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Environmental Monitoring Report

For Calendar Year 1979

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TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

Page

TABLES

TABLE OF CONTENTS

Page

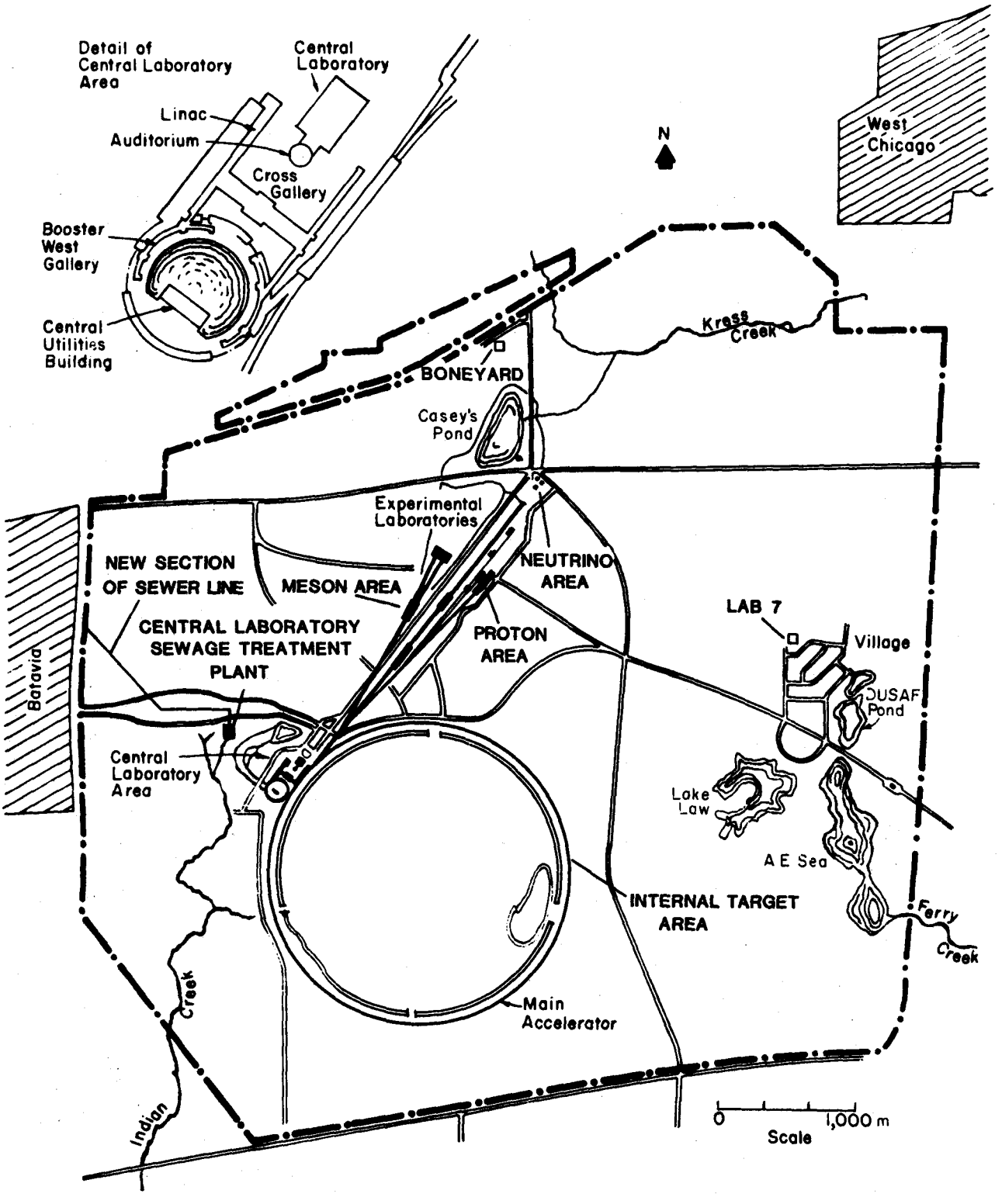
ILLUSTRATIONS

1. Introduction

This report gives the results of the environmental monitoring program at Fermi National Accelerator Laboratory (Fermilab) for Calendar Year (CY-) 1979. The Fermilab Facility is a proton synchrotron with an original design energy of 200 GeV (billion electron volts). As a result of accelerator improvements, protons were accelerated to an energy of 500 GeV in 1976 and operation at 400 GeV is now routine. The primary purpose of the installation is fundamental research in high energy physics. In addition, cancer patients are being treated using neutrons released by the interaction of 66 MeV protons from the second stage of the accelerator.

The proton beam extracted for high energy physics from the 2 km (1.2 mi) diameter main accelerator is taken to three different experimental areas on site (Meson, Neutrino and Proton Areas in Fig. 1). All three of these areas received proton beams for the first time in 1972. Radioactivity is produced as a result of the interaction of the accelerated protons with matter. Operation of the accelerator produces some radiation which penetrates the shielding material as well as some airborne radioactivity. Also, some radioactivation occurs in the soil and in the water used to cool radioactive components

Figure 1. - Fermilab Site



occurs. Since the Fermilab site is open to the public, this free access necessitates a thorough evaluation of the on-site discharges as well as the potential for off-site releases of radioactive effluents. Thus, an extensive monitoring program tailored to these needs is being monitored.

Monitoring results are also reported for non-radioactive pollutants. Included as pollutants are pesticides and copper used in weed, insect, rodent and algae control.

Also, a corrosion inhibitor containing zinc and chromium (as chromate) was formerly used in one of the water systems. Discharge underground and subsequent surfacing required monitoring. Although the use of chromates has been discontinued, monitoring for chromates has continued in CY-1979. The CY-1979 results are reported as well as those from monitoring the performance of the two sewage treatment plants on site. Discharges of suspended solids from these plants have sometimes exceeded permit requirements.

Fermilab is located in the greater Chicago area (Fig. 2) on a 27.5 km^2 (10.6 mi^2) tract of land in an area which is rapidly changing from farming to residential use. There are many municipalities in the

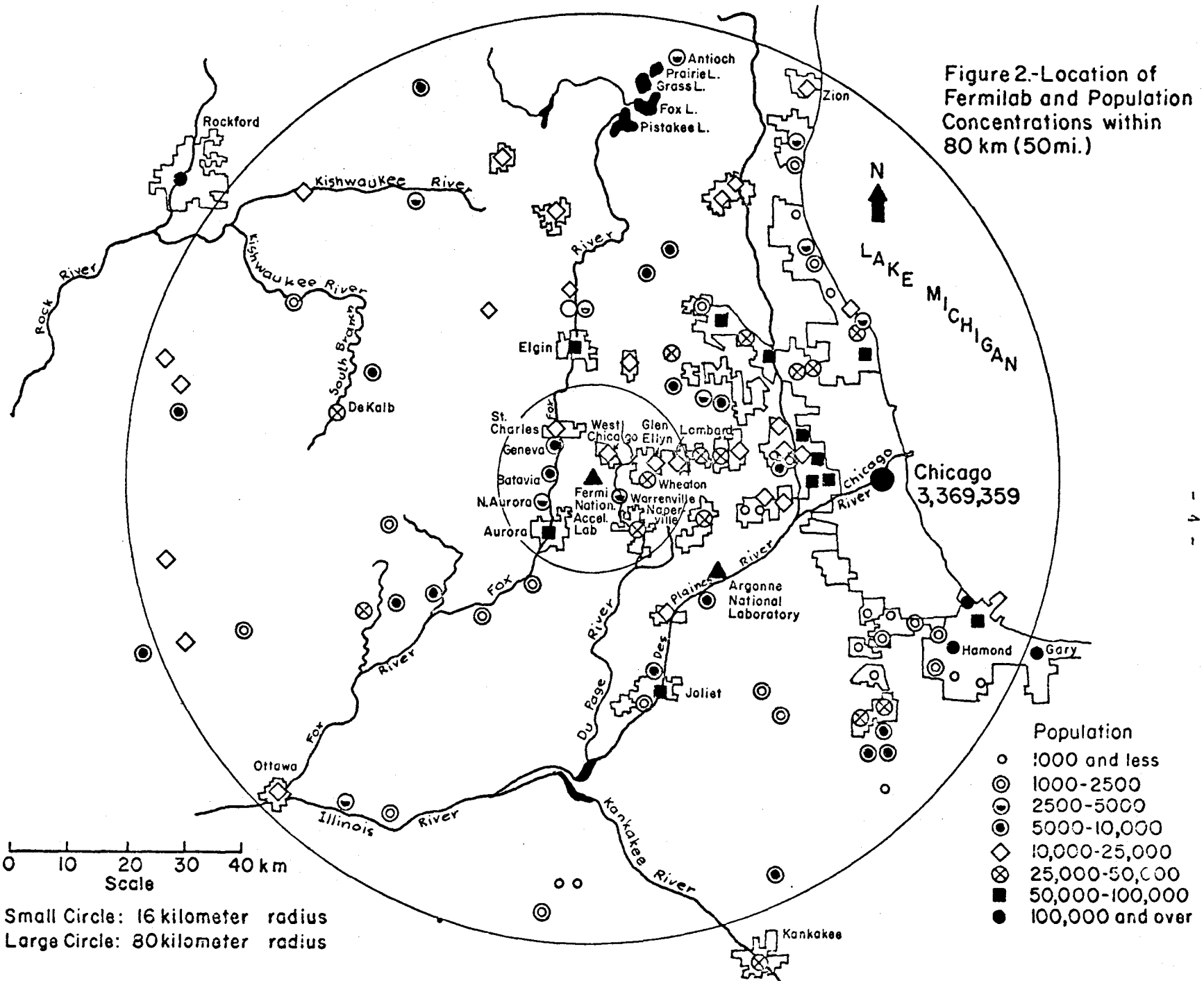


Figure 2.-Location of Fermilab and Population Concentrations within 80 km (50mi.)
N
LAKE MICHIGAN
Antioch
Prairie L.
Grass L.
Fox L.
Pistakee L.
Zion
Rockford
Kishwaukee River
Rock River
Kishwaukee River
South Branch
DeKalb
Elgin
Fox River
St. Charles
West Chicago
Glen Ellyn
Lombard
Geneva
Batavia
N. Aurora
Aurora
Fermi National Accel. Lab
Wheaton
Warrenville
Naperville
Chicago
Chicago River
3,369,359
Argonne National Laboratory
Plainfield River
Fox River
Des Plaines River
DuPage River
Joliet
Hamond
Gary
Ottawa
Illinois River
Kankakee River
Kankakee
0 10 20 30 40 km
Scale
Small Circle: 16 kilometer radius
Large Circle: 80 kilometer radius
Population
1000 and less
1000-2500
2500-5000
5000-10,000
10,000-25,000
25,000-50,000
50,000-100,000
100,000 and over

vicinity, resulting in a distinct pattern of high population concentration. Within a 3 km (2 mi) distance from the Laboratory boundaries, Batavia (pop. 9,000*), Warrenville (pop. 3,000*), and West Chicago (pop. 10,000*) can be found.

The two major environmental features near the Laboratory are the Fox River to the west, which flows south through Batavia with an average of 1900 million liters (500 million gallons) per day, and the west branch of the DuPage River which passes east of the site flowing south with an average of 265 million liters (70 million gallons) per day through Warrenville. The rainfall on site during 1979 was 96 cm (38 in).[1] The land on the site is relatively flat with a high area, elevation 244 m (800 ft) above mean sea level (MSL), near the western boundary and low point, elevation 218 m (715 ft), above MSL, toward the southeast. The drainage of the ground water and most of the surface water is toward the southeastern corner of the Laboratory, toward the DuPage River. A somewhat smaller amount drains to the southwest, toward the Fox River. The drinking water in many of the surrounding communities comes from deep

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*1970 U. S. Census.

wells usually drilled 360 m (1200 ft) deep into the Cambrian/Ordovician aquifer system.[2]

The mean wind speed for the 15-year period from 1950-1964 was 3.4 m/sec (7.6 mi/hr) at Argonne National Laboratory (ANL). The direction is quite variable with the observation of more southwesterly winds than from any other direction. In CY-1979 the mean wind speed was 3.8 m/sec (8.5 mi/hr).[3] Fermilab is about 30 km (19 mi) from ANL and the terrain between them is relatively flat. Movements of radioactive gas plumes at Fermilab have been strongly correlated with wind direction recorded at ANL during our releases.

2. Summary

The accelerator operated routinely at 400 GeV during CY-1979 with about the same number of protons accelerated during CY-1979 as in CY-1978. The total number of protons accelerated in 1979 was 2.5×10^{19}. Typical operation was at about 40 percent of the design intensity of 5×10^{13} protons per acceleration cycle. Thus, environmental monitoring in CY-1979 was done under operation conditions not grossly different from those expected in the future.

During CY-1979 there were no abnormal occurrences which had an impact on the facility and its operation. Chromate corrosion inhibitors, which were used in the past in water treatment systems and have a potential for environmental pollution, were not used this year. The perforated tile field at BO (Fig. 5) was sealed off and a new resin regeneration system became operational. Precipitates from the effluent are disposed of as radioactive waste. There is no evidence for any off-site impact from previous releases of any pollutant. Operation of the Central Laboratory Sewage Treatment Plant was discontinued in June 1979. At that time sewage was diverted to the City of Batavia Sewage Treatment Plant through a newly constructed sewer line (Fig. 1).

The maximum potential radiation exposure at the site boundary during CY-1979 was 2 mrem compared to 11 mrem last year. This dose rate was lower because the experimental areas produced fewer off-site muons this year.[4] This dose would correspond to 0.4 percent of the standard of 500 mrem for an individual who is not a radiation worker (Section 4).

The total potential radiation exposure to the general off-site population from Fermilab operations during CY-1979 was 3 man-rem compared to 5 man-rem last year.

Airborne radioactivity was released across the site boundary in small amounts throughout the year from the stacks ventilating a Neutrino Area enclosure where the proton beam strikes a target. The radioactive gas was primarily ^{11}C, total quantity released was 4 kCi, and the maximum dose at the site boundary was 1.0 mrem for 1979. The average concentration at site boundary based on measurements at the stack was 0.2 percent of the Concentration Guide (Sections 3.2 and 4). There was also a controlled release of tritium produced in helium gas near a target in the Meson Area. The total amount of tritium released was 280 mCi. Tritium was released continuously from about June 1, 1979 (when the Meson

Area resumed operations after a long shutdown) until the end of the year. The average concentration at the site boundary was about 0.00001 percent of the Concentration Guide (Sections 3.2 and 4), resulting in a negligible off-site exposure. There was one analysis which reported tritium above the new lower detection level in the ground water but below the detection level used last year. This tritium concentration was not verified by analysis of a new sample the following month and is not believed to be indicative of radioactivity in the ground water. The off-site release of tritium in surface water totaled 48 mCi, less than half last year's release.

3. Monitoring, Data Collection, Analysis and Evaluation

The three types of accelerator-produced radiation requiring environmental monitoring are discussed below. These radiations have direct pathways to the off-site population. Other more indirect pathways, such as through the food chain, have received little attention to date. The decision on what to monitor is based on the type of operation, radionuclides released and monitoring results from this and other high energy physics laboratories.

3.1 Penetrating Radiation

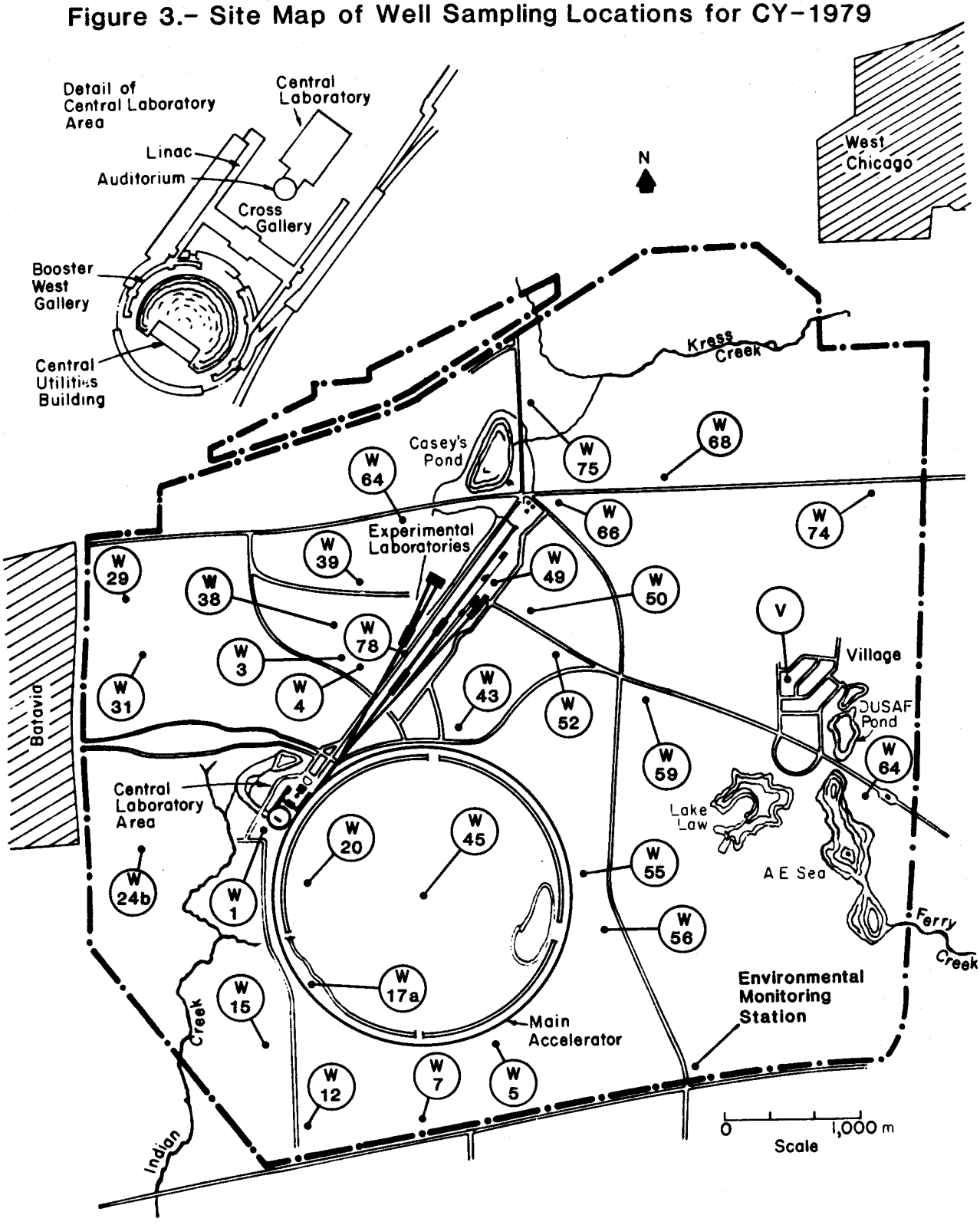
Operation of the accelerator at current energies and intensities results in production of some penetrating radiation (primarily muons and neutrons) outside the shielding. Although the shielding has been designed to be adequate for this operation, monitoring for purposes of determining actual radiation levels both on and off the site is necessary.

A large network of detectors was used to monitor penetrating radiation. At the end of CY-1979 there were approximately 200 detectors deployed around the site for the main purpose of protecting on-site personnel. The majority of these detectors

were connected to a data logger which automatically recorded the radiation levels for subsequent examination.[5] Seven detectors were used primarily for environmental radiation monitoring. Most of these were deployed at the ends of the paths traveled by the protons or near the site boundary. Of the latter, five were large volume, 110 liter, ionization chambers for gamma-ray and charged particle detection.

For several years an environmental radiation monitoring station has been maintained near the site boundary (Fig. 3).[6] This station has detected no accelerator-produced radiation. In CY-1977 the high sensitivity charged particle and neutron detectors were removed for use elsewhere on site. The remaining gamma-ray detector is a large scintillation counter identical to one used near the experimental areas (W43 in Fig. 3) to detect ^{11}C in the Neutrino Area radioactive gas releases. It provides background levels for comparison to those levels of ^{11}C and also to levels detected by the Mobile Environmental Radiation Laboratory (MERL). The MERL is a four-wheel-drive vehicle equipped with detectors of high sensitivity for finding penetrating radiations and measuring levels at different distances for determining dose rates at the

Figure 3.- Site Map of Well Sampling Locations for CY-1979

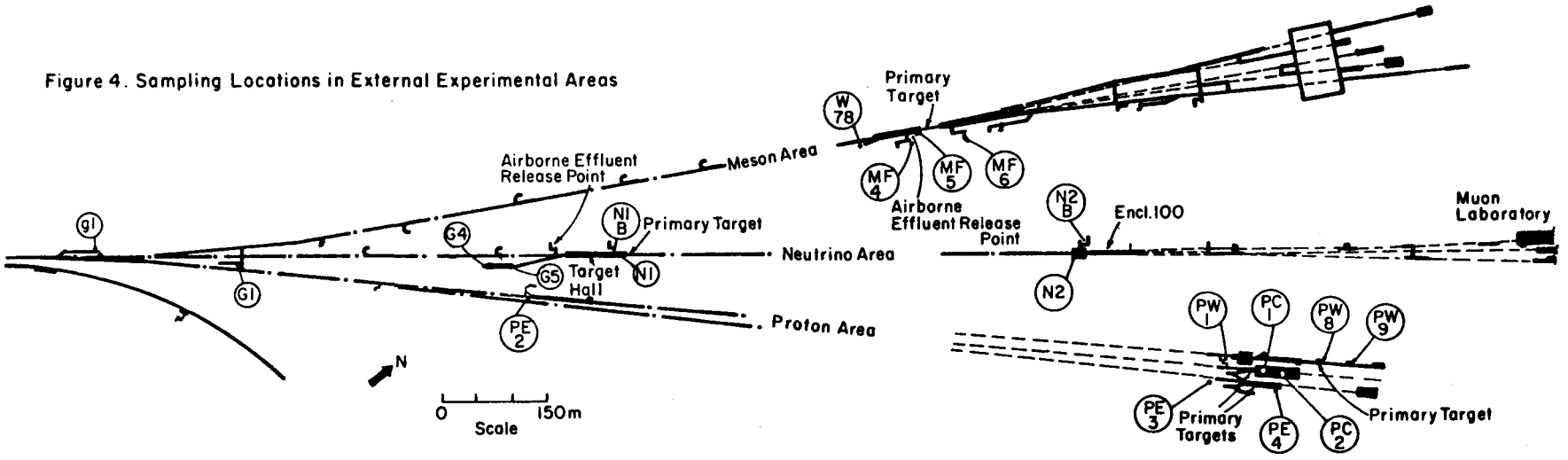


site boundaries. Measurements at distances closer to the shielding make it possible to control exposures on the site to levels far below the 500 mrem standard for an individual who is not a radiation worker. These measurements also help determine locations for 110 liter ion chambers which monitor the radiation levels continuously (Section 3.1.1 below).

3.1.1 Muons

The MERL was used for determining the exposure levels at the site boundary and for locating the source of the penetrating radiation discovered behind the Muon Laboratory, a facility in the Neutrino Area (Fig. 4).[4,7,8] The MERL was equipped with two 26 cm x 26 cm (8" x 8") scintillation counters, one behind the other, with associated electronics to verify that the penetrating radiation (the individual muons) came through both counters. These counters were used to determine the direction and radiation level of the penetrating radiation. Dose measurements were made at the site boundary with the scintillation counters while recording the number of counts from one of the 110 liter ionization chambers placed in the path of the muons much closer to the source. The

Figure 4. Sampling Locations in External Experimental Areas



counts from that ionization chamber were recorded for the entire year through the data logger and the natural background subtracted to determine the annual dose at the site boundary. Muons from the Neutrino Area in CY-1979 resulted in radiation capable of delivering a total dose of 1 mrem over a region of about 50 m (160 feet) wide at the site boundary. Considering that members of the general population spend less time on the site, one does not get greatly increased potential on-site muon doses.

3.1.2 Neutrons

Neutrons were detected outside the shielding in the Proton Area (Fig. 4) in CY-1979. The location where neutrons were detected was so far from site boundaries that the annual dose at site boundary from neutrons was negligible.

3.1.3 Gamma Rays

In May 1977 E G & G, Inc., under Energy Research and Development Administration (now U.S. Department of Energy) contract, conducted an aerial radiological survey of Fermilab and surrounding area.[4,9] The detection system

used consisted of 20 NaI(Tℓ) scintillation counters each 12.7 cm diameter by 5.1 cm thick (5" x 2") mounted in a helicopter. Data were recorded on magnetic tape and analyzed with the aid of computer techniques.

Flight paths were 100 m (300 ft) apart at an altitude of 100 m (300 ft) with location determined by referencing to radio beacons placed on nearby water towers. The area covered was approximately 6 km by 6 km (4 mi x 4 mi) with the Laboratory in the center. The results indicated three areas where radiation was significantly higher than natural background.[4] All three of these were locations where radioactive materials were stored. One of these, the Fitzgerald Barn, has been razed and the material moved to the Lundy Barn just south of the Boneyard (Fig. 1). This building was constructed of shielding blocks, hence it reduced the environmental radiation levels. The second of the three areas is Lab 7 in the Village (Fig. 1). Most of the radioactive material has been removed from Lab 7 and sent off site for burial. Dose rates in the three nearby houses occupied in 1977 and 1978 has been reduced to background levels.[4]

In June 1979 the house adjacent to Lab 7 was converted back to a residence and since that time has provided sleeping accommodations for three visiting experimenters.

Even with most of the radioactive materials removed from Lab 7 the experimenters received some exposure. If one takes the most conservative approach and assumes 24-hour occupancy, one obtains a "worst-case" exposure of approximately 15 mrem for each experimenter during CY-1979 from radioactivity in Lab 7. This is three percent of the standard of 500 mrem for an individual who is not a radiation worker.

The third of the three areas detected during the aerial survey is the primary radioactive waste disposal storage area on site - the Boneyard. As shown in Fig. 1, this area lies close to the site boundary. On the north side there is an earth berm to prevent any direct radiation from leaving the site. Since the survey, shielding has been added above and on all sides of the radioactive materials. This was done to protect Fermilab workers as well as reduce the off-site dose. Radiation from the Boneyard was responsible for a dose of only 0.08 mrem at the nearest site boundary for the entire year of 1979.

3.2 Airborne Radioactivity

Radioactivation of air in measurable concentrations will occur wherever the proton beam or the spray of secondary particles resulting from its interactions with

matter passes through the air. Along most proton beam lines (paths of the protons from the accelerator) the protons travel inside evacuated pipes. Thus, radioactivation of air is now usually caused by secondary particles. Monitoring of such activation is carried out for purposes of personnel exposure control. Under no circumstances is the off-site concentration of airborne radioactivity expected to approach the limits for uncontrolled areas set forth in the Department of Energy Manual, Chapter 0524 (DOE Manual 0524).

Radioactive gas, primarily ^{11}C, was produced by interaction of secondary particles with air. Monitoring was carried out by detecting the beta particles emitted in the radioactive ^{11}C decay.[6] A release of 4 kCi occurred from the labyrinth stack (Airborne Effluent Release Point)(Fig. 4) in the Neutrino Area during 1979. The spur track stack fan was shut off during accelerator operation. From measurements made at the stack and calculations based on a Gaussian plume diffusion model,[4,10] the expected dose at the site boundary for 1979 was 1.0 mrem, which corresponds to 0.2 percent of the applicable Concentration Guide[11] (Section 4).

Tritiated helium was released continuously as the tritium was produced from June 1, 1979 through

December 31, 1979 from the Meson Area Target Box. The total activity released for the year was 280 mCi of ^{3}H. The Gaussian plume diffusion model[10] was used with neutral wind conditions to calculate the site boundary ^{3}H concentration. The average site boundary concentration for the release was less than 2×10^{-14} $\mu Ci/m\ell$ or a negligible percentage (0.00001 percent) of the applicable Concentration Guide given in the DOE Manual Chapter 0524 (see Section 4).

A new facility, a debonding oven, was placed in operation in CY-1979 (near W43 in Fig. 3). Its purpose is to debond magnets by decomposing the epoxy adhesives at high temperatures. Most of these magnets are radioactive, having failed during accelerator operations. The gaseous effluent has been measured during the acceptance test on June 8, 1979 and contains only ^{3}H at very low levels. The test utilized a typical 6 m (20 ft) long magnet reading 0.8 mrem/hr at 0.3 m (1 ft) from the surface and 8 mrem/hr in the bore tube where the protons traveled. The total amount of ^{3}H released from this magnet was 160 μCi at a stack concentration of 1.3×10^{-8} $\mu Ci/m\ell$ or about 20 percent of the applicable Concentration Guide (Section 4). The stack is approximately

10 m (30 ft) high. Using the Gaussian plume diffusion model[10] with neutral wind conditions gives a negligible percentage of the applicable Concentration Guide at the site boundary. More than 20 magnets were debonded in CY-1979, and the total tritium release from this stack was approximately 4 mCi.

3.3 Waterborne Radioactivity

During accelerator operations, some radioactivation of the soil will occur.[12,13] Leaching of these radionuclides into the ground water provides a possible mechanism for transport of Fermilab-produced radionuclides into the surface run-off waters and aquifer. Hence, a broad program of ground water monitoring for radioactivity is maintained. Measurements are also made of on-site concentrations of radionuclides in our surface waters and in closed loop (recirculating) cooling systems which are sources of potential off-site releases.

Water samples are collected periodically on site and in surface waters off site. They are analyzed for the presence of those radionuclides which are produced in and leachable from Fermilab soils in measurable

quantities.[12] This group of radionuclides also includes those produced in water directly. Analyses are made for ^{3}H, ^{7}Be, ^{22}Na, ^{45}Ca, ^{54}Mn and ^{60}Co. The latter is hardly leachable (approximately 0.1 percent); however, it has been detected in discharges during regeneration of water treatment resin.

Water samples were collected from the following types of wells on site:

1. Farm Wells - Approximately 30 m Deep - 52 Samples
2. Fermilab Water Supplies - Approximately 70 m Deep - 10 Samples
3. Fermilab Deep Well Emergency Supply - 436 m Deep - 1 Sample

Water samples were also collected from sumps, creeks, and rivers. Samples were analyzed by Eberline Instrument Corporation, Midwest Facility, West Chicago, Illinois, during CY-1979. Each monthly shipment included at least one sample containing known amounts of several of the accelerator-produced radionuclides to check the accuracy of the assays.

In addition to Fermilab samples, Eberline also analyzed samples received from the DOE Environmental Measurements Laboratory (EML) as part of a quality assurance program. The results obtained by Eberline for EML samples are shown in Table 1. Also included are

TABLE 1

Comparison of Water Analyses

Sample Date	Radio-nuclide	Environmental Measurements Laboratory Results (μCi/mℓ) (x 10^{-6})	Percentage of Concentration Guide for Surface Waters (%)	Fermilab Results (μCi/mℓ) (x 10^{-6})	Eberline Results (μCi/mℓ) (x 10^{-6})	Mean Value for all Participants in Quality Assurance Program (μCi/mℓ) (x 10^{-6})
01/79	^{3}H	12.4	1		12 14	12.7
04/79	^{3}H	24.5	2		23 23 23	24.7
07/79	^{3}H	30.4	3		29 29 30	33.4
10/79	^{3}H	13.4	1		13 13 13	14.4
01/79	^{22}Na	0.843	8		0.85 0.99 0.88	0.87
10/79	^{22}Na	1.53	15	1.55	1.4 1.3 1.2	1.51
04/79	^{45}Ca	1.05	35		1.1 1.0 1.1	*
07/79	^{45}Ca	0.94	31		0.9 0.8 0.9	*
01/79	^{54}Mn	0.737	2		0.7 0.8 0.9	0.762
01/79	^{60}Co	0.871	9		0.96 1.0 0.95	0.866
04/79	^{60}Co	1.21	12	1.14	1.2	1.2
10/79	^{60}Co	1.24	12	1.27	1.2 1.3 1.1	1.27

*Only Eberline submitted results for ^{45}Ca.

results obtained by EML and by Fermilab.[14] The agreement between EML and Eberline results was within the precision specified by Fermilab (Section 4). Fermilab has no liquid scintillation counting apparatus, hence no ^{3}H or ^{45}Ca determinations in water were performed here.

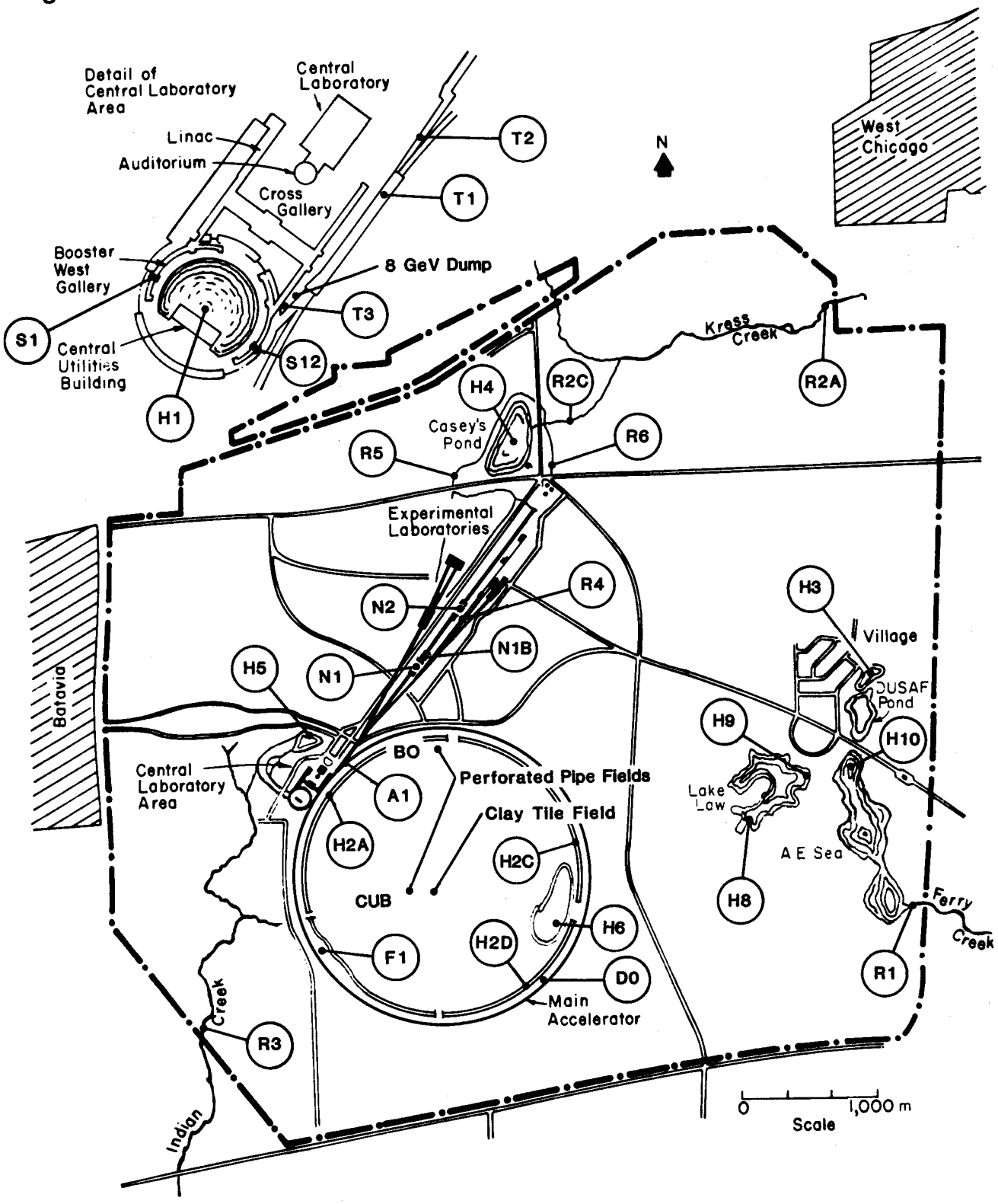
3.3.1 Results of Analyses

The Fermilab CY-1979 water sampling locations for detection of accelerator-produced activity are shown in Figs. 3, 4 and 5. No accelerator-produced radionuclides were reported in water samples taken from the three creeks leaving the site (Fig. 5). Eight samples were obtained from Kress Creek and three each from Ferry and Indian. River water samples were obtained once during CY-1979 from the Fox River in Aurora and from the west branch of the DuPage River in Warrenville. Neither river is utilized as a drinking water supply. No evidence for accelerator-produced radionuclides was found.

3.3.1.1 Tritium

The results for on-site tritium measurements yielding detectable levels in surface waters are given

Figure 5. - Site Map of Surface Water Sampling Locations for CY-1979



in Table 2 (Fig. 4). All other sampling points were essentially at background levels. The sumps collect waters from around the footings of the buildings and enclosures. This water is considered surface water. Only aquifers are called ground waters. The total off-site release in surface waters was 48 mCi of tritium this year compared with 125 mCi last year. The release occurred at less than 0.3 percent of the Concentration Guide (Section 4 below) and made a negligible contribution to the potential off-site dose.

A routine analysis of a water sample taken from the PW8 sump (Fig. 4) in the Proton Area on May 24, 1979 gave a ^{3}H concentration of 2.3×10^{-3} $\mu Ci/m\ell$. A scheduled maintenance and development period was in progress at that time, and the closed loop system which cools the Proton West High Intensity Area Target Box components was being worked on. The closed loop system had a concentration of 1.3×10^{-2} $\mu Ci/m\ell$ at that time, which is high enough to account for the ^{3}H concentration in the PW8 sump, the sump closest to the target box. Also, additional water had to be added to the closed loop system at the end of the maintenance period to fill it. Thus, although the mechanism by which the water reached the sump is unknown, it is believed that

TABLE 2

Tritium Detected in On-Site Water Samples

Collection Point	Number of Samples Collected	Tritium Concentration C (μCi/mℓ)*			Percentage of Relevant Standard
		C max	C min	C mean	
MF4 Sump	3	1.3×10^{-5}	$< 3 \times 10^{-6}$	6.8×10^{-6}	0.2
MF5 Sump	6	6.5×10^{-5}	$< 3 \times 10^{-6}$	2.7×10^{-5}	0.9
MF6 Sump	1	9.9×10^{-6}	9.9×10^{-6}	9.9×10^{-6}	0.3
N1 Sump	8	5.7×10^{-5}	4.7×10^{-6}	2.7×10^{-5}	0.9
N1B Sump	2	1.8×10^{-5}	1.1×10^{-5}	1.5×10^{-5}	0.5
N2 Sump	5	7.1×10^{-5}	1.1×10^{-5}	3.1×10^{-5}	1.0
N2B Sump	1	1.1×10^{-5}	1.1×10^{-5}	1.1×10^{-5}	0.4
PC1 Sump	3	1.1×10^{-5}	5.9×10^{-6}	7.6×10^{-6}	0.3
PC2 Sump	3	6.3×10^{-6}	3.2×10^{-6}	4.5×10^{-6}	0.2
PE4 Sump	3	6.5×10^{-6}	4.7×10^{-6}	5.7×10^{-6}	0.2
PW1 Sump	2	3.0×10^{-6}	2.9×10^{-6}	3.0×10^{-6}	0.1
PW8 Sump	11	2.3×10^{-3}†	1.8×10^{-6}	2.3×10^{-4}	7.8
PW9 Sump	3	6.0×10^{-4}	6.7×10^{-6}	2.1×10^{-4}	6.9

*C max is the highest concentration detected in any sample from that location and C min is the lowest. C mean is the average for all samples from one location.

†Measured during a one-day release in May when water was going off the site via Kress Creek.

about 380ℓ (100 gal) of closed loop water was pumped into the ditch from that sump and subsequently left the site. This corresponded to 4.9 mCi of tritium.

There were several other smaller leaks from the Proton West High Intensity Area closed loop system in 1979 which occurred when the water was flowing to Casey's Pond rather than off the site. The total amount of tritium from those releases was approximately 5 mCi. The surface water from the experimental areas flows into Casey's Pond most of the year. During periods of high rainfall the pond fills up and barricades are placed at the two entrances to the pond to keep the water from flooding the pump room. When these barriers, called stop logs, are in place the water bypasses the pond and leaves the site via Kress Creek.

Eberline Instrument Corporation reported a tritium level above the detection limit of 1×10^{-6} μCi/mℓ for one sample from the well at Site 55 (W55 in Fig. 3) this year. The reported concentration was 2.7×10^{-6} μCi/mℓ. Another sample was collected the following month and the tritium concentration was below the detection limit. The Environmental Protection Agency (EPA) limit for community water systems is 2×10^{-5} μCi/mℓ for tritium (Section 4).

3.3.1.2 Beryllium

Concurrent with the production of ^{3}H with 12 year half-life is the production of ^{7}Be with 53 day half-life in the closed cooling water systems. The ^{7}Be is chemically active and is easily removed from the water by the resins used to maintain water purity. These resins are regenerated in two separate systems located at the Central Utilities Building (Fig. 5). The ^{7}Be is precipitated out of the regeneration effluent and is disposed of as radioactive waste in an off-site burial ground in the case of the Main Ring Water Treatment System. The discharge from the other system, which regenerates resin from the small tanks used throughout the site, is sent to a clay tile field inside the main accelerator (Fig. 5). There it percolates into the soil about 60 cm (2 ft) below the surface. The short half-life of ^{7}Be and its strong chemical affinity with the soil ensure that the release will place no burden on the environment. There was no surfacing of effluent in the clay tile field in CY-1979. The perforated pipe field at BO (Fig. 5) has been sealed off and the perforated pipe field just west of the new clay tile field has been disconnected at

the entrance to the field. Thus, neither can be used again without considerable effort.

Areas where surfacing of effluents had occurred in the perforated pipe fields were monitored during CY-1979. The ^{7}Be concentration at BO was only 2.4 pCi/g and no other radionuclides were found. The radiation level from this concentration of ^{7}Be was negligible. No ^{7}Be was detected in the C.U.B. perforated pipe field soil; however, some longer half-life radionuclides were found there. These are remanents from the regeneration of resins contaminated with tungsten spallation products.[4] Only ^{172}Hf was found in a concentration greater than 1 pCi/g. The concentration of ^{172}Hf was 11 pCi/g.

The discharge from a sump in the Switchyard Area (T2 in Fig. 5) was resulting in traces of ^{7}Be at the discharge point.[4] However, the primary problem associated with it was release of short half-life radionuclides ^{15}O and ^{11}C. This release occurred into an area which was accessible to the public. There was concern that someone could have picked up some radioactivity on his or her shoes. Although the exposure would have been negligible, there could have been a

public relations problem. This problem has been eliminated by extending the discharge line into the Main Ring pond (Fig. 5).

Silt samples taken from the three creeks near the site boundary showed no ^{7}Be or other radionuclides. A silt sample was also taken in the sump discharge path near the Neutrino Target Hall (N1 in Figs. 4 and 5). This area was decontaminated in CY-1979 by removing the top few centimeters of soil. Residual accelerator-produced activity in the silt sample was less than 1 pCi/g with ^{54}Mn and ^{60}Co detected.

3.3.2 Vegetation Sampling

The vegetation sampling program initiated in CY-1978 was continued in CY-1979. Samples were taken at the points where surfacing of radionuclides has been occurring in the Main Ring perforated pipe fields, and around the two exhaust fan stacks where large volumes of radioactive gas have been vented in the Neutrino Area (N1 in Fig. 4). In addition, samples were taken in the vicinity of discharges from sumps collecting water in areas having the most soil activation resulting from direct interactions of the primary protons or the secondary particles they produce.

The results of the vegetation sampling are given in Table 3. The peak concentrations given are based on the weight of the unprocessed sample. From previous results[4] the radionuclide ^{7}Be is expected to be present as surface contamination while ^{22}Na and ^{54}Mn are most likely incorporated into the plants.

TABLE 3

Vegetation Sampling Results

Location	Radionuclides	Concentration (pCi/g)
DO Sump Discharge Area	^{7}Be	6.7
	^{22}Na	0.1
	^{54}Mn	0.2
Meson Stack	^{3}H	11
N1 Sump Discharge Area	^{7}Be	12
	^{54}Mn	1.6
N1 Labyrinth Stack	^{7}Be	69
	^{54}Mn	0.9
N2 Sump Discharge Area	^{7}Be	12
	^{22}Na	0.2
	^{54}Mn	0.2
PW8 Sump Discharge Area	^{7}Be	12
T2 Sump Discharge Area	^{7}Be	7.1

3.3.3 Soil Activation

Since the percolation rates for water in Fermilab soils are calculated to be very low - less than 1 m (3 ft) per year[15] - analyses of well waters do not provide the early warning desired for detection of accelerator-produced radioactivity in the ground water. To provide such a warning we have taken soil samples from the vicinity of targets and other locations where proton interactions result in some radioactivation of the soil. Many radionuclides were detected but since the major long-lived ones leachable from Fermilab soils were ^{3}H and ^{22}Na, quantitative measurements were made only on those.[12] The results have been presented elsewhere.[4,16]

In CY-1979 during an investigation of beam losses in the transport line to the 8 GeV Dump (proton beam stop for the Booster accelerator) (Fig. 5) it was discovered that the 0.46 m by 0.46 m by 29.2 m (18" x 18" x 96') channel leading to the dump was filled with water. A sample was analyzed and found to contain primarily ^{3}H and ^{7}Be. Concentrations are given in Table 4. The water was pumped out into radioactive waste drums, solidified, and will be disposed of as radioactive waste.

TABLE 4

8 GeV Dump Line Water Analysis

Radionuclide	Concentration (μCi/mℓ)
^{3}H	2.7×10^{-2}
^{7}Be	8×10^{-3}
^{22}Na	3×10^{-4}
^{24}Na	1.3×10^{-4}

Since the protons were being stopped in water instead of the steel in the beam dump, there was a significant soil activation outside the channel. To measure that activation and determine whether or not any leaching had occurred, a vertical hole was drilled in the region of maximum soil activation. Soil samples were taken to a depth 1.5 m (5 ft) below the center of the channel and 1 m (39") from the center of the

channel. The channel is surrounded by concrete so that more than 25 percent of the radioactivity produced outside the channel is produced in concrete. The amounts of ^{3}H and ^{22}Na leachable from concrete are far less than from soil. Also, the concrete will greatly reduce the percolation of water down into the soil beneath it.

Results of the analyses of the boring samples are given in Figure 6. There is no evidence for leaching and downward movement of radioactivity based on the total amount of ^{22}Na and the amount of leachable ^{3}H. The peak concentrations are similar to those found near Neutrino Area Enclosure 100.[4]

The most likely senario which would result in the observed activities and dose rates* is as follows:

Several years ago the channel filled up quickly during an extended power outage or a sump pump failure when the sump water backed up into the pit where the open upper end of water-tight channel is located. The water remained in the channel since that time.

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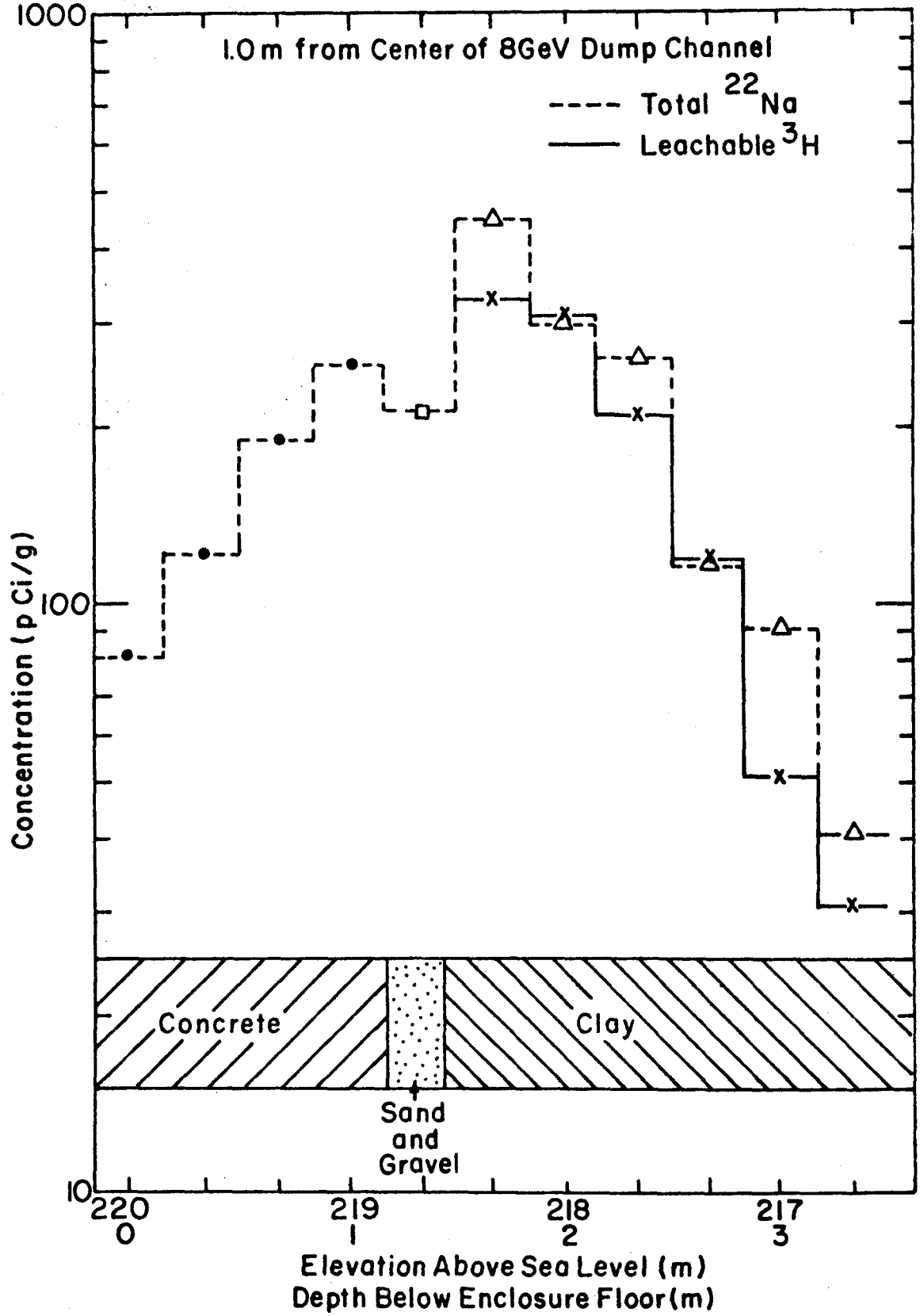
*A Geiger-Müller counter was lowered down the channel to the beam dump and revealed activity only near the top and at the dump.

Figure 6. Soil Activation Measurements



3.4 Nonradioactive Pollutants

3.4.1 Airborne Effluents

Of significant concern with respect to airborne effluents during 1979 was the installation and testing of a magnet debonding oven in the Industrial Building complex (W43, Fig. 3). It consists of an electrically heated oven operating at 450°C (850°F) with a propane fired afterburner operating at $\geq$ 760°C (1400°F) to assure complete oxidation of all combustion products.

This debonding oven was installed under a construction permit issued by the Illinois Environmental Protection Agency (IEPA). A fully documented acceptance test of emissions, including particulates, NO_x and hydrocarbons, was performed by the Almega Corporation and IEPA has granted an operating permit.

The debonding process removes approximately 57 kg (125 lb) of cured bonding epoxy from each magnet. There was an additional concern that there might be an airborne problem from the lead in the paint used on the magnets. The various paints were analyzed for lead content and an effluent sample was collected while a magnet was being debonded. Analysis of the sample and calculation of dispersion from plume effects, considering the stack height, calculated out to 3.5×10^{-5} $\mu g/m^3$. The EPA limit is 1.5 $\mu g/m^3$.

3.4.2 Water Utilization

3.4.2.1 Domestic Water Supplies

The domestic water supply at Fermilab is essentially provided by two wells pumping from an aquifer approximately 70 m (220 ft) deep. One (W1 in Fig. 3) is located in the Central Laboratory area and the other (V in Fig. 3) supplies the separate Village system. A third well (W3 in Fig. 3) pumps from the same aquifer and supplies water to the Main Site System when demand exceeds the capacity of W1.

These wells have chlorination systems and our water laboratory tests for pH, chlorine and coliform monthly. Test results conformed to Illinois standards during 1979. Our average use from these wells was 756,000 ℓ/day (200,000 gal/day), down slightly from 1978.

3.4.2.2 Industrial Water Ponding Systems

There are several water systems used for cooling magnets and for fire protection:

The Industrial Cooling Water (ICW) System consists of Casey's Pond (H4 in Fig. 5) at the end of the Neutrino Beam Line and underground

mains to fire hydrants and sprinkler systems throughout the Main Site and the Central Laboratory. Casey's Pond is supplied by surface drainage and can also be supplied by pumping from the Fox River. The pond, holding 68,000,000ℓ (18,000,000 gal) is accessible to the public.

The Swan Lake/Booster Pond System (H5 in Fig. 5) is used for cooling purposes at the Central Utilities Building (C.U.B.). Water is pumped from the Booster Pond into a ditch in which it runs by way of a small West Pond into Swan Lake. The water is then returned to the Booster Pond by a return ditch. Water is also pumped from Swan Lake to N1 Service Building for cooling purposes, from which it returns by a surface ditch. This system may be supplied water from the ICW System and it overflows into Indian Creek, from which it may be pumped into the Main Ring System.

The Main Ring Ponding System consists of a series of interconnecting canals completely

encircling the interior of the Main Ring with a large reservoir pond at C4 (H6 in Fig. 5). This water is used in heat exchangers at the Service Buildings for cooling the Main Ring magnets. The system is generally supplied by surface drainage, although water can be pumped from Casey's Pond and can be pumped back to Casey's Pond. The system overflows into Lake Law (H8-9 in Fig. 5). The public is excluded from the area inside the Main Ring, and hence the Main Ring Ponding System, for operational reasons.

The water in these systems meet or exceed the quality requirements of water in general use in Illinois (Section 4).

3.4.2.3 Other Lakes and Ponds

Surface drainage from the eastern portion of the site flows into Lake Law, DUSAF Pond and the AE Sea (H10 in Fig. 5). The chlorinated effluent from the Village sewage treatment plant oxidation pond (H3 in Fig. 5) also flows into DUSAF Pond. These lakes and ponds are accessible to the public, and they are the head waters of Ferry Creek.

3.4.2.4 Tests for Pollutants

Semi-annual tests are made of water samples taken where the three creeks leave the site (Fig. 5), as well as from Casey's Pond and the Fox River. Results for 1979 are found in Table 5. Tests for coliform bacteria are made monthly in our water laboratory.

TABLE 5

Site Wide Water Quality Report For CY-1979

	pH		DO mg/ℓ		BOD5 mg/ℓ		Susp. Solids mg/ℓ		Fecal Coliform # per 100 mℓ	
	April	Oct	April	Oct	April	Oct	April	Oct		
Ferry Creek	8.7	7.8	10.9	9.6	6.3	3.1	0.75	0.026	High Ave Low	184 38 0
Kress Creek	7.9	7.8	6.1	8.8	3.1	2.6	0.28	0.04	High Ave Low	256 79 0
Indian Creek	8.8	8.0	13.6	9.6	3.0	0.2	1.13	0.082	High Ave Low	900 271 27
Casey's Pond	8.6	7.9	10.8	7.6	4.8	0.8	1.27	0.056	High Ave Low	78 19 0
Fox River	8.7	8.4	11.8	10.2	5.6	2.4	0.07	0.056	High Ave Low	255 126 14

3.4.3 Sewage Treatment

Authorization permits to discharge under the National Pollutant Discharge Elimination System (NPDES) have been obtained for both sewage treatment plants, the Central Laboratory (Fig. 1), and the Village Oxidation Pond (H3 in Fig. 5). Monthly testing results for 1979 are in Table 6.

TABLE 6

Sewage Treatment Plants

Monthly Averages

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Village	pH	7.6	7.4	7.9	8.7	8.5	8.5	8.2	8.0	7.8	8.1	7.7	7.8
	BOD5 mg/ℓ	5.2	5.6	3.9	7.6	6.8	7.2	9.7	6.9	3.6	2.2	7.7	8.3
	Susp.Solids mg/ℓ	6.2	7.6	9.3	20.0	18.0	19.1	18.0	13.5	5.0	6.0	3.0	3.0
	Fecal Col. #/100 mℓ	0	0	0	0	0	0	0	0	18	0	0	0
Central Laboratory*	pH	7.5	7.6	7.6	7.6	7.5	7.5	*					
	BOD5 mg/ℓ	6.9	7.0	3.9	3.8	4.5	6.3	*					
	Susp.Solids mg/ℓ	5.5	9.6	7.3	1.9	2.8	4.3	*					
	Fecal Col. #/100 mℓ	0	0	0	0	0	0						

*Central Laboratory Plant Removed from Service June 26, 1979

As was mentioned in the Environmental Monitoring Report for CY-1978, agreement was reached with the City of Batavia and the Main Site sewer system was hooked into the Batavia system effective June 26, 1979. The Central Laboratory sewage treatment plant has been emptied, cleaned and decommissioned.

The Central Laboratory sewer system was again troubled with excessive infiltration of rain water in the Spring of 1979. Between March 3 and May 3 more than 794,000ℓ (210,000 gal) was trucked into the Village system. This effort was successful in preventing any violation of the NPDES permit limits of BOD5 (10 mg/ℓ) and suspended solids (12 mg/ℓ).

The NPDES permit for the Village sewer system was renewed by IEPA and the limits for 30 days average BOD5 and suspended solids were reduced from 30 mg/ℓ and 37 mg/ℓ to 10 mg/ℓ and 12 mg/ℓ respectively. Subject to the limits of the new permit, the Village system repeatedly exceeded the limits for suspended solids, beginning in April and extending into August, in spite of the repeated treatments with Aquazine to control algae. It should be noted that the highest reading for suspended solids was 36 mg/ℓ, which would have been acceptable under the old permit.

3.4.4 Chemical Treatment of Water Systems

Chemical treatment of our various water systems is required each year to control the growth of algae and aquatic weeds. Only EPA registered agents are administered by trained personnel following the manufacturer's directions.

3.4.4.1 Copper Sulfate and Dalapon

Copper sulfate was used once during 1979 to treat the Main Ring Pond System to control algae and weed growth. This chemical is used only in that pond system since it is closed to the public and fishing is not allowed. Silt samples taken from three locations and analyzed for heavy metals contained 11.5 ppm (parts per million), 13.7 ppm and 18.1 ppm of copper. Analysis of pond water samples taken concurrently at the vicinity of the C4 outlet gave 0.003 mg/ℓ and 0.009 mg/ℓ, well below the Illinois limit of 0.02 mg/ℓ for waters in general use. (Section 4).

Dalapon was used to treat drainage ditches for control of cattail growth. A total 87 Kg (192 lb) on an estimated 13 km (8 mi) of drainage ditches was applied.

3.4.4.2 Chlorine

In addition to the routine chlorination of the domestic water systems, the swimming pool and the Village Oxidation Pond, a new chlorination system for the Swan Lake cooling pond system has proven successful in helping to eliminate the need for chromate treatment of the cooling towers. Chlorine is added to the cooling water for a period of 30 minutes four times a day at a rate which results in a chlorine concentration of 0.5 ppm as the cooling water leaves the equipment.

3.4.4.3 Aquazine

As previously mentioned, it was necessary to repeatedly treat the Village Oxidation Pond to control algae growth and reduce suspended solids. The pond was treated a total of five times, following the manufacturer's application instructions. In addition, the Swan Lake cooling system, the Center Reflecting Pond and the East Reflecting Pond were treated with Aquazine once during 1979.

3.4.5 Heavy Metals and Toxic Materials

The continued success of the Swan Lake cooling pond system again made it possible to eliminate the use of chromates in 1979. Although it was necessary to use the cooling towers during the warm summer months, it was not necessary to treat the towers and thus no chromate compounds were pumped into the Main Ring tile field.

Continued testing for chromate, copper and zinc from various waters and wells was conducted in 1979. Results of these tests are shown in Table 7.

TABLE 7

Heavy Metal Analyses For CY-1979

	Chromium, hex	Copper	Zinc
Sample Date: May 1, 1979			
Well 45	< 0.01 mg/ℓ	<0.001 mg/ℓ	0.050 mg/ℓ
Sample Date: May 4, 1979			
Oxidation Pond	< 0.01 mg/ℓ	0.173 mg/ℓ	0.027 mg/ℓ
Well #1	< 0.01 mg/ℓ	0.006 mg/ℓ	0.012 mg/ℓ
C_4 at H6	< 0.01 mg/ℓ	0.003 mg/ℓ	0.007 mg/ℓ
C_4 at H2C	< 0.01 mg/ℓ	0.009 mg/ℓ	0.018 mg/ℓ
Lake Law at H8	< 0.01 mg/ℓ	0.004 mg/ℓ	0.018 mg/ℓ
Lake Law at H9	< 0.01 mg/ℓ	0.003 mg/ℓ	0.011 mg/ℓ
AE Sea at R1	< 0.01 mg/ℓ	0.004 mg/ℓ	0.009 mg/ℓ
AE Sea at H10	< 0.01 mg/ℓ	0.019 mg/ℓ	0.011 mg/ℓ
Swan Lake at H5	< 0.01 mg/ℓ	0.017 mg/ℓ	0.020 mg/ℓ
Casey's Pond	< 0.01 mg/ℓ	0.002 mg/ℓ	0.006 mg/ℓ
Well #17a	< 0.01 mg/ℓ	0.003 mg/ℓ	0.464 mg/ℓ
Well #43	< 0.01 mg/ℓ	0.006 mg/ℓ	0.093 mg/ℓ
Well #55	< 0.01 mg/ℓ	0.005 mg/ℓ	0.833 mg/ℓ
Well #56	< 0.01 mg/ℓ	0.004 mg/ℓ	0.558 mg/ℓ
DUSAF Pond	< 0.01 mg/ℓ	0.021 mg/ℓ	0.013 mg/ℓ
Sample Date: June 14, 1979			
DUSAF Pond	< 0.01 mg/ℓ	0.010 mg/ℓ	0.018 mg/ℓ
AE Sea	< 0.01 mg/ℓ	<0.001 mg/ℓ	0.015 mg/ℓ
Oxidation Pond	< 0.01 mg/ℓ	0.067 mg/ℓ	0.013 mg/ℓ

It should be noted that the Village Oxidation Pond is within limits for heavy metals set by IEPA for effluent and all other waters and wells are within standards for waters in general use. Wells 17a and 45 (Fig. 3) which monitor the Main Ring tile field continue to test normally. The zinc in wells 17a, 55 and 56 (Fig. 3) can be attributed to normal corrosion of galvanized piping and is within IEPA standards.

During CY-1979 it was found that the printed circuit laboratory in the Village periodically disposed of depleted etchant solution into the sanitary sewer. Although copper levels in the Oxidation Pond effluent are within IEPA limits, this discharge had not been reported on the application for the NPDES permit. This discharge has been discontinued and the liquid is being handled as hazardous waste. The copper level in DUSAF Pond (Fig. 5), which had reached IEPA limit in the May 4 sample, was significantly reduced in the June 14 sample.

During 1979 there were several instances where small PCB spills occurred, resulting from leakage or capacitor failure. These spills were decontaminated to

<50 ppm as confirmed by analysis of soil samples and swipes. These analyses were performed by Aqualab, Inc., Streamwood, Illinois 60103.

The preparation of the PCB materials for shipment was performed within the concrete containment at the Site 55 hazardous waste storage facility (near W55 in Fig. 3). Analysis of air samples taken during handling confirmed that there was no airborne contamination and swipe tests of the concrete confirmed that it had been decontaminated to <50 ppm.

3.5 Environmental Impact

3.5.1 Assessment of Potential Radiation Dose to the Public

Fermi National Accelerator Laboratory is located in the densely populated Chicago Area. The distribution of population in different directions from the center of the main accelerator is shown in Table 8 based on the 1970 census.[18]

TABLE 8

Summary of Population Exposures for CY-1979

Source	Contribution to Population Exposures (man-rem)
Penetrating Muons from Neutrino Area	0.3
Airborne Radioactivity from Neutrino Area	2.3
Gamma Rays from Lab 7*	0.05
TOTAL	2.6

*On-site exposure to individual members of the general population assuming 24 hour per day occupancy. Gamma rays from the Boneyard made a negligible contribution this year.[4]

Note that there are about eight million people living within 80 km (50 mi) of the site. There are only about 2000 within 5 km (3 mi), but the number of people living close to the Laboratory is rapidly increasing as a result of housing construction now in progress to the east, west and south of the site. The dose rates at the site boundary were highest from penetrating muons, resulting in a large contribution to the total off-site potential dose. The direction of the muons was northeast toward West Chicago where the increase has not been as rapid. The estimated population for West Chicago in 1978 was 12,000 or approximately 20 percent higher than the 1970 census.[19] The population distribution obtained from the 1970 census[4] was used to evaluate the potential exposure to the public for CY-1979 and the man-rem dose for muons obtained using the 1970 census was increased by 20 percent to reflect the increase in population.

The radiation exposure to the general population from operation of Fermilab in CY-1979 was about 3 man-rem. Approximately 0.3 man-rem was from muons and 2.3 man-rem from airborne radioactivity (^{11}C). The exposures are given in detail in Table 8.

The exposure from muons was determined by starting with the dose to an individual at the site boundary and calculating dose versus distance from the point on site where the penetrating radiation (Section 3.1) originated to 80 km (50 mi) from the site using the inverse square of the distance and summing over the appropriate numbers of individuals.

The exposure from airborne releases was calculated starting with the 1.0 mrem per year dose rate at the site boundary obtained using the Gaussian plume diffusion model and determining dose versus distances out to 80 km (50 mi) from the site including ^{11}C decay. Since most of the exposure occurred within 16 km (10 mi) from the site, the result based on the 1970 census was increased by 40 percent to reflect the growth in this region since 1970.[19]

Several of the closed loop cooling systems are reaching levels where off-site releases, from these loops, should they occur, would be detectable but not hazardous. Some off-site release of radioactive water occurred while Casey's Pond (H4 in Fig. 3), the reservoir receiving water from discharges in the three external areas to which protons are delivered, was full. The mean concentration of tritium during the period of

release was less than one percent of the Concentration Guide for uncontrolled areas. Also, drinking water in the area is taken from wells rather than from the creek receiving the discharge. Hence, the dose from the release is expected to be negligible. A trace amount of tritium was reported in one of the 65 samples of water from wells pumped in CY-1979. The well was sampled the following month and no tritium was found above the detection limit for ground water samples. This limit is 1×10^{-6} μCi/mℓ or five percent of the Concentration Guide for community water supplies (Section 4).

3.5.2 Assessment of Nonradioactive Pollutant Releases

Although it was necessary to chemically treat some waters to control the growth of algae and weeds during CY-1979, these treatments have been kept as low as possible in order to protect wildlife and fish. These levels, well within guidelines established by the State of Illinois, could have had no deleterious effects on off-site waters. Further, sampling the waters leaving the site confirmed that no Laboratory activity affected those waters in any way that might harm the off-site environment.

The Swan Lake Ponding System (Section 3.4.2.2) has been successful in eliminating the need for chromate treatment and subsequent disposal. The periodic release of spent etching solutions containing copper salts into the Village sewer system has been stopped and these solutions are now disposed of as hazardous waste by the Safety Section.

There was no significant environmental impact resulting from the operation of the magnet debonding oven (Section 3.4.1). In addition to the testing required by IEPA, tests were made to assure that there would be no problem with lead from the magnet paints.

There were no other activities during CY-1979 which created problems with respect to nonradioactive airborne effluents. Heating is accomplished by use of natural gas, liquefied propane gas, or electricity. The bulk of the heating is supplied by natural gas fired boilers located in the Central Utilities Building. The effluents from these boilers are analyzed annually to maintain proper combustion efficiency.

3.5.3 Potential Impact of Other Toxic Substances

3.5.3.1 Pesticides

In addition to the water treatments mentioned in Section 3.4.4, the following EPA registered herbicides, insecticides and rodenticides were applied by trained personnel following the manufacturer's instructions.

PRAMITOL 25E, in 20% solution, was sprayed on approximately 40,000 m^2 (10 acres) to control weed growth around service buildings, air conditioner pads, parking lots, and electrical substations throughout the site. A total of 757ℓ (200 gal) was applied during 1979.

2,4-D Amine was applied to 160,000 m^2 (40 acres) of turf in the Village at a rate of 0.9ℓ in 76ℓ of water (1 qt/20 gal) per 4,000 m^2 (1 acre). A total of 38ℓ (10 gal) was used for this purpose.

To maintain good relations with neighboring farmers and to voluntarily comply with local Weed Commission requirements, Fermilab again sprayed to control noxious weeds, primarily Canadian and

sow thistle. A total of 1900ℓ (500 gal) of 2,4-D Amine was applied to approximately 10 km^2 (2500 acres) as a 1.25% solution in water.

Corn was planted on 7.46 km^2 (1843 acres) by licensees who applied herbicides and fertilizers. Fermilab retains the services of a land management consultant who approved of the herbicides and their application rates. One licensee also applied an approved soil insecticide (COUNTER-15G) to 4.44 km^2 (1097 acres). This was the same insecticide as was used during CY-1978[4]; however, the application rate was reduced in 1979.

A 2% solution of ROUNDUP herbicide was applied to a 0.6 m (2 ft) circle around the bases of 150 trees in the Village. A total of 2.7ℓ (2 qt) was used in this manner.

For mosquito control, an ultra low volume application of CYTHION Premium Grade Malathion was performed at 11 different times. 15ℓ (4 gal) of CYTHION were used in each application and the following areas were covered: Village and Sauk

Circle just south of the Village (Fig. 3), Sites 29, 38 and 43 (W29, W38, and W43 in Fig. 3), the Meson, Proton and Neutrino experimental areas (Fig. 1), and the Industrial Areas (near W43 in Fig. 3).

EATON'S AC Formula 50, a rodenticide, was placed in pan-type feeders inside approximately 40 outdoor electrical substations to reduce rodent nesting in this high voltage equipment.

The services of a contract exterminator, licensed by the State of Illinois and using EPA registered pesticides, was retained during 1979 for the control of miscellaneous pests found in kitchens, laboratories and living areas throughout the site.

3.5.3.2 Polychlorinated Biphenyls

During CY-1979, USEPA promulgated final regulations governing the use and disposal of polychlorinated biphenyls (PCB's). These regulations have had an appreciable impact on Fermilab. An inventory of PCB's and a Status Report as of January 1, 1979

listed 10 pure askarel-filled transformers, 64 contaminated transformers and 4465 large capacitors in use or storage for future use. These PCB items have been labeled as required.

During CY-1979, 40 drums of PCB waste were generated and disposed of at an EPA permitted burial site. These wastes consisted of contaminated fuller's earth (a porous, absorptive clay which was used for processing transformer oil), contaminated soil from a spill clean up, rags, etc., and one drum containing 5 damaged capacitors. Pending transport for disposal, these materials were stored at a hazardous waste storage facility developed during 1979 at Site 55. These PCB wastes were shipped in November 1979 to Chemical Waste Management, c/o Resources Industries of Alabama, Emelle, Alabama 35459, for burial in an approved PCB repository.

It was erroneously reported in the 1978 monitoring report that all askarel-filled transformers in service had control curbing installed around them. There are, in fact, four transformers in service without curbing. In addition, it is now known that 62 Main Ring Pulse Power Supply transformers contain from 1% - 9% PCB's and

must be classified as PCB transformers. None of these have containment curbing.

It is apparent that the removal and disposal of PCB's from transformers site wide is a significant problem and its solution will be costly. A study is now underway to develop a long range plan to accomplish this purpose. In addition, the Spill Prevention, Control and Countermeasure Plan (SPCC) has been extensively redrafted to recognize the potential effects of PCB's and other toxic agents, in addition to oil spill potential.

3.5.3.3 Hazardous Wastes

Significant progress was made during 1979 with respect to identification, collection and disposal of hazardous waste in an environmentally acceptable manner. Responsibility for this program was assigned to the Safety Section and, as mentioned in a preceeding section, a hazardous waste handling and storage facility was developed at Site 55 (W55 in Fig. 3). This facility is roofed and fenced, has hardstand and a concrete containment area. In addition to the PCB's previously mentioned, a substantial shipment of waste

chemicals was disposed of, both by Chemical Waste Management, Inc., Calumet City, Illinois 60409. In addition, some 7500ℓ (2000 gal) of waste oil was sold.

Over the years it has been the practice to deposit excess materials such as lumber, concrete, building materials and earth on the Meson Area shielding hill. To assure that none of these materials are hazardous to the environment and will not contribute to the contamination of surface as ground waters, a program to control such deposition was developed during 1979. Rules have been promulgated and responsibility for access and control has been assigned to the Roads and Grounds group. The Safety Section monitors this program.

4. References

The appropriate Radiation Protection Standard for penetrating radiation applied to individuals in uncontrolled areas was taken from the DOE Manual, Chapter 0524, Paragraph II.A. The annual dose for whole-body exposure is 0.5 rem when applied to a suitable sample of the exposed population.

The Concentration Guides used in the analyses of the surface water samples for radioactivity were taken from the DOE Manual, Chapter 0524, Annex A, Table II, Column 2 (Water in Uncontrolled Areas) and reduced by a factor of three where 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 9. The Concentration Guides for airborne 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 determining the total off-site potential dose to the public. For tritium the Concentration Guide from Table II, Column 1, is 2×10^{-7} μCi/mℓ. For ^{11}C the Concentration Guide, 2×10^{-8} μCi/mℓ, was taken from the calculation by Yamaguchi.[11]

The Concentration Guide used in the analyses of ground water samples for tritium were taken from the U. S. Environmental Protection Agency regulations for community drinking water systems 40CFR141. This Guide is 2×10^{-5} μCi/mℓ and corresponds to an annual exposure of 4 mrem if one uses the supply as one's sole drinking water source. Note that this is 50 times more stringent than the DOE regulation for a suitable sample of the general population which corresponds to 170 mrem/yr. Although there remains some questions about what concentration will produce an exposure of 4 mrem/yr, the concentrations for the other radionuclides in our analyses of ground water samples have been determined by dividing the surface water concentrations for a suitable population sample by 50 (Table 9). The specified sensitivity and precision of the analyses have been reduced to well below these Concentration Guides.

The Air and Water Pollution Standards for nonradioactive pollutants were taken from Chapters 2 and 3 of the State of Illinois Pollution Control Board Rules and Regulations. The waters on site were considered to be in the "general use" category. The values for total

TABLE 9

Specifications For The Analyses Of
Accelerator-Produced Radionuclides In Water

Radionuclide	CONCENTRATION GUIDE FOR POPULATION			SPECIFIED SENSITIVITY AND PRECISION*	
	Individual (μCi/mℓ)	Suitable Sample (μCi/mℓ)	Community Water System	Surface Water (μCi/mℓ)	Ground Water (μCi/mℓ)
^{3}H	3×10^{-3}	1×10^{-3}	2×10^{-5}	3×10^{-6}	1×10^{-6}
^{7}Be	2×10^{-3}	6.7×10^{-4}	1.3×10^{-5}	5×10^{-7}	5×10^{-7}
^{22}Na	3×10^{-5}	1×10^{-5}	2×10^{-7}	3×10^{-7}	2×10^{-8}
^{45}Ca	9×10^{-6}	3×10^{-6}	6×10^{-8}	3×10^{-7}	6×10^{-9}
^{54}Mn	1×10^{-4}	3.3×10^{-5}	6.7×10^{-7}	1×10^{-7}	7×10^{-8}
^{60}Co	3×10^{-5}	1×10^{-5}	2×10^{-7}	1×10^{-7}	2×10^{-8}

* The precision and sensitivity are stated for the 68% confidence level (one standard deviation). The precision required is the value specified or ± 10 percent, whichever is the lesser precision. The sensitivity is taken to be the minimum concentration which can be detected within the 68 percent confidence level.

hexavalent chromium for general water quality is 0.05 mg/ℓ. The Standards for total copper at the discharge point and for general water quality are 1.0 and 0.02 mg/ℓ respectively, and for zinc are both 1.0 mg/ℓ for surface water and for well water. The Air Quality Standards limit the releases of SO_2 and oxides of nitrogen to 816 g (1.8 lbs) and 136 g (0.3 lbs) respectively, per 252 million calories (per million btu's) of actual heat input in any one hour.

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