	*-6.57E-01*	*-1.54E+00*	*-3.09E+00*	*1.94E+00*	*-3.67E-01*	**4.18E+00**	*-3.33E+00*	*-2.31E-01*	*-4.95E+00*	*2.36E+00*
Eu-155	*2.69E+00*	*1.95E+00*	*1.69E+00*	*-8.16E-01*	*-1.64E+00*	*-1.48E+00*	*4.13E+00*	*-2.08E+00*	*-8.41E-01*	*-9.54E-02*	*-3.66E-01*	*-2.02E+00*	*9.46E-01*
Pu-238	*1.71E-02*	*3.69E-02*	*-5.50E-03*	*2.65E-02*	*-6.50E-03*	*-3.59E-02*	*8.55E-02*	*1.13E-02*	*3.63E-02*	*7.08E-02*	*8.12E-02*	*-6.45E-04*	*-3.26E-02*
Pu-239/240	*9.28E-02*	*0.00E+00*	*-1.10E-02*	*5.83E-02*	*0.00E+00*	*0.00E+00*	**1.41E-01**	*5.87E-02*	*5.25E-02*	*9.15E-02*	*5.97E-02*	*-5.48E-03*	*7.02E-02*
Pu-241	*3.18E+00*	*-3.68E+00*	*-2.29E+00*	*-2.23E+00*	*8.49E+00*	*-6.92E-01*	*-5.85E-01*	*0.00E+00*	*-1.76E+00*	*5.04E-01*	*-3.71E+00*	*-3.97E+00*	*-6.46E+00*
Am-241	*1.28E-01*	*3.69E-02*	*-1.69E-02*	*1.10E-01*	**2.29E-01**	**1.40E-01**	*2.80E-02*	*6.62E-02*	*9.48E-02*	**2.51E-01**	*1.03E-01*	*1.06E-01*	**2.69E-01**

a Bold values indicate concentration greater than MDC. Italicized values indicate MDC value.

Figure 2-1 LACBWR Site Map – Open Land Survey Units and Classification

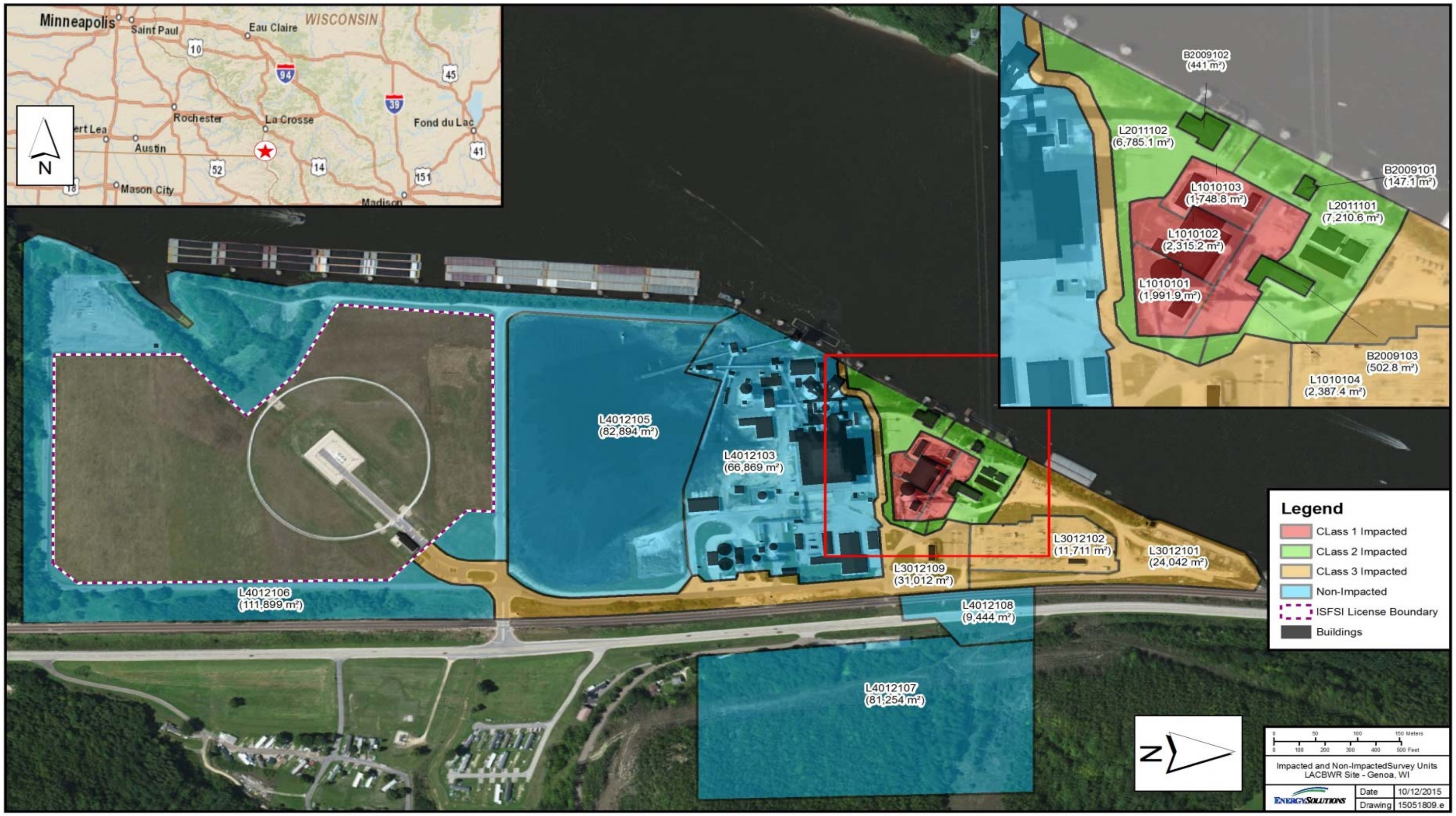


Figure 2-2 LACBWR Site Map – Buildings Identification

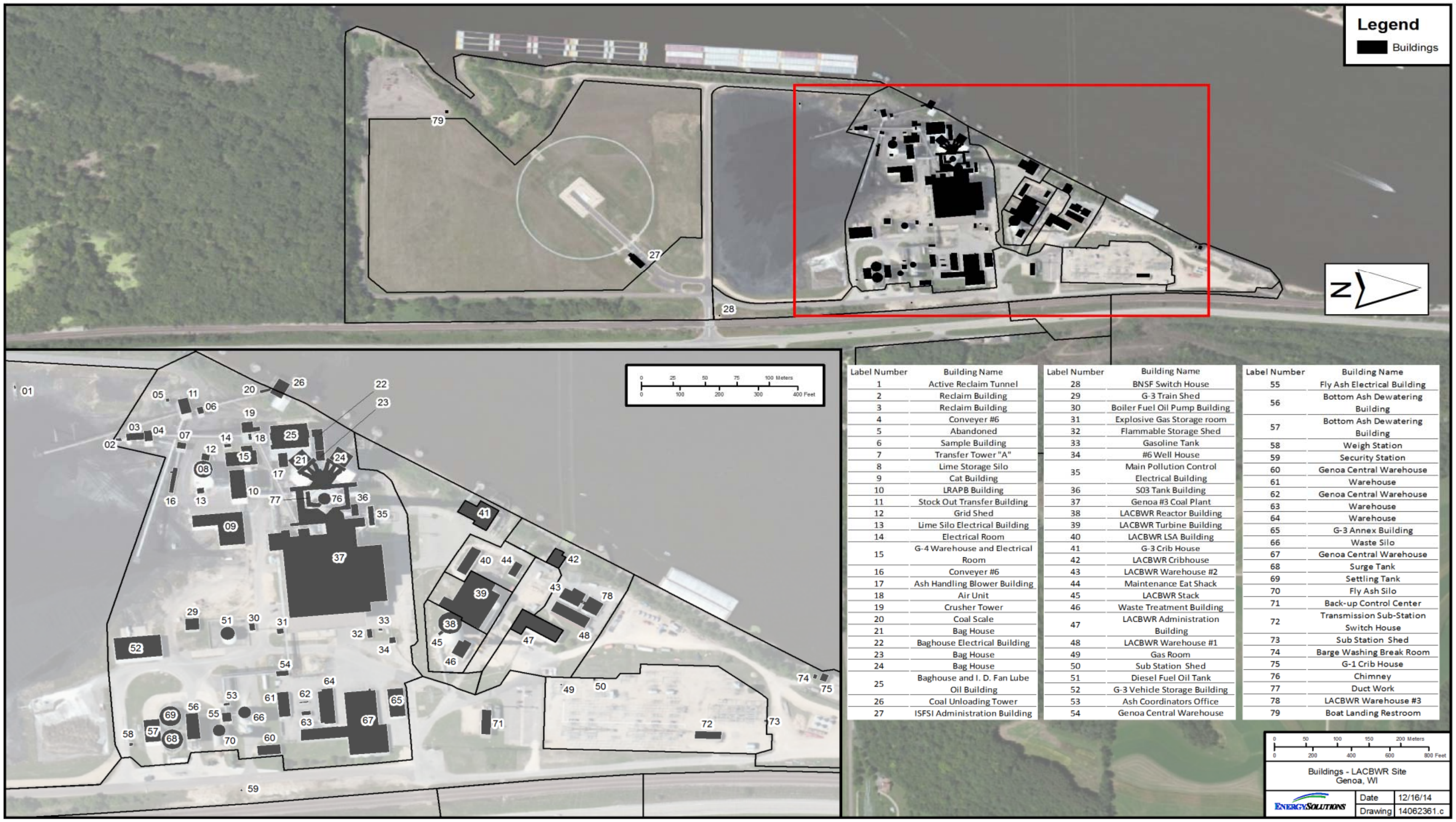


Figure 2-3 LACBWR Site Drainage and Sewer Map

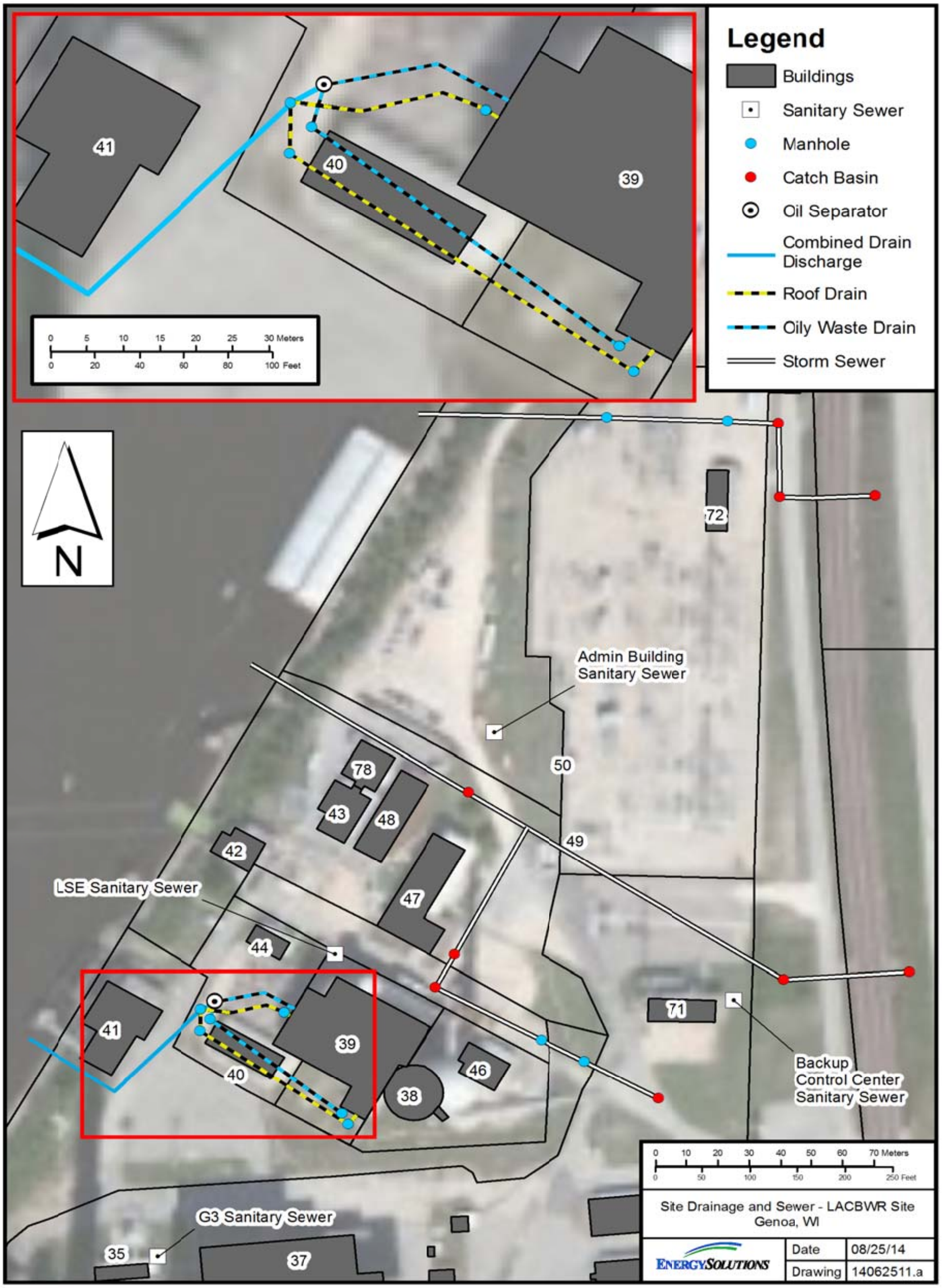


Figure 2-4 LACBWR LCE Exclusion Area (Class 1)

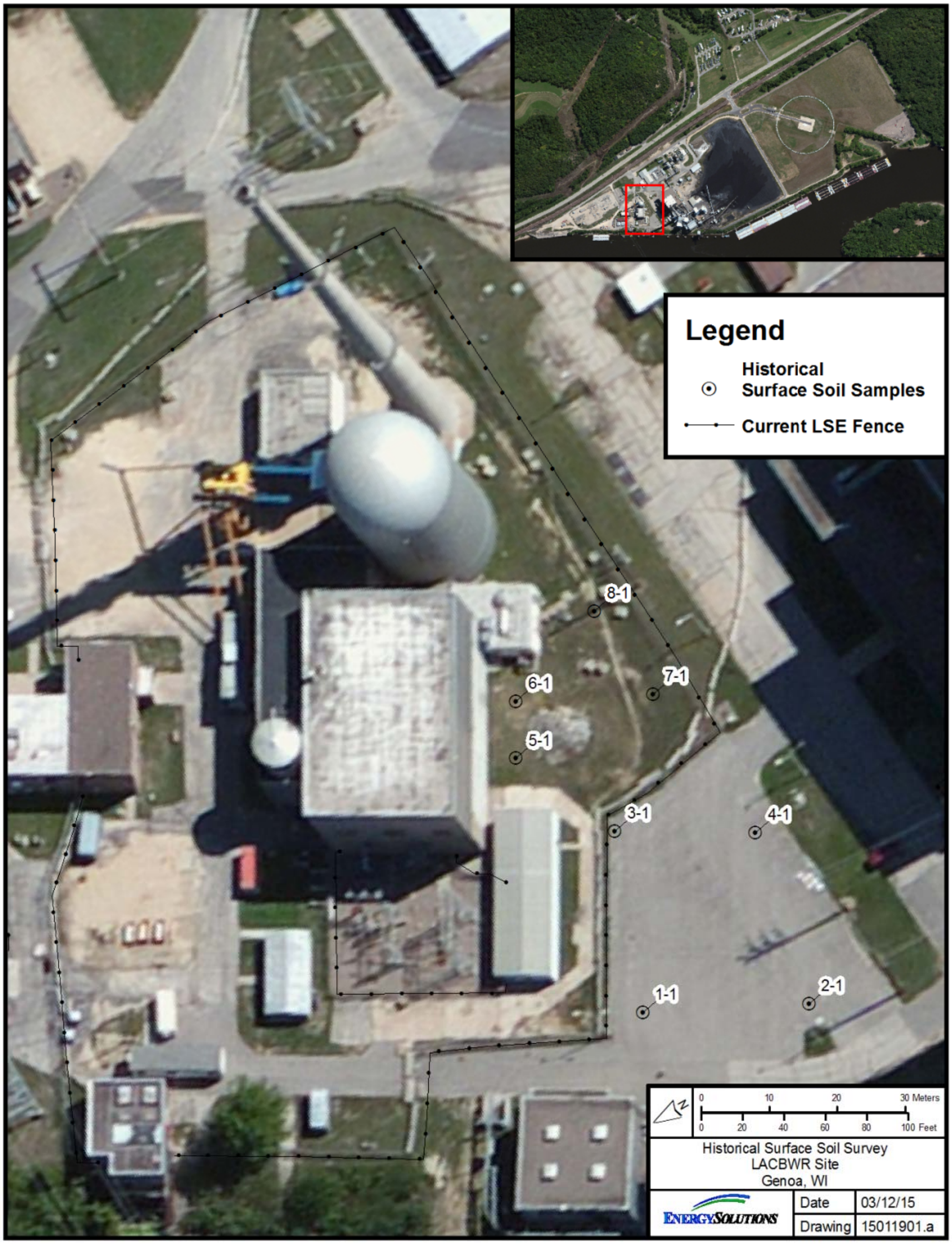


Figure 2-5 Non Impacted Open Land Sampling Locations

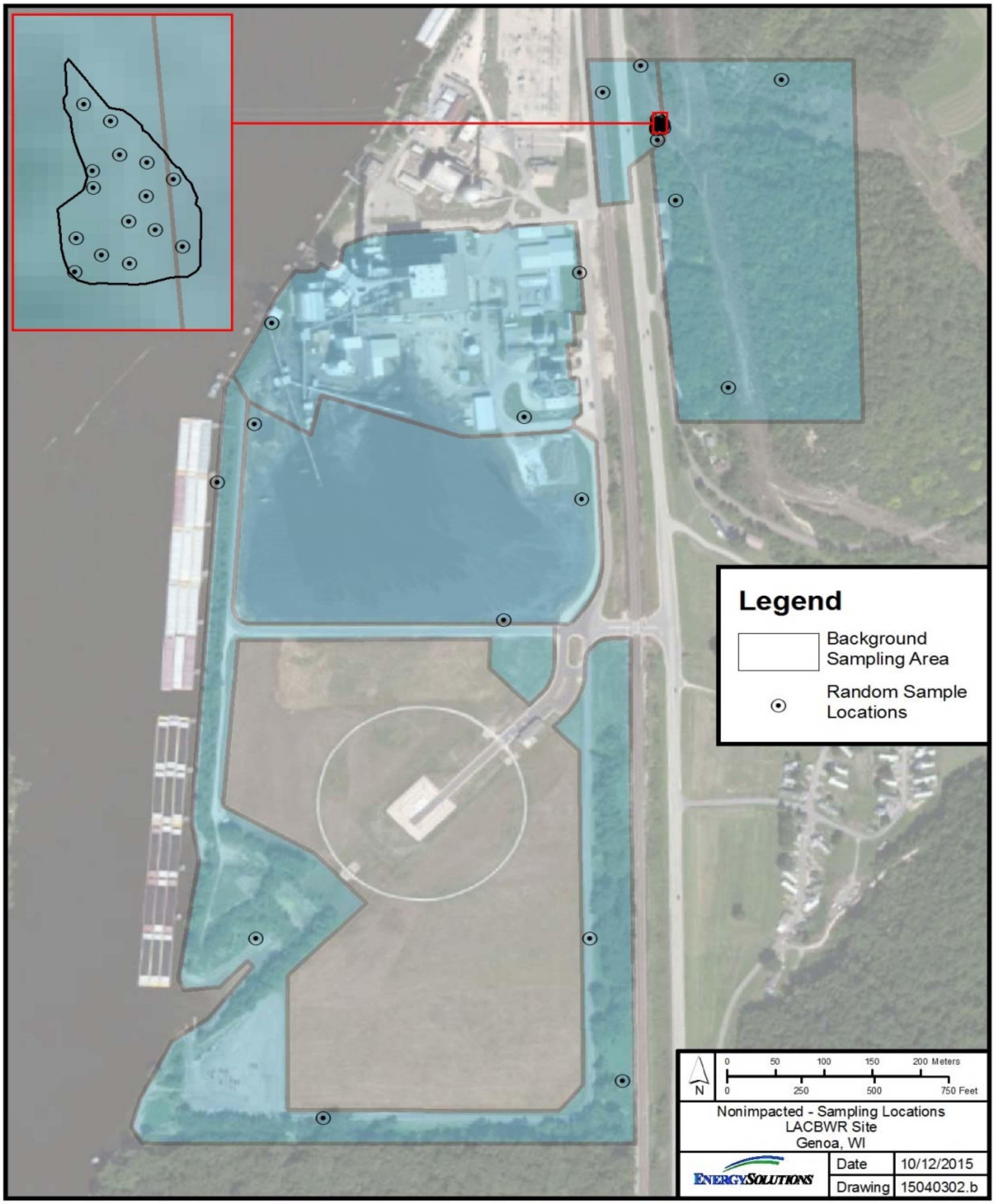


Figure 2-6 Class 1 Open Land Sampling Locations

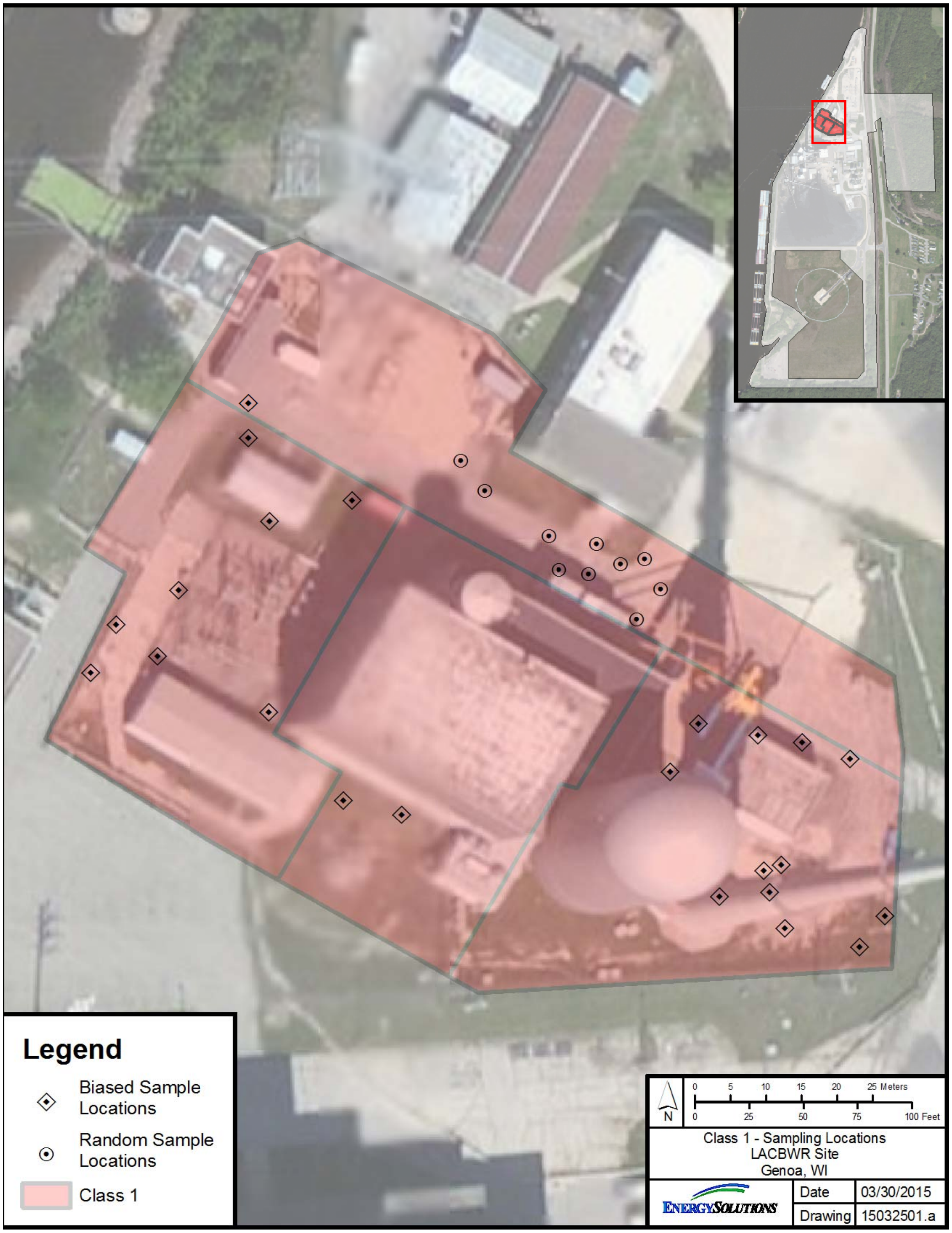


Figure 2-7 Class 2 Open Land Sampling Locations

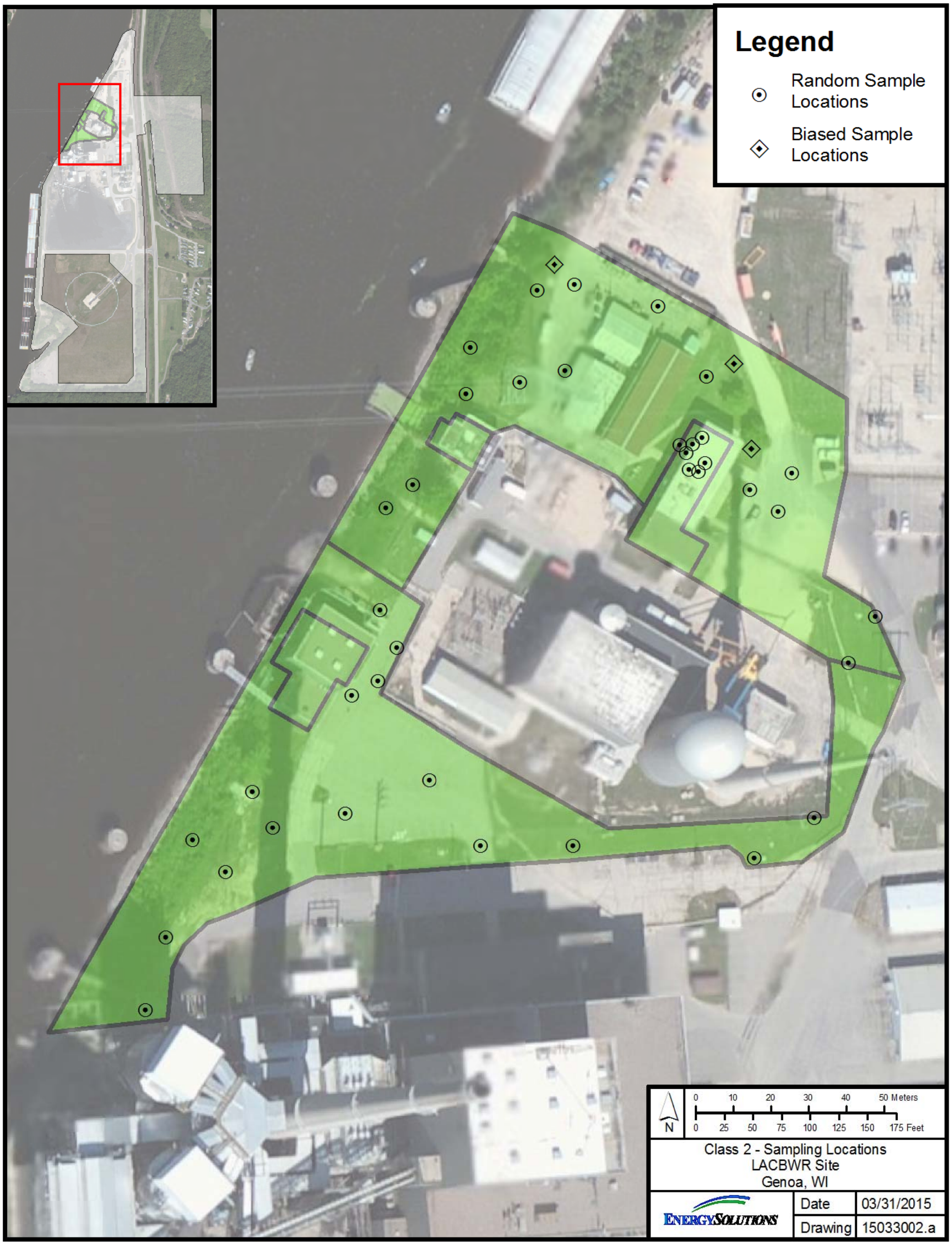


Figure 2-8 Class 3 Open Land Sampling Locations

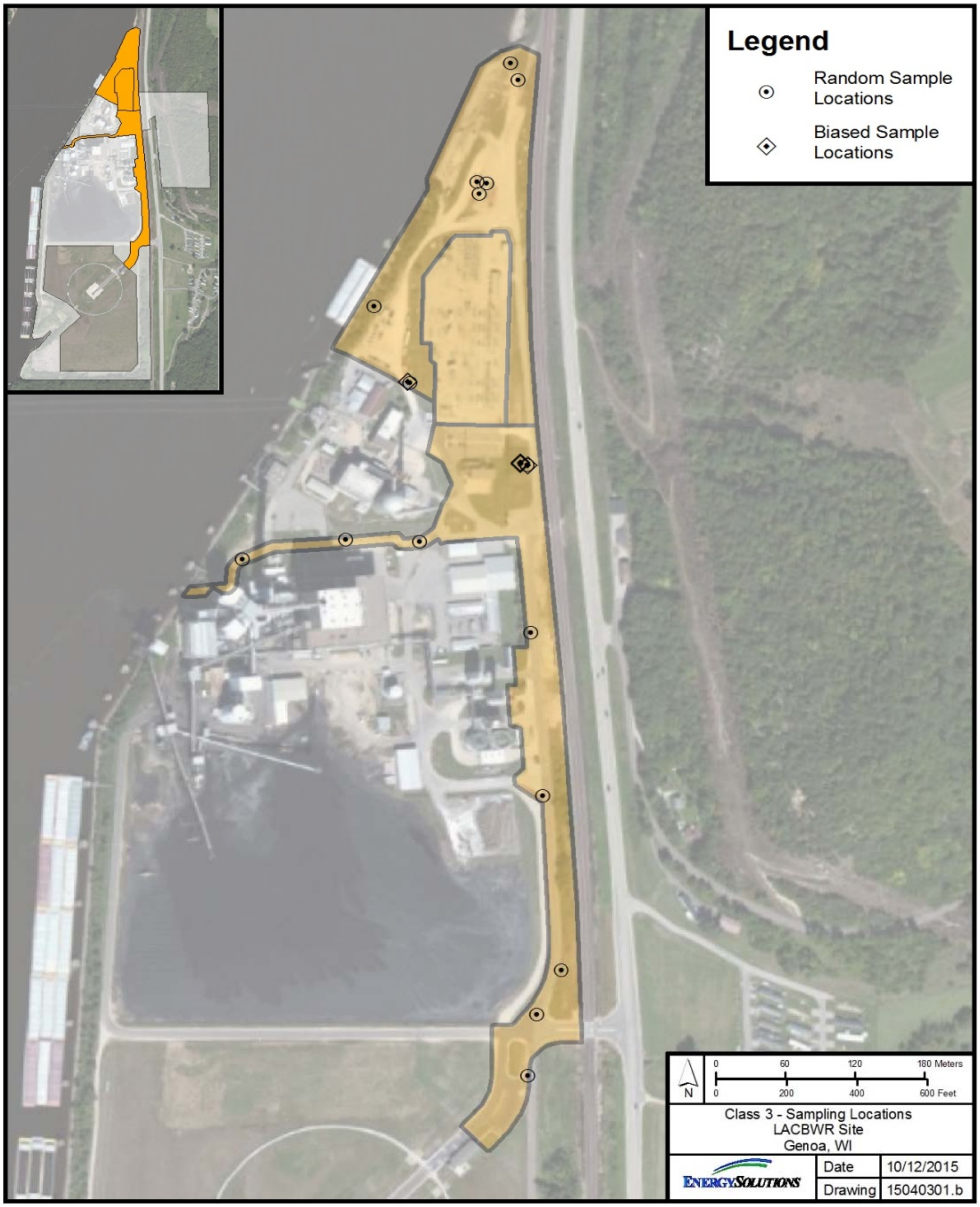
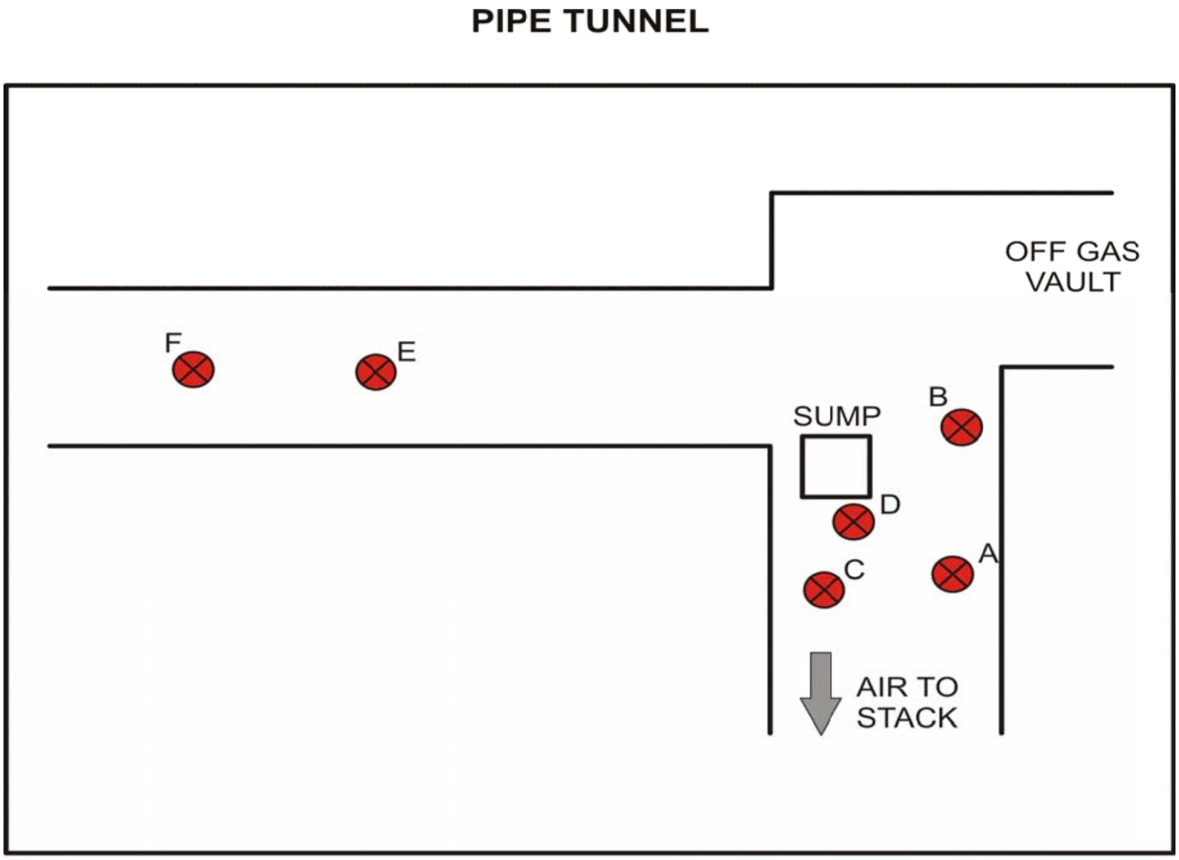


Figure 2-9 Concrete Core Sampling Locations



A	B1008101-CJ-FC-001-CV
B	B1008101-CJ-FC-002-CV
C	B1008101-CJ-FC-003-CV
D	B1008101-CJ-FC-004-CV
E	B1008101-CJ-FC-005-CV
F	B1008101-CJ-FC-006-CV

15081803.a

Figure 2-9 (continued) Concrete Core Sampling Locations

A	B1002101-CJ-FC-001-CV
B	B1002101-CJ-FC-002-CV
C	B1002101-CJ-FC-003-CV

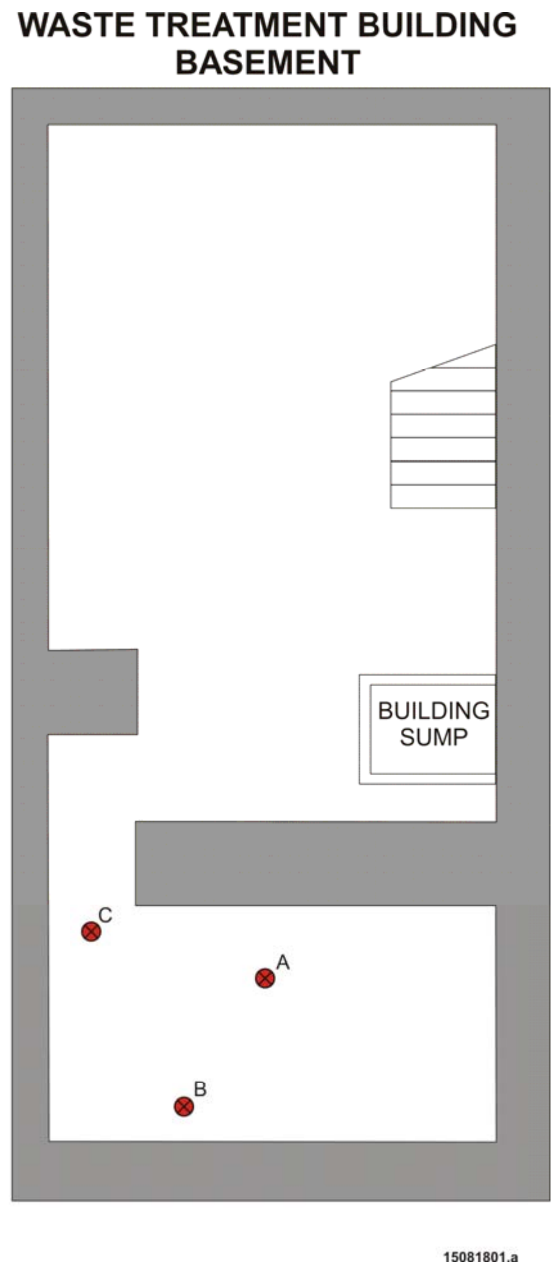
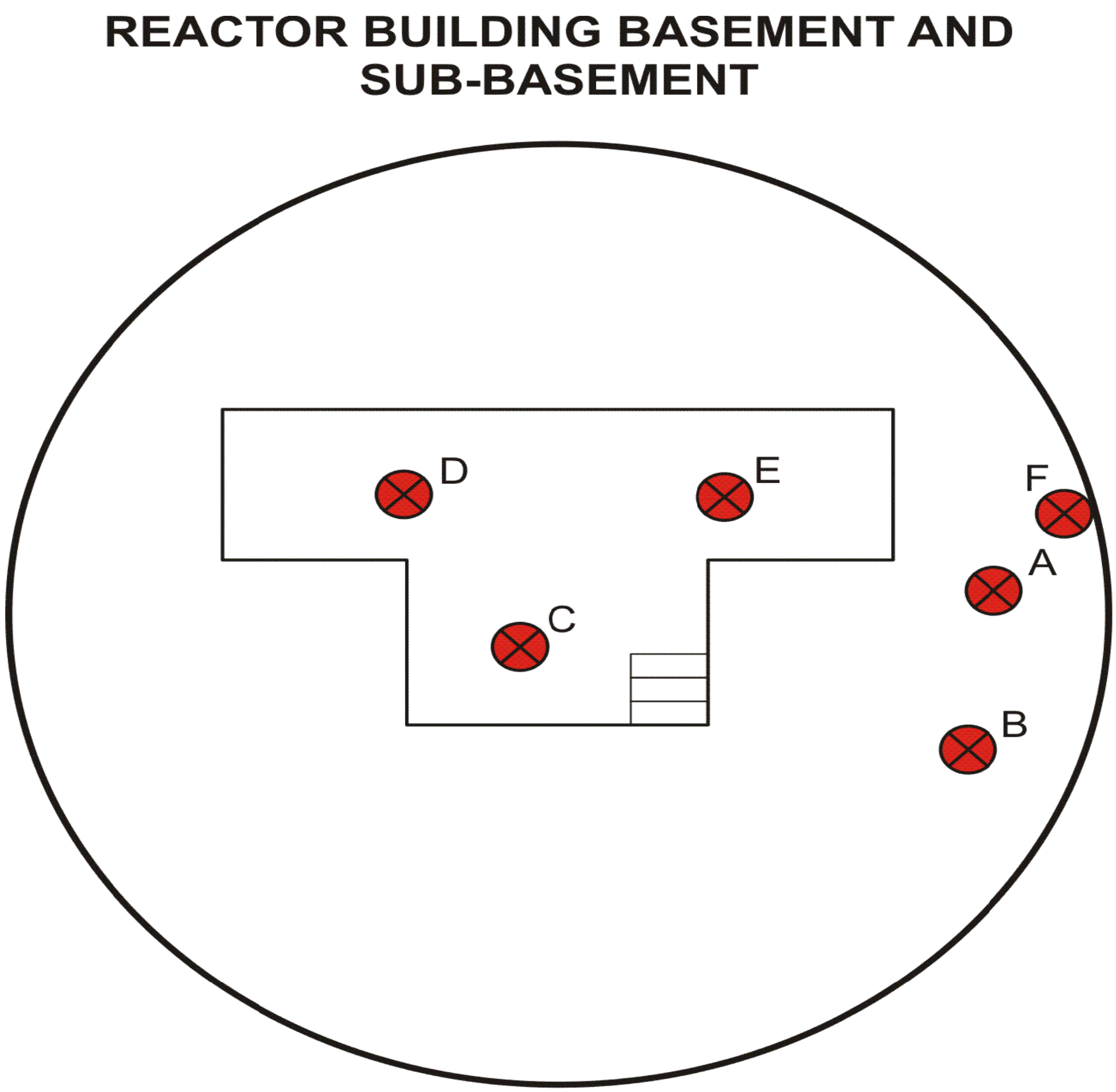


Figure 2-9 (continued) Concrete Core Sampling Locations



A	B1001101-CJ-FC-001-CV
B	B1001101-CJ-FC-002-CV
C	B1001101-CJ-FC-003-CV
D	B1001101-CJ-FC-004-CV
E	B1001101-CJ-FC-005-CV
F	B1001101-CJ-WC-006-CV

15081802.a

Figure 2-10 LACBWR Site - Typical Geological Cross-Section

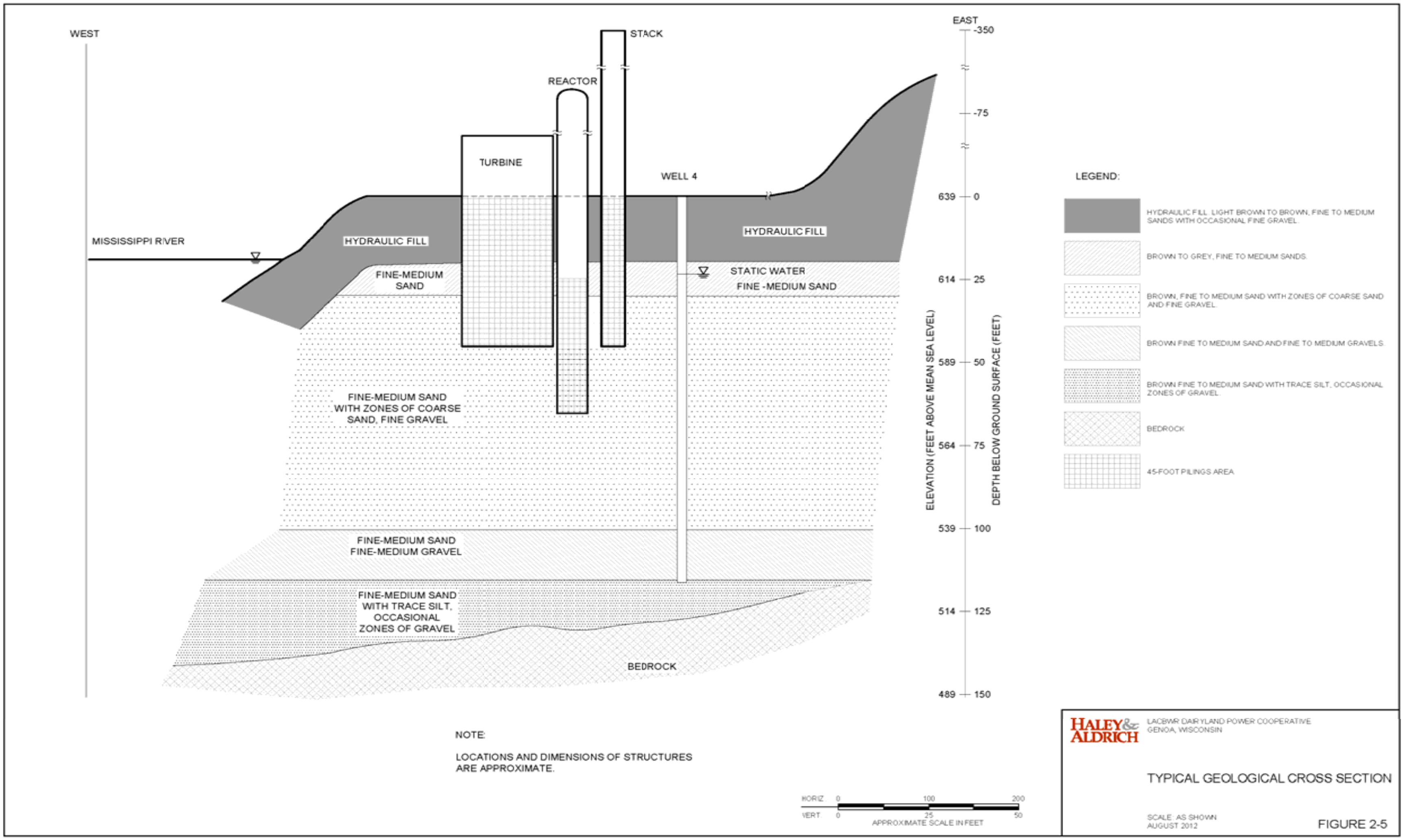


Figure 2-11 Groundwater Sampling Wells – LACBWR Site