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Document Number

Characterization Survey Plan for the La Crosse Boiling Water Reactor

Genoa, Wisconsin

Project No. 313196 **Revision 1**

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List of Acronyms and Abbreviations

ALARA	As Low As Reasonably Achievable
AEC	U.S. Atomic Energy Commission
BWR	Boiling water reactor
Ci	Curie
COC	Chain-of-Custody
DAW	Dry Active Waste
DCGL	Derived Concentration Guideline Level
DPC	Dairyland Power Cooperative
DQA	Data Quality Assessment
DQO	Data Quality Objective
FESW	Fuel Element Storage Well
FSS	Final Status Survey
G-3	Genoa Station #3
GPS	Global Positioning System
HASP	Health and Safety Plan
HSA	Historical Site Assessment
HTD	Hard-To-Detect
ISFSI	Independent Spent Fuel Storage Installation
JHA	Job Hazard Analysis
LACBWR	La Crosse Boiling Water Reactor
LBGR	Lower Bound of the Gray Region
LSE	LACBWR Site Enclosure Area
LTP	License Termination Plan
MARSAME	Multi-Agency Radiation Survey and Assessment of Materials and Equipment
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDA	Minimum detectable activity
MDC	Minimum detectable concentration
MWe	Megawatts electric
NIST	National Institute of Standards and Technology
NRC	United States Nuclear Regulatory Commission
NORM	Naturally Occurring Radioactive Material
pCi/g	PicoCuries per gram
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
ROC	Radionuclides of Concern
RPV	Reactor Pressure Vessel
RWP	Radiation Work Permit
TEDE	Total Effective Dose Equivalent
TRU	Transuranic
μCi/g	MicroCuries per gram
VSP	Visual Sample Plan

1.0 Introduction

This Characterization Survey Plan will support the License Termination Plan (LTP) [Reference 10-1] development and overall decommissioning operations for the Dairyland Power Cooperative (DPC) La Crosse Boiling Water Reactor (LACBWR), located near Genoa, Wisconsin, which was shut down in 1987. The 350-MWe fossil generating station, Genoa Station #3 (G-3), is located on the same site. The LACBWR site is about one (1) mile south of the Village of Genoa, WI, and approximately 19 miles south of the city of La Crosse, WI. Figure 1-1 shows the location of the plant.

The licensed site area totals 163.5 acres and includes land areas to the north of LACBWR, which includes the site switchyard and the site of the former G-1 facility (removed in 1989); areas south of LACBWR, which includes the area with the existing operational G-3 facility as well as the coal pile area and land surrounding the ISFSI; and a parcel of land to the east of Highway 35, across from LACBRW. Figure 1-1 "La Crosse Boiling Water Reactor Site" shows the general layout of the site and surrounding areas.

The following buildings and structures are within the LACBWR site enclosure (LSE) fenced area:

- Reactor Building
- Turbine Building
- 1B Diesel Generator Building
- Waste Treatment Building
- Gas Storage Vault
- Stack
- LSA Storage Building
- Maintenance Eat Shack
- Piping Tunnel

Other LACBWR Buildings nearby, but outside the LSE, include:

- Administrative Building
- Warehouses Nos. 1, 2, and 3
- LACBWR Crib House

Figure 3-2 "LACBWR Site Buildings Map" shows the respective location of the aforementioned facilities and structures.

As part of its License Termination Plan (LTP) scope for DPC, Energy*Solutions* reviewed current and historical facility operational and radiological information; and this information has been used in preparation of this Plan. At the completion of this characterization effort, data will be available to:

- Determine the nature and extent of contamination (e.g., radionuclides and ratios);
- Validate initial survey unit classifications;

- Support the development of Derived Concentration Guideline Levels (DCGLs) and completion of LTP Chapters 2 (Site Characterization), 5 (Final Status Surveys), and 6 (Compliance with the Radiological Criteria for License Termination); and
- Support planning for future MARSAME material release surveys, decontamination and demolition options, and waste classification/segregation.

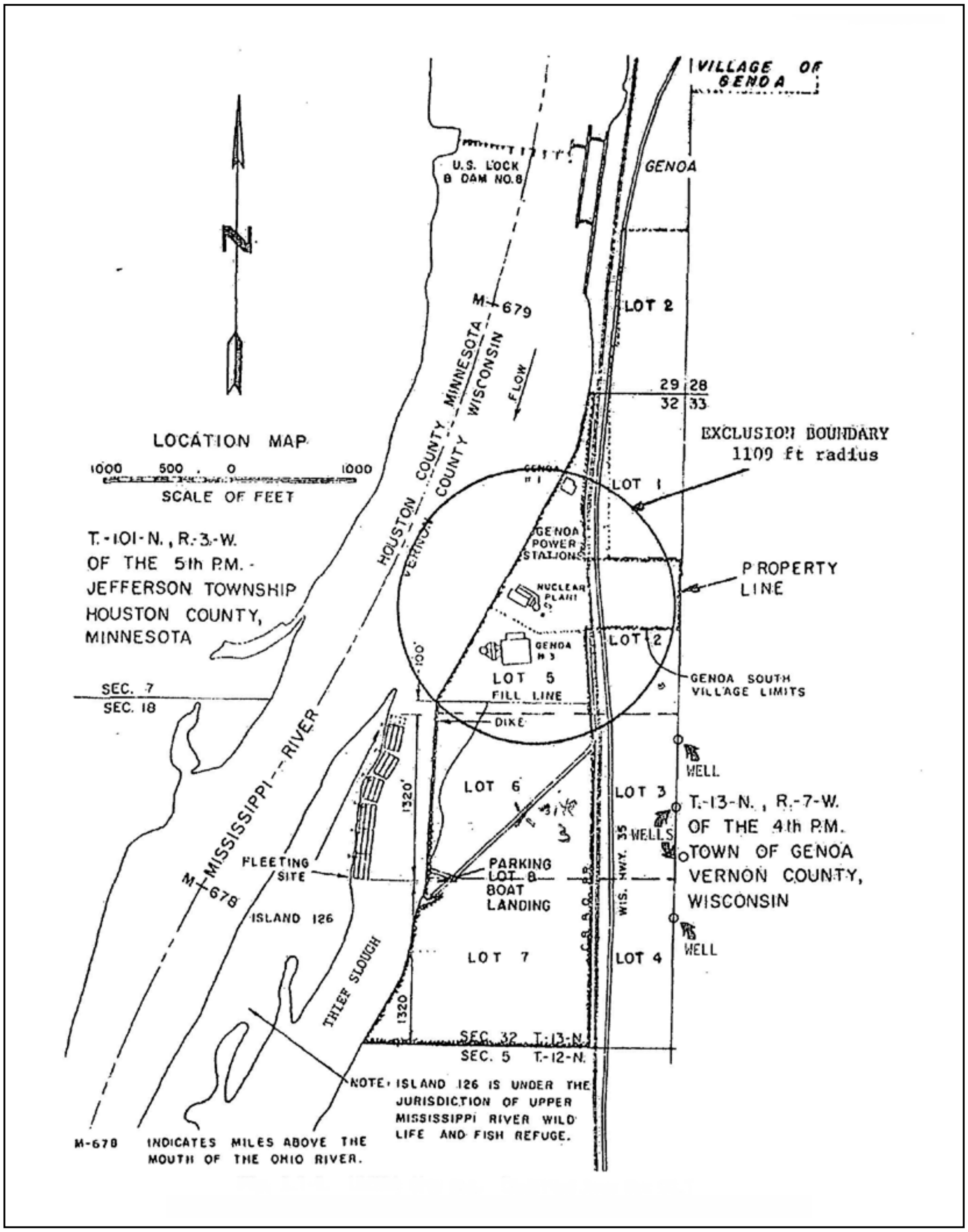

Figure 1-1 – La Crosse Boiling Water Reactor Site

1.1 Definitions

Activity - Rate of disintegration (transformation) or decay of radioactive material. The units of activity are the curie (Ci).

Action Level – A derived media-specific, radionuclide-specific concentration or gross activity level of radioactivity that triggers a response, such as further measurements, investigation, or remediation, if exceeded.

Biased Measurements – Measurements performed at locations selected using professional judgment based on unusual appearance, location relative to known contamination areas, high potential for residual radioactivity or other general supplemental information.

Data Quality Objectives (DQO) – Qualitative and quantitative statements derived from the DQO process that clarify technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Derived Concentration Guideline Levels (DCGL) – A derived, radionuclide-specific activity concentration within a survey unit corresponding to the release criterion. DCGLs are derived from activity/dose relationships through various exposure pathway scenarios.

Final Status Survey – Measurements and sampling to describe the radiological conditions of a site, following completion of decontamination and remediation activities, if any, in preparation for release of a survey area or unit(s) from a site license.

Impacted Area – An area with a possibility of containing residual radioactivity from licensed activities in excess of natural background or fallout levels.

Minimum Detectable Activity (MDA) – The smallest amount of radioactive material in a sample that will yield a net count, above system background, that will be detected with a 95% probability with only 5% probability of falsely concluding that a blank observation represents a real signal. MDA depends upon the type of instrument, the counting geometry, and the radionuclide to be detected.

Minimum Detectable Concentration (MDC) – The MDC is the a priori activity level that a specific instrument and technique can be expected to detect 95% of the time. When stating the detection capability of an instrument this value should be used.

1.2 Responsibilities

- The Project Manager is responsible for administering and implementing this plan.
- The Project Health Physicist is responsible for developing this plan and supporting survey packages as well as providing the technical oversight of this plan.
- The Radiation Protection Supervisor is responsible for overseeing and implementing work packages and survey packages developed to implement this plan as well as radiological protection of all workers.
- Health Physics Technicians are responsible for performing the surveys and sampling in accordance with the guidance provided in this plan and associated survey packages and instructions at the direction of the Radiological Protection Supervisor.

1.3 Prerequisites

- Ensure all survey instruments have been checked for proper operation and calibration prior to use in accordance with the applicable operating procedures.
- Trained and qualified health physics personnel will perform the radiological surveys and collection of environmental samples.
- All project personnel will understand the site and work area conditions prior to taking field radiological measurements and will comply with all required health and safety and radiation protection requirements.

2.0 Site Summary

2.1 Site Information and History

The La Crosse Boiling Water Reactor (LACBWR) is a 50 MWe BWR, which is owned and was operated by DPC. The plant is located on the east bank of the Mississippi River in Vernon County, Wisconsin, approximately one (1) mile south of the Village of Genoa, Wisconsin. The plant was one of a series of demonstration plants funded in part by the U.S. Atomic Energy Commission (AEC). The Allis-Chalmers Company was the original licensee; the AEC later sold the plant to DPC 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 DPC on April 30, 1987. Final reactor defueling was completed on June 11, 1987. The DPC authority to operate LACBWR under Provisional Operating License DPR-45, pursuant to 10 CFR Part 50, was terminated by License Amendment No. 56, dated August 4, 1987; and a possess but not-operate status was granted by the U.S. Nuclear Regulatory Commission (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 Independent Spent Fuel Storage Installation (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 heaters (except for the Condensate Storage Tank); and Component Cooling Water System pumps, heat exchangers, piping and components that were located in the Turbine Building.

The DPC "LACBWR Decommissioning Plan and Post-Shutdown Decommissioning Activities Report", March 12, 2014 [Reference 10-2] provides the latest information for the decommissioning activities conducted to date and the decommissioning planning for the plant.

2.2 Site Structures

The key LACBWR structures are summarized in Table 2-1 below and additional details are provided in the following subsections.

Table 2-1 – Summary of LACBWR Structures

Structure	Dimensions[1]
Reactor Building	Height (internal) = 144 feet Diameter (inside) = 60 feet Extends 26'-6' below grade (grade elevation is 639 feet)
Turbine Building (and Turbine Office Building)	Turbine Building – 104.5'x 79' x 60' Turbine Office Building -110'x50'x45'
1B Diesel Generator Building (note: attached to SE corner of the TB)	L-shaped, with largest dimensions of 30'-10" by 37'-11" Height = 13 feet
Waste Treatment Building	42'x34'x20' Basement floor @ 630' elevation; has a 3-foot deep sump with 8-inch thick walls and bottom which extends to a depth of 626'-4"
Underground Gas Storage Tank Vault	29'-6" by 31-6" (outside dimensions) Basement floor @ 639' elevation; has a 22-foot deep sump @ elevation 617'
Ventilation Stack	Height = 350 feet
Low Specific Activity (LSA) Storage Building	80'x27'x15'
Crib House (LACBWR)	45'x35'x15'
Maintenance Eat Shack	40'x20'x15'
Warehouses	Various dimensions; Warehouse #1 – 100'x30'x 12' Warehouse #2 - 50'x40'x12' Warehouse #3 – 45' x 40'x12'
Administration Building	Length = 120 feet Width = 62 feet at widest dimension Height = 25 feet

1 – Information from DPC LACBWR Decommissioning Plan and Post-Shutdown Decommissioning Activities Report (D-Plan/PSDAR) Revision, March 2014 as well as site drawings.

2.2.1 Reactor Building

The Reactor Building structure is enclosed inside a steel shell and extends 26'-6" below grade level (grade elevation is 639'). The interior of the shell is lined with a 9-inch thick layer of concrete to an elevation of 727'-10". The Reactor Building is supported on a foundation consisting of 232 concrete-steel piles and a pile capping of concrete approximately 3 feet thick.

There are two airlocks at elevation 642'-9". The personal airlock connects the Reactor Building to the Turbine Building. The emergency airlock has two circular doors, both with 30-inch openings.

The majority of pipe penetrations leave the Reactor Building approximately 1 to 10 feet below grade level either at the northeast quadrant or at the northwest quadrant and enter the pipe tunnel connecting the Turbine Building, Reactor Building, Ventilation Stack, Waste Treatment Building and the Underground Gas Storage Tank Vault. There is no external drain or processing piping in the subsurface soils associated with the Reactor Building.

A 45,000-gallon storage tank in the dome of the Reactor Building supplied water for the emergency core spray system and the building spray system. A 50-ton traveling bridge crane with a 5-ton auxiliary hoist is located in the upper part of the Reactor Building. The bridge completely spans the building and travels on circular tracks supported by columns around the inside of the building just below the hemispherical upper head.

The Reactor Building liquid waste system collects the liquid waste from the Reactor Building and stores this waste in two retention tanks (6,000 gallons each) located in the basement. Two separate sumps located in the Reactor Building basement pump to the two retention tanks in the Reactor Building. This system is still maintained operational.

The spent fuel has been removed but was previously stored underwater in racks in the bottom of the Fuel Element Storage Well (FESW) located adjacent to the reactor biological shielding in the Reactor Building.

2.2.2 Turbine Building (and Turbine Office Building)

The Turbine Building and Turbine Office Building is a combination metal and concrete structure with external roofs drains piping in the subsurface soils. The Turbine Building contained the steam turbine and generator, main condenser, electrical switchgear and other systems and equipment. A 30/5-ton capacity, remote-operated overhead electrical traveling crane spans the Turbine Building.

The Turbine Building liquid waste system collects the liquid waste from the Turbine Building, the Waste Treatment Building, the Underground Gas Storage Tank Vault, and the tunnel area and stores this waste in two storage tanks (3,000 gallons and 4,500 gallons) located in the tunnel between the Reactor Building and the Turbine Building. Three separate sumps located in the Turbine Building basement and in the tunnel between the Turbine and Reactor Building pump to the two storage tanks in the Turbine Building. This system is still maintained operational.

The Turbine Office Building contained offices, the Control Room, locker room facilities, laboratory, shops, counting room, personnel change room, decontamination facilities, heating, ventilation and air conditioning equipment, rest rooms, storeroom, and space for other plant services. In general, these areas were separated from power plant equipment spaces.

2.2.3 1B Diesel Generator Building

The 1B Diesel Generator Building is attached to the southeast corner of the Turbine Building and contains the Electrical Equipment Room, Diesel Generator Room, and an empty Battery Room. The building is constructed of concrete blocks and steam beams and braces and has external drain piping in the subsurface soils.

2.2.4 Waste Treatment Building

The Waste Treatment Building (WTB) is a concrete structure with no external drain or processing piping in the subsurface soils. This building is located to the northeast of the Reactor Building. The building contains facilities and equipment for decontamination and the collection, processing, storage and disposal of low level solid radioactive waste. The grade floor of the WTB contains a shielded compartment which encloses a 320 ft3 stainless steel spent resin receiving tank with associated resin receiving and transfer equipment. There is an adjacent shielded cubicle and two open cubicles. In the basement there is one sump which normally pumps to the Turbine Building waste water storage tanks.
The grade level contains two radioctive liquid waste filters, the spent resin liner level indication panel, and the spent resin liner final dewatering piping, container, and pumps. In an an above-grade area, there is a decontamination facility. Other areas contain a shower/wash/frisking area and temporary storage space for processed Dry Active Waste (DAW) containers.

2.2.5 Underground Gas Storage Tank Vault

The gas storage tank vault is an underground concrete structure with 14-feet high walls and 2-feet thick floors, walls, and ceiling. The vault is 3-feet below grade elevation of 639’ and the sump area extends to a depth of 22 feet. All support systems have been removed except for two 1,600 ft3 tanks. The tanks remain in place below grade along with the associated piping. The vault has one sump which normally pumps to the Turbine Building waste water storage tanks. There is no external drain or process piping in the subsurface soils.

2.2.6 Low Specific Activity (LSA) Storage Building

The LSA Storage Building is a sheet metal structure with a concrete floor which is located southwest of the Turbine Building. The facility does not contain drain or process piping. It is used to stored processed, packaged and sealed low level DAW and sealed low level activity components. No liquids are stored in this building and there are no effluent releases from this building during normal use.

2.2.7 Crib House (LACBWR)

The Crib House is a concrete and metal framed structure located on the bank of the Mississippi River to the west of the plant and through its intake structure, pulled waster from the river, and provided circulating water for the condenser as well as low- and high-

pressure service water. The Crib House contains the diesel-driven High Pressure Service Water pumps, Low Pressure Service Water pump, and the Circulating Water pumps. All water received from the Crib House was radiologically clean water and radioactive material was not stored in this structure.

2.2.8 Piping Tunnel

The Piping Tunnel is a subgrade concrete structure that contains two liquid drain collection tanks, sumps, and piping routing from the Turbine Building,Waste Treatment Building and Underground Gas Storage Tank Tank Vault areas.

2.2.9 Warehouses

The three LACBWR Warehouses are located outside of the LSE to the north. The warehouses are adjacent to one another and are made of a sheet metal structure with a concrete floor. The warehouses were used for storage of LACBWR equipment an dsupplies as well as served as a fab shop for the maintenance support group with carpentry,machine, and weld shop capability.

2.2.10 The LACBWR Administration Building

The LACBWR Administration Building is located outside of the LSE to the north. The facility hisotrically has been used to house LACBWR administrative and hourly staff as well as for records storage. In addition the facility has served functionally as an environmental lab and coal plant materials testing lab.

2.3 Noted Radionuclides and Site Conditions

Historical site information has been reviewed at the site, including early initial site characterization data compiled in the DPC document LAC-TR-138, Initial Site Characterization Survey for SAFSTOR (issued October 1995; updated December 2009) [Reference 10-3]. In addition, Energy*Solutions* has drafted a document, “Technical Basis Document for Radionuclides of Concern During the Decommissioning of the La Crosse Boiling Water Reactor” (July 2014) [Reference 10-4] which presents the expected radionuclides to be considered during characterization operations. The latest revision (March 2014) of the LACBWR Decommissioning Plan and Post-Shutdown Decommissioning [Reference 10-2] also provided a summary of ongoing material and metal removal operations.

2.3.1 Sources of Radioactivity

Boiling water reactor operations for close to 19 years resulted in material activation and radionuclide distribution throughout plant systems and structures. In addition, failed fuel was noted early in the plant life and these fuel failures were significant enough to allow fission products to escape into the Fuel Element Storage Well and reactor coolant. Assessments of radionuclide inventory in the reactor core, on plant system surfaces and internal locations conducted in January 1988 indicated that the primary radionuclides were fission and activation products such as Co-60, Fe-55, Cs-137 and Mn-54. The review of 10 CFR 61 analysis results for various metal and structural material waste streams from 1998 to 2010 showed that the predominant radionuclides to be expected, after decay correction to January, 2015, would be Co-60 and to a lesser extent, Ni-63. Depending upon the type of sample, Co-60 concentrations, after decay correction, ranged from 6 to 45% of the total activity. Other radionuclides noted above 0.1% of the total activity in some of the samples were H-3, C-14, Fe-55, Ni-59, Cs-137, Eu-152, Pu-238, Pu-239/240, Am-241 and Pu-241. Additional 10 CFR 61 samples were recently obtained in July 2014 and focused on liquid waste from various tanks and sumps. The majority of

samples were dominated by the presence of Cs-137, ranging from 71% to 92% of the total activity in a sample.

DPC has performed a number of soil surveys since the plant shutdown in 1987. These have involved soil sampling operations performed within the LACBWR RCA (e.g. LACBWR Site Enclosure Area, LSE, the fenced in area), the licensed site boundary and outside the site boundary. While most of the soil survey campaigns have been limited in scope, a review of the six soil sampling operations conducted between 1987 and 2008 indicated that the primary contaminant in the surface soils was Cs-137 at low levels. The last extensive soil sampling campaign conducted within the RCA was performed as part of an initial site characterization survey in 1995 and indicated that Cs-137 was present at levels up to 1.30 pCi/g. This was within the range of 1 to 3 pCi/g typically seen in Cs-137 fallout background levels noted in various industry studies.

The final suite of Radionuclides of Concern consists of 18 radionuclides with half-lives greater than 5 years, including gamma emitters, Hard-to-Detect (HTD) and Transuranic (TRU) alpha emitters. It was developed based upon the review of theoretical radionuclides noted in NUREG BWR studies, the specific engineering review of fuel inventory at LACBWR and other site-specific LACBWR sample results (e.g. the 10 CFR 61 reports, piping internal results, etc.). The list is shown in Table 2-1. As site characterization progresses and additional survey and sample data is collected, this list will be reviewed and updated, if necessary.

Table 2-1 – LACBWR Site-Specific Radionuclides of Concern

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
Cs-137	3.00E+01
Eu-152	1.33E+01
Eu-154	8.80E+00
Np-237	2.14E+06
Pu-238	8.78E+01
Pu-239	2.41E+04
Pu-240	6.60E+03
Am-241	4.32E+02
Am-243	7.37E+03
Cm-243/244*	1.81E+01

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

2.3.2 Preliminary Radionuclide Screening Criteria

As site specific DCGLs have not yet been established for the LACBWR decommissioning, alternative action levels must be selected for characterization. The concentration values associated with the interim screening DCGLs presented

in NUREG-1757 [Reference 10-5] and the NUREG/CR-5512, Volume 3 [Reference 10-6], using Table 6.91 (P_{crit}) for soils will be used as the alternate action level when assessing the characterization of impacted open land or soil survey units. The preliminary criteria are presented in Table 2-2.

Table 2-2, *Preliminary* Criteria for Surfaces and Soils

Preliminary Criteria (Limits) for Surfaces, Structures, and Paved Areas			
Radionuclide	**Total Activity ($dpm/100cm^2$)**	**Removable Activity ($dpm/100cm^2$)**	**Basis**
Alpha emitters (Pu, U, and Am)	100	20	USNRC Regulatory Guide 1.86, Termination of Operating Licenses for Nuclear Reactors
Beta-gamma emitters (with the exception of H-3)	7,100	710	7,100 $dpm/100cm^2$ for Co-60 in NUREG-1757 Volume 2 Table H.1 Screening Criteria. The removable value is based on the NRC default screening criterion that specifies 10% of the limit.
Preliminary Criteria (Limits) for Soils			
Radionuclide	**(pCi/g)**		**Basis**
H-3	110		NUREG-1757 Volume 2 Table H.2 Screening Criteria provided the basis for the radionuclides H-3 through Eu-154. For radionuclides Np-237 through Cm-244, the concentration values were obtained from NUREG/CR-5512 Volume 3, Residual Radioactive Contamination from Decommissioning Parameter Analysis, Table 6.91 (P_{crit} = 0.10) for soils.
C-14	12		
Fe-55	10,000		
Ni-59	5,500		
Co-60	3.8		
Ni-63	2,100		
Sr-90	1.7		
Nb-94	5.8		
Cs-137	11		
Eu-152	8.7		
Eu-154	8.0		
Np-237	0.09		
Pu-238	2.5		
Pu-239/240	2.3		
Am-241	2.1		
Am-243	2.0		
Cm-243	3.2		
Cm-244	4.2		

The preliminary criteria for the LACBWR Radionuclides of Concern (ROC) for concentration (pCi/g) in soil represents the surface soil concentrations of individual radionuclides that would be deemed to be in compliance with the 25 mrem/year unrestricted release dose limit in 10 CFR 20.1402 [Reference 10-7]. If multiple ROC are persent, then the dose contribution from each ROC is accounted for using a sum-of-fractions (SOF) calculation to ensure that the total dose from all ROC does not exceed the action level.

Radiological characterization of structures will provide the necesssary data to derive defensible radionulcide distributions which would then allow for the derivation of an adjusted gross DCGL for static measurements for the Final Status Survey. However, as a gross screening level that will be used during the characterization, the nuclide-specific screening value of 7,100 $dpm/100\ cm^2$ total

gross beta-gamma surface activity for Co-60 from NUREG-1757, Appendix H will be used. Use of the Co-60 screening value is appropriate and conservative as it is anticipated that the radionuclides distribution for surface contamination will be principally Co-60 and Cs-137 and the more conservative approach is to assume a distribution of 100% Co-60 as the screening value for Cs-137 is significantly greater. The removable activity (e.g. loose contamination) value is based upon a 10% removable fraction discussed in NUREG-1757.

For surface contamination by alpha emitters, the values from Regulatory Guide 1.86 [Reference 10-8] are the basis for characterization and assessment.

3.0 Characterization Plan Scope and Survey Units

3.1 Scope of Characterization Plan

Characterization is an initial step in the decommissioning process and requires a logical approach in obtaining the necessary data required for planning decommissioning activities. Radiological characterization provides a reliable database of information showing the quantity and type of radionuclides, their distribution, and their physical state as it applies to facilities and/or areas of the LACBWR Site. The characterization process also incorporates previously recorded survey data as described in Chapter 2 (Site Characterization) of the "LACBWR License Termination Plan (LTP)" [Reference 10-1] which includes scan and wipe measurements as well as soil sampling analyses to present a summary of radiological conditions of survey unit as known. The information collected during characterization will be used to:

- Determine the nature and extent of contamination (e.g., radionuclides and ratios) on the LACBWR Site;
- Validate initial survey unit classifications;
- Support the development of Derived Concentration Guideline Levels (DCGLs) and completion of LTP Chapters 2 (Site Characterization), 5 (Final Status Surveys), and 6 (Compliance with the Radiological Criteria for License Termination);
- Support planning for future MARSAME [Reference 10-9] material release surveys, decontamination and demolition options, and waste classification/segregation; and
- Support the protection of workers, the general public, and the environment.

The characterization survey will be designed and executed using the guidance provided in NUREG-1575, "Multi-Agency Radiation Survey and Site Investigation Manual" (MARSSIM) [Reference 10-10] and NUREG-1757, Volume 2, Revision 1, "Consolidated Decommissioning Guidance, Characterization, Survey and Determination of Radiological Criteria," [Reference 10-5]. In addition, the guidance recommends development and use of a Quality Assurance Project Plan (QAPP) [Reference 10-11] which describes policy, organization, functional activities, the Data Quality Objective (DQO) process, and measures necessary to achieve quality data [Reference 10-4]. Energy*Solutions* plans to use subcontractor(s) to perform soil sampling and asphalt/concrete boring as described in this plan, as well as obtain necessary radiological surveys with hand-held instrumentation. The Energy*Solutions* related procedures will be used for characterization work, as long as they do not conflict with any requirements in the LACBWR NRC Radioactive Material license and associated technical specifications. Energy*Solutions* and subcontractor personnel will perform work under the requirements of the LACBWR Radiation Protection, Health and Safety, and Work Control Program. Energy*Solutions* will conduct an equivalency review of the LACBWR Radiological Protection Program and, if areas are found that are not as conservative as Energy*Solutions* requirements, will invoke the more conservative requirements working in concert with the LACBWR Radiation Protection Manager.

Using a combination of radiological scanning surveys, fixed-point surveys, removable contamination measurements, beta-gamma exposure rate surveys and sampling of various media, the conditions of the LACBWR Site will be determined and documented. The design of surveys and sampling will have a statistical basis; and the data quality objectives of the survey

will be pre-defined to ensure sufficient data to finish development of the LACBWR License Termination Plan, design facility decommissioning activities, and data reliability.

3.2 Initial Site Classification

Classification of site areas is based initially 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 is performed at the time of identification of the survey area using the information available. This has been completed and is summarized in Chapter 2, Site Characterization, of [Reference 10-1]. The current classification of the LACBWR Site is presented in Figure 3-1, "LACBWR Site Survey Unit Map," and Figure 3-2, "LACBWR Site Buildings Map." Note that there are areas inside the LACBWR Site area that are considered likely non-impacted areas. A brief summary of the major findings and historical facts from Chapter 2 of the LACBWR LTP that are relevant to site characterization, as well as the initial classification of the areas, are presented as follows.

It should be noted that the Independent Spent Fuel Storage Installation (ISFSI) area is not included in the MARSSIM classified areas that will be undergoing characterization. This facility and surrounding fenced security area will remain after decommissioning and not be released from the Part 50 license. The spent nuclear fuel may be transferred at a later date to the U.S. government and then the ISFSI area will undergo a similar characterization and Final Status Survey effort to terminate the license of the associated property. Additional discussion on the ISFSI is provided in section 3.2.7.

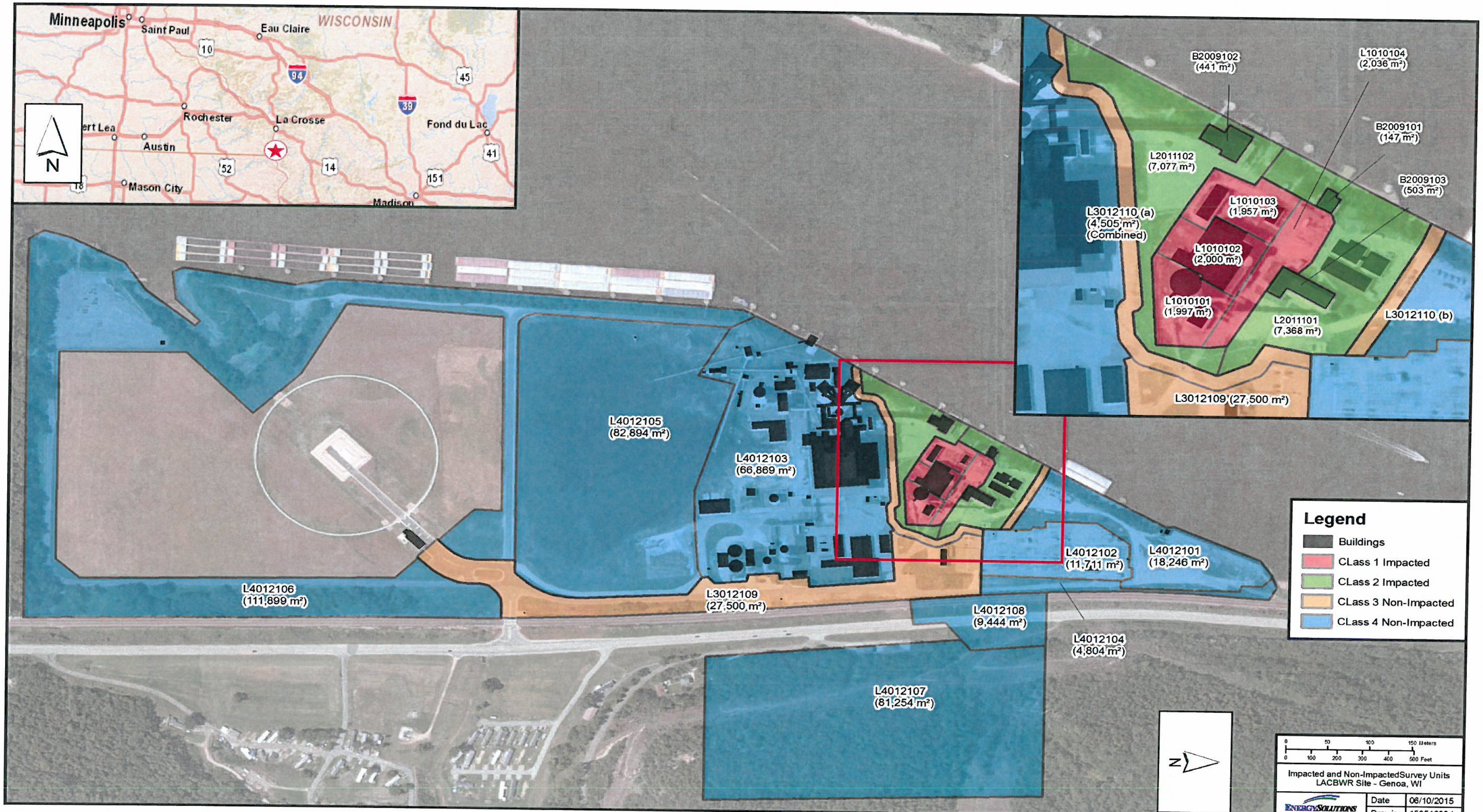

Figure 3.1 LACBWR Site Survey Unit Map

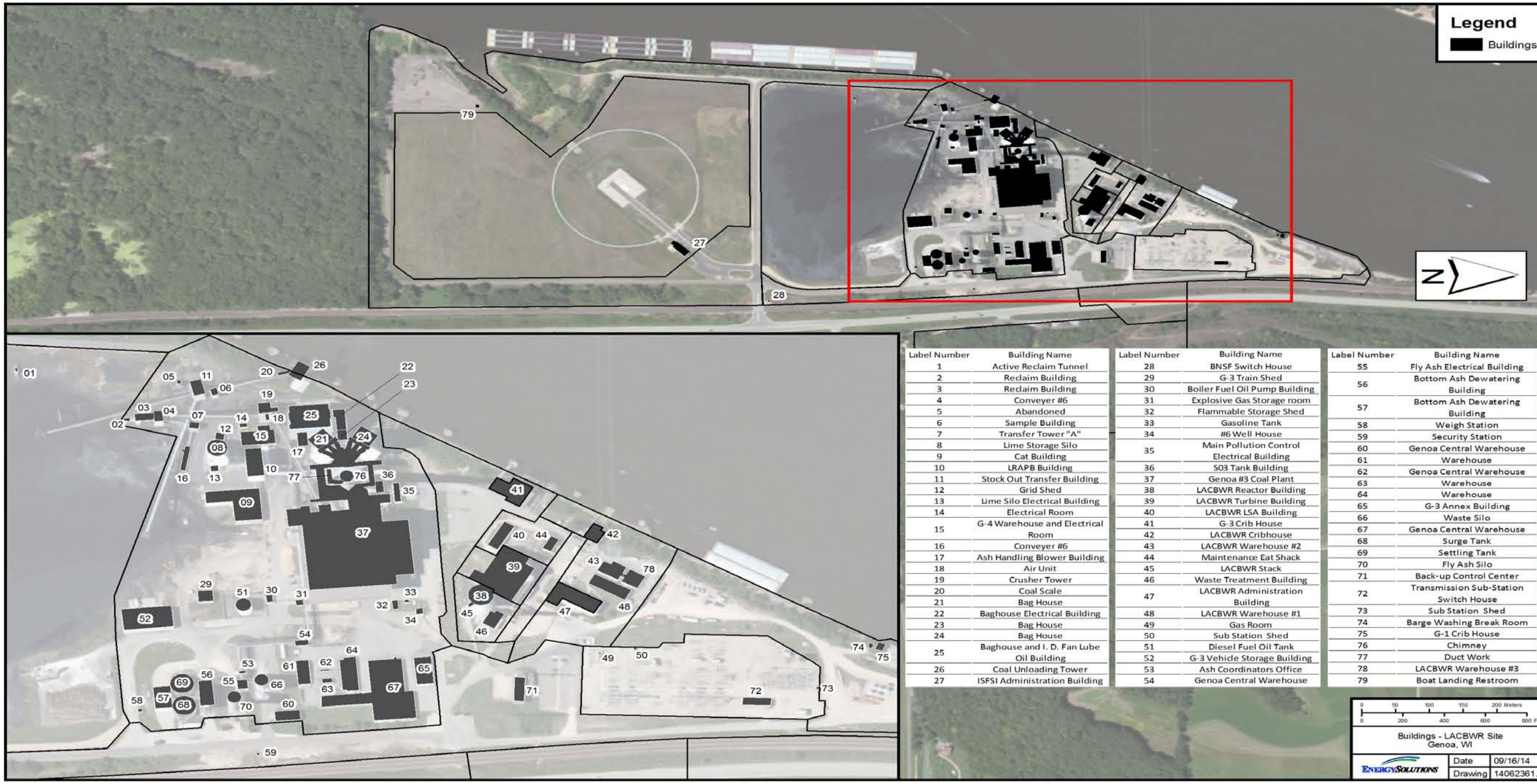

Figure 3.2 LACBWR Site Buildings Map

3.2.1 Class 1 Structures

The following is a list of the buildings that have been initially classified as impacted Class 1 structures in which, during operations; radioactive materials and wastes were routinely handled, transferred, and stored within these buildings. These structures contained the: nuclear reactor, primary reactor systems, reactor support systems, nuclear fuel handling and storage systems, turbine and turbine operating related systems, and radioactive waste systems. A vast majority of the current radioactive material inventory at the LACBWR Site continues to be found in these structures:

- LACBWR Reactor Building
- Waste Treatment Building
- LACBWR Stack
- Off Gas Retention Vault
- LACBWR Turbine Building
- LSA Building
- Piping Tunnel

Throughout facility operations, these structures were either subjected to or at risk of spills of radioactive liquids, the spread of loose surface contamination, and airborne radioactive material. The current decommissioning approach for these structures involves the complete segmentation, removal, and disposal of all systems and structural surfaces as waste. With the exception of structural below-grade foundations and concrete structure in the Turbine Building that are candidates for the potential reuse of concrete as hard fill, no portion of these structures will remain at site closure to be subjected to FSS.

3.2.2 Class 2 Structures

The following is a list of some of the major buildings that have been initially classified as impacted Class 2 structures and are found on the LACBWR Site. Their primary function is to house the raw water feed systems, or to act as office and/or warehouse space.

- LACBWR Crib House
- G-3 Crib House
- LACBWR Administration Building
- Warehouses 1, 2, and 3

The primary reason these facilities are classified as potentially impacted facilities is that these facilities are in open land buffer areas around the RCA with the potential for contamination translocation due to personnel and equipment movements as well as surface water runoff from the RCA. Additionally, the LACBWR Administration Building used radioactive check sources with radiological instrumentation and, according to former employee recollections; the warehouses stored other nuclear power plant-used equipment in the 1970s before the equipment was shipped off site. The current decommissioning approach calls for the G-3 Crib House, LACBWR Crib House, and LACBWR Administration Building to remain on site following FSS surveys and the Warehouses 1, 2,and 3 to be surveyed in place for free release and then demolished and the rubble removed from site for disposal as radiologically clean debris.

3.2.3 Non Impacted (Class 4) Structures

The following is a list of some of the major buildings that have been re- classified as non-impacted structures and are found on the LACBWR Site. Their primary function is to serve as primary electrical distribution from the LACBWR Site and as facilities associated with the operation of the G-3 Coal Plant. The balance of the facilities is presented on Table 3-1 "Initial Survey Areas for LACBWR Site Structures."

- G-3 Coal Plant
- G-3 Central Warehouse
- Back-Up Control Center
- G-3 Bag Houses

The decommissioning approach calls for all non impacted structures on LACBWR Site to remain following decommissioning activities.

Table 3-1 Survey Areas for LACBWR Site Structures

Survey Area	Survey Area Description	Initial Classification
001	Reactor Building	Class 1
002	Waste Treatment Building	Class 1
003	LACBWR Ventilation Stack	Class 1
004	Off Gas Retention Tanks/Vault	Class 1
005	LACBWR Turbine Bldg./Turbine Office Bldg.	Class 1
006	LACBWR 1B Diesel Generator Structure	Class 1
007	Low Specific Activity Storage Building	Class 1
008	Piping Tunnel	Class 1
009	Outbuildings	Class 2/Class 4
Survey Unit: 101	LACBWR Crib House	Class 2
102	G-3 Crib House	Class 2
103	LACBWR Administration Building	Class 2
104	LACBWR Warehouse #1	Class 2
105	LACBWR Warehouse #2	Class 2
106	LACBWR Warehouse #3	Class 2
107	G-3 Reclaim Building	Class 4
108	G-3 Stock Out Transfer Building	Class 4
109	G-3 Coal Unloading Tower	Class 4
110	G-3 Transfer Tower A	Class 4
111	G-3 Electrical Room	Class 4
112	G-3 Crusher Tower	Class 4
113	G-3 Conveyor #6 (2)	Class 4
114	G-4 Warehouse and Electrical Room	Class 4
115	G-3 LRAPB Building	Class 4
116	G-3 Lime Silo Electrical Building	Class 4
117	G-3 CAT Building	Class 4
118	G-3 Coal Plant	Class 4

Survey Area	Survey Area Description	Initial Classification
119	G-3 Vehicle Storage Building	Class 4
120	G-3 Train Shed	Class 4
121	G-3 Bottom Ash Dewatering Buildings	Class 4
122	G-3 Fly Ash Silo	Class 4
123	Genoa Central Warehouses (7)	Class 4
124	G-3 Annex Building	Class 4
125	G-3 Boiler Fuel Oil Pump Building	Class 4
126	G-3 Explosive Gas Storage Room	Class 4
127	G-3 Gas Room	Class 4
128	G-3 Sub Station Shed	Class 4
129	Genoa Back Up Control Center	Class 4
130	G-3 Transmission Sub Station Switch House	Class 4
131	G-1 Crib House	Class 4
132	G-3 Sub Station Shed	Class 4
133	G-3 Lime Storage Silo	Class 4
134	G-3 Weigh Station	Class 4
135	Genoa Security Station	Class 4
136	Boat Landing Restroom	Class 4
137	BNSF Switch House	Class 4
138	G-3 Active Reclaim Buildings/ Tunnel	Class 4
139	G-3 Ash Coordinator’s Office	Class 4
140	G-3 Bag Houses (5)	Class 4
141	G-3 Flammable Storage Shed	Class 4
142	#7 Well House	Class 4
143	Genoa Barge Washing Break Shack	Class 4
144	G-3 Coal Scale	Class 4
145	G-3 Sample Building	Class 4
146	G-3 Stock Out Transfer Building	Class 4
147	G-3 Grid Shed	Class 4
148	G-3 Ash handling Blower Building	Class 4
149	#6 Well House	Class 4
150	Main Pollution Control Electrical Building	Class 4
151	S03 Tank Building	Class 4
152	G-3 Fly Ash Electrical Building	Class 4
153	G-3 Waste Silo	Class 4
154	G-3 Surge Tank	Class 4
155	G-3 Settling Tank	Class 4

3.2.4 Class 1 Open Land Areas

Open land areas located inside the LACBWR Site Enclosure Area (LSE) have been initially classified as impacted Class 1. The basis for this initial classification is due to either documented incidents of the contamination of surface or subsurface soil by

radioactive material in these areas during facility operations or evidence demonstrating existing or likely soil contamination from past LSE area soil sampling studies as documented in Chapter 2 of the LACBWR License Termination Plan. These incidents include the spills of radioactive liquids/resins and radioactive system leakage. The storage of radioactive packages and containers was also part of the operational history of the LSE area.

Based on an assessment of historical incidents and events, it is anticipated that the surface and subsurface soils in these areas may hold residual radioactive material in excess of the unrestricted release criteria and will require excavation and appropriate disposal.
Table 3-2, "Initial Survey Units for LACBWR Site Open Land Areas," lays out the open land survey unit areas in their entirety on the LACBWR Site.

3.2.5 Class 2 Open Land Areas

The open land areas as shown on Figure 3-1 and identified as L211102 and L211101 have been initially classified as impacted Class 2. This classification is selected based on the fact that this survey unit is a buffer area around the RCA with the potential for contamination translocation due to personnel and equipment movements as well as surface water runoff from the RCA.

3.2.6 Class 3 Open Land Areas

The open land areas as shown on Figure 3-1 and identified as L3012109 thru L3012110 have been initially classified as Class 3. Historical information contained in Chapter 2 of the LACBWR License Termination Plan indicates that the presence of residual radioactivity in concentrations in excess of the unrestricted release criteria is not expected.

3.2.7 Class 4(Non Impacted) Open Land Areas

The open land areas as shown on Figure 3-1 and identified as L4012101 thru L4012108 have been re-classified as non-impacted areas based on characterization surveys performed on site to date and the historical review of the LACBWR Site. The open land area in the class does not contain any residual radioactivity of concern tied to past LACBWR operations.

3.2.8 ISFSI

As previously noted, the ISFSI facility and surrounding secured area are not classified or planned for this characterization effort due to the expected long-term on-site storage of the spent fuel assemblies. Information regarding the eventual decommissioning of the ISFSI has been provided in the LACBWR D-Plan/PSDAR [Reference 10-2]. The ISFSI facility is located 2,232 feet S-SW of the Reactor Building center and currently holds five (5) loaded Vertical Cask Containers on a 32'x48'x3' concrete storage pad. The ISFSI area is an area inside of the boundary strip that comprises Survey Unit L312106. This ISFSI area will remain a 10 CFR 50 licensed area after the remainder of the LACBWR site is released; upon removal of the spent nuclear fuel at a later date, the ISFSI area facility, foundations, below-grade soil and surrounding fenced area will be characterized and decommissioned.

Table 3-2 Initial Survey Units for LACBWR Site Open Land Areas

Survey Unit ID #	Survey Unit Description	Initial Classification	Approximate Survey Unit Area (m^2)
Survey Area 010	I/S LSE Open Land Areas		
101	Area under and around The Reactor Building/Waste Treatment Building/Ventilation Stack/Off Gas Retention Tank Vaults	Class 1	1,997
102	Area under and around the Turbine Building-Turbine Office Building/1B Diesel Generator Building	Class 1	2,000
103	Area under and around The LSA Building/Maintenance Eat Shack/surrounding grounds	Class 1	1,957
104	Grounds on the north end of LSE	Class 1	1,473
Survey Area 011	O/S LSE -Buffer Areas	Class 2	
101	Areas under and around the LACBWR Three Warehouses/Administration Building/LACBWR Crib House	Class 2	7,930
102	Areas under and around the G-3 Crib House/LACBWR Circ. Water Discharge Line/south of LSE fence	Class 2	7,084
Survey Area 012	Areas O/S of Buffer Areas		
101	North end of site and outside of switchyard	Class 4	18,246
102	Switchyard	Class 4	11,711
103	G-3 Coal Plant and related facilities area grounds	Class 4	66,839
104	Grounds west of railroad right of way and east of survey units L312102,L312103,L312105	Class 4	4,804
105	Coal Pile area grounds	Class 4	82,894
106	Capped ash impoundment ground area w/o ISFSI controlled area	Class 4	111,899
107	Grounds across Highway 35 to east	Class 4	81,254
108	Right of Ways -Hwy 35/Railroad	Class 4	9,444
109	Strip of Land and Asphalt just west of the highway 35	Class 3	27,500
110	Strip of land surrounding the Class 2 Open Land Areas	Class 3	4,505

3.3 Basis for Selection and Size of Initial Survey Units

Survey units have been delineated as physical areas with similar operational history or similar potential for residual radioactivity to the extent practical. If areas with more than one classification are combined into one survey unit, then the entire survey unit will be given the more restrictive classification. Survey units may have relatively compact shapes and not have highly irregular shapes unless the unusual shape is appropriate for the site operational history or the site topography. Survey units of the same classification may be combined and reconfigured as necessary provided that eventual area remains appropriate for the classification.

For the characterization surveys, survey area size will be 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. In accordance with the guidance provided in NUREG-1575 (MARSSIM) Section 4.6 [Reference 10-10], the suggested physical area sizes for survey units for FSS are as noted in Table 3-3:

Table 3-3 – Recommended Survey Unit Sizes

Classification	Suggested Area
Class 1	
Structures	up to 100 m^2 floor area
Land Areas	up to 2,000 m^2
Class 2	
Structures	100 m^2 to 1,000 m^2
Land Areas	2,000 m^2 to 10,000 m^2
Class 3/Class 4	
Structures	No Limit
Land Areas	No Limit

These areas are suggested because they give a reasonable sampling density and are consistent with most commonly used dose modeling codes. Since site characterization data does not require the detail or statistical significance of the Final Status Survey, adjustments to these survey unit sizes can be made, especially for the building areas, depending upon the classification, high radiation levels/ALARA concerns, and the specific characterization objective. Building survey units defined for characterization are typically based upon similar operations and known radiological conditions and will be broken down into rooms or elevations for data gathering.

As previously noted, the current decommissioning approach for Class 1 Structures calls for the complete segmentation, removal, and disposal of all impacted systems and structural surfaces. With the exception of structural below-grade foundations, and concrete structures that are candidates for the potential reuse of concrete as hard fill, no portion of these structures will remain at site closure to be subjected to FSS.

Survey units have not been established for systems (e.g., embedded or buried piping). If the DQOs developed for the characterization of a structural or open land survey unit require the acquisition of radiological survey data on systems, the survey will be designed and documented in the structural or open land survey unit in which it resides.

An initial descriptive list of the survey areas and survey units is provided in Tables 3-1 and 3-2. It is expected that the conceptual boundaries of these survey units may be altered based on the actual conditions at the time of FSS survey design. This may be especially characteristic of the site structure survey areas within open land areas.

Although it is expected that the existing areas and conceptual survey units will require little modification with regard to classification, the characterization process is iterative. When information is obtained during the decommissioning process through characterization, the data will be assessed using the DQO process to verify that the initial classification is appropriate, to guide reclassification of the survey unit and/or to guide the design of subsequent surveys. Changes from the initial survey units and site structure survey areas will be documented in the characterization sample plans and field logs.

4.0 Data Quality Objectives

4.1 Radiological Data Quality Objectives

The characterization surveys at LACBWR will be designed to gather the appropriate data using the Data Quality Objectives (DQO) process as outlined in NUREG-1575 (MARSSIM) [Reference 10-10] Appendix D – The Planning Phase of the Data Life Cycle. This process is an integral part of the planning and design steps for the characterization survey. The DQO process involves a series of planning steps found to be effective in establishing criteria for data quality and developing survey plans. It is flexible such that the level of effort associated with planning a survey is based on the complexity of the survey and nature of the hazards. It is also iterative, allowing for the incorporation of new data and modification of the output of previous steps to act as input in subsequent steps.

The specific objectives for the characterization surveys will be defined for each Survey Unit and addressed in the survey packages and survey and sampling instructions. To support further development of DCGLs and Final Status Survey planning, additional information is needed and the DQO process will ensure that appropriate, valid radiological data is obtained.

Characterization data collection and evaluation will include measurements of radiation exposure rates, direct surface contamination, removable surface contamination, volumetric contamination levels (for certain structural components and soil) and radionuclide analysis at on-site and off-site laboratories.

An overview for the DQO objectives for the Class 1, 2, 3, and 4 areas is provided in Table 4-1 on the following page. The seven steps of the DQO process are outlined in the following sections and additional survey and sampling measurement details are provided in Section 7 – Survey Design and Implementation, including Attachment 7.1 – Survey Unit Classification Table and Preliminary Measurements and Samples for Characterization Survey.

4.1.1 Problem Identification

Based on previous operations at LACBWR and storage of radioactive materials it has been determined that radiological contamination exists and that the facility may require remediation in order to meet the criteria for unrestricted release, meeting the requirements of 10 CFR 20.1402, "Radiological Criteria for Unrestricted Use" [Reference 10-7]. Based upon this criteria, the site will be considered acceptable for unrestricted use if the residual radioactivity that is distinguishable from background radiation results in a Total Effective Dose Equivalent (TEDE) to an average member of the critical group that does not exceed 25 mrem per year, including from groundwater sources of drinking water.

The problem associated with radiological characterization is to perform characterization inspections and surveys of sufficient quality and quantity to determine the nature, extent and range of radioactive contamination in each survey unit. According to U.S. NRC Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors" [Reference 10-12]: "the LTP site characterization should be sufficiently detailed to allow the NRC to determine the extent and range of radiological contamination of structures, systems (including sewer systems, waste plumbing systems, floor drains, ventilation ducts, and piping and embedded piping), rubble, and paved parking lots (both on and beneath the site)." For land areas, radiological data is also obtained for soil.

Table 4-1 – Summary of DQOs for Class 1, 2, and 3 Survey Units

Classification	Overall DQO Objectives and Actions
Class 1	<u>Objective:</u> As allowable per accessibility, current facility/ background radiation levels and RP/ALARA considerations, obtain radiological data for below-grade structures and soils expected to remain and be subject to FSS. This will be accomplished through specific actions, including but not limited to, the following: Actions: -Obtain 10 gamma exposure measurements (open and closed window readings) in each of the Reactor Building, Waste Treatment Building (WTP) and Turbine Building (TB) basements using a meter such as the Ludlum RO-20. -Take up to 10 direct (static) alpha/beta smears in each building basement and count them on a Ludlum 2929, meeting MDCs of approximately 15 dpm/100 cm^2 for removable alpha contamination (below the 20 dpm/100 cm^2 criteria being used to assess alpha contamination) and preferably less than 350 dpm/100 cm^2 for removable beta contamination (approximately 50% of the gross beta/gamma DCGL of 7,100 dpm/100 cm^2). -Obtain concrete cores from selected locations in the Reactor Building Basement, Waste Treatment Building and Piping Tunnel and conduct nuclide specific off-site analysis for gamma spectroscopy, Hard-to-Detect (HTD), and Transuranic (TRU) analysis at least 50%, but preferably 10% of the preliminary DCGL levels, where possible; for the Radionuclides of Concern, gamma spectroscopy MDCs are expected to be approximately 0.10 pCi/g-1.0 pCi/g.. -Obtain soil samples under the TB piping tunnel concrete flooring to obtain representative radiological data beneath the TB and send the samples off-site for gamma spectroscopy, HTD and TRU analysis, again ideally meeting 10% of the preliminary nuclide-specific DCGL levels. -Where accessible and background allows for surrounding paved areas, perform a 25% beta scan of the surface area, using a Ludlum 43-37 detector, meeting a MDC_{scan} of approximately 3,500 dpm/100 cm^2, which is approximately 50% of the gross beta/gamma DCGL of 7,100 dpm/100 cm^2. - Note 10 biased sample locations in paved asphalt areas and obtain 10 direct alpha/beta measurements with a Ludlum 2360 with a 43-93 detector for alpha mode, meeting a MDC of 90 dpm/100 cm^2 for alpha, and a 43-93 detector for beta detection, meeting a MDC of 800 dpm/100 cm^2 for beta (Cs-137). For each location, also obtain an asphalt sample and an underlying soil sample and perform onsite gamma spectroscopy. Send one sample of each material off-site for QC gamma spectroscopy. If any of the initial asphalt or soil samples shows plant-derived radioactive materials above the preliminary DCGL values, then have the off-site samples also undergo HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. -Where accessible and background allows for surrounding land areas, perform a 25% gamma scan with a Ludlum 44-10 NaI detector, meeting MDCs of approximately 3.5 pCi/g (Co-60) and 6.5 pCi/g (Cs-137).

Classification	Overall DQO Objectives and Actions
	- Note 10 biased sample locations in land soil areas and obtain 10 surface soil samples and 10 corresponding subsurface samples, at 1 meter depth, in each location. Perform onsite gamma spectroscopy analysis on the soil samples, sending off 1 surface soil and 1 subsurface sample for off-site QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels.
Class 2	Objective: Determine the extent and boundary of radiological contamination, including subsurface soils at depths associated with effluent lines and impact, if any, of radiological contamination on drain lines and sanitary sewer lines. This will be accomplished through specific actions, including but not limited to, the following: Actions: -For the asphalt paved areas, perform a 50% beta scan of the surface area, using a Ludlum 43-37 detector, meeting a MDC_{scan} of approximately 3,500 dpm/100 cm^2, which is approximately 50% of the gross beta/gamma DCGL of 7,100 dpm/100 cm^2. - Note 6 random sample locations in paved asphalt areas and obtain 6 direct alpha/beta measurements with a Ludlum 2360 with a 43-93 detector for alpha mode, meeting a MDC of 90 dpm/100 cm^2 for alpha, and a 43-93 detector for beta detection, meeting a MDC of 800 dpm/100 cm^2 for beta (Cs-137). For each location, also obtain an asphalt sample and an underlying soil sample and perform onsite gamma spectroscopy. Send one sample of each material off-site for QC gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. -Where accessible and background allows for surrounding land areas, perform a 50% gamma scan with a Ludlum 44-10 NaI detector, meeting MDCs of approximately 3.5 pCi/g (Co-60) and 6.5 pCi/g (Cs-137). - Note 15 sample locations (random & biased) in land soil areas and obtain 15 surface soil samples. For either biased locations or locations noted as elevated during the gamma scan, obtain 5 corresponding subsurface samples, at 5 meter depth, in each location. Perform onsite gamma spectroscopy analysis on all soil samples, sending off 1 surface soil and 1 subsurface sample for off-site QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. - For the stormwater line, obtain 1 sediment sample at an entry point and perform onsite gamma spectroscopy analysis and also send the sample off-site for QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. - For the largest building structure in the Class 2 areas, the Administration Building, perform a 10% beta scan of the roof surface area, using a Ludlum 43-37 detector, meeting a MDC_{scan} of approximately 3,500 dpm/100 cm^2, which is approximately 50% of the gross beta/gamma DCGL of 7,100 dpm/100 cm^2. - For the drain lines within the Administration Building, obtain 2 sediment samples at an entry point and perform onsite gamma spectroscopy analysis and also send the 2

Classification	Overall DQO Objectives and Actions
	samples off-site for QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. - If any radioactivity is detected in above the MDCs, notify the Project Manager, assess the results with the Radiation Protection Supervisor and Project Health Physicist, and determine any required further investigation surveys and sampling activities, as appropriate, to confirm or bound the radiological contamination noted.
Class 3	Objective: Obtain random representative surveys and samples to support the determination that the Class 3 areas are likely free of any significant radiological contamination due to LACBWR past operations. This will be accomplished through specific actions, including but not limited to, the following: Actions: - Note 3 random sample locations in paved asphalt areas and obtain 3 direct alpha/beta measurements with a Ludlum 2360 with a 43-93 detector for alpha mode, meeting a MDC of 90 dpm/100 cm^2 for alpha, and a 43-93 detector for beta detection, meeting a MDC of 800 dpm/100 cm^2 for beta (Cs-137). For each location, also obtain an asphalt sample and an underlying soil sample and perform onsite gamma spectroscopy and send one sample off-site for QC gamma spectroscopy. If there is any indication of plant-derived radioactivity by either on-site or off-site gamma spectroscopy for the asphalt or soil, also analyze the off-site samples for HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. - Note 3 random sample locations in land soil areas and obtain 3 gamma exposure measurements (open and closed window readings) in each location, using a meter such as the Ludlum 2350 with a 44-10 detector. - For the soil sampling, obtain 3 surface soil samples and 3 corresponding subsurface samples, at 1 meter depth, in each location. Perform onsite gamma spectroscopy analysis on the surface soil samples, sending off 1 surface soil sample for off-site QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. - Perform on-site gamma spectroscopy on the 3 subsurface samples. If any of the subsurface samples show plant-derived radioactivity, send the sample for off-site QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. -For identified basins and sanitary sewer lines, obtain 1 sediment sample at an entry point and perform onsite gamma spectroscopy analysis and also send the sample off-site for QC, gamma spectroscopy, HTD and TRU analysis, meeting MDCs, where feasible, at 10% of the preliminary nuclide-specific DCGL levels. - If any radioactivity is detected in above the MDCs, notify the Project Manager, assess the results with the Radiation Protection Supervisor and Project Health Physicist, and determine any required further investigation surveys and sampling activities, as appropriate, to confirm or bound the radiological contamination noted.

Classification	Overall DQO Objectives and Actions
Class 4 (Non-Impacted)	Objective: Obtain random and biased representative surveys and samples to support the determination that the Class 4 areas are not impacted by past LACBWR operations and are free of radiological contamination. This will be accomplished through specific actions, including ,but not limited to the following: Actions: - Scan 1% of open land areas as well as facilities built in the same time frame as the LACBWR Facility. Use the Ludlum-2350-1 with 44-10 for the open land areas gamma scans and the Ludlum 2360 with 43-93 for the facility scanning for alpha and beta contamination. - Note areas of elevated readings above defined MDCs for the Model 44-10 for open land areas and collect a static measurement above the area of the elevated scan readings with the Model 44-10 detector. Based on the results of the static measurement exceeding the MDC either preferably monitor with the InSpector^{TM} 1000 Digital Hand Held Multi-Channel Analyzer or similar or take bulk sample of the area of concern . All collected bulk samples will be analyzed on the on-site gamma spectroscopy system. Consult with the Radiation Protection Supervisor and Project Manager concerning the need to send collected bulk samples off site for lab analysis based on site gamma spectroscopy results. Samples sent off site will be analyzed using gamma spectroscopy/HTD methods/ and alpha spectroscopy. Additionally 5% of collected bulk samples will be split and sent off site for gamma spectroscopy/HTD methods/ and alpha spectroscopy analyses as a QC measure. Note areas of above MDC for structural scanning surveys. At areas above MDC conduct static surveys for beta and alpha as well as take a smear for alpha and beta counting. Consult with the Radiation Protection Supervisor/Project Manager/ and Dairyland Power Representative about the need to collect an intrusive sample of the structural material following collection of the static surveys and the results of the smear survey. Any collected bulk sample of structural material may be qualitatively analyzed on site but will also be sent off site for gamma spectroscopy/HTD methods/ and alpha spectroscopy analyses.

Characterization data is required to evaluate the radiological contaminants present and the extent of the radiological contamination. The data may be used to develop a conceptual site model for use in deriving site specific DCGLs. The data will also likely be useful in defining future measurement and sampling protocols that will be employed for remedial action surveys and Final Status Surveys (FSS).

The approach for demonstrating that the site meets the criteria for unrestricted release will depend on some factors that have yet to be fully investigated including final Derived Concentration Guideline Levels (DCGLs), the defined End State condition of the site at the time of the Final Status Survey, the statistical tests to be employed, etc. The approach for demonstrating that the site meets the criteria for free release will be discussed in detail in the License Termination Plan (LTP) Chapter 5 – Final Status Survey Plan and Chapter 6 – Compliance with the Radiological Criteria for License Termination.

4.1.2 Decision Identification

During radiological characterization, an important step in the DQO process is decision identification. This step consists of developing a decision statement, or in most cases, several decision statements, based on a principal study question (e.g. the stated problem) and determining alternative actions that may be taken based on the answers. For each survey unit, each of the characterization objectives must be assessed with regards to their applicability to the end state of each specific survey unit. These objectives may include, but not be limited to the following:

- Providing a basis for the initial classification (e.g. Class 1, 2, 3 or 4);
- Confirming the expected Radionuclides of Concern (ROC) and determining the relative proportions;
- Providing a basis for surrogate relationships for Hard-to-Detect (HTD) radionuclides;
- Providing a basis for the extent of remediation of surface and subsurface soils; and,
- Collecting data to support future planning of remediation, decontamination, and waste management operations.

4.1.3 Inputs to the Decision

This step in the DQO process identifies the types and quantity of information necessary to address the different decisions which are identified in the previous steps. The information required depends on the type of media under consideration (e.g. soil, sludge, concrete, asphalt, etc.) and the adequacy of existing data. If new data is needed, then the type of measurement (e.g. scan measurement, static measurement, and sampling) will be determined in the next step. Initial sources of information utilized for determination of the necessary inputs include:

- Historical site information, including incidents and evidence of previous radioactive material storage;
- Radionuclides of Concern study;
- Initial survey unit classification and basis;
- Default or other DCGL values; desired Action Levels associated with decision objectives;
- Instrumentation and MDA/MDC values;
- Laboratory counting and analytical requirements; and,
- QC sample requirements.

4.1.4 Boundaries of the Study

This step of the DQO process typically includes identification of the target population and material of interest, the spatial boundaries, and other constraints for collecting the data (e.g. weather conditions and impact on personnel and instrumentation; physical obstacles or work interferences, etc.). The target population for characterization tasks for this Plan is the set of scan, static or sample measurements from the Survey Unit. The media of interest is the type of materials that will be surveyed or sampled (e.g. soil,

sludge, sediment, concrete and steel). The spatial boundaries to be defined include the entire area of interest within Survey Units, including area dimensions and depth of soil, depth of concrete, etc.

The characterization work at LACBWR will involve Class 1 and 2 Survey Units associated with a number of facility buildings and their subgrade structures as well as the nearby paved and unpaved grounds. The focus for the Class 3 Survey Units will be various paved and unpaved grounds that are adjacent to the Class 2 Survey Units.

4.1.5 Decision Rule

This step of the DQO process develops the binary type statement that presents a logical process for choosing among alternative actions. Making decisions is facilitated by the developing of a clear statement using the "If…then…else" format. For characterization surveys, this process often involves selecting a workable Action Level (e.g. some level of contamination defined in dpm/100 cm2 or pCi/g, typically associated with meeting desired MDA and MDC criteria) and developing a decision rule which involves this Action Level. Depending upon the objectives of a specific characterization survey task, there could be a number of decision statements.

One of the key evaluations will involve comparison of the surface measurements and soil sampling results from within the impacted areas to the preliminary criteria noted in Table 2-1. If radionuclides other than those shown in Table 2-1, are identified they will be compared with the default screening values in NUREG 1757, Volume 2, Appendix H [Reference 10-5]. The DandD code may also be used, as applicable, to calculate the screening value.

If appropriate, material specific background measurements or activity concentrations may be obtained to aid in the evaluation of material specific measurements and sample analysis results. An approach to background measurements in soil and materials is presented in Section 7.5.10 – Background Measurements and Background Reference Materials in this Characterization Plan.

Once the site specific DCGLs have been calculated the sampling results will be evaluated using the DCGLs and accounting for background activity concentrations.

NOTE: Development of DCGLs is not part of this Characterization Plan. Site-specific DCGLs will be developed and included in the LTP after review and consideration of all collected characterization data.

4.1.6 Limits on Decision Error

This step of the DQO process often involves statistical hypothesis testing and probabilistic sampling distributions to control decision errors during data analysis when characterization data is to be considered for FSS purposes. However, site characterization surveys are more of an exploratory nature versus the verification phase of the FSS. Therefore, decision errors are more subjective during the characterization process and the use of descriptive statistics is more appropriate.

The decision errors will be limited by performing measurements, smears, and sampling activities in accordance with this Characterization Plan and the corresponding survey packages which will specify the number of measurements and samples to be collected, the sample locations, the amount of samples to be collected, chain-of-custody requirements for each sample, sample preparation, the type of analyses, and the minimum detectable concentration for each of the analyses.

Split samples will be collected to monitor the accuracy of the on-site laboratory, with designated Quality Control samples also sent to a qualified, licensed off-site laboratory.

In addition to the samples specified in the survey package, additional biased measurements and samples, as dictated by the professional judgment of the Radiation Protection Supervisor and/or the Project Health Physicist may be collected to support the characterization of specific areas.

4.1.7 Design for Data Collection

The first six steps of the DQO process (subsections 4.1.1 through 4.1.6) provide information that supports optimizing the plan for data collection. The final step is to use this information and establish an adequate survey design.

Both random and biased measurements and samples will be collected as part of this Characterization Plan. Random samples will be located based at pre-defined locations. The biased samples will be based in part on the results of gamma scans performed in the area to be sampled and/or based on the judgment of the RPS or the Project Health Physicist.

The characterization surveys will have complied with this Characterization Plan if all the surveys are of sufficient sensitivity, accuracy, reproducibility, and are well documented. Implementation of this Characterization Plan and associated procedures, including the preparation of characterization survey packages will ensure characterization survey quality.

To ensure data collection is optimized, all areas to be surveyed will be walked down as part of the characterization survey package development. Minimum data requirements shall be defined, special situations identified, specific instructions provided, etc.

Quality control of instrumentation shall include efficiency checks, source checks, and background checks will be conducted.

Where possible, the Minimum Detectable Concentration (MDC) for each measurement or sample should be less than 50% of the limits for the expected Radionuclides of Concern. For Class 3 areas, where it is expected that plant-derived radionuclides are expected not to be present or present at a small percentage of the DCGL, it is appropriate to apply MDCs at a lower level, e.g. approximately 10% of the limit, where feasible. Non Impacted areas (Class 4) should typically be at levels of not having ROCs identified above instrument MDCs other than for Cs-137 which should be at site established background levels for the Cs-137 radionuclide.

Chain-of-Custody will be maintained for all samples to be analyzed off-site. All samples will be retained following analysis until released for disposal by the Project Health Physicist.

5.0 Radiological Instrumentation and Laboratory Analysis

5.1 Introduction

The areas and materials to be surveyed and/or sampled in and around the LACBWR Site as part of this characterization survey include:

- Perform assessment of facility structural materials that will be subject to FSS and the associated surrounding soils as much as possible;
- Building concrete may be sampled at locations of interest in the Turbine Building, Reactor Building, Waste Treatment Building, and the Gas Storage Tank Vault by obtaining core samples;
- Surface and subsurface soils samples will be taken in all Class 1, 2, and 3, 4 open land area survey units except for Survey Unit L312102 [Note: this survey unit is the switchyard with operations and access requirements making survey operations difficult in this area. For purposes of characterization, surveys from the adjacent survey units, including biased sampling near the perimeter of the switchyard will be taken to evaluate the potential for radioactive contamination in this area].
- Asphalt and concrete samples will be taken from roads and paved areas as well as the soil area directly below the asphalt or concrete sampling areas to a one meter depth;
- Accessible roof and other elevated surfaces, especially around roof vents, and in the predominant downwind wind direction(s) from the stack;
- Accessible facility drains;
- Septic drain fields; and
- Perform a background radiation study of surfaces of similar material to those to be characterized at the LACBWR Site.
- Perform surveys of Class 4 Facilities of interest to demonstrate that the facilities are not impacted by past LACBWR operations.

The typical characterization surveys of building surfaces will consist of a combination of beta surface scans, static beta and alpha measurements, smears for alpha and beta, and material samples. The surveys of open land soil, asphalt, concrete areas will consist of gamma scans and volumetric sampling of surface and subsurface soils and if directed by survey package beta scans and static beta and alpha static surveys. Survey packages will be developed for each open land area survey unit and for each stand-alone facility which will define the surveys to be performed in detail.

5.2 Radionuclides of Concern

Based on the Energy*Solutions* “Technical Basis Document for the Radionuclides of Concern” [Reference 10-4], the Radionuclides of Concern remaining at the LACBWR Site are presented in Table 5-1. The table below lists these radionuclides including half lives, major radiations and intensities.

Table 5-1 Radionuclides of Concern

Radionuclide	Half Life (Years)	Major Radiations Energies and Intensities		
		Alpha	Beta (average)	Gamma
H-3	1.24E01		5.685 keV	
C-14	5.73E03		49.47 keV	
Fe-55	2.70E0			Low energy x-rays
Co-60	5.27E0		95.79 keV	1173 keV 100% 1332 keV 100%
Ni-59	7.50E04			Low energy x-rays
Ni-63	9.60 E01		17.13 keV	
Sr-90/Y-90	2.91 E01		195.8 keV /934.8keV	
Nb-94	2.03E04		145.9 keV	702 keV 100% 871 keV 100%
Cs-137	3.0E01		156.8 keV 94.6% 415.2 keV 5.4%	
Eu-152	1.33E01		300.8 keV	121.8 keV 28.4% 964 keV 14.4% 1085.8 keV 10% 1112 keV 13.3% 1407 keV 20.7% 344 keV 26.5% 778.9 keV 12.7%
Eu-154	8.80E0		225.4 keV	123.1 keV 40% 1274 keV 35.5%
Np-237	2.140E06	4.8 MeV (average)	70keV	35keV (average)
Pu-238	8.78E01	5500keV 72% 5460keV 28%		
Pu-239	2.41E4	5104 keV 11.5% 5142 keV 15.1% 5155 keV 73.3%		
Pu-240	6.60E03	5170keV 76% 5120keV 24%		
Am-241	4.32E02	5443 keV 13% 5486 keV 85%		59.5 keV 35.9%
Am-243 Cm-243/244	7.37E03 1.81E01 (shortest half life)	5280 keV 87% 5230 keV 12% 5810keV 77% 5770 keV 23%		55 keV (average) 130keV (average)

5.3 Instrumentation

The selection and use of survey instrumentation will ensure that their sensitivities will be sufficient to detect the identified radionuclides of concern at the minimum detection requirements. Table 5-2 provides a list of the instruments to be used during the characterization survey and their nominal detection sensitivity.

The Ludlum Model 2350 Data Logger will be used in combination with a gas flow proportional detector to obtain static measurements of alpha and beta activity and for performing beta scans on surfaces. The Data Logger is a portable microprocessor computer-based counting instrument. The data logger is designed to operate with a wide variety of detectors. It will also be used in combination with sodium iodide detectors for obtaining count rate or exposure rate measurements on soils.

The Ludlum Model 2360 Data Logger will be used with the dual phosphor scintillation detectors to obtain static measurements of alpha and beta activity and for performing beta scans on surfaces.

The Model 12 with 44-9 detector will be used for beta scanning during field progress surveys, field counting of swipes, and to support equipment release surveys.

Analysis for removable alpha and beta activity will be performed using a Ludlum Model 2929 or equivalent alpha/beta counter.

Tritium (H-3) and Carbon-14 (C-14) swipes will be analyzed at an approved off-site radioanalytical laboratory.

An on-site calibrated gamma spectroscopy system will be used for soil, asphalt sample analysis, possibly liquid/sludge analyses, and qualitative analyses of concrete samples.

An off-site lab will be used to conduct gamma spectroscopy analyses of duplicate soil and/or asphalt samples as well as concrete and liquid/sludge analyses. The off-site lab will also analyze submitted soil, concrete, asphalt, sludge/liquid samples for hard to detect nuclides and transuranics.

Table 5-2. Survey Instrumentation

Detector Model [2]	Meter Model	Application	Nominal Detection Sensitivity	
			MDC_{scan} (dpm/100cm^2)	MDC_{static} [1] (dpm/100cm^2)
Ludlum 44-9	Ludlum Model 3	β static	N/A	3,500 – 4,000
Ludlum 43-68 β mode	Ludlum 2350-1	β static & scan	3,000-3,500 (Co-60) 1,600 – 1,700 (Cs-137)	1,300 – 1,400 (Co-60) 600 – 700 (Cs-137)
Ludlum 43-68 α mode	Ludlum 2350-1	α static	N/A	80-90
Ludlum 43-93 β mode Ludlum 43-89 β mode	Ludlum 2360	β static & scan	3,500 – 4,000 (Co-60) 1,600 – 1,700 (Cs-137) 3,200 – 3,500 (Co-60) 1,700 – 1,800 (Cs-137)	1,200 – 1,400 (Co-60) 700-800 (Cs-137) 1,200 – 1,400 (Co-60) 700-800 (Cs-137)
Ludlum 43-93 α mode Ludlum 43-89 α mode	Ludlum 2360	α static	N/A	80-90 90-100
Ludlum 44-10	Ludlum 2350-1	γ scan	3.5 pCi/g (Co-60) 6.5 pCi/g (Cs-137) [with 10,000 cpm background minimum]	N/A
Ludlum 43-37	Ludlum 2350-1	β scan	3,500 – 4,000 (Co-60) 2,000 – 2,300 (Cs-137)	N/A
Ludlum 43-10-1	Ludlum 2929	α and/or β smear analysis	N/A	α – 14-15 β – 300-350 (Co-60) 175-200 (Cs-137)
Gamma Spectroscopy System	N/A	γ Analysis	N/A	~0.10 pCi/g for Co-60 and Cs-137

1. Based on 1-minute count time and use of either Cs-137 or Co-60 β energy max for surface efficiencies, $\in_{s,}$ as specified in International Standard, ISO 7503-1 [Reference 10-13].
2. Functional equivalent instrumentation may be used.
3. Based on the current version of Energy*Solutions* Procedure CS-FO-PR-001, "Performance of Radiological Surveys" [Reference 10-14] and NUREG 1507, "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions" [Reference 10-15].

5.4 Calibration

The Data Loggers, associated detectors and all other portable instrumentation are calibrated on an annual basis using National Institute of Technology (NIST), traceable sources and calibration equipment. Procedures for calibration, maintenance, operation and quality control implement the appropriate guidance established in American National Standard Institute (ANSI) standards. Calibration typically includes:

- High voltage calibration
- Discriminator/threshold calibration
- Window calibration
- Alarm operation verification
- Scaler calibration verification

Detector calibration includes:

- Operating voltage determination
- Calibration constant determination
- Dead time correction determination

Calibration labels showing the instrument identification number, calibration date, and calibration due date will be attached to all instruments. All instrumentation will be inspected and source response checked daily before use to verify calibration status and proper operation. Control charts and/or source check criteria will be established prior to the initial use of the instrument, including the calculation of instrument efficiencies and surface efficiencies for portable instruments based on the requirements in the Energy*Solutions* procedure CS-FO-PR-001, "Performance of Radiological Surveys" [Reference 10-14].

5.5 On-Site Sample Analysis

A Canberra gamma spectroscopy system with a High Purity Germanium (HPGe) detector will be set up and calibrated to analyze soil and asphalt samples for gamma emitting radionuclides as well as possibly liquid/sludge type samples. The analysis library will include Co-60, Cs-137, and other fission and activation products will be included in the library to ensure Radionuclides of Concern [Reference 10-4] can be flagged, if present, during analysis. All samples collected will be uniquely numbered and samples will be tracked through the analysis process.

The on-site gamma spectroscopy system is operated with calibration performed at routine intervals per a plant procedure, with the use of appropriate multi-energy solid Marinelli source standards sized to correspond to sample container sizes and sample matrices with a density of 1.15 g/cc to perform the calibration. A 10 ml solid multi-energy source standard with energies representative of LACBWR radionuclides is used to perform daily source response checks of the gamma spectroscopy system and is logged. Upper and lower bound "Pass" or "Fail" ranges are checked during the daily source check prior to the gamma spectroscopy system use for the day. Additionally, daily background checks are run on the gamma spectroscopy systems to verify acceptable backgrounds and to ensure that the detector and shield have not become contaminated.

On-site sample types and quantities will be discussed in greater detail in Chapter 7 of this document.

5.6 Off-Site Sample Analysis

A representative population of soil, asphalt, concrete, and sludge/liquid samples will be sent to an off-site lab for analysis for hard to detect and transuranic analyses based on [Reference 10-1] radionuclides of concern. In addition, a representative population of samples analyzed on-site by gamma spectroscopy will be sent to the off-site lab for duplicate analysis. Off-site sample types and quantities will be discussed in greater detail in Chapter 7 of this document.

All samples will be uniquely numbered (ad described in Section 7.6.1 of this Plan); and samples will be tracked using chain of custody records, packing lists for transportation, laboratory verification of receipt, and laboratory tracking during analyses.

6.0 Minimum Detectable Concentration

The Minimum Detectable Concentration (MDC) is dependent on count times, geometry, sample size, media type, detector efficiency, background, and for scanning the scanning rate and the efficiency of the surveyor.

Typically, the MDCs should be set to see less than 50% of the preliminary limits specified in Table 2-1, where possible. For Class 3 land area soil samples, the off-site sample analysis should be established, where feasible, to 10% of the soil sample preliminary DCGL levels (in pCi/g). The MDC criteria for any liquid sample analysis (oils and liquids) will be lower than indicated for solid samples in Table 2-1, Preliminary Criteria for Surfaces and Soils. The desired MDC for these samples will be determined prior to analysis of samples.

The following key equations used for calculating the MDC for direct (static) measurements, smears, and beta surface scans are obtained from the formulas noted in procedure CS-FO-PR-001, "Performance of Radiological Surveys" [Reference 10-14].

<u>Direct or Static Measurements</u>

$$MDC_{Static} = \frac{\frac{2.71}{t_S} + (3.29) \cdot \sqrt{\frac{R_B}{t_S} + \frac{R_B}{t_B}}}{\varepsilon_i \cdot \varepsilon_s \cdot \left(A / 100\,cm^2 \right)}$$

Where:
R_B = Ambient Background Count Rate (cpm)
t_S = Sample Counting Time (min)
t_b = Background Counting Time (min)
ε_i = Instrument Efficiency (%)
ε_S = Source Efficiency (%)
A = Detector Area (note: assumed to a maximum value of 1.26 cm^2)

For very low background count rates (i.e., alpha counting), the constant 2.71 should be 3, based upon the Poisson distribution.

<u>Removable Activity (Smears)</u>

$$MDC_{Smear} = \frac{\frac{2.71}{t_S} + (3.29) \cdot \sqrt{\frac{R_B}{t_S} + \frac{R_B}{t_B}}}{\varepsilon_i \cdot \varepsilon_s}$$

<u>Beta Surface Scans</u>

$$MDC_{Scan-\beta} = \frac{MDCR}{\sqrt{p} \cdot \varepsilon_i \cdot \varepsilon_s \cdot \left({A}/{100\,cm^2} \right)}$$

Where: p = Surveyor efficiency, which is typically considered to be 50% (0.50).

A = Detector area (cm^2)

<u>Note:</u> Detector area is assumed to be a maximum of 126 cm^2.

7.0 Survey Design and Implementation

To facilitate the characterization survey, the areas to be surveyed will be divided into survey areas. The characterization survey will include beta scans, measurements for total alpha and total beta activity, smears for determining the presence of removable alpha and removable beta activity, gamma scans and exposure rate measurements. In addition, representative structural material, paved material (e.g. concrete and asphalt), and soil samples will be collected for on-site analysis by gamma spectroscopy and for off-site analysis. Both biased (judgment) and random measurement locations will be defined. The system for random measurements will be based on guidance from the Project Health Physicist and will be based on using pre-established survey units and georeferenced to Wisconsin South state plane coordinates. The random sampling points will be generated with the use of the software Visual Sample Plan. All measurement and sample locations will be marked or otherwise identified.

7.1 Survey Areas and Units

The survey areas and initial site classifications were previously discussed in Section 3.0 – Characterization Plan Scope and Survey Units. Based upon available information, the entire LACBWR site was conservatively classified as “Impacted” and appropriate Class 1, 2, and 3 Survey Units were established for the overall land areas encompassing the site. Subsequent to initial characterization the site was reclassified in to Impacted and Non-impacted areas, including:

- Eight (8) Class 4 Non-Impacted Survey Units
- Eight (2) Class 3 Survey Units,
- Five (5) Class 2 Survey Units, and,
- Four (4) Class 1 Survey Units.

The survey units for the land areas and buildings will generally follow the size limits and approaches as specified in Table 7-1.

Table 7-1 – Recommended Survey Unit Sizes

Survey Unit Classification	Type of Area	Size Limit (m^2)
Class 1	Building Surfaces	Will be based upon specific building rooms and elevations suitable for grouping into a specific survey unit
	Land Areas	up to 2,000
Class 2	Building Surfaces	Will be based upon specific building rooms and elevations suitable for grouping into a specific survey unit
	Land Areas	up to 10,000
Class 3/Class 4	Building Surfaces	Will be based upon specific building rooms and elevations suitable for grouping into a specific survey unit
	Land Areas	No Limit

The level of scanning (beta or gamma, as appropriate, for the surfaces to be scanned) is driven by the classification of a survey unit. The area to be scanned in each survey unit will be determined by the professional judgment of the Project Health Physicist during the survey design process. Based upon the review of historical and current radiological data at LACBWR, Table 7-2 provides a list of the recommended scan coverage for the characterization surveys.

Table 7-2 – Scan Coverage

Survey Area Classification	Recommended Characterization Scan Coverage for Open Land Areas
Class 1	○ Up to 25% scanning will be attempted based on background radiation conditions
Class 2	○ 25-50% ○ Concentrating on areas with an increased probability of exhibiting elevated activity (e.g. Class 1 boundaries, waste transfer areas, vehicle transit routes, etc.)
Class 3	○ 0-10% ○ Judgmental; focus on areas downwind of known effluent release points and areas adjacent to Class 2 areas
Class 4	○ 1%

Attachment 7-1 provides a more detailed listing of Survey Units, their preliminary classification as well as the estimated number and types of measurements. For the Class 1, 2, and 3 survey unit areas, it identifies the expected scan percent of the open land areas (paved and unpaved), the number of samples anticipated to be collected for on-site gamma spectroscopy and the number of samples anticipated for QC purposes and obtaining additional radiological data such as the presence and concentrations of Hard-to-Detect (HTD) and Transuranic (TRU) radionuclides. For the subgrade structural surveys, rooms and areas will likely be grouped by level, size, area usage and accessibility in order to facilitate the survey packages and ensure adequate survey coverage. The Attachment 7-1 is a statement of proposed characterization survey activities from the original characterization effort described in Rev. 0 of this Plan.

7.2 Survey Unit Preparation for Characterization

Preparation for characterization will be performed in all survey units as deemed appropriate and practical. Prior to performing characterization surveys on structural surfaces, the areas should be cleared of all loose equipment and materials to the extent possible. Prior to performing characterizations in open land survey units (e.g. roads, parking lots, land areas), it may be necessary to clear the area of debris and/or vegetation to the extent possible, to eliminate physical obstructions. In this case, vegetation should be cut as close to the ground surface as possible. All physical hazards in the survey unit should be either identified and removed or marked as appropriate. The measurement locations will be marked on the building surface or equipment and on a map or drawing prepared to document the measurement location for in facility characterization measurements.

For open land survey units, reference coordinates can be established using a Global Positioning System (GPS) coupled with a standard topographical grid coordinate system such as the North American Datum (NAD) system. Original Class 3 Survey units, the parking lot area in the Class 2 Survey Unit L2011102, and possibly other open land area of L2011102 and L2011101 survey units had random sampling locations generated using the Visual Sample Plan software and the sampling locations were located in the field with the GPS and marked for survey work. Bias sampling locations in the Class 1 and Class 2 open land survey unit areas were located in the

field with GPS and coordinates logged and specific sample location marked for survey work and on prepared survey maps for documentation. Class 4 open land area surveys will minimally have sample locations located by GPS equipment or equivalent.

ATTACHMENT 7-1 - Survey Unit Classification Table and Preliminary Measurements and Samples for Characterization Survey

CLASS 1 Survey Units

*Sampling and On-Site and Off-Site Analysis**

Survey Unit/Description	MARSSIM Classification	Structure or Land Area	Gamma Exposure Measurements (Number)	Gamma Scan (Percent)	Beta Scan (Percent)	Direct Alpha/ Beta Measurements (Number)	Alpha/Beta Smears (Number)	H-3/C-14 Wipes (Number)	Structural Samples On-Site	Structural Samples Off-Site	Soil Under Struct. On-Site	Soil Under Struct. Off-Site	Paved Asphalt Samples On-Site	Paved Asphalt Samples Off-Site**	Soil Beneath Asphalt On-Site	Soil Beneath Asphalt Off-Site**	Land Surface Samples On-Site	Land Surface Samples Off-Site	Land Subsurface Samples On-Site	Land Subsurface Samples Off-Site	Basin/Sewer/Sump Sludge/Sediment On-Site	Basin/Sewer/Sump Sludge/Sediment Off-Site	Total Samples On-Site	Total Samples Off-Site
L110101																								
Includes Reactor Building & WTP	1	Rx Basement	10 (biased)	N	N (high bkgrd)	N (high bkgrd)	10 (biased)	6		1														1
		Rx Circ Pump Cubicles (2)	5 ea (biased)	N	N (high bkgrd)	N (high bkgrd)	5 ea (biased)	3																
		Rx Sumps (2)	5 ea (biased)	N	N (high bkgrd)	N (high bkgrd)	5 ea (biased)	3																
		WTB Basement	10 biased	N	N (high bkgrd)	N (high bkgrd)	10 (biased)	3		1														1
		WTB Sump (1)	5 ea (biased)	N	N (high bkgrd)	N (high bkgrd)	5 ea (biased)																	
		Gas Storage Tk Vault/Sump	TBD	N	TBD	TBD	TBD	3																
		Paved Area (as available)	N	N	Y (25%)	10 (tied to sample loc)	N						10	1	10	1							20	2
		Land Area	N	Y (25%)	N	N	N										10	1	10	1			20	2
																	(15 cm)		(1m deep)					
Total Samples for Analysis																							**40**	**6**
L110102																								
Inludes Turbine Building	1	TB Piping Tunnel	10 (biased)	N	TBD	TBD	10 (biased)	3		2	2	2											2	4
		TB Tunnel Sumps (1)	5 (biased)	N	N (high bkgd)	N (high bkgd)	5 (biased)																	
		TB Basement/Sumps (2)	10 (biased)	N	TBD	TBD	10 (biased)	3																
		Paved Area (as available)	N	N	Y(25%)	10 (tied to sample loc)	N						10	1	10	1							20	2
		Land Area	N	Y (25%)	N	N	N										10	1	10	1			20	2
																	(15 cm)		(1m deep)					
Total Samples for Analysis																							**42**	**8**
L110103																								
Includes LSA Bldg; Transformer	1	Paved Area	N	N	Y(25%)	12 (tied to sample loc)	N						10	1	10	1					2	1	22	3
		Land Area	N	Y (25%)	N	N	N										10	1	10	1	(Sanitary samples)		20	2
Total Samples for Analysis																	(15 cm)		(1m deep)				**42**	**5**
L110104																								
North end of RCA grounds	1	Paved Area	N	N	Y(25%)	10 (tied to sample loc)	N						10	1	10	1							20	2
		Land Area	N	Y (25%)	N	N	N										10	1	10	1			20	2
Total Samples for Analysis																	(15 cm)		(1m deep)				**40**	**4**
TOTAL for All Class 1 Areas																					***TOTAL for All Class 1 Areas***		164	23

***NOTE: Off-site samples will be designated for QC and have gamma spectroscopy, HTD and TRU analysis performed**

****NOTE: The paved materials (asphalt) and underlying soil will be asssessed on-site and sent off-site for QC/gamma spectroscopy only. The additional HTD and TRU analysis will only be performed if the on-site results indicate contamination above specified Action Levels and/or at the direction of the Project Health Physicist.**

ATTACHMENT 7-1 - Survey Unit Classification Table and Preliminary Measurements and Samples for Characterization Survey

CLASS 2 Survey Units

*Sampling and On-Site and Off-Site Analysis**

Survey Unit/Description	MARSSIM Classification	Structure or Land Area	Gamma Exposure Measurements (Number)	Gamma Scan (Percent)	Beta Scan (Percent)	Direct Alpha/ Beta Measurements (Number)	Alpha/Beta Smears (Number)	H-3/C-14 Wipes (Number)	Structural Samples		Soil Under Struct.		Paved Asphalt Samples		Soil Beneath Asphalt		Land Surface Samples		Land Subsurface Samples		Basin/Sewer/Sump Sludge/Sediment		Total Samples	
									On-Site	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site***	*On-Site*	*Off-Site***	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*
L211101																								
North area surrounding LACBWR	2	Warehouses (3) (note: no below-grade structures or drains)																						
		Paved Area			Y (50%)-Random	6 (tied to sample loc)							6	1	6	1							12	2
		Land Area	21 (tied to sample)	Y (50%) - Bia/Ran													15 (15 cm)	1	5 (5m deep)	1	1 (stormwater line)	1	21	3
Total Samples for Analysis																							**33**	**5**
L211102																								
South area surrounding LACBWR	2	Paved Area			Y (50%)-B & R	6 (tied to sample loc)							6	1	6	1							12	2
		Land Area	20(tied to sample)	Y (50%)													15 (15 cm)	1	5 (5m deep)	1			20	2
Total Samples for Analysis																							**32**	**4**
B209101																								
LACBWR Cribhouse	2	Bldg (Cribhouse-LACBWR)	0	N	N	N																		
Total Samples for Analysis																							**0**	**0**
B209102																								
G-3 Cribhouse	2	Bldg (Cribhouse - G-3)	0	N	N	N																		
Total Samples for Analysis																							**0**	**0**
B209103																								
Administration Building	2	Bldg (Administration)	0	N	N	N															2	2	**2**	**2**
		Admin Bldg Roof			10%	6	6														(drain lines i/s Bldg)			
Total Samples for Analysis																								
																					TOTAL for All Class 2 Areas		67	11
TOTAL for All Class 2 Areas																								

***NOTE: Off-site samples will be designated for QC and have gamma spectroscopy, HTD and TRU analysis performed**

****NOTE: The paved materials (asphalt) and underlying soil will be asssessed on-site and sent off-site for QC/gamma spectroscopy only. The additional HTD and TRU analysis will only be performed if the on-site results indicate contamination above specified Action Levels and/or at the direction of the Project Health Physicist.**

ATTACHMENT 7-1 - Survey Unit Classification Table and Preliminary Measurements and Samples for Characterization Survey

CLASS 3 Survey Units

*Sampling and On-Site and Off-Site Analysis**

Survey Unit/Description	MARSSIM Classification	Structure or Land Area	Gamma Exposure Measurements (Number)	Gamma Scan (Percent)	Beta Scan (Percent)	Direct Alpha/ Beta Measurements (Number)	Alpha/Beta Smears (Number)	H-3/C-14 Wipes (Number)	Structural Samples		Soil Under Struct.		Paved Asphalt Samples		Soil Beneath Asphalt		Land Surface Samples		Land Subsurface Samples		Basin/Sewer/Sump Sludge/Sediment		Total Samples	
									On-Site	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site***	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*	*On-Site*	*Off-Site*
L312101		Paved Area	N	N	N	3 (tied to sample loc)	N	N					3	1	1								4	1
Area North of LACBWR	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3		1	1	7	2
																	(15 cm)		(1m deep)		(sanitary drain line)			
Total Samples for Analysis																							**11**	**3**
L312102		Paved Area	*Note: Due to access and safety requirements working in a Switchyard area, no measurements or samples will be taken in this Survey Unit. Results, including some biased measurements will be used to bound the radiological condition of this Survey Unit.*																					
Switchyard	3	Land Area																						
Total Samples for Analysis																							**0**	**0**
L312103		Paved Area	N	N	N	3 (tied to sample loc)	N	N					3	1	1								4	1
G-3 Plant and Grounds	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3				6	1
G-3 Bldg Roof*																	(15 cm)		(1m deep)					
*TBD - if an appropriate building (e.g. Central Warehouse) roof area can be approved for access, obtain some level of scan, fixed (alpha/beta), and smear data																								
Total Samples for Analysis																							**10**	**2**
L312104		Paved Area	N	N	N	3 (tied to sample loc)	N	N					3	1	1								4	1
Land strip/area East of LACBWR	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3		1	1	7	2
																	(15 cm)		(1m deep)		(basin sample)			
Total Samples for Analysis																							**11**	**3**
L312105		Paved Area	N	N	N	N	N	N															0	0
Coal pile area South of G-3	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3				6	1
																	(15 cm)		(1m deep)					
Total Samples for Analysis																							**6**	**1**
L312106		Paved Area	N	N	N	3 (tied to sample loc)	N	N					3	1	1								4	1
Road/land strip by ISFSI	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3				6	1
																	(15 cm)		(1m deep)					
Total Samples for Analysis																							**10**	**2**
L312107		Paved Area	N	N	N	N	N	N															0	0
Hilly area E of Highway 35	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3				6	1
																	(15 cm)		(1m deep)					
Total Samples for Analysis																							**6**	**1**
L312108		Paved Area	N	N	N	N	N	N															0	0
Strip immediately E of Highway 35	3	Land Area	3 (at sample loc)	N	N	N	N	N									3	1	3				6	1
		Gravel by Railroad							1								(15 cm)		(1m deep)				1	
Total Samples for Analysis																							**7**	**1**
TOTAL for All Class 3 Areas																					***TOTAL for All Class 3 Areas***		**61**	**13**

***NOTE: Off-site samples will be designated for QC and have gamma spectroscopy, HTD and TRU analysis performed**

****NOTE: The paved materials (asphalt) and underlying soil will be asssessed on-site and sent off-site for QC/gamma spectroscopy only. The additional HTD and TRU analysis will only be performed if the on-site results indicate contamination above specified Action Levels and/or at the direction of the Project Health Physicist.**

7.3 Survey Package Development

A Characterization Survey Package will be developed for each survey area to be included in the characterization survey and covers the survey units designated in Tables 3-1 and 3-2 in Section 3.0 – Characterization Plan Scope and Survey Units. Multiple survey plans associated with each Characterization Survey Package may be generated for a given survey unit to accommodate performing characterization in phases.

Specific survey instructions/work sheets will be prepared for each survey area detailing the survey requirements and providing instructions for completing the survey. The survey instructions will describe the number, type and location of scan and static measurements, smears, and samples to be collected as well as the type of analyses to be performed. Direction will also be provided for selection of instruments, count times, instrument modes, survey methods, required documentation, actions levels, investigation actions, background requirements and other appropriate instructions. In conjunction with the survey instructions, survey data forms, indicating desired measurements, are prepared to assist in survey documentation.

Each individual survey plan may contain the following types of information:

- Detailed description of the survey unit,
- Photographs, maps, and/or drawings of the survey unit,
- A summary of the operational history pertinent to the survey unit and summary data from any previous radiological surveys if available,
- The specific DQO(s) for the survey unit,
- Types and number of survey measurements and/or samples prescribed for the survey,
- Specific survey instructions,
- Survey measurement and sample designation codes and locations,
- Quality Assurance measures in accordance with the Quality Assurance Project Plan (QAPP) requirements, and,
- Any pertinent information such as support from others, health and safety information and necessary Work Orders (e.g. for coring, drilling, access, lifting, etc.) and permits (e.g. Excavation Permit, Radiation Work Permit, etc.).

The survey packages will be the primary method of controlling and tracking the survey results. Survey records, including the sample analysis results will be maintained in the survey packages.

7.4 Survey Unit Walk Down

Survey plan development will begin with the performance of a walk down of the survey unit. During the walk down, details regarding the physical survey area will be compiled such as the surfaces in the unit (wall, floor, ceiling, surface soils, etc.). Data from available operational surveys will be reviewed and utilized as appropriate.

Significant health and safety concerns include the potential industrial hazards commonly found at a construction site, such as exposed electrical lines, excavations, enclosed work spaces, hazardous atmospheres, insects, unstable or sharp surfaces, hot and cold temperature extremes, tripping hazards, vehicle traffic, and working at heights. The pre-survey walk down will identify potential industrial safety hazards specific to the survey unit.

Each hazard will be evaluated to determine if the hazard can be eliminated, avoided, or minimized, as well as to determine if the need for additional outside support/expertise is necessary to complete further evaluation or mitigation. If a serious hazard is identified that requires immediate action, the survey unit will be isolated and the characterization survey will not commence until the hazard has been taken care of.

7.5 Survey Design and Protocols

Characterization surveys will be designed and performed in accordance with this Characterization Survey Plan and applicable approved procedures (e.g. procedures CS-FO-PR-001, CS-FO-PR-002, CS-FO-PR-003, and CS-FO-PR-004; [References 10-14, 10-16, 10-17 and 10-18] as well as the Energy*Solutions* instrument-specific operating procedures).

7.5.1 Graded Approach

The survey design will incorporate a graded approach based upon the DQOs for the survey unit. For example, Class 1 open land survey units are expected to contain radiological contamination greater than the established action levels and in accordance with the expected decommissioning approach, a majority of the Class 1 structures (and systems) will be removed and disposed as radioactive waste. Therefore, the characterization surveys that will be performed in Class 1 survey units will focus on bounding the contamination where contamination is known to exist. The survey design will be based upon the number of measurements and samples required to identify the lateral and vertical extent of the contamination.

Areas classified as Class 2, 3 or 4 will receive surveys developed to include a combination of random and biased survey measurement locations and scan areas. This will supplement what is currently known concerning the condition of the areas with respect to the presence or absence of radiological contamination.

There are two approaches that can be used for survey design – biased and random. Biased survey designs use known information to select locations for static measurements and/or samples. Random survey design selects static measurement and/or sample locations at random or by using a systematic sampling design with a random start and will be based on using pre-established survey units and georeferenced to Wisconsin South state plane coordinates. The random sampling points will be generated with the use of the software Visual Sample Plan [Reference 10-19]. A biased approach should be considered when the characterization effort is designed to delineate the extent of an area that requires remediation. Alternatively, a random approach should be considered if the characterization effort is designed to verify the basis for classifying an area.

7.5.2 Number of Static Measurements and/or Samples

The number of measurements and/or samples that will be taken in each survey unit will be based upon this Characterization Plan as well as reflecting the population size necessary to satisfy the specific DQOs for each survey unit.

For the characterization of impacted Class 1, 2 and 3 structures, the number of static measurements and/or samples will be based upon the DQO (e.g. confirming extent of radiological contamination that may need remediation; obtaining additional radiological information to confirm the presence and ratios of ROC nuclides; etc.) and the professional judgment of the Radiological Protection Supervisor and/or the Project Health Physicist, dependent upon existing radiological conditions and background levels,

accessibility to structures expected to be remaining and subject to FSS, radiological/ALARA exposure and industrial hazard considerations, and other factors.

For the characterization of impacted Class 2 open land areas (paved and unpaved) that will be subjected to FSS, the minimum number of random static measurements and/or samples taken in the survey unit should be commensurate with the probability of the presence of residual radioactive contamination in the survey unit. Sufficient samples should be taken to make this evaluation and in these areas, generally 5 to 15 samples will be obtained.

For impacted Class 3 open land areas that will be subjected to FSS, sufficient random or biased measurements or samples, at the professional judgment of the Radiological Protection Supervisor and/or the Project Health Physicist will be taken to assess the initial classification and determination that no significant (<10% of the DCGLs) licensed radioactive material is present in these areas.

For Class 4 open land areas and facility areas sufficient random or biased measurements or samples, at the professional judgment of the Radiological Protection Supervisor and/or the Project Health Physicist will be taken to assess the initial classification and determination that no licensed radioactive material is present in these areas.

7.5.3 Scan Coverage

Survey units will be scanned in accordance with their classification. The area to be scanned in each survey unit will be determined by the professional judgment of the Radiation Protection Supervisor and/or the Project Health Physicist during the survey design process, including information obtained during the initial survey unit walkdowns. The recommended scan coverage for open land areas was previously presented in Table 7-2 for guidance.

7.5.4 Static Measurements

Static measurements are performed to detect direct levels of contamination on structural surfaces of the buildings or on concrete or asphalt paved areas. These measurements are typically performed using ~100 cm^2 or greater scintillation or gas-flow proportional detectors.

Static measurements are conducted by placing the detector very near the surface to be counted and acquiring data over a pre-determined time count time. A count time of one minute is typically used for surface measurements and generally provides detection levels well below the designated investigation level or MDC under consideration. The instrument count times will be adjusted as appropriate to achieve an acceptable MDC for static measurements.

7.5.5 Beta Surface Scans

Scanning is performed in order to locate areas of residual activity above the investigation level or MDC under consideration. Beta scans are performed over accessible structural surfaces, including, but not limited to: floors, walls, roofs, asphalt and concrete paved areas. Floor monitors using large area gas-flow proportional detectors may be used for floor and other large accessible horizontal and vertical surfaces. Smaller hand-held beta scintillation and/or gas-flow proportional detectors (typically 126 cm^2) may be used for surfaces not accessible by a floor monitor.

Beta scanning will typically be performed with the detector positioned within ~ 1 cm of the surface and with a scanning speed of one detector active window width per second. If surface conditions prevent scanning at the specified distance, the detection sensitivity for an alternate distance can be determined and the scanning technique adjusted accordingly. Scanning speed is calculated a priori to assure the MDC for scanning is appropriate for the stated objective of the survey. Adjustments to scan speed and distance may be made when necessary by the Project Health Physicist or the Radiation Protection Supervisor.

Whenever possible, Health Physics Technicians should monitor the audible response to identify locations of elevated activity that require further investigation and/or evaluation. All areas of elevated contamination should be identified and marked for further investigation and potential decontamination.

7.5.6 Gamma Surface Scans

Gamma scans are normally performed over unpaved land surface to identify locations of residual surface activity. Sodium iodide (NaI) gamma scintillation detectors (typically 2" x 2") are usually used for these scans.

Scanning may be performed by moving the detector in a serpentine pattern, while advancing at a rate of about 0.5 m (20 inches) per second. The distance between the detector and the surface should typically be maintained within approximately six inches. Audible signals should be monitored and locations of elevated direct levels should be flagged for further investigation and/or sampling. Scanning speed is calculated a priori to assure the MDC for scanning is appropriate for the stated objective of the survey. Adjustments to scan speed and distance may be made when necessary by the Project Health Physicist or the Radiation Protection Supervisor.

7.5.7 Removable Surface Contamination

Removable beta and/or alpha contamination or smear surveys are performed to verify loose surface contamination is less than the designated investigation level. A smear for removable activity is usually taken at each static measurement location. A 100 cm^2 surface area will be wiped with a circular cloth or paper filter, using moderate pressure. Smears will then be analyzed for the presence of gross beta and/or gross alpha activity as appropriate. This is typically done using a proportional counting system or equivalent. Additionally, 100 cm^2 surface area smears may be taken for Tritium and Carbon -14 and analyzed by LSC equipment.

7.5.8 Concrete and Asphalt Core Sampling

Concrete and asphalt core boring and sample collection are conducted to supplement the scans and static measurements and provide information regarding the potential penetration of radiological contamination in structural surfaces and paved areas. Core bore sampling of concrete typically involves manual hammering methods or diamond bit core drills, as necessary. Sampling in asphalt surfaces may involve the use of a jackhammer.

The concrete samples obtained for evaluating depth of radiological activation or contamination penetration in structural buildings are typically sliced into 1/2-inch wide "pucks", representing incremental depths into the surface. Scanning measurements are performed on the top and bottom of the pucks to determine contamination intrusion depth and/or the activation of the material. Concrete pucks are also pulverized and analyzed for radionuclide content which assists with the contamination depth study and activation of

material evaluation as well as validating the radionuclides of concern for the site and average percentage of activity by radionuclide considering the total activity level of the concrete sample. Asphalt samples are typically pulverized and analyzed for evaluation of contamination intrusion depths into the asphalt matrix.

7.5.9 Soil Sampling

Samples of soil will be obtained from designed judgmental and random sample locations as well as biased 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 meter increments. The depth of soil sampling required in the Class 1, 2, 3, and 4 will be defined in the survey packages and instructions.

Surface soil can be collected using a split spoon sampling system or, by using hand trowels, bucket augers or other suitable sampling tools. Subsurface soil is typically sampled by direct push sampling systems (e.g. GeoProbe methods). Subsurface soil sampling will be performed as necessary to address the DQOs for the survey unit. Typically only one subsurface sample at a depth of one meter will be required at a sampling location where both surface and subsurface samples are obtained. It is anticipated, however, that samples at additional depths may be required at select sampling locations such as along the effluent discharge piping pathway and beneath the Turbine Building and Waste Treatment Building.

A sufficient amount of material (e.g. may range from 0.5 liters up to 2 liters) will be collected at each location; the amount of material needed may also be defined by the requirement for split sampling and the volumes needed by on-site and off-site laboratories for the analysis DQOs. Sample preparation may include the removal of extraneous material and the homogenization and drying of the sample for analysis. Separate containers will be used for each sample and each container will be accounted for throughout the sampling and analysis process. Samples will be split when required in the survey instructions or as specified in the QAPP.

7.5.10 Background Measurements and Background Reference Materials

Background level assessments are necessary because the decommissioning unrestricted release criteria for surface activity and soil contamination are presented in terms of radiation or radioactivity levels above ambient levels at a decommissioning site. The considerations for selecting background reference areas include:

- The background location should be representative of the survey unit location and,
- The background location should be non-impacted from site operations.

Normally, the background reference areas should be reasonably close to the decommissioning site to be representative and generally upwind of site operations. However, if no suitable off-site location can be identified, then an on-site area expected to be non-impacted can be used. Based upon the previous radiological results summarized in the LTP [Reference 10-1], including the discussion in Section 2.5 – Background Considerations, the Project Health Physicist and the Radiation Protection

Supervisor will determine an appropriate area for the background measurements associated with soils.

In addition, as some subgrade and above-grade materials such as asphalt and concrete are expected to remain at the site and be subjected to FSS and/or MARSAME processes, surface material background reference information also needs to be obtained. Construction materials may exhibit significant variability based on the origin of the materials used in the construction of the material and may not exactly match the composition and age of the materials used during the construction of LACBWR. Therefore, it may be necessary to select on-site materials outside of the LSE area and confirm that they do not contain radionuclides of concern for further consideration and use as background reference materials. The radiological data obtained may also be beneficial for future decision making on the disposition of asphalt and concrete debris and soil generated during decommissioning and remediation operations. Possible options for asphalt and concrete could be materials present in the original Class 3 Survey Unit L3012101 (North of LACBWR) described in Rev 0 of this Plan or the G-3 Crib House concrete; i.e., the Crib House is basically the same vintage as the buildings of the LACBWR facility.

Once background locations are selected, a series of scanning and direct (static) measurements will be made on the identified asphalt, concrete and/or soil areas with the same instruments and procedures that will be implemented for the field characterization surveys. Samples will also be obtained from the background locations for asphalt and concrete and soil (surface and subsurface). It is anticipated that the minimum number of background reference samples collected may be approximately 15 each for asphalt, concrete, surface soil and subsurface soil. The sample locations will be indicated on a map or drawing of the background reference area. All measurements and sampling, including the specific number of measurements and samples, will be performed in accordance with the survey guidance and instructions associated with the respective Background Study Survey Package. Prior to conducting the background surveys and sampling, the Project Health Physicist and the Radiation Protection Supervisor will concur on the locations and approach.

7.6 Survey Implementation

When a survey package has been approved and prior to implementation, the Radiological Protection Supervisor will perform a pre-survey briefing with the Health Physics Technicians who will perform the survey. During the briefing, the survey package and its specific survey instructions will be reviewed. The survey package implementation may include the following:

- The set-up of the survey instrumentation,
- Check source and background radiation evaluation before and after each shift to ensure proper instrument operation,
- Performing preliminary inspections of the area to identify any additional specific survey instructions,
- Required measurements and samples in the survey unit,

- Locating and marking static measurement and/or sample locations using the coordinates or directions provided in the survey instructions,
- Measurement parameters such as required MDCs and counting times,
- Taking survey measurements and analyzing samples using appropriate calibrated instruments,
- Documentation of survey measurements and sample analysis data collected during the characterization and placement of information into the survey package, and,
- Review of the survey results to identify any areas exceeding the specific action levels.

Review of the completed survey packages to ensure that all required surveys have been performed.

7.6.1 Survey/Sample Measurement Location Codes

Each characterization survey media sample collected will have a unique survey location code associated with the sample. Table 7-3 Sample Unique Identification Designation presents the sample measurement unique identification designation system that will be used to identify sample types and locations.

Table 7-1 Sample & Measurement Unique Identification Designation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)

Classification & Survey Area

1st digit indicates type of Survey Area
L = Open Land Area
B = Structural Survey Area
S = System

2nd digit indicates Classification
1 = Class 1
2 = Class 2
3 = Class 3
4 = Non-impacted
5 = Unassigned

3rd, 4th and 5th digits indicate the Survey Area Number

Survey Unit Number & Sequence Indicator

6th and 7th digits indicate the Survey Unit Number

The 8th digit indicates alphanumeric sequence
(Sequence A-J) allows the survey unit to be divided into 10 smaller survey units.
(Sequence K-Z) allows for up to 16 different survey instructions for a single survey unit.

Survey and Measurement Type

The 9th digit indicates the type of survey.
B = Background
S = Scoping
C = Characterization
R = Remedial Action
F = FSS
I = Investigation
V = Verification
Q = QA/QC

The 10th digit indicates the type of measurement.
B = Background
R = Random
S = Systematic
J = Judgmental
I = Investigation
V = Verification
Q = QA/QC

Surface Type

The 11th digit indicates the type of surface where the measurement was taken.
F = Floor
W = Wall
C = Ceiling
S = System
R = Roof
P = Paved Road
G = Ground
L = Water

The 12th digit indicates the material composition of the surface where the measurement was taken.
C = Concrete
M = Metal
W = Wood
B = Cinder Block
K = Brick
A = Asphalt
S = Soil
T = Tar
L = Liquid

Sample or Measurement No.

The 13th, 14th and 15th digits indicate the alphanumeric measurement number
Sequentially, 001 through 999

Media Type

The 16th and 17th digits indicate the type of media that was sampled.
SS = Surface Soil
SB = Subsurface Soil
SM = Sediment
WT = Water
LQ = Other liquids besides water
OL = Oil
CV = Volumetric Concrete
AV = Volumetric Asphalt
MT = Metal
PT = Paint
SW = Smear Sample
BD = Beta Direct
AD = Alpha Direct
GD = Static Gamma measurement
BS = Beta Scan
GS = Gamma Scan
JS = Juncture Scan
JD = Juncture Direct
PS = Penetration Scan
PD = Penetration Direct

8.0 Quality Assurance and Quality Control

Energy*Solutions* possesses a USNRC-approved Quality Assurance Program; our QA Program meets the requirements of 10CFR50 Appendix B [Reference 10-20], ASME NQA-1 [Reference 10-21] , 10 CFR 71 Subpart H [Reference 10-22], and 10 CFR 72 subpart G [Reference 10-23]. Energy*Solutions*' Quality Assurance/Quality Control Programs will ensure that all quality and regulatory requirements are satisfied. All activities affecting quality will be controlled by written plans and procedures. The following Quality Assurance measures will be an integral part of the characterization survey.

8.1 Selection of Personnel

All management and supervisory personnel will have had experience in performing characterization surveys of nuclear or reactor facilities, and in implementing NUREG-1575 (MARSSIM). They will also be familiar with the requirements of this characterization survey plan, instrumentation to be used and all implementing procedures. The Health Physics Technicians supporting the characterization survey will also be familiar with the requirements of this characterization survey plan, instrumentation to be used and all implementing procedures for the project. All project personnel will have received satisfactory and documented radiation worker training within the last year.

8.2 Training

In addition to radiation worker training, all project personnel will receive site specific training that will include applicable site emergency procedures and safety orientation. All personnel will review all plans and procedures to be used in implementing this characterization survey. Document acknowledgement sheets will be used to document the review.

8.3 Written Plans and Procedures

All activities affecting quality will be controlled by written plans and procedures. This includes this Characterization Plan, a project-specific Quality Assurance Project Plan (QAPP) and key implementing procedures such as the following:

- CS-FO-PR-001, Performance of Radiological Surveys,
- CS-FO-PR-002, Calibration and Maintenance of Radiological Survey Instruments,
- CS-FO-PR-003, Soil Surveys; Collection of Water, Sediment, Vegetation and Soil Samples; and Chain-of-Custody Procedure, and,
- CS-FO-PR-004, QA/QC of Portable Radiological Survey Instruments.

8.4 Survey Documentation

Hard copies of all survey results will be maintained in survey packages. A separate survey package will be maintained for each survey area. As applicable, each measurement and sample result will be identified by date, technician, instrument type and serial number, detector type and serial number, location code etc. All completed survey packages will be reviewed by at least two individuals including the Radiation Protection Supervisor and the Project Health Physicist to ensure the package is complete and that the results adequately characterize the survey area.

8.5 Chain-of-Custody

All samples sent off-site for analysis will be accompanied by a chain-of-custody (COC) record to track the location of the sample and ensure that each sample receives the appropriate analysis. Upon receipt of sample analysis results, the results will be compared to the COC records to ensure all samples were analyzed and that the correct analyses were performed.

9.0 Characterization Survey Report

Following the completion of the characterization survey and the availability of all the off-site sample analysis results a draft characterization survey report will be prepared for Energy*Solutions* and DPC review. Once the characterization report has been reviewed and approved, it will be used to aid in the development of the LTP, including final DCGLs and the Final Status Survey Plan.

10.0 References

10-1 Energy*Solutions* "License Termination Plan", DRAFT revision October 2014

10-2 Dairyland Power Cooperative "LACBWR Decommissioning Plan and Post-Shutdown Decommissioning Activities Report (D-Plan/PSDAR), Revision March 2014

10-3 Dairyland Power Cooperative LAC-TR-138, "Initial Site Characterization Survey for SAFSTOR," Revision December 2009

10-4 Energy*Solutions* "Technical Basis Document RS-TD-313196-001, Radionuclides of Concern During the Decommissioning of the La Crosse Boiling Water Reactor," June 2014

10-5 U.S. Nuclear Regulatory Commission NUREG-1757, "Consolidated NMSS Decommissioning Guidance – Characterization, Survey and Determination of Radiological Criteria", Volume 2, Revision 1, September 2002

10-6 U.S. Nuclear Regulatory Commission NUREG/CR-5512, "Residual Radioactive Contamination From Decommissioning – Parameter Analysis", Volume 3, October 1999

10-7 U.S. Nuclear Regulatory Commission 10 CFR 20.1402, "Radiological criteria for unrestricted use."

10-8 U.S. Nuclear Regulatory Commission Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors" June 1975

10-9 U.S. Nuclear Regulatory Commission NUREG-1575, Supplement 1, "Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)," January 2009

10-10 US Nuclear Regulatory Commission NUREG-1575, Revision 1, "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", August 2000

10-11 Energy*Solutions* GP-EO-313196-QA-PL-001, "Quality Assurance Project Plan LACBWR Site Characterization Project"

10-12 U.S. Nuclear Regulatory Commission Regulatory Guide 1.179, "Standard Format and Content of License Termination Plans for Nuclear Power Reactors," Revision 1, June 2011

10-13 International Standard ISO 7503-1, "Evaluation of Surface Contamination-Part 1 Beta Emitters and Alpha Emitters," August 1988

10-14 Energy*Solutions* CS-FO-PR-001, "Performance of Radiological Surveys"

10-15 U.S. Nuclear Regulatory Commission NUREG -1507 "Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions," June 1998

10-16 Energy*Solutions* CS-FO-PR-002, "Calibration and Maintenance of Radiological Survey Instruments"

10-17 Energy*Solutions* CS-FO-PR-003, "Soil Surveys; Collection of Water, Sediment, Vegetation and Soil Samples; and Chain-of-Custody Procedure"

10-18 Energy*Solutions* CS-FO-PR-004, "QA/QC of Portable Radiological Survey Instruments"

10-19 Pacific Northwest National Laboratory software, "Visual Sample Plan", VSP Version 7.0

10-20 U.S. Nuclear Regulatory Commission 10 CFR 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"

10-21 American Society of Mechanical Engineers, ASME, NQA-1, "Quality Assurance Requirements for Nuclear Facilities Applications"

10-22 U.S. Nuclear Regulatory Commission 10 CFR 71, Subpart H, "Quality Assurance"

10-23 U.S. Nuclear Regulatory Commission 10 CFR 72, Subpart G, "Quality Assurance"