national accelerator laboratory
P. O. Box 500, Batavia, Illinois 60510

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I. ENVIRONMENTAL MONITORING REPORT
FOR CALENDAR YEAR 1971

F. Schamber and S. Baker

July 14, 1972

II. Introduction

The National Accelerator Laboratory facility is a 200 GeV proton synchrotron. The primary purpose of the installation is fundamental research in high-energy physics. The 1.2 mile diameter main accelerator (Fig. 1) receives 8 GeV protons from a booster accelerator which is fed by a 200 MeV linear accelerator (linac). The linac receives protons from an ion source via a Cockroft-Walton accelerator. Radioactivity is produced as a result of the interaction of the high-energy protons with matter. Most of this radioactivity will be contained in insoluble shields and beam dumps. Operation of the accelerator at full design energy and intensity will produce some radiation which penetrates the shielding as well as some air-borne activity. Also, some radioactivation of soil will occur. Thus, a broad program of environmental monitoring is being maintained.

III. Summary

During this reporting period, the pre-accelerator components (Cockroft-Walton, 200 MeV Linac, 8 GeV Booster synchrotron) were operated to design energy but at reduced current. The main accelerator was operated in the injection mode (no acceleration). No extraction from the main accelerator to the targeting areas was attempted. Therefore, accelerator produced radiation and radioactivity during this reporting period was negligible with respect to applicable environmental protection standards and the data recorded can be regarded as indicative of normal background levels.

A central monitoring station is maintained for detecting penetrating radiation. The detectors in this station are described in Section IV. The three gamma sensitive monitors have indicated natural-background-level exposures of 0.006 to 0.007 milliRoentgens/hour. The neutron monitors have indicated an average flux of approximately 17 n/(cm^2-hr), which is consistent with the expected cosmic-ray neutron background.

Since no beam was extracted from the accelerator and the coasting beam intensities were quite low, operations during this reporting period could not have produced measurable quantities of air-borne radioactivity. Hence, no air-monitoring was performed. Monthly water samples were taken at various locations on the site and analyzed for the presence of those radionuclides which have been experimentally determined to be produced and to be leachable from National Accelerator Laboratory (NAL) soils in measurable quantities. No measurable concentrations of accelerator produced radionuclides were found in any of the water systems. The data recorded can be regarded as indicative of normal background levels.

There were no unusual incidents or releases during the reporting period. Thus, no evidence has been found to indicate that the operations of the NAL facility during the calendar year 1971 have in any way increased the environmental radiation levels in the vicinity of the site. In addition, there were no non-radioactive materials produced in quantities which could pollute the environment, and there were no abnormal occurrences which could have resulted from or have had some impact upon the facility or its operation.

IV. Monitoring, Data Collection, Analysis and Evaluation

Three types of accelerator produced radiation meriting monitoring for environmental purposes are discussed below.

A. Penetrating Radiation

Operation of the accelerator at full design energy and intensity will inevitably result in production of some penetrating radiation (primarily neutrons and muons) outside the shielding. Although the shielding has been designed to be adequate for foreseeable circumstances, monitoring for purposes of determining actual radiation levels both on and off the site is necessary.

A central monitoring station is maintained in the NAL site "village" for detecting penetrating radiation. The monitoring equipment consists of five major components.

1. Aluminum-Argon ionization chamber. This chamber is mostly sensitive to muons and gammas, and much less sensitive to neutrons. The data is recorded as daily integrals of the ionization current. A continuous strip-chart record of ionization current is also made.

2. Tissue-equivalent ionization chamber. This chamber is sensitive to neutrons as well as gammas and directly ionizing radiations. The data is recorded as daily integrals of the ionization current and as a strip-chart record of ionization current.

3. A 3 in x 3 in NaI(Tl) radiation ratemeter. This device is sensitive primarily to gamma radiation above 100 keV. The data is recorded as daily integrals of the counts and as a strip-chart record of count rate.

4. Bonner spectrometer. This device is an array of moderating hydrogenous spheres with thermal-neutron sensitive $Li^6I(Eu)$ scintillators located at the center of each sphere. The data is recorded as the daily integral of counts in each detector. It may be unfolded by a computer program to obtain the neutron flux and dose.

5. Precision reproducible (DePangher) long counter. This device is a BF_3 proportional counter moderated by polyethylene to obtain an essentially energy independent response to neutrons up to about 14 MeV. The count rate from this device is thus a measure of neutron flux. The data is recorded as daily integrals of neutron counts.

No evidence of accelerator induced radiation was seen by any detector. The radiation level has remained relatively stable throughout the reporting period at a value consistent with natural background exposures. The results were given in Section III.

B. Air-borne Radioactivity

Under normal operation of certain of the beam dumps and target boxes, radioactivation of air may occur. Monitoring of such activation will be carried out for purposes of personnel exposure control. Under no circumstances is the off-site concentration of air-borne radioactivity expected to approach the limits set forth in the applicable standards.

Operations during this reporting period could not produce measurable quantities of air-borne radioactivity. Hence, no air monitoring was performed.

C. Water-borne Radioactivity

During accelerator operations, some radioactivation of the soil will occur. Leaching of these radionuclides into the ground water provides a possible mechanism for transport of NAL produced radionuclides into surface run-off waters. Also, a very small fraction of these radionuclides may reach the aquifer. Hence, a broad program of ground water monitoring for radioactivity is maintained.

Monthly water samples were taken at various locations on the site and analyzed for the presence of those radionuclides which have been experimentally determined to be produced and to be leachable from NAL soils in measurable quantities.

The water sampling locations were chosen to sample two ground water systems:

1. Surface and near-surface waters. These samples were taken from sumps which collect water in the vicinity of accelerator components and from on-site streams and industrial holding ponds.
2. Silurian aquifer. These samples were taken from farm wells which tap the 70 foot silurian dolomite aquifer which is a prime water supply for many private residences in the area.

The sample analysis service was contracted to U. S. Testing Company (Richland Laboratory, Richland, Washington). Most monthly sample shipments contained one unidentified sample to which known concentrations of radionuclides had been added. The agreement of the reported concentrations to the known concentrations for these control samples provided verification of compliance with the analysis specifications. The specifications for these analyses are given in Section V.

The locations of the sampling points are shown in Figure 1 and are further described in Table 1. The results of the analyses are tabulated in Tables 2 and 3. No measurable concentrations of accelerator produced radionuclides were found.

V. References

The concentration guides used in the analyses of the water samples were taken from the Atomic Energy Commission Manual, Chapter 0524, Annex A, Table II, Column 2 (Water in Uncontrolled Areas) and reduced by a factor of three as appropriate for a suitable sample of exposed population. The smaller of the values given for soluble and insoluble forms has been used in each case. The specifications are given in Table 4. The concentration guides for air-borne activity were taken from the same source, Table II, Column 1 (Concentrations in Air in Uncontrolled Areas) and divided by a factor of three for application to populations. The appropriate standard for penetrating radiation applied to populations was taken from the AEC Manual, Chapter 0524, Paragraph II.A: 0.17 rem/year (exposure to whole body, gonads or bone marrow).

Table 1

Description of Sampling Locations

Designation	Description	Water System Sampled
A1,A2,B1,B2,B4, C1,C3,D1,D3, E1,E2,F1,F4	Sumps adjacent to Main Accelerator enclosure	Shallow ground water from footings
H1	Central Utilities Building Cooling Pond	Industrial cooling water
H2	Main Accelerator Cooling Pond	Industrial cooling water
H3	Village Waste Holding Pond	Effluent
N1	Sump in Neutrino Lab Front-end enclosure	Shallow ground water collected in decay pipe underdrains
N2	Sump in Neutrino Lab Enclosure 100	Shallow ground water collected in decay pipe underdrains
R1	Ferry Creek	Surface water
R2	Kress Creek	Surface water
R3	Indian Creek	Surface water
S1,S9,S12,S21	Sumps adjacent to Booster enclosure	Shallow ground water from footings
T1	Sump adjacent to extraction area in Transfer Hall	Shallow ground water from footings
Village	NAL Village water supply	Silurian aquifer
W21,W29,W38,W39, W43,W49,W50,W52,W55, W64,W66,W68,W74,W75	Cased farm wells	Silurian aquifer

Table 2

Results of Water Sample Analyses
For First Half of Calendar Year 1971

Batch Number	Month	Sample Location*	Detectable** Activities
8	January	S 21	None
8	January	W 43	None
9	February	S 21	None
9	February	W 43	None
10	March	S 21	None
10	March	W 43	None
11	April	W 38	See Note 1
11	April	W 43	None
11	April	S 21	None
11	April	W 21	None
13	May	W 50	None
13	May	W 55	None
13	May	W 21	None
13	May	W 43	None
13	May	S 21	None
14	June	W 21	None
14	June	W 43	None
14	June	W 64	None
14	June	W 50	None
14	June	S 21	None
14	June	W 29	None
14	June	W 49	None

Note 1 $(3 \pm 3) \times 10^{-7}$ μCi/ml of Ca^{45} was reported. This result is at the threshold of sensitivity for the analysis, and should be regarded as a 'null' result. None of the other radionuclides were detected.

* Sampling locations are shown on Figure 1 and described in Table 1.

** "None" means that none of the five radionuclides tested for was observed. Refer to Table 4 for the applicable sensitivities.

Table 3

Results of Water Sample Analyses
For Second Half of Calendar Year 1971†

Part A - Surface and Ground Water

Month	July	Aug.	Aug.	Sept.	Oct.	Nov.	Dec.
Batch No.	15	16	17	18	19	20	21
Location							
A1					None		
A2	None[1]						
B1				None		None	
B2		None[2]					
B4							None
C1					None		
C3	None						
D1				None			
D3							None
E1					None		
E2		None					
F1				None			
F4							None
H1			None	None	None	None	
H2				None		None	
H3							None
N1						None	
N2						None	
R1			None				
R2			None				
R3			None				
S1	None	None	None		None		None
S9				None			
S12					None		None
S21	None	None	None	None			
T1	None	None		None			

† (Footnotes follow Part B.)

Table 3

Results of Water Sample Analyses†

Part B - Wells

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.
Batch No.	15	16	18	19	20	21
Location						
Village	None	None[2]	None			
W21	None	None[2]	None	None	None	
W29			None			
W38				None		
W39		None				None
W43	None	None[2]	None	None	None	None
W49	None	None[2]	None	None	None	None
W50		None			None	
W52			None			
W55	None				None	
W64		None				
W66				None		
W68	None					None
W74				None		
W75				None		

† Interpretation of data entries:

A blank indicates no sample was taken.

"None" means that none of the five radionuclides tested for was observed. Refer to Table 4 for applicable sensitivities.

Well locations are shown on Figure 1 and described in Table 2.

Example: A sample was collected in August from well W21; no radionuclides were detected.

1) $(3 \pm 1) \times 10^{-7}$ μCi/ml of Ca^{45} was reported. This concentration is at the threshold of sensitivity for the analysis and should be regarded as a null result.

2) H^3 concentrations of $3\text{-}4.5 \times 10^{-6}$ μCi/ml were reported for these samples. These concentrations are not statistically significant and

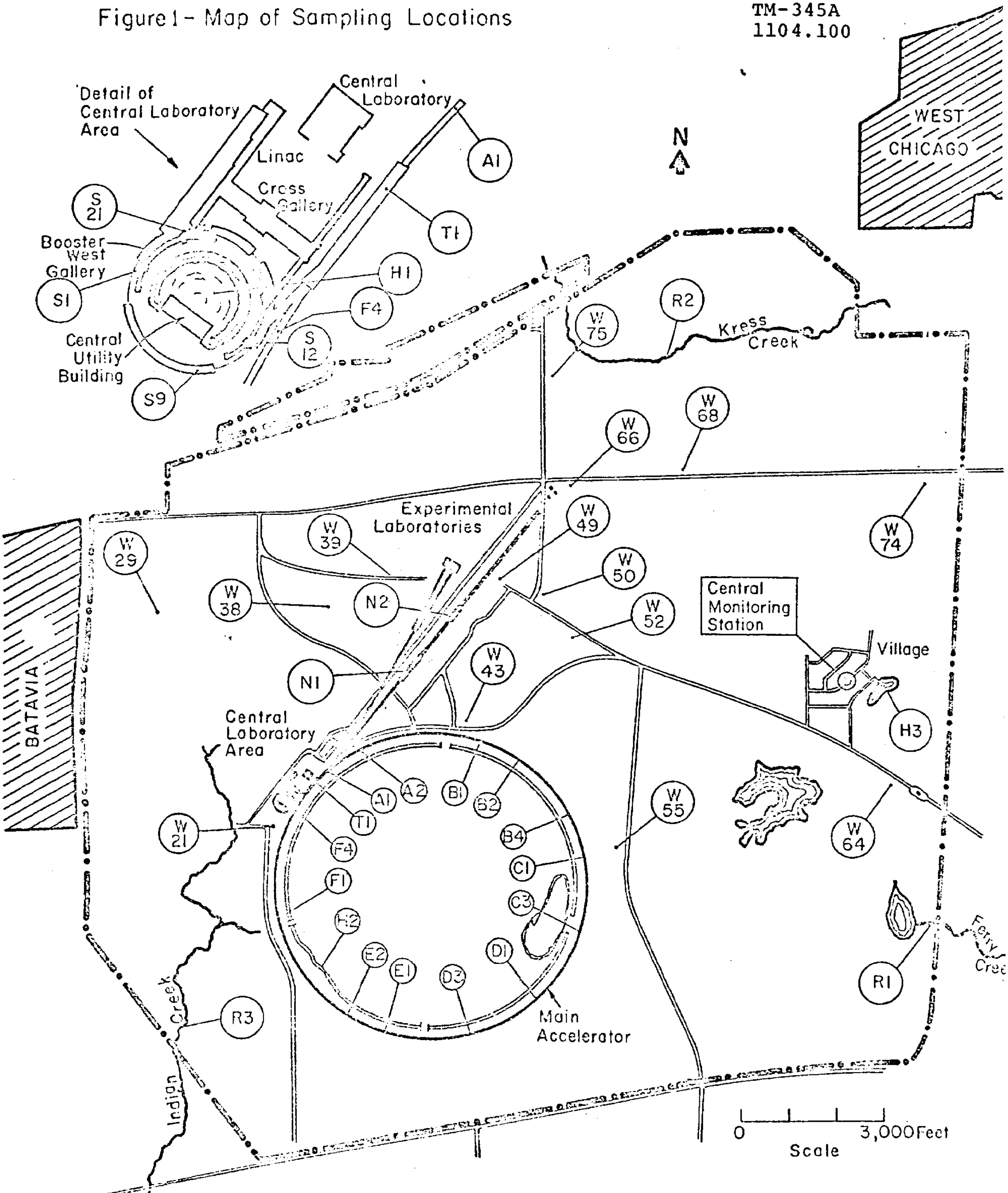
Table 4

Specifications for the Analyses of Radionuclides in Water

Radionuclides	Concentration Guide μCi/ml	Specified* Sensitivity μCi/ml	Specified* Precision μCi/ml
Na^{22}	1×10^{-5}	3×10^{-7}	3×10^{-7}
Ca^{45}	3×10^{-6}	3×10^{-7}	3×10^{-7}
Mn^{54}	3.3×10^{-5}	5×10^{-8}	5×10^{-8}
H^{3}	1×10^{-3}	3×10^{-6}	3×10^{-6}
Be^{7}	6.7×10^{-4}	5×10^{-7}	5×10^{-7}

* The precision and sensitivity are stated for the 68% confidence level (one standard deviation).

Figure 1 - Map of Sampling Locations



national accelerator laboratory
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I. TITLE PAGE

SEMIANNUAL ENVIRONMENTAL MONITORING REPORT
January 1, 1971 to June 30, 1971

II. Introduction.

The National Accelerator Laboratory facility is a 200 GeV proton synchrotron. The primary purpose of the installation is fundamental research in high-energy physics. Most of the radioactivity produced as a result of accelerator operation is contained in insoluble shields and beam dumps.

During this reporting period, the pre-accelerator components (Cockroft-Walton, 200 MeV Linac, 8 GeV Booster synchrotron) were operated to design energy but at reduced current. The main accelerator was operated only with coasting beam (no acceleration). No extraction from the main accelerator to the targeting areas was attempted. Therefore, accelerator produced radiation and radioactivity during this reporting period is negligible with respect to applicable environmental protection standards and the data recorded can be regarded as indicative of normal background levels.

Only three types of accelerator produced radiation merit monitoring for environmental purposes:

A. Penetrating Radiation.

Operation of the accelerator at full design energy and intensity will inevitably result in production of some penetrating radiation (primarily neutrons and muons) outside the shielding. Although the shielding has been designed to be adequate for foreseeable circumstances, monitoring for purposes of determining actual radiation levels both on and off site is necessary.

B. Air-borne Radioactivity.

Under normal operation of certain of the beam dumps and target boxes, radioactivation of air may occur. Monitoring of such activation will be carried out for purposes of personnel exposure control. Under no circumstances is the off-site concentration of air-borne radioactivity expected to approach the limits set forth in the appropriate guidelines.

C. Water-borne Radioactivity.

During accelerator operations, some radioactivation of the soil will occur. Leaching of these radionuclides into the ground water provides a possible mechanism for transport of NAL produced radionuclides into surface run-off waters. Also, a very small fraction of these radionuclides may reach the aquifer.

III. Applicable Standards.

All of the standards pertinent to the operation of this facility are contained in the AEC Manual, Chapter 0524, Standards for Radiation Protection, Part II, Individuals and Population Groups in Uncontrolled Areas.

A. Penetrating Radiation.

The appropriate standard is taken from the AEC Manual, Chapter 0524, Paragraph II.A, applied to populations:

0.17 rem/year (exposure to whole body, gonads or bone marrow).

B. Air-borne Radioactivity.

The concentration guides are taken from the AEC Manual Appendix 0524, Annex A, Table II, Column 1, Concentrations in Air in Uncontrolled Areas, and divided by a factor of three for application to samples of the population (0524, Par. II.C.1.)

C. Water-borne Radioactivity.

The concentration guides are taken from the AEC Manual, Chapter 0524, Annex A, Table II, Column 2, Concentrations in Water in Uncontrolled Areas, and divided by a factor of three for application to populations (0524, Par. II.C.1.)

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IV. Sample Collection and Analysis Summary.

A. Penetrating Radiation.

A central monitoring station is maintained in the NAL site "village". The monitoring equipment consists of four major components:

1. Aluminum-Argon ionization chamber. This chamber is mostly sensitive to muons and gammas, and much less sensitive to neutrons. The data is recorded as daily integrals of the ionization current. During the latter part of the recording period, a continuous strip-chart record of ionization current was also made.

2. Tissue-equivalent ionization chamber. This chamber is sensitive to neutrons as well as gammas and directly ionizing radiations. The data is again recorded as daily integrals of the ionization current.

3. 3 in x 3 in NaI(Tl) spectrometer. This device is sensitive primarily to gamma radiation above 100 keV. The data is recorded as daily integrals of the counts.

4. Bonner spectrometer. This device is an array of moderating hydrogenous spheres with thermal-neutron sensitive $Li^6I(Eu)$ scintillators located at the center of each sphere. The data is recorded as the daily integral of counts in each detector and unfolded by a computer program to obtain the neutron flux and dose.

B. Air-borne Radioactivity.

Operations during this reporting period could not produce measurable quantities of air-borne radioactivity. Hence, no air-monitoring was performed.

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C. Water-borne Radioactivity.

Monthly water samples were taken at various locations on the site and analyzed for the presence of those radionuclides which have been experimentally determined to be produced and leachable from NAL soils in measurable quantities.

The water sampling locations were chosen to sample two ground water systems:

1. Surface and near-surface waters. These samples were taken from sumps which collect water in the vicinity of accelerator components.

2. Silurian Aquifer. These samples were taken from farm wells which tap the 70 foot Silurian Dolomite Aquifer which is a prime water supply for many private residences in the area.

The sample analysis service was contracted to U.S. Testing Company (Richland Laboratory, Richland, Washington). Each monthly sample shipment contained one unidentified sample to which known concentrations of radionuclides had been added. The agreement of the reported concentrations to the known concentrations for these control samples provided verification of compliance with the analysis specifications. The specifications for these analyses are summarized in Table 1.

V. Monitoring Data.

A. Penetrating Radiation.

The location of the central monitoring station is shown in Figure 1. No evidence of accelerator induced radiation was seen by any detector. The three gamma sensitive monitors (aluminum-argon ion chamber, tissue-equivalent ion chamber, NaI crystal) have consistently indicated natural-background-level exposures of approximately .007 milliRoentgens/hour. Neutron dose rates monitored have indicated an average neutron component not exceeding approximately .0006 millirem/hour which is again completely consistent with the expected cosmic-ray neutron background.

In summary, all data indicates that operation of the NAL facility during this reporting period did not measurably increase the ambient radiation at the monitoring station.

B. Air-borne Radioactivity.

No data was taken.

C. Water-borne Radioactivity.

The locations of the sampling points are shown in Figure 1 and further described in Table 2. The analysis results are tabulated in Table 3. No measurable concentrations of accelerator produced radionuclides were found in any of the water systems.

VI. Interpretation and Summary.

The monitoring data give no evidence that the operations of the NAL facility during this reporting period have in any way increased the environmental radiation levels in the vicinity of the site.

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Table 1

Specifications for the Analyses of Radionuclides in Water

Radionuclide	Concentration Guide* µCi/ml	Specified** Sensitivity µCi/ml	Specified*** Precision µCi/ml
Na^{22}	1×10^{-5}	1.3×10^{-6}	5×10^{-7}
Ca^{45}	3×10^{-6}	3×10^{-7}	3×10^{-7}
Mn^{54}	3.3×10^{-5}	3.3×10^{-6}	1×10^{-6}
H^{3}	1×10^{-3}	1×10^{-4}	2.5×10^{-5}
Be^{7}	6.7×10^{-4}	3×10^{-5}	1×10^{-5}

* The concentration guides are taken from the AEC Manual, Chapter 0524, Annex A, Table II, Column 2 (Water in Uncontrolled Areas) and reduced by a factor of three as appropriate for a suitable sample of exposed population. The smaller of the values given for soluble and insoluble forms has been used in each case.

** For most radionuclides the actual analysis sensitivity was found to be considerably better than that specified in the contract with U.S. Testing Company. Therefore, these sensitivities should be considered as an upper limit to the detectable concentrations.

*** The precision is stated for the 95% confidence level (two standard deviations).

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Figure 1 - Map of Sampling Locations

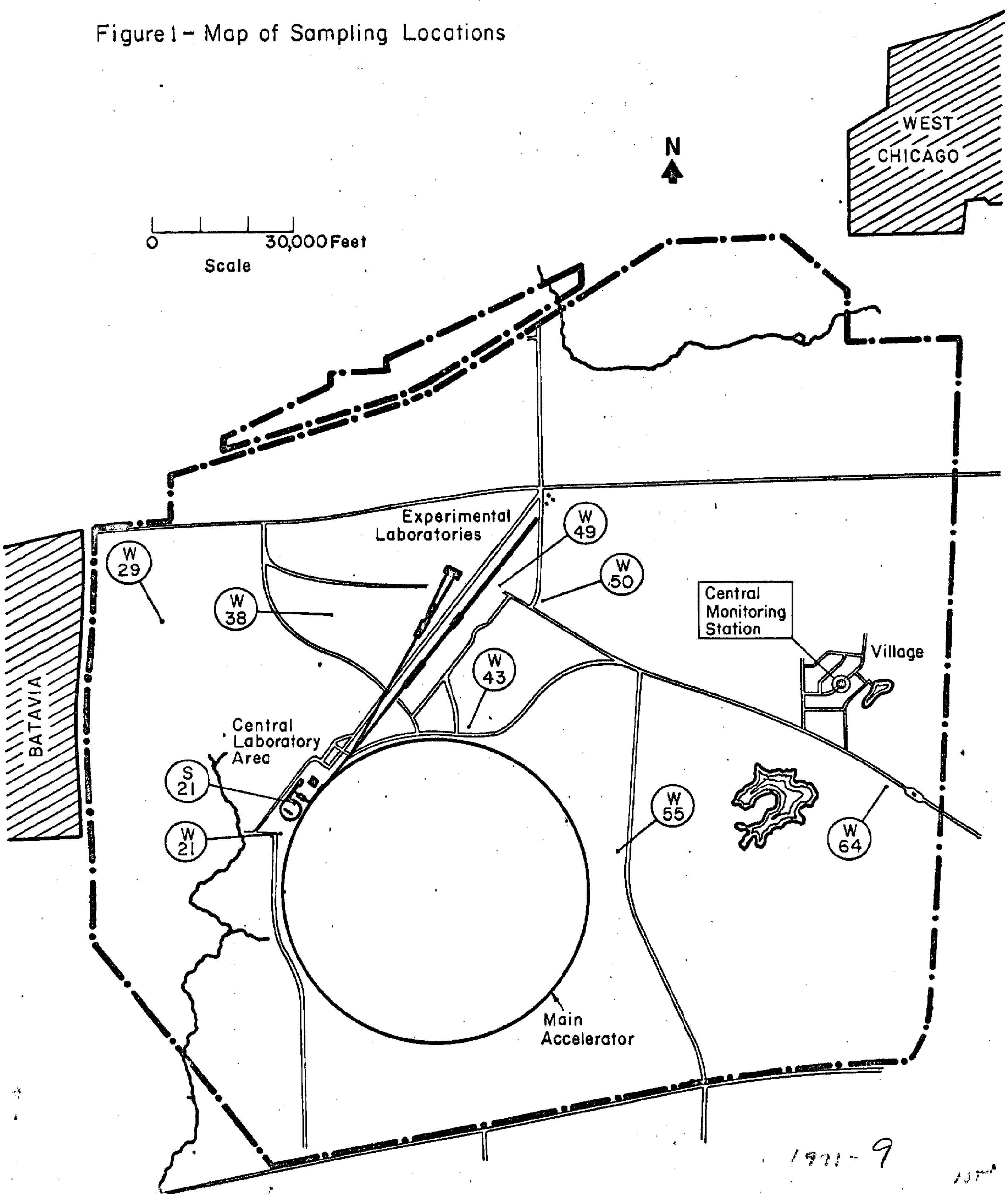

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Table 2

Description of Sampling Locations

Designation	Description	Water System Sampled
S 21	Sump in vicinity of 200 MeV transport (Booster enclosure)	Shallow ground water
W 21	Farm well	Silurian aquifer
W 29	Farm well	Silurain aquifer
W 38	Farm well	Silurian aquifer
W 43	Farm well	Silurian aquifer
W 49	Farm well	Silurian aquifer
W 50	Farm well	Silurian aquifer
W 55	Farm well	Silurian aquifer
W 64	Farm well	Silurian aquifer

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Table 3

Results of Water Sample Analyses

Sample Number	Month	Sample Location*	Detectable** Activities
8-B	January	S 21	None
8-C	January	W 43	None
9-A	February	S 21	None
9-B	February	W 43	None
10-A	March	S 21	None
10-D	March	W 43	None
11-A	April	W 38	See Note 1
11-B	April	W 43	None
11-D	April	S 21	None
11-E	April	W 21	None
13-A	May	W 50	None
13-B	May	W 55	None
13-C	May	W 21	None
13-H	May	W 43	None
13-I	May	S 21	None
14-A	June	W 21	None
14-B	June	W 43	None
14-C	June	W 64	None
14-E	June	W 50	None
14-G	June	S 21	None
14-H	June	W 29	None
14-I	June	W 49	None

Note 1 $(3 \pm 3) \times 10^{-7}$ µCi/ml of Ca^{45} was reported. This result is at the threshold of sensitivity for the analysis, and should be regarded as a 'null' result. None of the other radionuclides were detected.

* Sampling locations are shown on Figure 1 and described in Table 2.

** "None" means that none of the five radionuclides tested for was observed. Refer to Table 1 for the applicable sensitivities.

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I. SEMIANNUAL ENVIRONMENTAL MONITORING REPORT

July 1, 1971 to December 31, 1971

F. Schamber

January 18, 1972

II. Introduction.

The National Accelerator Laboratory facility is a 200 GeV proton synchrotron. The primary purpose of the installation is fundamental research in high-energy physics. Most of the radioactivity produced as a result of accelerator operation is contained in insoluble shields and beam dumps.

During this reporting period, the pre-accelerator components (Cockroft-Walton, 200 MeV Linac, 8 GeV Booster synchrotron) were operated to design energy but at reduced current. The main accelerator was operated in the injection mode (no acceleration). No extraction from the main accelerator to the targeting areas was attempted. Therefore, accelerator produced radiation and radioactivity during this reporting period is negligible with respect to applicable environmental protection standards and the data recorded can be regarded as indicative of normal background levels.

Only three types of accelerator produced radiation merit monitoring for environmental purposes:

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Operation of the accelerator at full design energy and intensity will inevitably result in production of some penetrating radiation (primarily neutrons and muons) outside the shielding. Although the shielding has been designed to be adequate for foreseeable circumstances, monitoring for purposes of determining actual radiation levels both on and off site is necessary.

B. Air-borne Radioactivity.

Under normal operation of certain of the beam dumps and target boxes, radioactivation of air may occur. Monitoring of

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such activation will be carried out for purposes of personnel exposure control. Under no circumstances is the off-site concentration of air-borne radioactivity expected to approach the limits set forth in the applicable standards.

C. Water-borne Radioactivity.

During accelerator operations, some radioactivation of the soil will occur. Leaching of these radionuclides into the ground water provides a possible mechanism for transport of NAL produced radionuclides into surface run-off waters. Also, a very small fraction of these radionuclides may reach the aquifer. Hence, a broad program of ground water monitoring for radioactivity is maintained.

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III. Applicable Standards.

All of the standards pertinent to the operation of this facility are contained in the AEC Manual, Chapter 0524, Standards for Radiation Protection, Part II, Individuals and Population Groups in Uncontrolled Areas.

A. Penetrating Radiation.

The appropriate standard is taken from the AEC Manual, Chapter 0524, Paragraph II.A, applied to populations*:

0.17 rem/year (exposure to whole body, gonads or bone marrow).

B. Air-borne Radioactivity.

The concentration guides are taken from the AEC Manual Appendix 0524, Annex A, Table II, Column 1, Concentrations in Air in Uncontrolled Areas, and divided by a factor of three for application to samples of the population* (0524, Par. II.C.1).

C. Water-borne Radioactivity.

The concentration guides are taken from the AEC Manual, Chapter 0524, Annex A, Table II, Column 2, Concentrations in Water in Uncontrolled Areas, and divided by a factor of three for application to populations* (0524, Par. II.C.1).

* Based on an average dose to a suitable sample of the exposed population.

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IV. Sample Collection and Analysis Summary.

A. Penetrating Radiation.

A central monitoring station is maintained in the NAL site "village". The monitoring equipment consists of five major components.

1. Aluminum-Argon ionization chamber. This chamber is mostly sensitive to muons and gammas, and much less sensitive to neutrons. The data is recorded as daily integrals of the ionization current. A continuous strip-chart record of ionization current is also made.

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3. A 3 in x 3 in NaI(Tl) radiation ratemeter. This device is sensitive primarily to gamma radiation above 100 keV. The data is recorded as daily integrals of the counts and as a strip-chart record of count rate.

4. Bonner spectrometer. This device is an array of moderating hydrogenous spheres with thermal-neutron sensitive $Li^6I(Eu)$ scintillators located at the center of each sphere. The data is recorded as the daily integral of counts in each detector. It may be unfolded by a computer program to obtain the neutron flux and dose.

5. Precision (DePangher) long counter. This device is a BF_3 proportional counter moderated by polyethylene

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to obtain an essentially flat energy response to neutrons. The count rate from this device is thus a measure of neutron flux. The data is recorded as daily integrals of neutron counts.

B. Air-borne Radioactivity.

Operations during this reporting period could not produce measurable quantities of air-borne radioactivity. Hence, no air-monitoring was performed.

C. Water-borne Radioactivity.

Monthly water samples were taken at various locations on the site and analyzed for the presence of those radionuclides which have been experimentally determined to be produced and to be leachable from NAL soils in measurable quantities.

The water sampling locations were chosen to sample two ground water systems:

1. Surface and near-surface waters. These samples were taken from sumps which collect water in the vicinity of accelerator components and from on-site streams and industrial holding ponds.

2. Silurian aquifer. These samples were taken from farm wells which tap the 70 foot silurian dolomite aquifer which is a prime water supply for many private residences in the area.

The sample analysis service was contracted to U. S. Testing Company (Richland Laboratory, Richland, Washington). Most monthly sample shipments contained one unidentified sample to which known concentrations of radionuclides had been added. The agreement of the reported concentrations to the known concentrations for these control samples provided verification of compliance with the analysis specifications. The specifications for these analyses are summarized in Table 1.

V. Monitoring Data.

A. Penetrating Radiation.

The location of the central monitoring station is shown in Figure 1. No evidence of accelerator induced radiation was seen by any detector. The three gamma sensitive monitors (aluminum-argon ion chamber, tissue-equivalent ion chamber, NaI crystal) have consistently indicated natural-background-level exposures of approximately .007 milliRoentgens/hour. The neutron monitors have indicated an average flux of approximately 17 n/cm^2/hr, which is consistent with the expected cosmic-ray neutron background. This corresponds to a neutron dose of approximately 0.0005 mrem/hr.

In summary, all data indicates that operation of the NAL facility during this reporting period did not measurably increase the ambient radiation at the monitoring station.

B. Air-borne Radioactivity.

No data was taken.

C. Water-borne Radioactivity.

The locations of the sampling points are shown in Figure 1 and further described in Table 2. The analysis results are tabulated in Table 3. No measurable concentrations of accelerator produced radionuclides were found in any of the water systems.

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VI. Interpretation and Summary.

The monitoring data give no evidence that the operations of the NAL facility during this reporting period have in any way increased the environmental radiation levels in the vicinity of the site.

VII. Summary for the Calendar Year 1971.

The monitored data gives no evidence that the operations of the NAL facility during the calendar year 1971 have in any way increased the environmental radiation levels in the vicinity of the site.

Figure 1- Map of Sampling Locations

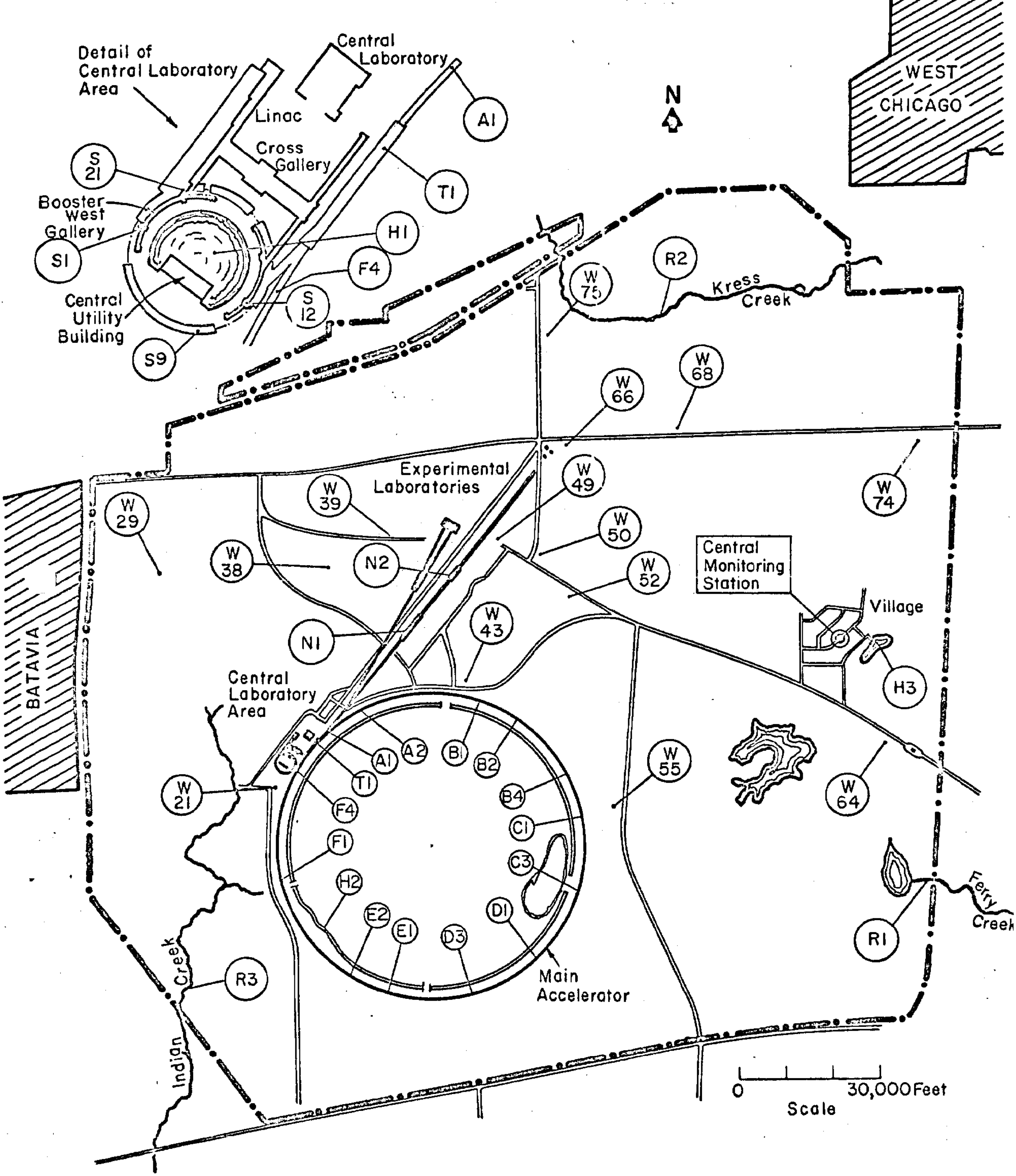

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Table 1

Specifications for the Analyses
of Radionuclides in Water

Radionuclide	Concentration Guide* $\mu Ci/ml$	Specified** Sensitivity $\mu Ci/ml$	Specified** Precision $\mu Ci/ml$
Na^{22}	1×10^{-5}	3×10^{-7}	3×10^{-7}
Ca^{45}	3×10^{-6}	3×10^{-7}	3×10^{-7}
Mn^{54}	3.3×10^{-5}	5×10^{-8}	5×10^{-8}
H^{3}	1×10^{-3}	3×10^{-6}	3×10^{-6}
Be^{7}	6.7×10^{-4}	5×10^{-7}	5×10^{-7}

* The concentration guides are taken from the AEC Manual, Chapter 0524, Annex A, Table II, Column 2 (Water in Uncontrolled Areas) and reduced by a factor of three as appropriate for a suitable sample of exposed population. The smaller of the values given for soluble and insoluble forms has been used in each case.

** The precision and sensitivity are stated for the 68% confidence level (one standard deviation).

Table 2

Description of Sampling Locations

Designation	Description	Water System Sampled
A1,A2,B1,B2,B4, C1,C3,D1,D3, E1,E2,F1,F4	Sumps adjacent to Main Accelerator enclosure	Shallow ground water from footings
H1	Central Utilities Building Cooling Pond	Industrial cooling water
H2	Main Accelerator Cooling Pond	Industrial cooling water
H3	Village Waste Holding Pond	Effluent
N1	Sump in Neutrino Lab Front-end enclosure	Shallow ground water collected in decay pipe underdrains
N2	Sump in Neutrino Lab Enclosure 100	Shallow ground water collected in decay pipe underdrains
R1	Ferry Creek	Surface water
R2	Kress Creek	Surface water
R3	Indian Creek	Surface water
S1,S9,S12,S21	Sumps adjacent to Booster enclosure	Shallow ground water from footings
T1	Sump adjacent to extraction area in Transfer Hall	Shallow ground water from footings
Village	NAL Village water supply	Silurian aquifer
W21,W29,W38,W39, W43,W49,W50,W52,W55, W64,W66,W68,W74,W75	Cased farm wells	Silurian aquifer

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Table 3

Results of Water Sample Analyses†

Part A - Surface and Ground Water

Month	July	Aug.	Aug.	Sept.	Oct.	Nov.	Dec.
Batch No.	15	16	17	18	19	20	21
Location							
A1					None		
A2	None[1]						
B1				None		None	
B2		None[2]					
B4							None
C1					None		
C3	None						
D1				None			
D3							None
E1					None		
E2		None					
F1				None			
F4							None
H1			None	None	None	None	
H2				None		None	
H3							None
N1						None	
N2						None	
R1			None				
R2			None				
R3			None				
S1	None	None	None		None		None
S9				None			
S12					None		None
S21	None	None	None	None			
T1	None	None		None			

(Footnotes follow Part B.)

Table 3

Results of Water Sample Analyses†
Part B - Wells

Month	July	Aug.	Sept.	Oct.	Nov.	Dec.
Batch No.	15	16	18	19	20	21
Location						
Village	None	None[2]	None			
W21	None	None[2]	None	None	None	
W29			None			
W38				None		
W39		None				None
W43	None	None[2]	None	None	None	None
W49	None	None[2]	None	None	None	None
W50		None			None	
W52			None			
W55	None				None	
W64		None				
W66				None		
W68	None					None
W74				None		
W75				None		

† Interpretation of data entries:

A blank indicates no sample was taken.

"None" means that none of the five radionuclides tested for was observed. Refer to Table 1 for applicable sensitivities.

Well locations are shown on Figure 1 and described in Table 2.

Example: A sample was collected in August from well W21; no radionuclides were detected.

1) $(3 \pm 1) \times 10^{-7}$ μCi/ml of Ca^{45} was reported. This concentration is at the threshold of sensitivity for the analysis and should be regarded as a null result.

2) H^3 concentrations of $3\text{-}4.5 \times 10^{-6}$ μCi/ml were reported for these samples. These concentrations are not statistically significant and should be regarded as "null" results.