State of Wisconsin

2012

La Crosse Boiling Water Reactor

Environmental Radioactivity Survey

Wisconsin Department of Health Services
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State of Wisconsin, Department of Health Services

2012

La Crosse Boiling Water Reactor Environmental Monitoring Survey

Executive Summary

Wisconsin Public Health Statutes 254.41 mandates the State of Wisconsin, Department of Health Services to conduct environmental radiation monitoring around the nuclear power facilities that impact Wisconsin. This environmental monitoring report is for the La Crosse Boiling Water Reactor (LACBWR) nuclear generating plant for the calendar year January - December 2012 and provides a description and results of this environmental monitoring program.

The Wisconsin Department of Health Services' environmental monitoring program consists of the collection of various types of samples from the air, water and terrestrial exposure pathways, sample analysis and interpretation of the data. The sampling program included samples of air, ambient gamma radiation, surface water, fish, bottom sediment, soil and vegetation that are collected from selected locations at planned sampling intervals.

Program Summary

For 2012, all sample results from the LACBWR environmental monitoring area were less than state and federal standards or guidelines.

The Wisconsin Department of Health Services' environmental monitoring programs provide an ongoing baseline of radioactivity measurements to access any Wisconsin health concerns from the operation of nuclear power generating facilities in or near Wisconsin or other radiological incidents that may occur within Wisconsin or worldwide. These monitoring programs show the following:

- Environmental radioactivity levels have been trending downward in the time period since the 1950's-1960's atmospheric nuclear testing and such radiological incidents as the Chernobyl nuclear reactor incident.
- There were no incidents during 2012, such as the 2011 Japan Fukushima Daiichi incident, that required additional environmental monitoring.
- There is no radioactive problem in types of food consumed in Wisconsin or a health problem for Wisconsin citizens.

The ongoing environmental monitoring programs will continue to provide assurances to the citizens of Wisconsin that the environment surrounding the LACBWR nuclear power facility and other monitoring areas will continue to be evaluated.

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Introduction

Wisconsin Public Health Statutes 254.41 mandates the Wisconsin (WI) Department of Health Services (DHS) to conduct environmental radiation monitoring around the nuclear power facilities that impact Wisconsin. This environmental monitoring report is for the La Crosse boiling water reactor (LACBWR) for the calendar year January - December 2012 and provides a description and results of this environmental monitoring program.

WI DHS LACBWR Environmental Monitoring Sampling Program

The WI DHS environmental monitoring program consists of the collection of various types of samples from the air, water and terrestrial exposure pathways. The sampling program included samples of air, ambient gamma radiation as measured by thermoluminescent dosimeters (TLD), surface water, fish, bottom sediments, soil and vegetation that are collected from selected locations at planned sampling intervals.

Table 1 is a listing of sampling sites and includes a description, direction and distance from the monitored power plant. Table 2 provides a listing of the types of samples collected, sites where samples are collected, the number of samples collected, number of samples that were missed or had noted problems and a listing of the required analyses. Table 3 provides an explanation of missing samples or non-routine sample analyses. Figure 1 is a map showing the location of each environmental sampling site.

Program Modifications

On April 30, 1987, Dairyland Power Cooperative permanently shut down the LACBWR facility. Their USNRC (United States Nuclear Regulatory Commission) licensee was amended to a possess-but-not-operate status on August 4, 1987 and they are now in the process of decommissioning the LACBWR facility. Since any severe accident involving the stored spent fuel will have little offsite consequences, the WI DHS environmental radioactivity monitoring program was modified in June 1988. These modifications included the elimination of precipitation, shoreline sediment and well water samples as well as a reduction in vegetation, soil and some surface water sampling.

In response to this and considering other funding restrictions, the LACBWR environmental monitoring program was reviewed and further modified in 1998, 1999 and 2000. Table 1 is a listing of presently used sampling sites that have been renumbered after eliminating sample sites that have been discontinued. Sampling sites that have been discontinued were last listed as sampling sites in WI DHS' environmental monitoring report for the La Crosse boiling water reactor (LACBWR) for the calendar year of January - December 1999.

Due to funding restrictions and the future relocation of the spent fuel to the LACBWR Independent Spent Fuel Storage Installation (ISFSI), program modifications were implemented beginning in the 3rd quarter of 2010.

Beginning the 1st quarter of 2011, two additional TLD sites were placed on the outside ISFSI fence.

There were no further program modifications done in 2012.

Laboratory Services and Quality Assurance

The analysis of the samples is performed under contract with the Wisconsin State Laboratory of Hygiene (WSLH). WSLH maintains a quality assurance program. Analytical procedures provide for routine replicate analyses to verify methods and instrument operation. Traceable sources are used to regularly calibrate the counters and daily performance checks are made between calibrations. In addition, quality control charts are maintained on the counters.

WSLH participates in the Environmental Resource Associates' Proficiency Testing program and has performed satisfactorily over the report period. Proficiency testing results are available from the Wisconsin State Laboratory of Hygiene.

Detection Limits

Detection limits, required by WI DHS, will be expressed as a lower limit of detection (LLD). The required WI DHS LLD as indicated in Table 4 under the heading "LLD" is an "a priori" estimate of the capability for detecting an activity concentration by a given measurement system, procedure, and type of sample. Counting statistics of the appropriate instrument background are used to compute the LLD for each specific analysis. Using 4.66 times the standard deviation (s_b) of the instrument background, the LLD for each specific analysis is defined at the 95% Confidence Level.

The LLD for each radioisotope listed in Table 4 has been calculated from the following equation:

$$LLD = \frac{4.66\, s_b}{E * V * 2.22 * Y * S * \exp(-dt)}$$

Where:

LLD	is the "a priori" lower limit of detection as defined above, as picocuries per unit mass or volume,
s_b	is the standard deviation of the background counting rate or of the counting rate of blank sample as appropriate, as counts per minute,
E	is the counting efficiency, as counts per disintegration,
V	is the sample size in units of mass or volume,
2.22	is the number of disintegrations per minute per picocurie,
Y	is the fractional radiochemical yield, when applicable,
S	is the self-absorption correction factor,
d	is the radioactive decay constant for the particular radionuclide, and
t	for environmental samples is the elapsed time between sample collection, or end of the sample collection period, and time of counting.

Typical values for E, V, Y and dt have been used to calculate the LLD.

Reporting of Sample Analysis Results

Results for specific analyses will be reported as either a "less than" (<) value or an actual activity value. The reporting of results in Table 4 under the heading "Range" and in Tables 5-11 are "a posteriori" calculations based on the actual analysis performed using the actual sample values for E, V, Y and dt. Typically the reported "less than" (<) results are lower than the required WI DHS LLD indicating that the required WI DHS LLD has been met.

An actual activity value will be accompanied by an uncertainty term for that analysis. The uncertainty term is a plus or minus counting uncertainty term at the 2 sigma (95%) confidence interval and is

printed as (+- or ±). Examples and explanations of data reporting are:

Example	Nuclide	Activity reported
1	^{137}Cs	< 10 pCi/liter
2	^{137}Cs	15 ± 3 pCi/liter

In example 1 we can be 95% confident that the sample activity, if any, is less than the LLD of 10 pCi/liter. In example 2 we can be 95% confident that the actual sample activity is greater than the LLD for that analysis and is between 12 and 18 pCi/liter.

Table 1. WI DHS LACBWR environmental monitoring sampling sites.

Sample site	Distance and direction (miles)	Location description
LAC-1	15.0 N	La Crosse State Office Building (discontinued July 2010)
LAC-2	0.6 N	Lock & Dam #8
LAC-3	0.1 WSW	Discharge channel
LAC-4	0.7 SSW	Boat launch area
LAC-5	0.6 NNE	Hwy 35 parking lot
LAC-6	0.7 S	Boat launch access road
LAC-7	0.8 ENE	Philip Malin farm (discontinued January 2001)
LAC-T1	0.6 N	Lock & Dam #8
LAC-T2	2.0 E	Radio tower, Mound Ridge road
LAC-T3	0.5 SSE	Trailer court, Hwy 35
LAC-T4	15.0 N	La Crosse State Office Building
LAC-T5	0.2 S	ISFSI outside fence - west
LAC-T6	0.2 S	ISFSI outside fence - west

Table 2. Sample collection summary and required analyses for 2012.

Sample Type	Collection and Frequency	LAC Site locations	Number of Samples Collected	Number of Sample Deviations	Required Analyses
air particulate	C/BW	2	26	0	GA, GB, GI
TLD	G/Q	T1-T6	24	0	direct exposure
surface water	G/Q	2, 3	8	0	GA, GB, GI, Sr, H
bottom sediment	G/A	2, 3, 4	3	0	GA, GB, GI
fish	G/SA	3	4	0	GI
vegetation	G/SA	5, 6	4	0	GA, GB, GI
soil	G/SA	5, 6	4	0	GA, GB, GI

Collection type: C/ = continuous; G/ = grab

Frequency: /W = weekly; /M = monthly; /Q = quarterly; /A = annually; /BW = bi-weekly; /SA = semi-annually

Required analyses: GA = gross alpha; GB = gross beta; GI = gamma isotopic; Sr = strontium; H = tritium

Table 3. WI DHS missing sample or non-routine analysis report for 2012.

Sample type	Date	Site	Explanation
			There were no missing samples or non-routine analyses.

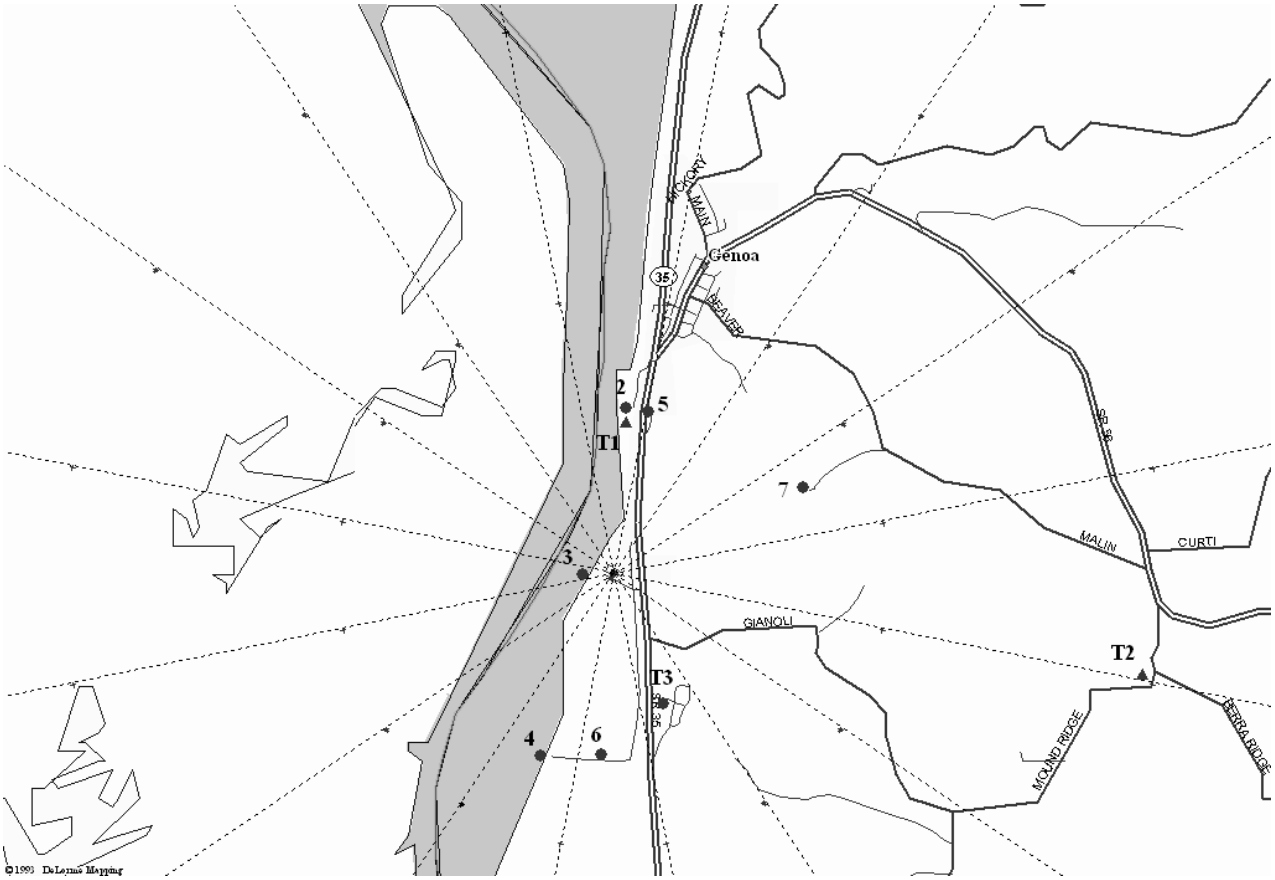

Figure 1. LACBWR environmental monitoring sampling sites.

Results and Discussion for the LACBWR Environmental Monitoring Program

Air Particulate

A summary of reported activities by WI DHS for air particulate samples is included in Table 4. Results from the individual sample analyses are listed in Tables 5 and 6.

From the bi-weekly and quarterly gross beta activities listed in Table 5 it may be noted that there are no significant differences from gross beta activities in the three other WI DHS environmental monitoring programs. With no significant differences, an increase in gross beta activity attributable to the LACBWR facility is not evident.

The gamma isotopic analysis of the quarterly air particulate filter composites detected only small amounts of the radioisotopes listed in Table 4. Beryllium-7 (^{7}Be), detected in all composites, is a naturally occurring radioisotope that is constantly produced through nuclear reactions between cosmic rays and nuclei in the atmosphere. It is detected in air composites from other areas of the state on a routine basis. Influence by the LACBWR facility on air quality is not evident from air particulate analysis.

Ambient Gamma Radiation - Thermoluminescent Dosimeters (TLDs)

A summary of reported activities by WI DHS for ambient gamma radiation is included in Table 4. Results from the individual sample analyses are listed in Table 7.

Ambient gamma radiation (TLD) data for 2012 from the WI DHS network was comparable for all sites. Significant differences in exposure were not noticed at different distances from the LACBWR facility. The average quarterly exposure from the four sites located within Wisconsin was 15.7 $\pm$ 2.3 milliroentgens. The average quarterly exposure for 2012 is at background levels and is comparable to other areas within Wisconsin. Influence by the LACBWR facility is not evident from air ambient gamma radiation analysis.

Fish

A summary of reported activities by WI DHS for fish samples is included in Table 4. Results from the individual sample analyses are listed in Table 8.

The fish samples showed no unusual activities. Naturally occurring potassium-40 (^{40}K) was reported in all samples. All other radioisotopes were below their respective lower limit of detection. Influence by the LACBWR facility is not evident from fish sample analysis.

Bottom sediments

A summary of reported activities by WI DHS for bottom sediment samples is included in Table 4. Results from the individual sample analyses are listed in Table 9.

The naturally occurring radioisotope potassium-40 (^{40}K) was detected in all samples. The gamma isotopic analysis of the bottom sediment samples taken at sites LAC-3 and LAC-4 detected small activities for cesium-137 (^{137}Cs). The reported activities for cesium-137 (^{137}Cs) can be attributed to past effluent discharges from the LACBWR facility and have also been detected in previous years. Naturally occurring radioisotopes from the uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported. Influence by the LACBWR facility is not evident from bottom sediment sample analysis.

Surface Water

A summary of reported activities by WI DHS for surface water samples is included in Table 4. Results from the individual sample analyses are listed in Table 10.

The surface water samples showed no unusual activities. All detected activities are at background levels and are comparable to data from previous years. The surface water samples uniformly show activities below state or federal standards. Influence by the LACBWR facility is not evident from surface water sample analysis.

Vegetation

A summary of reported activities by WI DHS for vegetation samples is included in Table 4. Results from the individual sample analyses are listed in Table 11.

Analysis of the vegetation samples showed no unusual activities. The gamma isotopic analysis detected only small amounts of naturally occurring potassium-40 (^{40}K) and beryllium-7 (^{7}Be) listed in Table 4. Influence by the LACBWR facility is not evident from vegetation sample analysis.

Soil

A summary of reported activities by WI DHS for soil samples is included in Table 4. Results from the individual sample analyses are listed in Table 11.

Analysis of the soil samples showed no unusual activities. The gamma isotopic analysis detected only small amounts of the radionuclides listed in Table 4. The naturally occurring radioisotope potassium-40 (^{40}K) was detected in all samples. The reported activities for cesium-137 (^{137}Cs) were also detected in previous years and can be attributed to residual fallout from previous atmospheric nuclear weapons tests. Naturally occurring radioisotopes from the uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported. Influence by the LACBWR facility is not evident from soil sample analysis.

Dose to an Average Individual

Federal regulations 10 CFR 20, 10 CFR 50 Appendix I and 40 CFR 190 restrict the annual exposure of the population from all parts of the nuclear fuel cycle, including nuclear power plants. Doses resulting from gaseous and liquid effluent releases from the LACBWR facility are less than the limits as stated in these Federal regulations.

The WI DHS limits for permissible levels of radiation exposure from external sources in unrestricted areas are defined in the Wis. Adm. Code section DHS 157.23. Doses resulting from gaseous and liquid effluent releases from the LACBWR facility are less than the limits as stated in Wis. Adm. Code section DHS 157.23.

References

State of Wisconsin, Wisconsin Administrative Code, DHS 157.23

U.S. Environmental Protection Agency, Environmental Radiation Requirements for Normal Operations of Activities in the Uranium Fuel Cycle, EPA 520/4-76-016, 40 CFR Part 190, November 1976.

U.S. Nuclear Regulatory Commission, Title 10, Part 20.

U.S. Nuclear Regulatory Commission, Title 10, Part 50, Appendix I.

Table 4. Sample activity summary for the WI DHS LACBWR environmental monitoring program.

Sample type (units)	LLD	Number of samples [a]	Analysis	Range
Air Particulate	0.003	26 / 26	gross beta	0.012 - 0.039
(pCi/m^3)			gamma isotopic	
	0.020	4 / 4	Be-7	0.042 - 0.095
	0.002	4 / 0	Mn-54	< 0.0005
	0.002	4 / 0	Co-58	< 0.0004
	0.005	4 / 0	Fe-59	< 0.0012
	0.002	4 / 0	Co-60	< 0.0007
	0.005	4 / 0	Zn-65	< 0.0009
	0.002	4 / 0	Nb-95	< 0.0005
	0.005	4 / 0	Zr-95	< 0.0008
	0.002	4 / 0	Ru-103	< 0.0007
	0.015	4 / 0	Ru-106	< 0.0037
	0.020	4 / 0	I-131	< 0.0020
	0.002	4 / 0	Cs-134	< 0.0005
	0.002	4 / 1	Cs-137	< 0.0006
	0.030	4 / 0	Ba-140	< 0.0042
	0.020	4 / 0	La-140	< 0.0016
	0.002	4 / 0	Ce-141	< 0.0009
	0.005	4 / 0	Ce-144	< 0.0029
Direct Exposure	1.0 [c]	24 / 24	direct exposure	10.3 – 19.9
(mR/Std Qtr)				
Surface Water	3.0	8 / 6	gross beta (sol)	< 2.3 – 2.6
(pCi/liter)	3.0	8 / 0	gross beta (insol)	< 2.9
	3.0	8 / 0	gross alpha (sol)	< 2.4
	3.0	8 / 0	gross alpha (insol)	< 3.1
	300	8 / 0	H-3	< 199
	2.0	8 / 2	Sr-89	< 1.6 – 0.7
	1.0	8 / 1	Sr-90	< 0.7 – 1.1
			gamma isotopic	
	10	8 / 0	Mn-54	< 10
	15	8 / 0	Co-58	< 10
	30	8 / 0	Fe-59	< 23
	15	8 / 0	Co-60	< 12
	30	8 / 0	Zn-65	< 20
	15	8 / 0	Nb-95	< 10
	30	8 / 0	Zr-95	< 17
	15	8 / 0	I-131	< 14
	15	8 / 0	Cs-134	< 11
	15	8 / 0	Cs-137	< 12
	60	8 / 0	Ba-140	< 47
	15	8 / 0	La-140	< 13

Table 4. Sample activity summary for the WI DHS LACBWR environmental monitoring program, continued.

Sample type (units)	LLD	Number of samples [a]	Analysis	Range
Bottom Sediment	6000	3 / 3	gross beta	4780 – 18300
(pCi/kg dry)	13000	3 / 1	gross alpha	< 6420 – 14600
			gamma isotopic	
	800	3 / 3	K-40	4540 – 13100
	60	3 / 0	Mn-54	< 27
	90	3 / 0	Co-58	< 38
	600	3 / 0	Fe-59	< 73
	90	3 / 0	Co-60	< 28
	300	3 / 0	Zn-65	< 62
	100	3 / 0	Nb-95	< 48
	250	3 / 0	Zr-95	< 70
	80	3 / 0	Cs-134	< 21
	80	3 / 2	Cs-137	< 16 - 200
Vegetation	5000	4 / 0	gross alpha	< 3610
(pCi/kg wet)	4000	4 / 4	gross beta	5580 – 10200
			gamma isotopic	
	600	4 / 3	Be-7	< 260 – 2310
	2000	4 / 4	K-40	5800 – 7080
	90	4 / 0	Mn-54	< 40
	100	4 / 0	Co-58	< 29
	200	4 / 0	Fe-59	< 66
	100	4 / 0	Co-60	< 48
	250	4 / 0	Zn-65	< 81
	100	4 / 0	Nb-95	< 38
	200	4 / 0	Zr-95	< 73
	80	4 / 0	I-131	< 50
	80	4 / 0	Cs-134	< 40
	90	4 / 0	Cs-137	< 55
	350	4 / 0	Ba-140	< 152
	100	4 / 0	La-140	< 47
fish			gamma isotopic	
(pCi/kg wet)	800	4 / 4	K-40	2840 – 3390
	50	4 / 0	Mn-54	< 13
	60	4 / 0	Co-58	< 13
	130	4 / 0	Fe-59	< 41
	60	4 / 0	Co-60	< 14
	130	4 / 0	Zn-65	< 30
	50	4 / 0	Nb-95	< 15
	100	4 / 0	Zr-95	< 22
	50	4 / 0	Cs-134	< 10
	60	4 / 0	Cs-137	< 15

Table 4. Sample activity summary for the WI DHS LACBWR environmental monitoring program, continued.

Sample type (units)	LLD	Number of samples [a]	Analysis	Range
soil	6000	4 / 4	gross beta	14600 – 39200
(pCi/kg dry)	13000	4 / 3	gross alpha	< 8130 – 19900
			gamma isotopic	
	800	4 / 4	K-40	12000 – 33100
	60	4 / 0	Mn-54	< 30
	90	4 / 0	Co-58	< 25
	600	4 / 0	Fe-59	< 74
	90	4 / 0	Co-60	< 37
	300	4 / 0	Zn-65	< 72
	100	4 / 0	Nb-95	< 31
	250	4 / 0	Zr-95	< 55
	80	4 / 0	Cs-134	< 23
	80	4 / 2	Cs-137	< 18 – 160

a - Number of analysis / number of analyses detected above the WI DHS LLD.
b – LLD activities expressed in units of pCi/liter.
c - 1.0 mR / TLD.

Table 5. WI DHS air particulate gross beta analysis results from the LACBWR environmental monitoring program.

Measurements in units of pCi/m^3

Site: LAC-2; Lock & Dam #8

Collection date	volume m^3	Air particulate	Collection date	volume m^3	Air particulate
01/09/12	1,065	0.021 +- 0.002	07/09/12	981	0.024 +- 0.002
01/23/12	1,141	0.029 +- 0.002	07/23/12	947	0.024 +- 0.002
02/06/12	1,138	0.028 +- 0.002	08/06/12	964	0.022 +- 0.002
02/21/12	1,222	0.023 +- 0.001	08/20/12	1006	0.015 +- 0.001
03/05/12	1,057	0.021 +- 0.002	09/04/12	1082	0.030 +- 0.002
03/20/12	1,194	0.022 +- 0.001	09/17/12	948	0.020 +- 0.002
04/03/12	1,105	0.012 +- 0.001	10/01/12	1009	0.018 +- 0.001
1st Qtr mean +- s.d.		0.022 +- 0.006	3rd Qtr mean +- s.d.		0.022 +- 0.005
04/16/12	1060	0.016 +- 0.001	10/15/12	1015	0.021 +- 0.002
04/30/12	1074	0.018 +- 0.001	10/29/12	1020	0.023 +- 0.002
05/14/12	1085	0.012 +- 0.001	11/12/12	1128	0.021 +- 0.001
05/29/12	1152	0.020 +- 0.001	11/26/12	1128	0.039 +- 0.002
06/11/12	973	0.014 +- 0.001	12/11/12	1208	0.036 +- 0.002
06/25/12	1026	0.016 +- 0.001	12/27/12	1297	0.031 +- 0.002
2nd Qtr mean +- s.d.		0.016 +- 0.003	4th Qtr mean +- s.d.		0.029 +- 0.008

Table 6. WI DHS gamma isotopic analysis results from the quarterly composites of air particulate filters collected from the LACBWR environmental monitoring program.

Measurements in units of pCi/m^3

Site: LAC-1	1st quarter	2nd quarter	3rd quarter	4th quarter
Be-7	0.059 +- 0.009	0.074 +- 0.008	0.095 +- 0.006	0.042 +- 0.008
Mn-54	< 0.0005	< 0.0004	< 0.0002	< 0.0004
Co-58	< 0.0004	< 0.0004	< 0.0002	< 0.0004
Fe-59	< 0.0012	< 0.0012	< 0.0005	< 0.0008
Co-60	< 0.0007	< 0.0004	< 0.0003	< 0.0005
Zn-65	< 0.0008	< 0.0007	< 0.0004	< 0.0009
Nb-95	< 0.0004	< 0.0004	< 0.0003	< 0.0005
Zr-95	< 0.0008	< 0.0006	< 0.0004	< 0.0004
Ru-103	< 0.0007	< 0.0004	< 0.0003	< 0.0003
Ru-106	< 0.0037	< 0.0030	< 0.0018	< 0.0029
I-131	< 0.0020	< 0.0013	< 0.0019	< 0.0014
Cs-134	< 0.0005	< 0.0003	< 0.0002	< 0.0004
Cs-137	< 0.0006	< 0.0004	< 0.0003	< 0.0004
Ba-140	< 0.0042	< 0.0025	< 0.0029	< 0.0026
La-140	< 0.0016	< 0.0011	< 0.0011	< 0.0011
Ce-141	< 0.0009	< 0.0005	< 0.0005	< 0.0006
Ce-144	< 0.0029	< 0.0016	< 0.0013	< 0.0018

Radioisotopes other than those reported were not detected.

Table 7. WI DHS TLD network for the LACBWR environmental monitoring program.

	1st quarter	**2nd quarter**	**3rd quarter**	**4th quarter**
Date Placed:	01/10/12	04/10/12	07/09/12	10/09/12
Date Removed:	04/10/12	07/09/12	10/09/12	01/08/13
Days in the Field:	91	90	92	91
	Individual quarterly date is reported as: mR / Standard Quarter + 2 sigma counting error.			
LAC-T1	15.4 +- 1.0	13.4 +- 0.7	14.6 +- 0.9	15.8 +- 0.9
LAC-T2	18.6 +- 0.9	10.3 +- 0.6	12.5 +- 0.6	12.2 +- 0.6
LAC-T3	13.5 +- 0.6	16.4 +- 0.5	18.2 +- 0.9	19.9 +- 1.0
LAC-T4	17.9 +- 1.6	14.6 +- 0.9	17.0 +- 0.9	17.6 +- 1.1
LAC-T5	15.3 +- 1.2	15.1 +- 0.7	17.0 +- 2.0	18.7 +- 0.5
LAC-T6	15.5 +- 0.8	14.3 +- 0.5	16.0 +- 0.9	17.5 +- 0.5

Table 8. WI DHS analysis results for fish samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/kilogram (wet)

Collection date:	06/07/12	06/07/12	09/26/12	09/26/12
Type	pike	Carp	sheephead	sheephead
gamma isotopic				
K-40	3390 +- 570	2840 +- 540	3100 +- 560	2990 +- 550
Mn-54	< 9	< 13	< 11	< 10
Co-58	< 10	< 13	< 11	< 13
Fe-59	< 26	< 41	< 28	< 28
Co-60	< 11	< 14	< 13	< 12
Zn-65	< 19	< 30	< 24	< 21
Nb-95	< 15	< 14	< 11	< 13
Zr-95	< 21	< 22	< 19	< 21
Cs-134	< 9	< 10	< 9	< 10
Cs-137	< 10	< 9	< 15	< 10

Radioisotopes other than those reported were not detected.

Table 9. WI DHS analysis results for bottom sediment samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/kilogram (dry)

Collection date:	06/07/12	06/07/12	06/07/12
Site	LAC-2	LAC-3	LAC-4
gross alpha	< 6420	< 6000	14600 +- 5360
gross beta	4950 +- 1330	4780 +- 1500	18300 +- 1960
gamma isotopic			
K-40	4540 +- 790	5880 +- 980	13100 +- 2180
Mn-54	< 16	< 12	< 27
Co-58	< 17	< 11	< 38
Fe-59	< 40	< 36	< 73
Co-60	< 17	< 15	< 28
Zn-65	< 26	< 28	< 62
Nb-95	< 26	< 22	< 48
Zr-95	< 35	< 26	< 70
Cs-134	< 12	< 12	< 21
Cs-137	< 16	19 +- 8	200 +- 40

Naturally occurring radioisotopes such as radium-226 (^{226}Ra), bismuth-214 (^{214}Bi), lead-214 (^{214}Pb), actinium-228 (^{228}Ac), bismuth-212 (^{212}Bi), lead-212 (^{212}Pb) from the naturally occurring uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported.

Radioisotopes other than those reported were not detected.

Table 10. WI DHS analysis results for surface water samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/liter

LAC-2; Lock & Dam #8

Collection date:	01/10/12	04/10/12	07/09/12	10/09/12
gross alpha-sol	< 1.5	< 1.5	< 2.4	< 1.5
gross beta-sol	1.9 +- 0.6	2.4 +- 0.6	1.9 +- 1.1	1.7 +- 0.6
gross alpha-insol	< 1.0	< 0.9	< 0.8	< 0.8
gross beta-insol	< 1.1	< 0.8	< 1.3	< 0.9
H-3	< 178	< 179	< 180	< 199
Sr-89	< 0.3	< 0.4	0.6 +- 0.2	< 1.6
Sr-90	< 0.3	< 0.3	< 0.4	< 0.7
gamma isotopic				
Mn-54	< 9	< 8	< 9	< 5
Co-58	< 7	< 6	< 9	< 5
Fe-59	< 18	< 14	< 13	< 10
Co-60	< 10	< 9	< 12	< 6
Zn-65	< 19	< 14	< 17	< 11
Nb-95	< 8	< 8	< 8	< 5
Zr-95	< 12	< 12	< 13	< 10
I-131	< 11	< 9	< 12	< 6
Cs-134	< 8	< 7	< 9	< 6
Cs-137	< 7	< 10	< 11	< 6
Ba-140	< 40	< 34	< 38	< 17
La-140	< 12	< 10	< 12	< 7

LAC-3; discharge channel

Collection date:	01/10/12	04/10/12	07/09/12	10/09/12
gross alpha-sol	< 1.2	< 2.1	< 1.8	< 1.7
gross beta-sol	1.8 +- 0.5	< 2.3	< 1.5	2.6 +- 0.6
gross alpha-insol	< 0.9	< 3.1	< 1.0	< 0.8
gross beta-insol	< 1.1	< 2.9	< 1.5	< 1.0
H-3	< 178	< 179	< 180	< 199
Sr-89	< 0.3	< 0.5	0.7 +- 0.2	< 1.6
Sr-90	< 0.3	< 0.3	< 0.5	1.1 +- 0.5
gamma isotopic				
Mn-54	< 10	< 8	< 7	< 4
Co-58	< 10	< 8	< 9	< 4
Fe-59	< 23	< 14	< 11	< 7
Co-60	< 12	< 8	< 11	< 5
Zn-65	< 20	< 18	< 16	< 8
Nb-95	< 10	< 7	< 7	< 4
Zr-95	< 17	< 17	< 12	< 8
I-131	< 14	< 11	< 10	< 5
Cs-134	< 11	< 8	< 9	< 5
Cs-137	< 12	< 8	< 9	< 5
Ba-140	< 47	< 27	< 38	< 16
La-140	< 13	< 11	< 13	< 7

Radioisotopes other than those reported were not detected.

Table 11. WI DHS analysis results for vegetation and soil samples collected for the LACBWR environmental monitoring program.

Vegetation - Measurements in units of pCi/kilogram (wet)

Site:	LAC-5	LAC-6	LAC-5	LAC-6
Collection date:	06/12/12	06/12/12	09/24/12	09/24/12
gross alpha	< 3610	< 2640	< 2550	< 2640
gross beta	10200 +- 1470	7860 +- 1090	5580 +- 580	5650 +- 590
gamma isotopic				
Be-7	1000 +- 240	< 260	1980 +- 110	2310 +- 470
K-40	7080 +- 1370	6080 +- 1180	5950 +- 930	5800 +- 1220
Mn-54	< 24	< 19	< 4	< 40
Co-58	< 24	< 16	< 4	< 29
Fe-59	< 63	< 55	< 10	< 66
Co-60	< 33	< 24	< 5	< 48
Zn-65	< 59	< 60	< 11	< 81
Nb-95	< 26	< 22	< 4	< 38
Zr-95	< 34	< 46	< 6	< 73
I-131	< 38	< 34	< 4	< 50
Cs-134	< 24	< 25	< 4	< 40
Cs-137	< 28	< 17	< 4	< 55
Ba-140	< 126	< 109	< 14	< 152
La-140	< 47	< 30	< 4	< 42

Soil - Measurements in units of pCi/kilogram (dry)

Site:	LAC-5	LAC-6	LAC-5	LAC-6
Collection date:	06/12/12	06/12/12	09/24/12	09/24/12
gross alpha	14900 +- 7540	19900 +- 8150	< 8130	9980 < 5280
gross beta	39200 +- 4060	21700 +- 3530	30400 +- 2220	14600 +- 1760
gamma isotopic				
K-40	33100 +- 5260	12300 +- 2000	26900 +- 4290	12000 +- 1850
Mn-54	< 30	< 19	< 27	< 5
Co-58	< 25	< 18	< 25	< 5
Fe-59	< 74	< 38	< 65	< 10
Co-60	< 34	< 19	< 37	< 5
Zn-65	< 72	< 41	< 65	< 11
Nb-95	< 26	< 19	< 31	< 5
Zr-95	< 50	< 34	< 55	< 8
Cs-134	< 23	< 17	< 23	< 4
Cs-137	150 +- 30	< 18	160 +- 40	< 4

Naturally occurring radioisotopes such as radium-226 (^{226}Ra), bismuth-214 (^{214}Bi), lead-214 (^{214}Pb), actinium-228 (^{228}Ac), bismuth-212 (^{212}Bi), lead-212 (^{212}Pb) from the naturally occurring uranium-238 (^{238}U) and thorium-232 (^{232}Th) decay series are commonly detected but have not been quantified or reported.

Radioisotopes other than those reported were not detected.