Consumers Power
POWERING MICHIGAN'S PROGRESS
General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0550

November 12, 1987

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50-255 - LICENSE DPR-20 - PALISADES PLANT -
REQUEST TO RETAIN SOIL IN ACCORDANCE WITH 10CFR20.302

The Code of Federal Regulations, Title 10, section 20.302 allows for approval of proposed procedures to dispose of licensed material in a manner not otherwise authorized in the regulations. Flooding of the South Radwaste Building has caused contamination of 4,173 cubic feet of soil with 2,992.6 µCi of Cs-137 and 79.3 µCi of Co-60. The area is approximately 30 meters from Lake Michigan. Site hydrology (Attachment 2, FSAR 2.2) indicates most of the activity will migrate to Lake Michigan in a few years. In July, 1986 a two-fold evaluation began to identify and map the extent of the ground contamination in the flood plain. The initial findings and evaluation were provided to NRC and the Michigan Department of Public Health by internal letter dated September 26, 1986, to LHueter, NRC, Region III.

Consumers Power Company requests authorization to dispose of this soil inplace as the costs of disposal at a burial ground is estimated at $270,000 while radiological consequences to the general public and site employees is very low. The activities in the contaminated soil were input as a single radioactive liquid release to Lake Michigan into the NRC LADTAP Code. The output indicated an estimated wholebody dose to the general public (50 mile radius population 1.05E06) of 1.69E-02 manRem or 1.6E-05 millirem per person. The maximum estimated wholebody dose to an individual would be 5.13E-03 millirem and maximum organ dose (teenage liver) would be 8.67E-03 millirem. The maximum whole body dose rate was assumed to be at 18 inches from contaminated soil. The maximum whole body dose rate calculated using the Microshield Code was 1.02E-02 mR/hr. Occupancy of this area is controlled by the Radiological Safety Department and secured by a locked fence. Average yearly occupancy is approximately 8 hours per week per individual for 4 to 5 individuals. A radiation worker should not exceed an additional wholebody dose of 4.08 millirem/year.

Flooding of the South Radwaste Building as a result of the cooling tower overflows is being addressed in two stages. For the short term the cooling tower bypass valve is now electrically isolated during cooling tower operation. Most previous flooding has been due to instrument failures that cause the valve to open during normal operation. In addition the South Radwaste Building has been decontaminated to eliminate or minimize contamination that

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could be transported to the environment. A long term solution to remove radwaste activities from this area is being included in the Five-Year Plan.

The activity released to the environment from a flooding release prior to 1986 was estimated and added to the liquid section of the Semi-Annual Radiological Effluent Release Report dated February 28, 1986. Following approval of this application, it is proposed to account for current activity as an abnormal liquid release included in the semi-annual effluent report. A background, evaluation and survey results discussion follows in Attachment A. Attachment 1 is the Microshield Code output and Attachment 2 is FSAR section 2.2 (including referenced tables and figures) on site hydrology.

Pursuant to 10CFR170.12(c) a check in the amount of $150 is attached.

Thomas C Bordine
Administrator, Nuclear Licensing

CC Administrator, Region III, NRC
NRC Resident Inspector - Palisades

Attachment

ATTACHMENT A

Consumers Power Company
Palisades Plant
Docket 50-255

EVALUATION AND SURVEY RESULTS

November 12, 1987

10 Pages

TPN-HP01-NL01

Background

In 1986, a soil survey was conducted south of the Turbine Building which included the South Radwaste area. The survey was conducted due to the South Radwaste Building being in the main flowpath of 'A' Cooling Tower, which has overflowed on three separate occasions in 8 years. The survey found that radioactive material was deposited in the soil due to the flooding of contamination and radioactive material areas inside the South Radwaste Building. Other areas sampled that were not in the flood plain were; liquid radwaste storage tanks, T-90, T-91, storm drains, the beach and the sand dunes. The survey included a survey grid, surface sample results and core sample results. All contaminated areas found in Area A (Figure 1) were packaged as radwaste. In addition, the highest activity areas adjoining the South Radwaste Building were also packaged. A total of 16-98 cubic foot boxes were packaged containing over 85 percent of the estimated activity.

Evaluation

In August of 1987, the survey was conducted again to prepare this report and to verify the location of the ground contamination and if any contamination migrated further into the ground since the 1986 survey. The survey was a two phase evaluation with the first phase being a mapped area consisting of 25' x 25' squares south of the Turbine Building. Once mapped out, surface samples were taken in this area. The intent of this phase was to accurately map the location and determine the activity in μCi/gram of all ground surface contamination. Each surface sample consisted of approximately 20 grams of soil taken

from the top 1/2" of ground and placed in a petri dish for analysis on the Multi-Channel Analyzer (MCA). Over 275 samples were collected and analyzed with two surface samples being taken in each sector. All samples were counted on MCA, Intrinsic Detector #1. Figure 2 shows the sector where activity was detected and their highest levels in μCi/gram.

Phase II was initiated after completion of the "surface" sample analysis. This consisted of taking core samples in 6" increments where activity was detected. Core samples were taken until two consecutive core samples reflected no activity. Core samples were also taken below the activity levels found in the 1986 soil survey until two consecutive core samples revealed no activity.

Figure 3 indicates the depth level where activity was no longer detectable. For example, 6 inches is indicated in H-10 on Figure 3. This indicates that activity was only detected on the surface. H-9 and I-10 indicate 18" which means activity was detected only at 12". Table 1 shows the results summary in μCi/gram of the highest activity at all sample locations. The sector numbers respond to grid coordinates shown on Figures 1, 2 and 3.

In addition to the sample sectors shown on Figure 1, 25 samples were collected at various locations on site. These include surface and core samples around T-90, and T-91 on the Northwest side of the Turbine Building (location not shown on figures). Surface samples were taken under the asphalt around the South Radwaste Building. These are indicated by a hexagon on Figure 1 in F-11, I-12 and K-10 sectors. Core samples taken under the South Radwaste Building are indicated by circles on Figure 1. Of the areas sampled above activity was

found only under the East side of the South Radwaste Building in sector I-9 (Table 1).

In the 1986 soil survey other areas were sampled that were not in the flood plain of the South Radwaste Building. Those included Feedwater Purity Building, North Storage Building, beach areas North and South of Plant, North and Northeast sand dunes and various storm drains. In all of these areas no activity was detected. Therefore, they were not sampled in the 1987 soil survey as they were not in the flood plain.

Since the 1986 soil survey, asphalt has been placed over various locations in the protected area. Asphalt was placed around all storm drains and approximately 50% of the South end of the Turbine Building. Before asphalt was laid down, about 3-6" of the top soil was removed and taken offsite. The soil before leaving site was sampled and counted with no activity detected.

Results

To quantify activity and determine impact, the areas of ground contamination were separated into two areas. Area A which contains all the sectors (A-L, 1-8) North of the "black top" to the Turbine Building. Area B contains all sectors (C-L, 9-14) South of "black top" in the vicinity of the South Radwaste Building. In Area A no activity was detected, therefore it was not used in determining activity or impact.

In Area B activity was detected in almost all sectors to the East of the South Radwaste Building (Figure 2). Activities ranged from 2.07E-6 μCi/gram (E-11) to 3.75E-5 μCi/gram (H-11). Cs-137 was the primary radionuclide present in all samples with two other samples containing Co-60 1.12E-5 μCi/gram at 6" and 5.80E-6 μCi/gram at 12" (I-9 East Figure 2). The greatest depth where activity was detected was in sector H-11 at 18" and when compared to the 1986 soil survey the activity has migrated down into the soil 6" inches further. Activity was detected at the surface in sectors E-11, E-13, J-12 and L-9 and at 6" in L-9. This was a result of moving the sand deposited on the asphalt during the flood to these sectors and the movement of soil during the grading and dumping during the asphalting of the South Radwaste area.

Activity in μCi was calculated for each sector (Table 2) by the following formula: sector ft^2 x depth of activity ft x *48144 grams/ft^3 x activity (μCi/gram) = μCi. *Average liter of soil weighed 1700 grams x 28.32 L/ft^3 = 48144 grams/ft^3. The first level at which no activity was detected was used to determine depth of activity. In a few sectors, activity was only detected on the first 1/2" of soil, but for determining cubic feet and activity a depth of 6" was used. For example, activity for H-10 was calculated as follows: 625 ft^2 x .5 ft. depth x 48144 grams/ft^3 x 2.6E-6 μCi/gram activity of surface sample equals 39.12 μCi.

Total volume in cubic feet and total activity in μCi were calculated for each sector of Area B. For sectors with activity, the highest activity detected per sector was used in the μCi calculation. Total contaminated area in Area B is

4173 ft^3, total activity is 3071.9 µCi. Sector H-11 contains 73.5% of the total activity which comprises 14.5% of the total contaminated area of Area B.

To quantify the dose to the population projections, 2992.6 µCi of Cs-137 and 79.3 µCi of Co-60 was entered into the LADTAP computer program. Assuming that the total 3071.9 µCi was eventually released to Lake Michigan thru the water table, and the uptake pathways which included fish, drinking, swimming, boating and shoreline the 50 mile population estimated at 1.05E6 would receive a total body dose of 1.69E-2 manRem, or 1.61E-5 millirem per person. The maximum wholebody dose to an individual would be 5.13E-3 millirem and maximum organ dose (teenage liver) would be 8.67E-03 millirem.

Direct dose to an individual working in the affected areas was calculated using the MICROSHIELD code. The activities from sectors H-11 and I-9 were used for a dose 18 inches above the surface. The dose rates from H-11 and I-9 are 8.75E-06 R/hr and 1.02E-05 R/hr respectively (Attachment 1). Therefore, a 50 hour occupancy in one week could result in a maximum exposure of 0.51 millirem. Normal occupancy of this area is on an as needed bases and averages less than 8 hours/week per individual in contact with contaminated soil.

Table 1

Soil Sample Core Results (uCi/gram)

Sector #	Surface	6"	12"	18"	24	30"	36"	42"	48"
E-11	2.07E-6	<MDA	<MDA	<MDA					
E-13	4.39E-6	<MDA	<MDA	<MDA					
H-9	4.19E-6	<MDA	4.79E-6	<MDA	<MDA	<MDA			
H-10	2.60E-6	<MDA	<MDA						
H-11	3.75E-5	<MDA	<MDA	8.45E-6	<MDA	<MDA	<MDA		
I-9	1.24E-5	<MDA	<MDA						
I-10	<MDA	<MDA	5.39E-6	<MDA	<MDA	<MDA	<MDA	<MDA	
J-9	5.39E-6	<MDA	<MDA						
J-12	6.39E-6	<MDA	<MDA						
L-9	<MDA	6.77E-6	<MDA	<MDA					
T-90	<MDA	<MDA							
T-91	<MDA	<MDA							
**I-9 #1	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA	<MDA		
**I-9 #2	<MDA	1.40E-5*	5.80E-6+	<MDA	<MDA	<MDA	<MDA		
**I-10 #3	<MDA	<MDA							
**I-11 #4	<MDA	<MDA							
***K-10	<MDA								
***I-12	<MDA								
***F-11	<MDA								

+ Activity is all Co-60

* Includes 1.12E-5 μCi/gram of Co-60. All other activities listed were identified as Cs-137.

** Core samples under foundation of the South Radwaste Building.

*** Surface samples under asphalt in South Radwaste area.

Table 2

Activity Calculations per Sector

Area B

Sector #	Sq.ft.	X	Depth	=	ft^3	X	g/ft^3	X uCi/g	=	Total uCi
E-11	375		0.5		187.5		48144	2.07E-6		18.7
E-13	375		0.5		187.5		48144	4.39E-6		39.6
H-9	625		1.5		937.5		48144	4.79E-6		216.2
H-10	625		0.5		312.5		48144	2.60E-6		39.1
H-11	625		2.0		1250.0*		48144	3.75E-5		2256.8*
I-9	527		0.5		263.5		48144	1.24E-5		157.3
I-10	275		1.5		412.5		48144	5.39E-6		107.0
J-9	450		0.5		225		48144	5.39E-6		58.4
J-12	200		0.5		100		48144	6.39E-6		30.8
L-9	150		1.0		150		48144	6.77E-6		48.9
I-9 east	98		1.5		147		48144	1.40E-5		99.1
	4325				4173					3071.9
					*1250				=	*2256.8 = 73.5% of total activity

FIGURE 1

SURVEY GRID

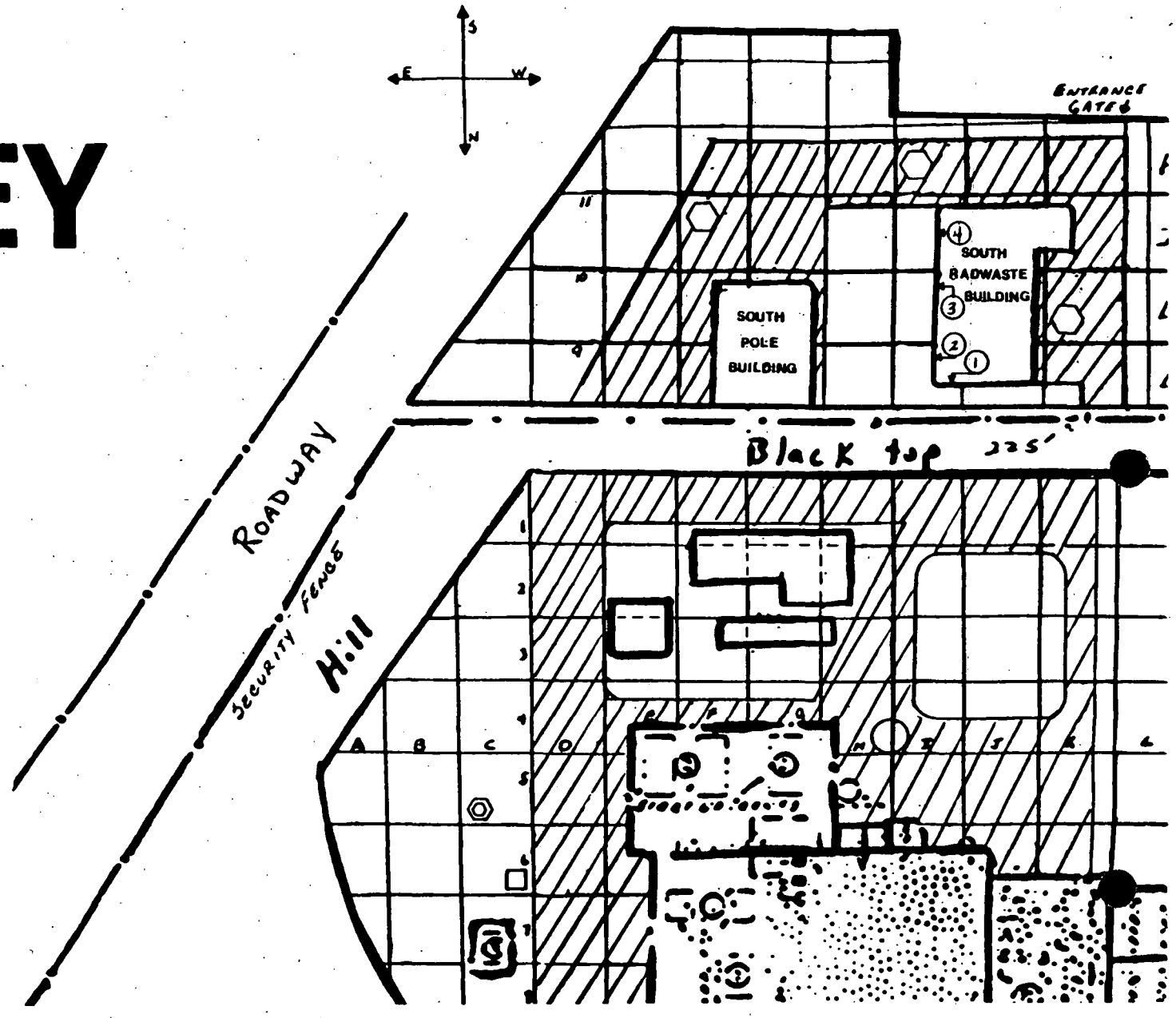
LEGEND

ASPHALT AREAS

25′ x 25′ SECTORS

AREA "B"

AREA "A"



AUGUST 1987

AUGUST 1987

FIGURE 2

SURFACE RESULTS

LEGEND

- <LMDA — <MINIMUM DETECTABLE ACTIVITY (1.00E-6 µCi/UNIT)
- SURFACE AREA UNDER ASPHALT
  CORE SAMPLE UNDER FOUNDATION
- 1.50E-6* — SURFACE ACTIVITY OF SECTOR
- ASPHALT AREAS
  *EXAMPLE ONLY

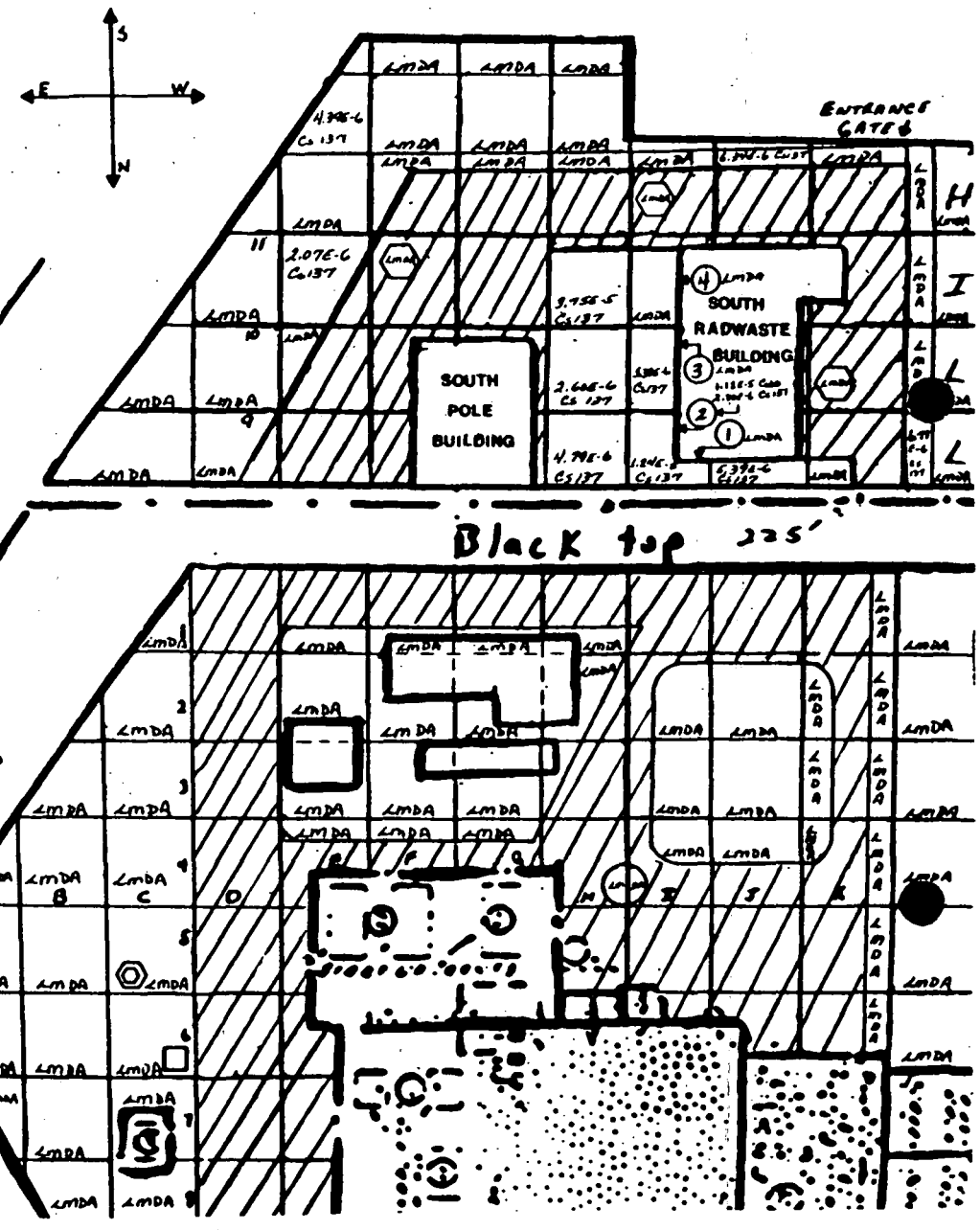


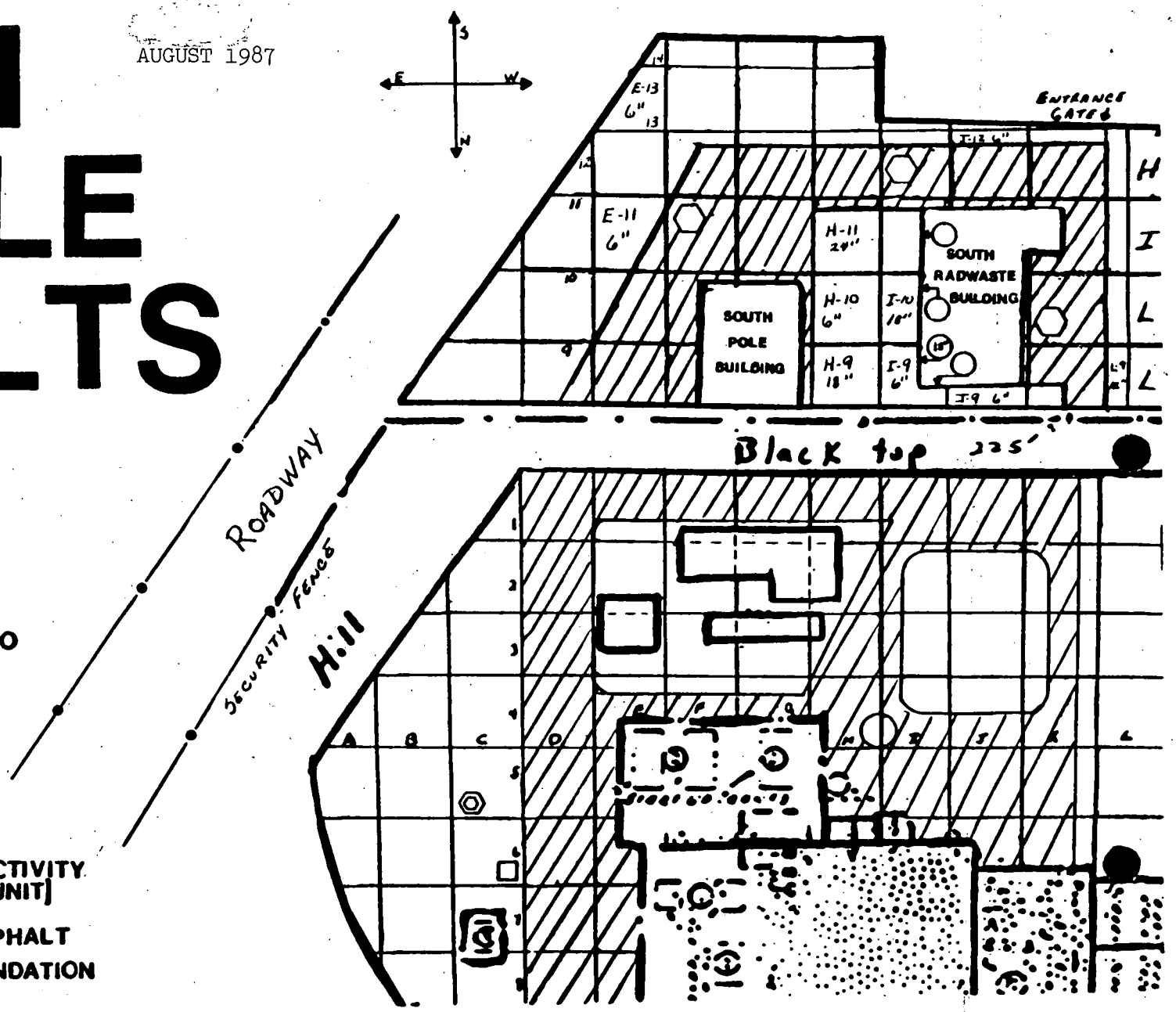
FIGURE 3

DEPTH SAMPLE RESULTS

AUGUST 1987

LEGEND

D-4	LETTER (D)=COLUMN NUMBER (4)=ROW
6"	DEPTH LEVEL AT WHICH NO ACTIVITY WAS DETECTED
	ASPHALT AREAS
	∠ MINIMUM DETECTABLE ACTIVITY [1.00 E-6 µCi/UNIT]
	SURFACE AREA UNDER ASPHALT CORE SAMPLE UNDER FOUNDATION



ATTACHMENT 1

Consumers Power Company
Palisades Plant
Docket 50-255

MICROSHIELD CODE OUTPUT

November 12, 1987

8 Pages

TPN-HP01-NL01

Page : 1 of 2
File : SOIL8 .OUT
Saved: 09:03:09
: 06-28-1987

File Ref: _____
Date: ___/___/___
By: _____
Checked: _____

****** CASE TITLE ******
CONTAMINATED SOIL @ H-11 LOCATION (6 INCHES DEEP)

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME.....SLAB

Locating dimensions	Source dimensions	Shields
X = 60.96	thickness = 15.24	t(2) = 45.72
	height = 335.28	
	width = 762	

Integration parameters
radial increment = 2
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = 3.894E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 1.)

Material	Source	Shield 2
Water	1.000	
Air	0.00129	0.00129
Carbon	1.700	

 File Ref: _____

File : SOIL8 .OUT
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: 09-28-1987

****** CASE TITLE ******
CONTAMINATED SOIL @ H-11 LOCATION (6 INCHES DEEP)

****** SOURCE STRENGTH ******

Isotope	Activity (microCuries/cc)
Ba 137m	3.750E-05

****** RESULTS ******

Photon group energy (MEV)	Activity (photons/sec)	Dose point flux (MEV/sq cm/sec)	Dose rate (R/hr)
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75	4.808E+06	4.208E+00	8.753E-06
0.75 - 0.90			
0.90 - 1.10			
1.10 - 1.35			
1.35 - 1.60			
1.60 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.20			
7.20 - 10.00			
Totals:	4.808E+06	4.208E+00	8.753E-06

+ 9.446E-11 (page 4)

= 8.75 E-06 Total

Page : 1 of 2
File : SOIL9 .OUT
Saved: 09:02:38
: 09-28-1987

File Ref: _____
Date: ___/___/___
By: _____
Checked: _____

****** CASE TITLE ******
CONTAMINATED SOIL @ H-11 LOCATION (24 INCHES DEEP)

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME.....SLAB

Locating dimensions	Source dimensions	Shields
X = 106.68	thickness = 15.24	t(2) = 45.72
	height = 335.28	t(3) = 45.72
	width = 762	

Integration parameters
radial increment = 2
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = 3.894E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 2.)

Material	Source	Shield 2	Shield 3
Water	1.000	1.000	
Air	0.00129	0.00129	0.00129
Carbon	1.700	1.700	

Page : 2 of 2 File Ref: _____
File : SOIL3 .OUT
Saved: 09:02:38
: 09-28-1987

****** CASE TITLE ******
CONTAMINATED SOIL @ H-11 LOCATION (24 INCHES DEEP)

****** SOURCE STRENGTH ******

Isotope	Activity (microCuries/cc)
Ba 137m	8.450E-06

****** RESULTS ******

Photon group energy (MEV)	Activity (photons/sec)	Dose point flux (MEV/sq cm/sec)	Dose rate (R/hr)
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75	1.083E+06	4.541E-05	9.446E-11
0.75 - 0.80			
0.80 - 1.10			
1.10 - 1.35			
1.35 - 1.60			
1.60 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.20			
7.20 - 10.00			
Totals:	1.083E+06	4.541E-05	9.446E-11

****** MICROSHIELD 2.02 ******

Page : 1 of 2
File : SOIL6 .OUT
Saved: 09:05:15
: 09-28-1987

File Ref: _____
Date: ___/___/___
By: _____
Checked: _____

****** CASE TITLE ******
CONTAMINATED SOIL @ I-9 LOCATION (6 INCHES DEEP)

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME.....SLAB

Locating dimensions	Source dimensions	Shields
X = 60.96	thickness = 15.24	t(2) = 45.72
	height = 335.28	
	width = 762	

Integration parameters
radial increment = 2
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = 3.884E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 1.)

Material	Source	Shield 2
Water	1.000	
Air	0.00129	0.00129
Carbon	1.700	

File : SOIL6 .OUT
Saved: 05:05:15
: 09-23-1987

File Ref: _____

****** CASE TITLE ******
CONTAMINATED SOIL @ I-9 LOCATION (6 INCHES DEEP)

****** SOURCE STRENGTH ******

Isotope	Activity (microCuries/cc)
Ba 137m	2.800E-06
Co 60	1.120E-05

****** RESULTS ******

Photon group energy (MEV)	Activity (photons/sec)	Dose point flux (MEV/sq cm/sec)	Dose rate (R/hr)
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75	3.590E+05	3.142E-01	6.535E-07
0.75 - 0.90	1.613E+02	1.598E-04	3.396E-10
0.90 - 1.10			
1.10 - 1.35	3.225E+06	4.988E+00	9.179E-06
1.35 - 1.60			
1.60 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.20			
7.20 - 10.00			
Totals:	3.584E+06	5.303E+00	9.832E-06

+ 3.280E-07 (page 8)

= 1.02 E-05 (Total)

Page : 1 of 2
File : SOIL7 .OUT
Saved: 09:04:05
: 09-28-1987

File Ref: _____
Date: ___/___/___
By: _____
Checked: _____

****** CASE TITLE ******
CONTAMINATED SOIL @ I-9 LOCATION (12 INCHES DEEP)

****** GEOMETRY (centimeters) ******

RECTANGULAR VOLUME.....SLAB

Locating dimensions	Source dimensions	Shields
X = 76.2	thickness = 15.24	t(2) = 15.24
	height = 335.28	t(3) = 45.72
	width = 762	

Integration parameters
radial increment = 2
horiz. intervals = 5
vert. intervals = 5

Source volume (cubic centimeters) = 3.894E+06

****** SHIELD MATERIAL DENSITIES (g/cc) ******
(Buildup is based on the properties of shield 2.)

Material	Source	Shield 2	Shield 3
Water	1.000	1.000	
Air	0.00129	0.00129	0.00129
Carbon	1.700	1.700	

Page : 2 of 2 File Ref: _____
File : SOIL7 .OUT
Saved: 09:04:05
: 09-28-1987

****** CASE TITLE ******
CONTAMINATED SOIL @ I-9 LOCATION (12 INCHES DEEP)

****** SOURCE STRENGTH ******

Isotope	Activity (microCuries/cc)
Co 60	5.800E-06

****** RESULTS ******

Photon group energy (MEV)	Activity (photons/sec)	Dose point flux (MEV/sq cm/sec)	Dose rate (R/hr)
0.10 - 0.20			
0.20 - 0.30			
0.30 - 0.40			
0.40 - 0.55			
0.55 - 0.75			
0.75 - 0.90	8.356E+01	4.299E-06	8.598E-12
0.90 - 1.10			
1.10 - 1.35	1.670E+06	1.782E-01	3.280E-07
1.35 - 1.60			
1.60 - 1.80			
1.80 - 2.00			
2.00 - 2.20			
2.20 - 2.40			
2.40 - 2.60			
2.60 - 2.80			
2.80 - 3.20			
3.20 - 4.00			
4.00 - 5.00			
5.00 - 6.00			
6.00 - 7.20			
7.20 - 10.00			
Totals:	1.670E+06	1.782E-01	3.280E-07

ATTACHMENT 2

Consumers Power Company
Palisades Plant
Docket 50-255

FSAR SECTION 2.2 - SITE HYDROLOGY

November 12, 1987

10 Pages

TPN-HP01-NL01

2.2 HYDROLOGY

The Palisades Plant site is surrounded on the north, east and south sides by sand dunes. The west side of the site is the Lake Michigan shoreline. As a result of this local topography, the site drainage is independent of the Brandywine Creek drainage basin which drains the hinterland. All surface water runoff drains directly to the lake and the percolating runoff also discharges to the lake (see Reference 3). There are no data available to verify the amount of surface runoff from the site; however, the flow from the Brandywine Creek drainage basin should be useful for the purpose of comparison.

Data obtained to establish base flow figures for Van Buren County streams indicate that the Brandywine Creek drainage basin is about 17 square miles (see Reference 4). The average annual rainfall for the area is 34 inches. During the period September 1962 to October 1963, the base flow measurements varied from a minimum of 0.90 cubic feet per second (ft^3/s) to a maximum of 11.4 ft^3/s. This resulted in a mean annual 7-day minimum flow of 1.6 ft^3/s or 0.094 $ft^3/s/sq$ mi (cubic feet per second per square mile). The period of stream measurements was representative of drought conditions.

The deposits of Brandywine Creek drainage basin are of low permeability which results in a nearly total runoff to Lake Michigan. This runoff probably occurs soon after precipitation. Minor groundwater storage in the old beach and reworked older sandy lake deposits observed on the surface to the east of the site area probably maintain Brandywine Creek during periods of low rainfall.

2.2.1 GROUNDWATER

Almost all the water used in Van Buren County is obtained from wells. Exceptions are the City of South Haven that obtains its municipal supply from Lake Michigan and some irrigation supplies that are obtained from streams, lakes and local ditches (see Reference 4).

The glacial drift is the only known source of fresh groundwater in the county. All the glacial deposits are capable of yielding some water to wells, but the sand and gravel outwash deposits yield the largest quantities (see Reference 4).

The area of sand dunes along Lake Michigan is not generally favorable for obtaining large supplies of groundwater. Probably most of the dune sand is above the water table and most wells must be drilled into the underlying lake deposits (see Reference 4).

1. General

Groundwater levels were established by the 1966 Geology and Groundwater Investigation conducted by Bechtel Company for Consumers Power Company (see Reference 3). The results of the investigation are shown on Figure 2-9. It is readily apparent that subsurface drainage is generally westward

toward the lake (see Profile A-A). Minor variations; ie, flow toward surface streams, may exist but are not considered significant.

An average hydraulic gradient toward the lake of about 13 feet per mile was obtained along Profile A-A as shown on Figure 2-9. This gradient represents only the upper surface of unconfined groundwater. Water released on the surface would move toward the lake at an estimated rate of 650 feet per year (see Reference 3).

The nearest domestic wells to the site are located one-half mile to the east and south. The data indicates that groundwater in the vicinity of the eastern wells is flowing west toward the site. Local groundwater in the area of the southern wells is also flowing west toward the lake, perpendicular to the shoreline.

There are no major sources of groundwater withdrawal, eg, large-scale industrial or agricultural pumping, that might reverse the direction of groundwater flow and cause groundwater to flow from the Plant area toward any existing domestic wells. Without such pumping, it is difficult to envision a condition which would cause sufficient groundwater lowering at any of the domestic wells such that the direction of flow might be reversed.

2. Plant Site

Groundwater levels in the vicinity of the site are shown on Figure 2-9. The water table generally slopes toward the lake. During the site investigations, groundwater elevations averaged 580 feet MSL beneath the building site. This elevation corresponds to the approximate mean level of Lake Michigan. As shown by water levels measured during drilling, groundwater levels rise to the east to approximately 604 feet MSL beneath the switchyard and 601 feet MSL near the eastern site boundary (see Reference 3).

Field permeability tests performed during the 1965 exploratory drilling yielded values ranging from 30 to 1,720 feet per year in the site area, Table 2-11. In Drill Hole 5, located approximately 500 feet northwest of the containment building, the permeability values ranged from 30.4 feet per year to 143 feet per year. In Drill Hole 7, located approximately 650 feet south of the containment building, the permeability values ranged from 156 feet per year to 1,720 feet per year.

3. Groundwater Movement

An unconfined aquifer is present in the dune area with groundwater levels controlled by the level of Lake Michigan. The rate of movement of groundwater downward into material underlying the dunes appears to be very slow. Nine samples from Drill Hole 22 in the site area were tested for sodium absorption ratio (SAR), Table 2-12. A high SAR indicates poor downward percolation of water due to sodium deposition on and between soil particles. At the Plant site, the SAR is considered to be high between elevations 596 and 566 feet MSL and low between 566 and 555 feet MSL (see Reference 3).

Groundwater levels and permeability data from the sandy lake deposits underlying the dunes indicate a slow rate of discharge into Lake Michigan.

4. Conclusions

a. Groundwater in the unconfined aquifer moves westerly from the Brandywine Creek basin to Lake Michigan.

b. The hydraulic gradient is approximately 13 feet per mile and flow is essentially perpendicular to the shoreline.

c. Water discharged on the ground surface at the Plant site will percolate downward at a slow rate and mix with groundwater moving toward Lake Michigan.

d. Infiltration of surface water from the site to domestic wells offsite does not appear to be possible under present groundwater conditions.

2.2.2 GENERAL LAKE HYDROLOGY

1. Lake Levels

The level of Lake Michigan is cyclic and is expected to fluctuate with time and is dependent on long-term above-normal or below-normal amounts of precipitation. The highest monthly mean stage of Lake Michigan was 583.68 feet MSL in 1886. Subsequent modifications in the St Clair River and the opening of the diversion out of the basin at Chicago have tended to reduce the maximum level attainable. During the recent period of record (1900 to present), the highest recorded monthly mean stage was 582.6 feet MSL in July 1974, and the lowest monthly mean stage was 576.91 feet MSL in March and April 1964 (see Reference 5). Great Lakes levels are reported using International Great Lakes Datum which is converted to MSL at the Palisades site by adding 1.558 feet. The 1.558-foot correction factor is taken from the reference point at St Joseph, Michigan.

Short-time variations in lake levels (seiches), caused by meteorological factors and measured in hours rather than days, occur occasionally. The greatest level change of this type on record over a 105-year period involved a sudden rise of 6 feet at Michigan City, Indiana (8:10 AM, June 26, 1954) and a rise of 8 feet at Montrose Harbor, Chicago (9:30 AM on the same date) (see Reference 6). These seiches were reported in the "Science" article by Ewing, Press and Donn (Vol 120, Page 684). On passing into the shallow water at Michigan City, the wave was reflected and refracted to reach the Chicago shore of the lake. The US Lake Survey gauge at Holland, Michigan, which is 30 miles north of the Palisades site and has similar lake geometry to the site, indicated no surge on June 26, 1954.

As part of the Systematic Evaluation Program (SEP Topic II-3.B), the maximum probable surge elevation was reevaluated. The offshore surge value was reevaluated to produce an onshore surge height of 10.9 feet. The maximum monthly mean level was also reduced from 583.6 feet MSL to 582.6 feet MSL.

This resulted in a probable maximum flood protection level for the Palisades Plant of 593.5 feet MSL.

The service water pump motors at 594.7 feet MSL provide the basis for determining the minimum flood protection requirements for the Plant. Therefore, the resultant wave surges from Lake Michigan do not present a problem at Palisades.

2. Water Movements

Conclusions from a study of lake hydrology in the Palisades Park, Michigan area by Dr J L Hough (see Reference 6) indicate that surface currents generated by wind conditions and modified by the earth's rotation and lake configuration will provide adequate mixing of Plant liquid effluents into the lake. The study included actual measurements of lake water movement in the area near the Plant site, and water mixing where the Black River enters Lake Michigan at South Haven.

A summary of the study is as follows:

> Lake water is almost constantly moving past the Palisades site, with an appreciable velocity of flow, under the influence of winds. It is estimated, on the basis of wind records, that an alongshore current flows northward about 33% of the time and an alongshore current flows southward about 23% of the time. Offshore drift of surface water should occur about 38% of the time, according to frequency of offshore winds, but these would have a minimal effect close to shore, which is bordered by a high dune ridge. It is likely, therefore, that the alongshore currents would tend to persist, once set up, while offshore winds were blowing. Thus, the frequency of alongshore current flow is probably greater than the 33% and 23% based on wind directions.
>
> Under the procedure of taking water from a depth of about 20 feet, 3,500 feet offshore, raising its temperature as it is used for service water and dilution of cooling tower blowdown, and returning the effluent to the lake near shore, the effluent water will almost always be warmer than the lake water into which it is discharged. This is because a single Lake Michigan water mass is involved during most of the year. When the effluent is warmer, it will tend to float at the surface, to drift with the surface current, and to be mixed by surface turbulence due to wave action. On rare occasions, during the spring warming period when the upper layer of lake water is less than 20 feet deep, and during the summer when strong offshore winds cause a thinning of the normally deep surface mass to less than 20 feet, the intake water coming from a colder layer may not be warmed in the Plant sufficiently to have a temperature higher than that of the surface lake water. At such times, the effluent water will tend to sink to the thermocline and it will not be subject to vigorous turbulence caused by surface wave action. It will tend to mix more slowly.
>
> Surveys of the performance of Black River water, entering Lake Michigan at South Haven under various weather conditions, have indicated that

the river water is diluted rapidly, reaching a concentration of about only 1% in the lake within a mile of the river mouth.

The discharge of the Black River was evaluated because the rate was determined to be nearly the same as the discharge rate from the Palisades Plant with once-through cooling. Since the Plant is now operated with cooling towers, the discharge to the lake has been reduced to approximately 60,000 gpm or about 1/7 the original rate. The mixing and dilution factors are considered to be as great as during the higher discharge periods and the discharge concentrations should be diluted at least 1,000 times by the time the discharge could reach the public water intake at South Haven, Michigan.

3. Conclusions

a. The level of Lake Michigan is cyclic; however, the recorded high of 1886 is unlikely to be exceeded. High lake levels are not expected to present a problem at the Plant site.

b. There is no recorded evidence of short-time variations in lake levels (seiches) along the eastern shore of Lake Michigan which would be expected to affect the Plant site.

c. Surface currents generated by wind conditions and modified by the earth's rotation and lake configuration will provide adequate mixing of Plant liquid effluents into the lake.

TABLE 2-11

FIELD PERMEABILITY TEST RESULTS

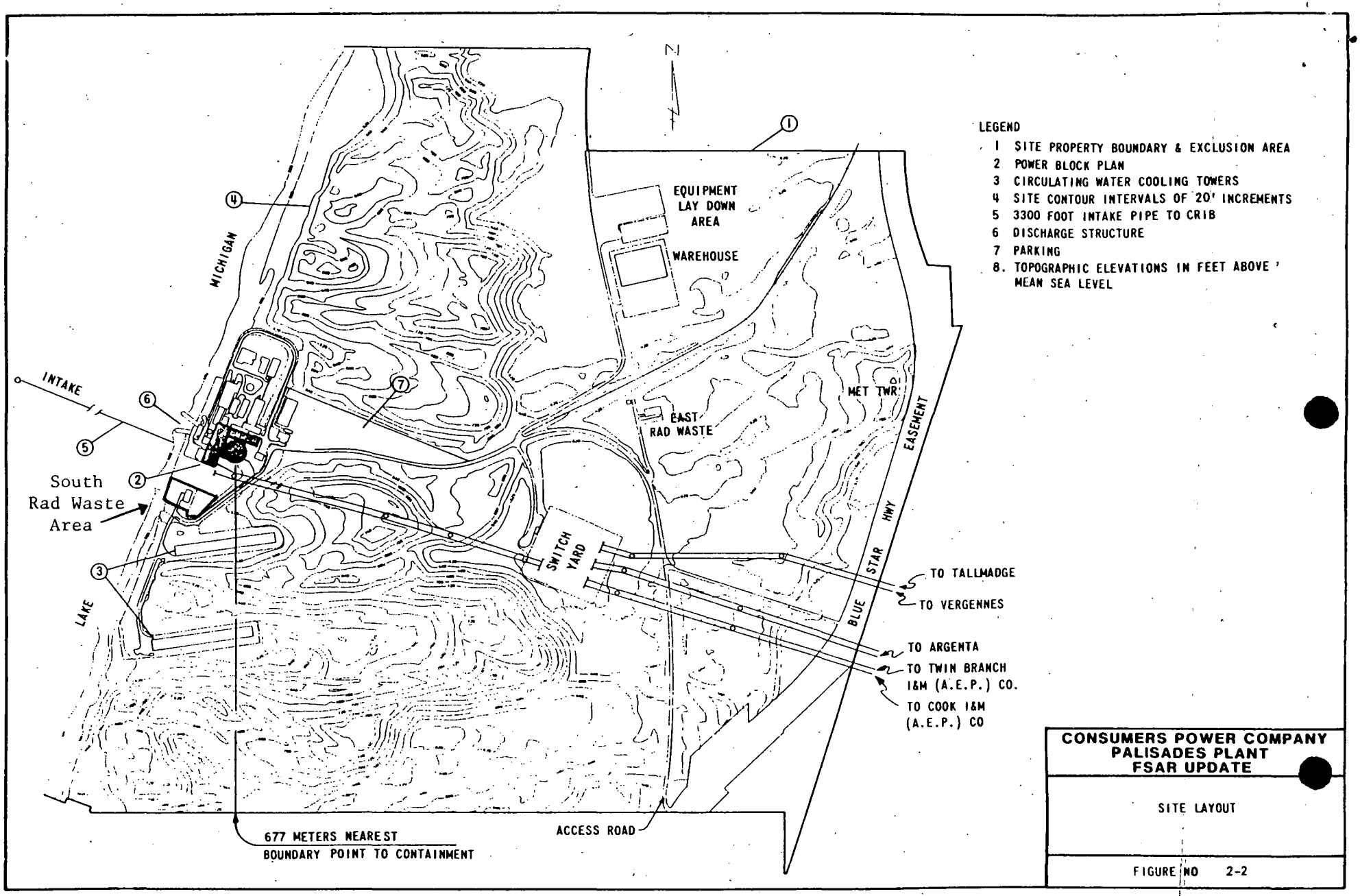
Drill Hole Number	Elevation of Test	Flow "Q" (Gpm)	Head "H" (Feet)		Permeability "K" (ft/Yr)	Permeability "K" (cm^3/s)
5	576	0.0029	12.3		30.4	0.3×10^{-4}
	570	0.0101	12.3		106.0	1.1×10^{-4}
	565	0.0088	12.3		92.0	0.89×10^{-4}
	560	0.0035	12.3		36.8	0.36×10^{-4}
	555	0.0136	12.3		143.0	1.4×10^{-4}
	550	0.0064	12.3		67.0	0.65×10^{-4}
	545	0.0033	12.3		34.6	0.34×10^{-4}
				Average	72.8	0.72×10^{-4}
7	580	0.0303	25		156	1.5×10^{-4}
	575	0.0477	25		246	2.4×10^{-4}
	570	0.0588	25		303	2.9×10^{-4}
	565	0.0588	25		303	2.9×10^{-4}
	560	0.0834	25		430	4.2×10^{-4}
	550	0.3333	25		1,720	16.7×10^{-4}
	545	0.0677	25		350	3.4×10^{-4}
	540	0.2500	25		1,290	12.5×10^{-4}
	535	0.2000	25		1,035	10.1×10^{-4}
				Average	648	6.3×10^{-4}

TABLE 2-12

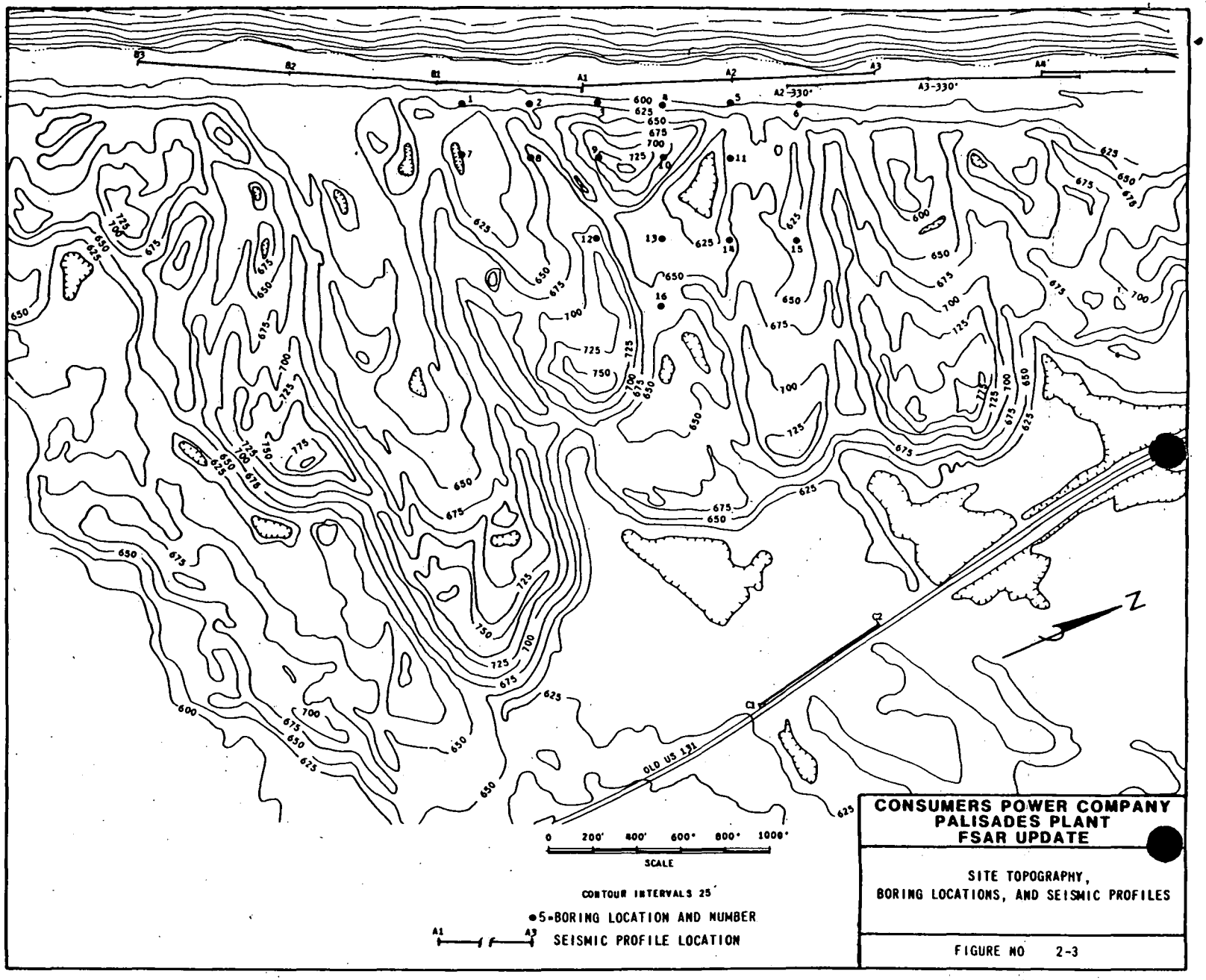
ANALYSES OF SOIL SAMPLES

Sample No	pH	Saturation Extract Values Milliequivalents per Liter ECe	Calcium	Magnesium	Sodium	SAR	Sample Description
1	8.25	1.2	0.5	Trace	11.7	23.5	DH 22 El 596
2	8.4	1.4	0.5	Trace	13.0	26	DH 22 El 591
3	8.3	1.3	0.5	Trace	12.3	24.5	DH 22 El 586
4	8.45	1.4	0.5	Trace	14.4	29	DH 22 El 581
5	8.5	1.5	0.5	0.1	14.8	27	DH 22 El 576
6	8.3	1.5	0.5	Trace	14.8	29.5	DH 22 El 571
7	8.5	1.3	0.5	0.05	12.7	24	DH 22 El 566
8	8.2	0.5	3.0	0.4	1.1	1	DH 22 El 561
9	8.1	0.6	3.4	0.7	2.4	1.5	DH 22 El 555

ECe = Millimhos per centimeter
SAR = Sodium adsorption ratio on saturation extract



ATTACHMENT 2



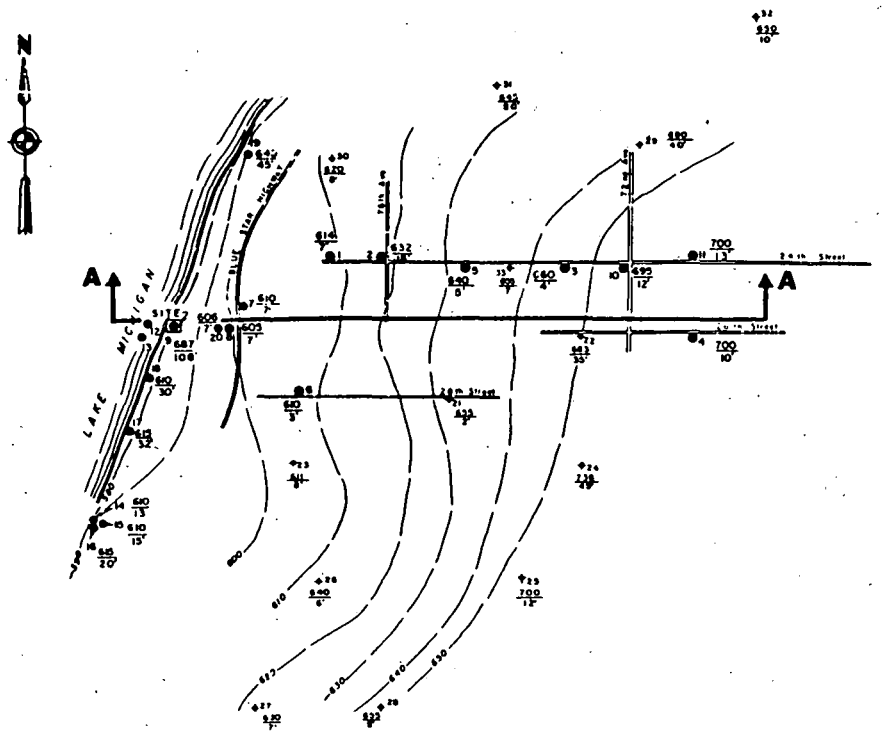
CONSUMERS POWER COMPANY
PALISADES PLANT
FSAR UPDATE

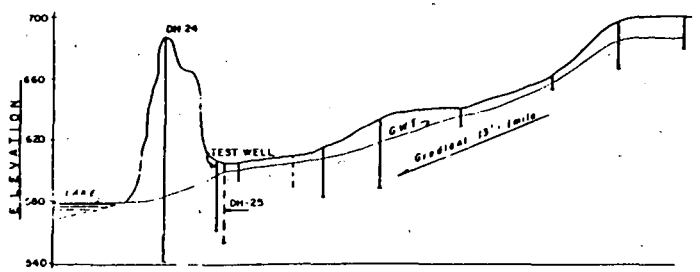
SITE TOPOGRAPHY,
BORING LOCATIONS, AND SEISMIC PROFILES

FIGURE NO 2-3

REVISION NO 0

ATTACHMENT 2





SECTION A-A PARALLEL TO 24th. St. LOCATED .5 MILES SOUTH

EXPLANATION

WATER SAMPLE LOCATION AND NUMBER — 610 / 7' = ELEVATION OF WELL COLLAR / DEPTH TO WATER

29 ELEVATION WELL AND NUMBER — 633 / 2 = ELEVATION OF COLLAR / DEPTH TO WATER

600 — GROUND WATER CONTOUR

HORIZONTAL

VERTICAL

SCALES

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GROUNDWATER ELEVATIONS AND AREA GRADIENTS

FIGURE NO 2-9

REVISION NO. 0

ATTACHMENT 2