ENVIRONMENTAL IMPACT APPRAISAL

EXXON NUCLEAR COMPANY

NUCLEAR FUEL FABRICATION PLANT

RICHLAND, WASHINGTON

RELATED TO LICENSE RENEWAL OF SPECIAL

NUCLEAR MATERIALS LICENSE NO. SNM-1227

DOCKET NO. 70-1257

PREPARED BY

DIVISION OF FUEL CYCLE

AND MATERIAL SAFETY

U. S. NUCLEAR REGULATORY COMMISSION

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SUMMARY

The objective of this report is to assess the environmental impact of the proposed renewal of Exxon Nuclear Company's (ENC) license number SNM-1227. The assessment has been prepared in accordance with the CEQ Guidelines presented in the Code of Federal Regulations, Title 40, Chapter 1500 (40 CFR 1500) and the NRC Regulations presented in 10 CFR 51.

Historically the effluents of ENC's plant have resulted in small impacts to the quality of the local environment. Furthermore, the effects associated with the continued operation are projected to result in small impacts to the environment.

The findings of our assessment are summarized in the following four points:

- o The radiological releases during normal operations of the ENC plant result in doses to the nearest resident that are a small percentage of the 25 mrem/year limit specified in 40 CFR 190. The future projected doses from normal operations are expected to be small.

- o Radiological assessments for a hypothetical accidental criticality and a larger UF_6 release were performed using conservative assumptions. The resulting dose levels at the nearest industrial site and the nearest residence show that there would be no significant consequences to humans or the environment.

- o The environmental monitoring program of test wells detected leakage from the lagoons. The investigative action limit specified in ENC's license was exceeded and action was taken. Investigation of the leakage found several possible causes of the leaks; and the containment system has been redesigned incorporating double liners for the lagoons as well as a leak detection system below and between the two liners. Continued monitoring of the test wells indicates that the corrective action has had a positive effect on the concentrations of various contaminants in the groundwater.

- Releases of fluorides under normal operations and for a large accidental UF_6 release have been assessed. The concentration of fluoride in vegetation is inconsistent with measurements of fluoride in the stack releases if the ENC plant is the source of the fluoride found in vegetation (see Section 3.3.2). The measurement of fluorides in the stacks is significantly different from the EPA recommended procedure. The staff requires that ENC modify their method for measuring total fluoride releases from the stacks (see Section 3.3.4).

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1.0 PURPOSE AND NEED FOR THE PROPOSED ACTION

The action proposed is renewal of the Exxon Nuclear Company's (ENC) license for acquisition, storage, processing, and disposition of special nuclear materials (SNM). The action proposed would authorize the continued possession and use of up to 10,000 kg of U-235 (<5% enrichment) and possession of 100 kg of plutonium of which at least 90 kg is in encapsulated form.

The purpose of the action proposed is to provide the enabling mechanism to permit the continuance of the manufacture, by ENC, of low-enriched uranium fuel for light water reactors (LWR) to provide continuing contribution to the maintenance of an ample supply of fuel for ENC's customers.

1.1 BACKGROUND INFORMATION

On September 14, 1971 ENC was granted an interim operating license for nuclear fuel manufacturing at their Richland, Washington, site. In March 1974 the Final Environmental Statement related to the operation of the uranium oxide fuel plant[1] was published and in June of the same year the Final Environmental Statement related to the operation of the mixed oxide fabrication plant[2] was published. A full term license was issued April 22, 1974. The operations at ENC nuclear fuel manufacturing site have been in accord with the processing described in the two environmental statements. As the production capacity was increased, ENC twice requested (references 3,4), and was granted, license amendments to authorize the operation of expanded uranium fuel manufacturing capacity. At the present time, the operation involving the use of plutonium has ceased. If the licensee plans to resume such operation in the future, a license amendment will be required and an environmental impact assessment will be prepared by NRC.

2.0 INTRODUCTION AND ORGANIZATION

2.1 SCOPE

This Environmental Assessment of a proposed operating license renewal for the Exxon Nuclear Company has been prepared in accordance with the Code of Federal Regulations, Title 10, Part 51 (10 CFR 51), "Licensing and Regulatory Policy and Procedures for Environmental Protection," and Sections 51.5, 51.7, 51.20, 51.21, 51.30, and 51.70 thereof.

This assessment was made by preparing estimates of the environmental consequences of continuing manufacture of low enriched uranium nuclear fuel and comparing these estimated consequences with applicable Federal standards. The specific Federal standards used were (1) 10 CFR 20.105, "Permissible Levels of Radiation in Unrestricted Areas" (2) 10 CFR 20.106, "Radioactivity in Effluents in Unrestricted Areas" (3) 40 CFR 190.10, "Environmental Standards for the Uranium Fuel Cycle" and (4) 40 CFR 141.11, "Maximum Contaminant Levels For Inorganic Chemicals (National Interim Primary Drinking Water Regulations)". In addition, the concentrations of fluoride releases and fluoride in vegetation were compared to the Washington State Standards[5].

Because the facility is an operating plant and actual plant effluent releases have been monitored and are documented, this evaluation has addressed the most significant environmental indices. These relate to demography, site meteorology data, hydrology, control of effluents, environmental monitoring, and accident potential.

2.2 ASSESSMENT ACTIVITIES

During assessment preparation, applicable Federal and State legislation and Federal guidelines were reviewed. Appropriate Federal and State agencies were contacted in person, by phone and/or mail. Conferences were held with facility management and staff. A site visit, including surrounding areas, was conducted. Data from the site visit and personnel contacts were collected, evaluated and analyzed for incorporation into the final report.

2.3 ORGANIZATION

This assessment is organized according to the guidelines established by the President's Council on Environmental Quality (40 CFR 1506) and the U.S. Nuclear Regulatory Commission (10 CFR 51). Section 3.0 summarizes the principal changes in the characteristics of the site and facility since the previous environmental statements and environmental monitoring programs. The operational data from the environmental monitoring are also presented in Section 3.0. In Section 4.0 the affected environment relative to the operation of the ENC plant is discussed. Section 5.0 addresses the environmental consequences of the Proposed Action.

3.0 CHANGES IN SITE AND FACILITY DESCRIPTIONS; ENVIRONMENTAL MONITORING PROGRAM OPERATIONAL DATA; AND ALTERNATIVE

3.1 SITE DESCRIPTION

The Exxon Nuclear Company site coordinates are at 146° 21' N and 119° 17' W, just inside the northern limit of the City of Richland, Washington, on a 6100-acre parcel of land known as the Horn Rapids Triangle (Figure 3.1). The site is square, consists of 160 acres and occupies the entire Southwest Quarter of Section 15, Township 10 North, Range 28 East, Willamette Meridian in Benton County, Washington. The facility process and ancillary buildings, storage lagoons, offices and parking accommodations occupy an area of approximately 26.4 acres in the northeast corner of the site. With exception of the office buildings and parking areas, the entire facility is fenced with an eight-foot security fence (Figure 3.2).

3.1.1 Demography

The City of Richland, in which the Exxon Nuclear Company is located, along with Pasco and Kennewick comprise a metropolitan area known as the Tri-Cities. In 1970 the Tri-Cities population was approximately 56,000. During the past ten years, due mainly to the increased activities on the Hanford Reservation, the population of the Tri-Cities area has increased to 84,750, i.e., a 51% increase. Table 3.1 shows the 1980 population distribution within a 50-mile radius of the ENC by compass direction and radii interval. Projected population within 50 miles of ENC for 1985 is presented in Table 3.2. The developments within a five mile radius of the site are shown in Figure 3.3 and the industrial population distribution within five miles is shown in Table 3.3.

The 1970 population within a 50-mile radius of the ENC was 184,294. Today's population within that radius has increased by 36% to 250,220. Table 3.4 compares the 1980 data to the projections made in 1974 (reference 2). It is evident from Table 3.4 that the area, particularly within 20 miles of the plant, has exceeded the growth projections. The large growth is due primarily to increased activities on the Hanford site, including the location of several new power plants adjacent to the Hanford site.

3.1.2 Meteorology and Climatology

Measurements of the wind characteristics in the vicinity of the Exxon Nuclear site are summarized by Figure 3.4 and Table 3.5. The annual average X/Q values for the ENC site are tabulated on Table 3.6. The prevailing wind at the Exxon Nuclear site is from the southwest along the Yakima River corridor, which enters the Columbia Basin near the site. Secondary direction frequency maxima are from the northwest and the southeast along the axis of the Columbia River Valley, and the lowest frequencies are from the east and northeast. This pattern holds most of the year, with the exception of a few months in the fall and early winter, when the wind direction is predominantly from the north and northwest.

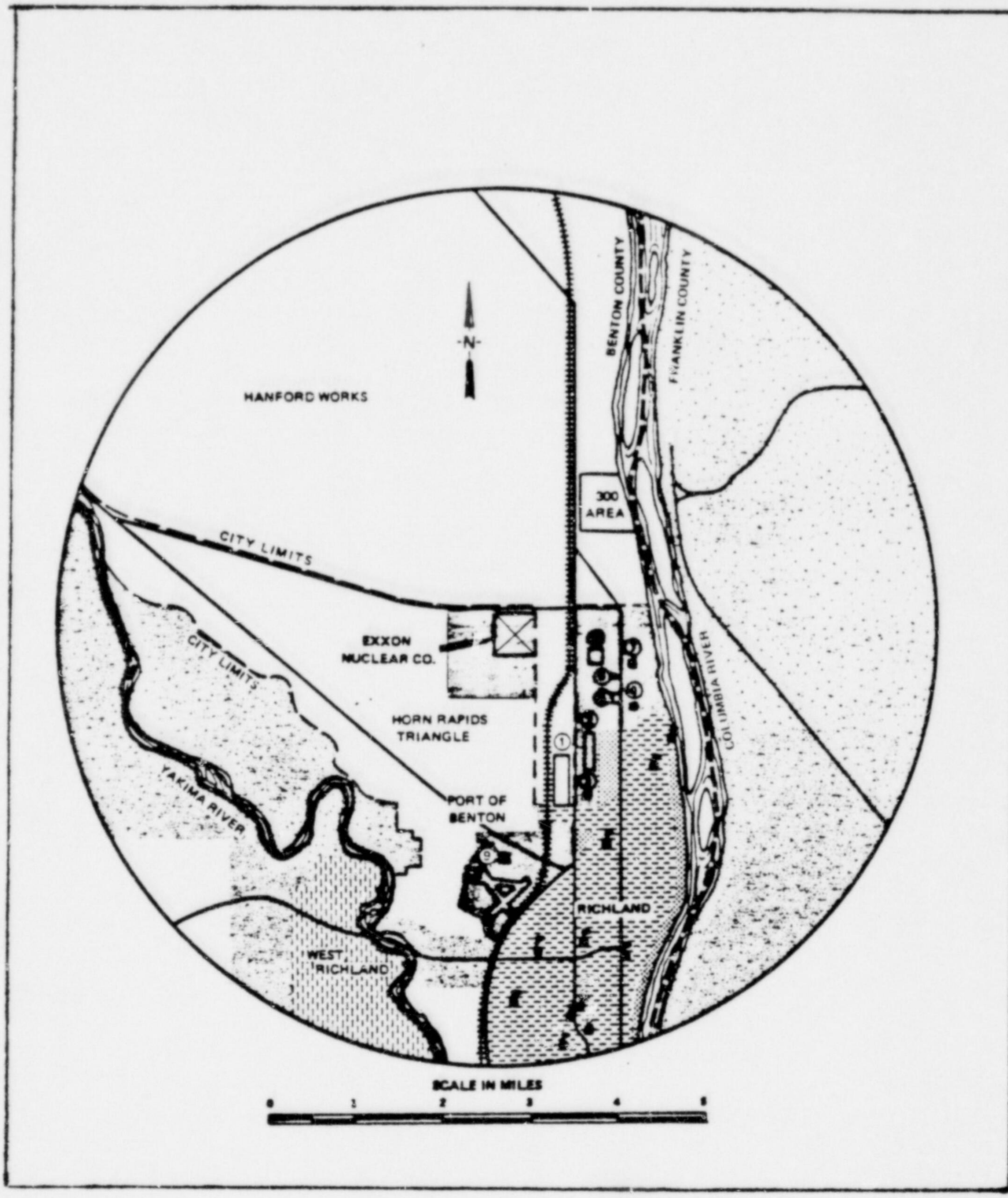


Figure 3.1 Exxon Nuclear Company Site Location

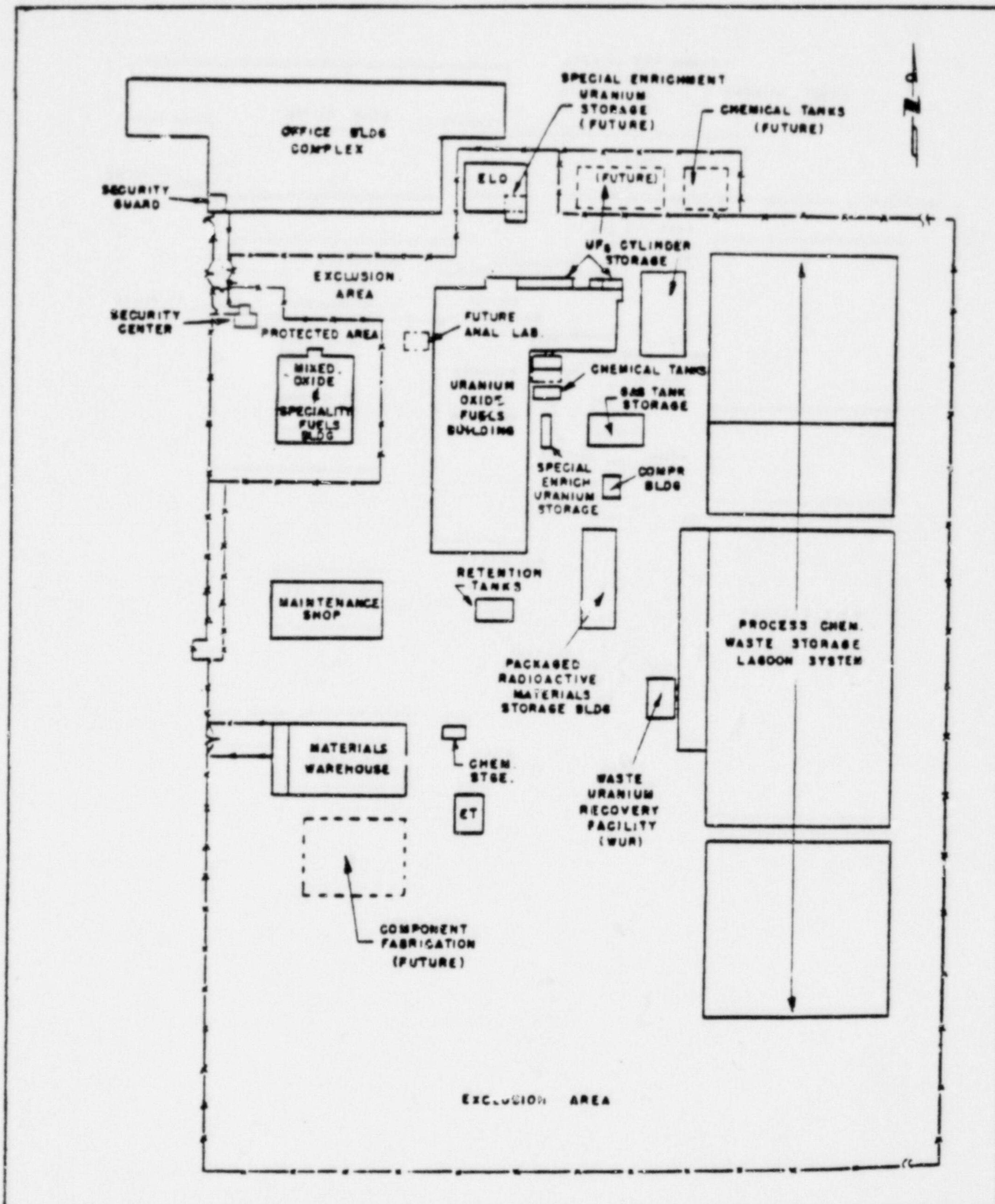


Figure 3.2 Exxon Nuclear Company Site

Table 3.1

Estimated Population Distribution (1980) Within 50 Miles of the Exxon Nuclear Site
(By Compass Sector and Distance)

Compass Sector	Miles 0-5	5-10	10-20	20-30	30-40	40-50	TOTAL
N	0	0	140	520	1,350	1,050	3,060
NNE	0	20	250	530	4,450	1,420	6,670
NE	0	130	700	1,500	1,220	550	4,100
ENE	50	150	500	180	270	250	1,400
E	100	200	250	250	150	550	1,500
ESE	120	2,700	4,260	420	650	900	9,050
SE	2,730	3,780	48,880	2,600	1,160	690	59,840
SSE	13,750	13,030	15,160	410	1,920	1,900	46,170
S	13,710	5,680	4,550	4,670	11,680	3,030	43,320
SSW	960	320	450	260	2,600	1,200	5,790
SW	1,120	240	880	510	320	410	3,480
WSW	170	1,750	1,360	6,200	10,240	810	20,530
W	250	430	1,020	1,650	15,450	17,510	36,310
WNW	0	0	0	1,280	1,300	2,670	5,250
NW	0	0	0	110	590	1,160	1,860
NNW	0	0	0	10	300	1,580	1,890
TOTAL	32,960	28,430	78,400	21,100	53,650	35,680	250,220

Table 3.2

Projected Population Distribution (1985) Within 50 Miles of the Exxon Nuclear Site
(By Compass Sector and Distance)

Compass Sector	Miles 0-5	5-10	10-20	20-30	30-40	40-50	TOTAL
N	0	0	180	560	1,500	1,110	3,350
NNE	0	30	320	570	4,750	1,530	7,200
NE	0	150	840	1,560	1,350	610	4,510
ENE	70	170	510	180	280	270	1,480
E	150	300	390	300	150	570	1,860
ESE	280	2,950	4,400	430	670	930	9,660
SE	4,250	5,300	58,600	3,100	1,450	720	73,420
SSE	16,000	15,500	18,200	500	2,020	2,000	54,220
S	16,500	6,600	5,300	5,850	13,300	3,400	50,950
SSW	1,750	340	540	350	2,750	1,280	7,010
SW	1,200	250	950	600	330	430	3,760
WSW	170	2,000	1,500	7,600	10,550	830	22,650
W	260	450	1,080	1,750	16,800	18,800	39,140
WNW	0	0	0	1,650	1,330	2,800	5,780
NW	0	0	0	110	620	1,200	1,930
NNW	0	0	0	10	320	1,660	1,990
TOTAL	40,630	34,040	92,810	25,120	58,170	38,140	288,910

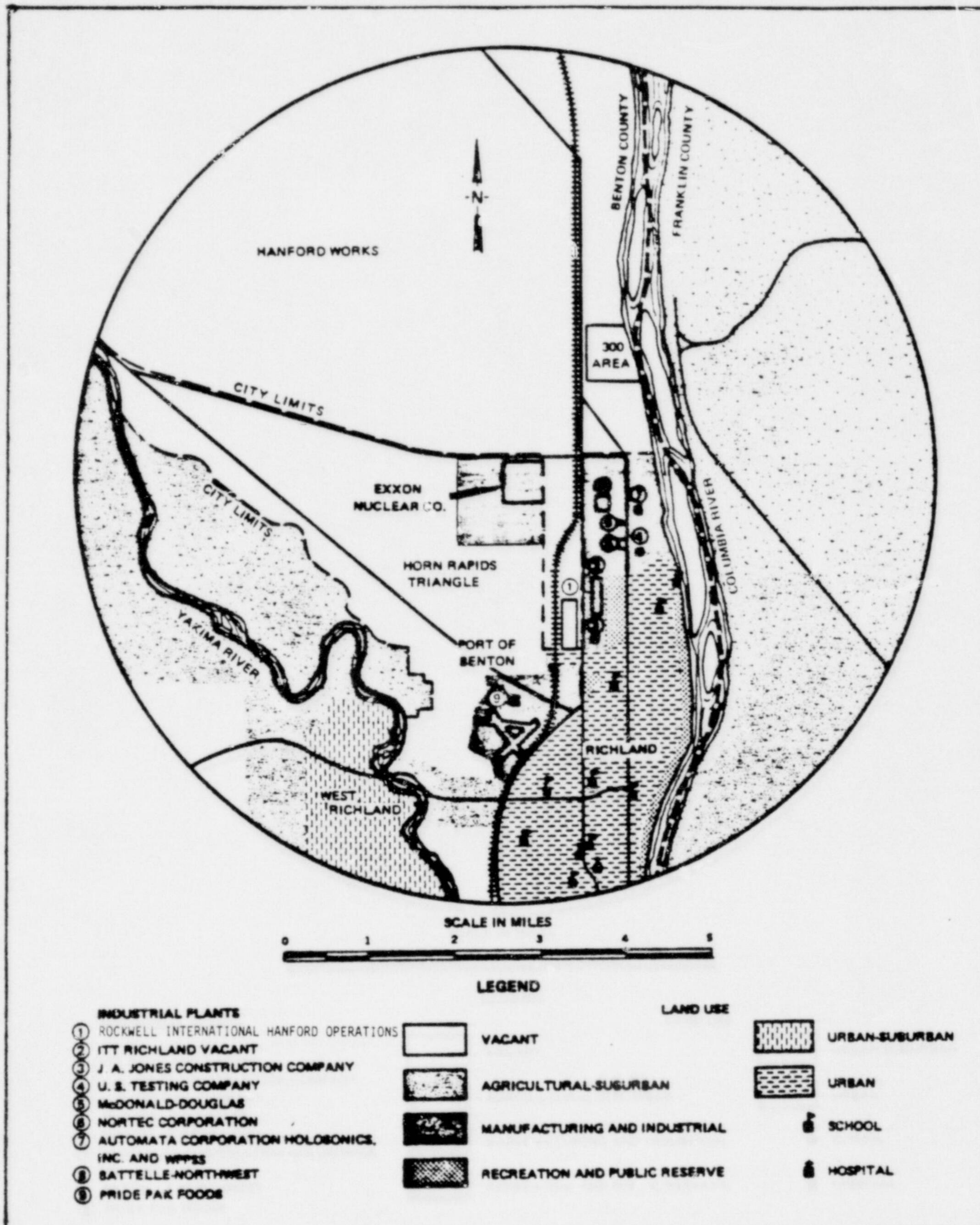


Figure 3.3 Surrounding Development

Table 3.3

Industrial Population Distribution (1980) Within 5 Miles of the Exxon Nuclear Site
(By Compass Sector and Distance)

Compass Sector	Miles 0-1	1-2	2-3	3-4	4-5	TOTAL
N	0	0	0	0	0	0
NNE	0	100	100	0	0	200
NE	0	2445	465	0	0	2910
ENE	0	120	0	0	0	120
E	0	1620	0	0	0	1620
ESE	0	1140	0	0	0	1140
SE	0	750	20	0	0	770
SSE	0	630	325	60	0	1015
S	0	0	40	30	0	70
SSW	0	0	0	5	5	10
SW	0	0	0	5	5	10
WSW	0	0	0	0	0	0
W	0	0	0	0	0	0
WNW	0	0	0	0	0	0
NW	0	0	0	0	0	0
NNW	0	0	0	0	0	0
TOTAL	0	6805	950	100	10	7865

Table 3.4 Comparison of 1980 Population Projections With 1980 Census

	0-10 Miles	10-20 Miles	20-30 Miles	30-40 Miles	40-50 Miles
Projection	37,920	56,910	18,120	45,640	44,900
Census	61,390	78,400	21,100	53,650	35,680

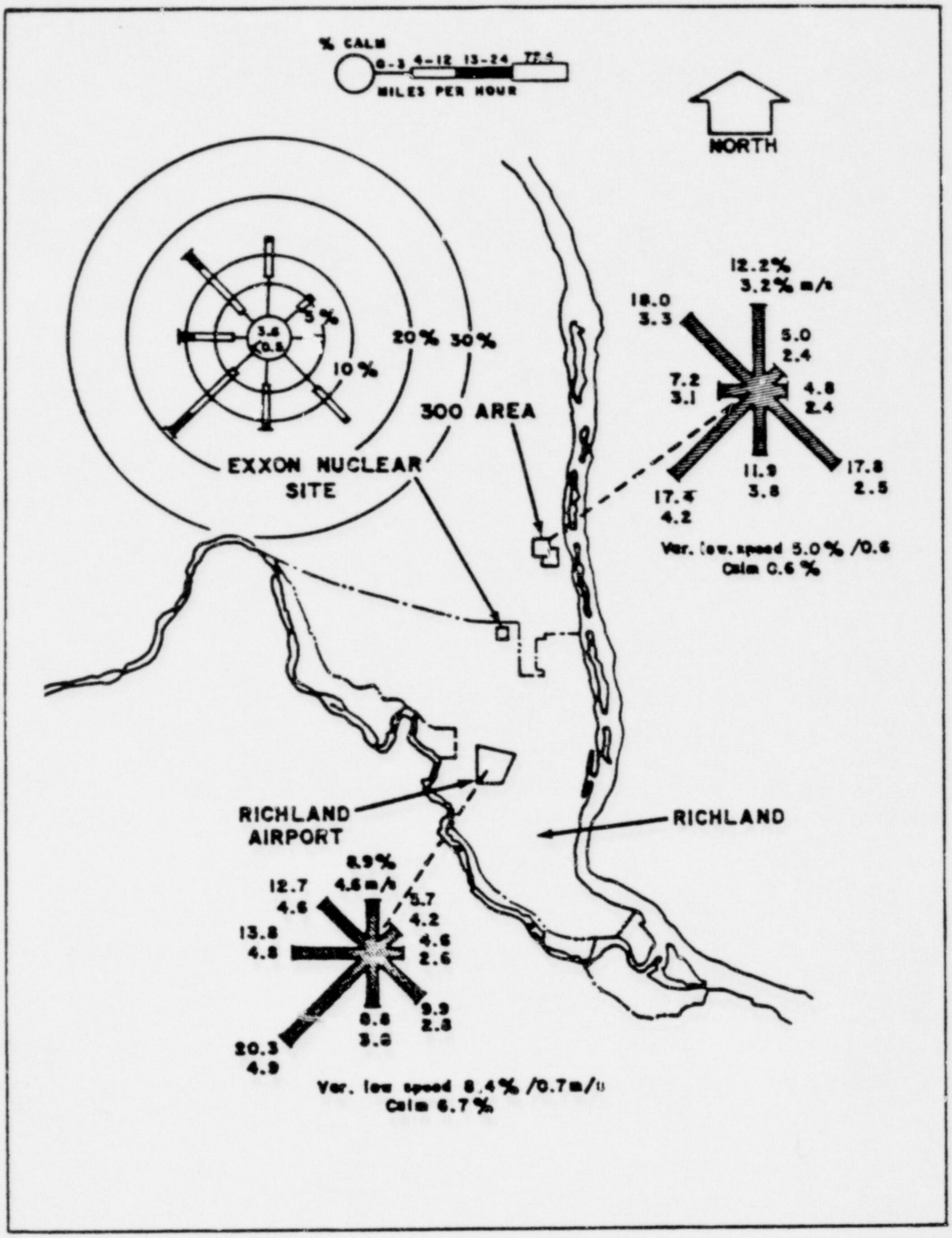


Figure 3.4 Wind Characteristics

Table 3.5

Joint Frequency Distribution (5) of Wind Speed, Wind Direction and Atmospheric Stability Applicable to the Exxon Nuclear Plant Site

Wind Speed	Pasquill Stability	Wind Direction NE	E	SE	S	SW	W	NW	N	Total
Calm	G	.10	.11	.26	.14	.12	.058	.097	.20	
(presumed	F	.10	.11	.26	.14	.12	.058	.097	.20	
0-0.5 mph)	D	.033	.035	.087	.046	.042	.019	.032	.065	
	C	.10	.11	.26	.14	.12	.058	.097	.20	
	All	.33	.35	.87	.46	.42	.19	.32	.65	3.59%
0.5-3 mph	G	.66	.69	1.71	.90	.81	.38	.63	1.28	
	F	.66	.69	1.71	.90	.81	.38	.63	1.28	
	D	.22	.23	.57	.30	.27	.13	.21	.43	
	C	.66	.69	1.71	.90	.81	.38	.63	1.28	
	All	2.19	2.30	5.71	2.99	2.72	1.26	2.11	4.28	23.56%
4-7 mph	F	1.08	1.17	3.49	2.36	3.26	2.12	2.84	2.64	
	D	.18	.19	.58	.39	.54	.35	.47	.44	
	C	.54	.58	1.75	1.18	1.63	1.06	1.42	1.32	
	All	1.80	1.95	5.82	3.94	5.43	3.53	4.73	4.40	31.60%
8-12 mph	F	.38	.24	.97	.95	2.76	2.18	2.96	.94	
	D	.063	.04	.16	.16	.46	.36	.49	.16	
	C	.19	.12	.49	.47	1.38	1.09	1.48	.47	
	All	.63	.40	1.61	1.58	4.60	3.63	4.93	1.57	18.95%
13-19 mph	F	.16		.19	.52	2.09	.93	1.47	.29	
	D	.027		.032	.087	.35	.16	.25	.048	
	C	.082		.097	.26	1.04	.46	.74	.14	
	All	.27		.32	.87	3.48	1.55	2.45	.48	9.42%
19-24 mph	F				.24	1.00	.26	.60		
	D				.039	.17	.043	.10		
	C				.12	.50	.13	.30		
	All				.39	1.67	.43	1.00		3.49%
25-31 mph	F				.095	.42	.043	.34		
	D				.016	.070	.007	.057		
	C				.047	.21	.021	.17		
	All				.16	.70	.072	.57		1.50%
32-38 mph	F					.18				
	D					.031				
	C					.092				
	All					.31				.31%

Table 3.5 (Cont'd)

Wind Speed	Pasquill Stability	NE	E	SE	S	SW	W	NW	N	Total
		Wind Direction								
Variable* 0-3 mph	G	.13	.14	.35	.18	.16	.076	.13	.26	
	F	.13	.14	.35	.18	.16	.076	.13	.26	
	D	.044	.046	.12	.060	.055	.025	.043	.086	
	C	.13	.14	.35	.18	.16	.076	.13	.26	
	All	.44	.46	1.15	.60	.55	.25	.43	.86	4.74%
Variable# 4-7 mph	F	.067	.072	.22	.15	.20	.13	.18	.16	
	D	.011	.012	.035	.024	.034	.022	.029	.027	
	C	.033	.036	.11	.073	.10	.065	.088	.082	
	All	.11	.12	.35	.24	.34	.22	.29	.27	1.94%

*Direction frequency distributed proportional to distribution within 0-3 mph class.

#Direction frequency distributed proportional to distribution within 4-7 mph class.

Table 3.6. Annual Average Atmospheric Dilution Factors

Exxon Nuclear Plant
Annual Average CHI/Q (sec/meter cubed)

Distance in Miles

Direction From Site	0.500	1.000	2.000	3.000	4.000	5.000	10.000	20.000	30.000	40.000	50.000
N	0.635E-05	0.214E-05	0.819E-06	0.474E-06	0.322E-06	0.239E-06	0.965E-07	0.408E-07	0.249E-07	0.176E-07	0.134E-07
NNE	0.656E-05	0.223E-05	0.852E-06	0.492E-06	0.334E-06	0.247E-06	0.998E-07	0.421E-07	0.256E-07	0.180E-07	0.137E-07
NE	0.678E-05	0.232E-05	0.884E-06	0.510E-06	0.345E-06	0.256E-06	0.103E-06	0.434E-07	0.263E-07	0.185E-07	0.141E-07
ENE	0.517E-05	0.177E-05	0.675E-06	0.389E-06	0.264E-06	0.195E-06	0.736E-07	0.330E-07	0.200E-07	0.141E-07	0.107E-07
E	0.353E-05	0.122E-05	0.463E-06	0.267E-06	0.181E-06	0.134E-06	0.538E-07	0.225E-07	0.137E-07	0.957E-08	0.727E-08
ESE	0.453E-05	0.156E-05	0.593E-06	0.342E-06	0.231E-06	0.171E-06	0.689E-07	0.289E-07	0.175E-07	0.123E-07	0.935E-08
SE	0.553E-05	0.190E-05	0.722E-06	0.417E-06	0.282E-06	0.209E-06	0.841E-07	0.353E-07	0.214E-07	0.150E-07	0.114E-07
SSE	0.703E-05	0.238E-05	0.912E-06	0.528E-06	0.358E-06	0.265E-06	0.107E-06	0.453E-07	0.276E-07	0.195E-07	0.148E-07
S	0.861E-05	0.289E-05	0.111E-05	0.642E-06	0.436E-06	0.323E-06	0.131E-06	0.555E-07	0.339E-07	0.239E-07	0.182E-07
SSW	0.645E-05	0.217E-05	0.829E-06	0.481E-06	0.326E-06	0.242E-06	0.981E-07	0.416E-07	0.254E-07	0.179E-07	0.137E-07
SW	0.429E-05	0.144E-05	0.551E-06	0.320E-06	0.217E-06	0.161E-06	0.653E-07	0.277E-07	0.169E-07	0.120E-07	0.913E-08
WSW	0.438E-05	0.147E-05	0.562E-06	0.326E-06	0.221E-06	0.164E-06	0.666E-07	0.283E-07	0.173E-07	0.122E-07	0.932E-08
W	0.448E-05	0.150E-05	0.575E-06	0.333E-06	0.226E-06	0.168E-06	0.681E-07	0.289E-07	0.177E-07	0.125E-07	0.954E-08
WNW	0.795E-05	0.267E-05	0.102E-05	0.592E-06	0.402E-06	0.298E-06	0.121E-06	0.513E-07	0.313E-07	0.221E-07	0.169E-07
NW	0.114E-04	0.383E-05	0.147E-05	0.851E-06	0.578E-06	0.429E-06	0.174E-06	0.736E-07	0.450E-07	0.318E-07	0.242E-07
NNW	0.887E-05	0.298E-05	0.114E-05	0.662E-06	0.449E-06	0.333E-06	0.135E-06	0.572E-07	0.349E-07	0.246E-07	0.188E-07

CHI/Q (sec/meter cubed) for each segment

Segment Boundaries in Miles

Direction From Site	.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
N	0.347E-05	0.124E-05	0.610E-06	0.387E-06	0.275E-06	0.142E-06	0.586E-07	0.312E-07	0.207E-07	0.152E-07
NNE	0.360E-05	0.129E-05	0.634E-06	0.401E-06	0.285E-06	0.147E-06	0.605E-07	0.321E-07	0.212E-07	0.156E-07
NE	0.373E-05	0.134E-05	0.658E-06	0.415E-06	0.295E-06	0.152E-06	0.624E-07	0.330E-07	0.218E-07	0.160E-07
ENE	0.284E-05	0.103E-05	0.502E-06	0.317E-06	0.225E-06	0.116E-06	0.476E-07	0.251E-07	0.166E-07	0.122E-07
E	0.195E-05	0.705E-06	0.344E-06	0.217E-06	0.154E-06	0.793E-07	0.325E-07	0.172E-07	0.113E-07	0.828E-08
ESE	0.250E-05	0.902E-06	0.441E-06	0.273E-06	0.198E-06	0.102E-06	0.417E-07	0.220E-07	0.145E-07	0.106E-07
SE	0.304E-05	0.110E-05	0.537E-06	0.339E-06	0.241E-06	0.124E-06	0.509E-07	0.269E-07	0.177E-07	0.130E-07
SSE	0.385E-05	0.138E-05	0.679E-06	0.430E-06	0.306E-06	0.158E-06	0.651E-07	0.346E-07	0.229E-07	0.169E-07
S	0.469E-05	0.168E-05	0.825E-06	0 523E-06	0.373E-06	0.192E-06	0.795E-07	0.424E-07	0.281E-07	0.207E-07
SSW	0.352E-05	0.126E-05	0.618E-06	0.392E-06	0.279E-06	0.144E-06	0.596E-07	0.318E-07	0.211E-07	0.156E-07
SW	0.234E-05	0.835E-06	0.411E-06	0.261E-06	0.186E-06	0.959E-07	0.397E-07	0.212E-07	0.141E-07	0.104E-07
WSW	0.239E-05	0.852E-06	0.419E-06	0.266E-06	0.190E-06	0.978E-07	0.405E-07	0.216E-07	0.144E-07	0.106E-07
W	0.244E-05	0.871E-06	0.429E-06	0.272E-06	0.194E-06	0.100E-06	0.414E-07	0.221E-07	0.147E-07	0.108E-07
WNW	0.433E-05	0.155E-05	0.761E-06	0.483E-06	0.344E-06	0.178E-06	0.734E-07	0.392E-07	0.260E-07	0.192E-07
NW	0.623E-05	0.223E-05	0.109E-05	0.694E-06	0.494E-06	0.255E-06	0.106E-06	0.563E-07	0.374E-07	0.276E-07
NNW	0.484E-05	0.173E-05	0.851E-06	0.539E-06	0.384E-06	0.198E-06	0.819E-07	0.437E-07	0.290E-07	0.214E-07

3.1.3 Hydrology

The local groundwater hydrology at the ENC site was investigated in late 1977 and early 1978 because of the leakage in the lagoons. As part of this investigation the elevation of groundwater in 15 test wells was determined. From this information isopiestic lines were calculated and their positions shown on Figure 3.5. Water elevation information is presented below for the respective test wells.

Test Well No.	Water Elevation MSL (ft)*	Test Well No.	Water Elevation MSL(ft)*
1	353.36	9	353.29
2	353.33	10	353.35
3	353.39	11	353.50
4	353.45	12	353.45
5	353.45	13	353.48
6	353.46	14	353.06
7	353.42	15	353.06
8	353.56		

* Average of 10 measurements each for test wells 1 through 13 between March 3, 1980 and January 21, 1981; average of 5 measurements each for test wells 14 and 15 between September 15, 1980 and January 21, 1981. (Test wells are about 25 ft deep.)

According to the ENC staff, these data show that the groundwater elevation at test well no. 8 is higher than that at any of the other test wells, thus supporting the concept of generally easterly flow; also, the groundwater elevations at the test wells west of the lagoon system are higher than those at test wells east of the lagoons. Further, these data support the concept of localized northwardly flow of the groundwater in the vicinity of the lagoon system.

ENC staff further state that, based on the chemical characteristics of water in the test wells, groundwater flows in a direction which parallels lines between test wells 1 to 14 and 2 to 15.

3.2 FACILITY DESCRIPTION

The operations at the Exxon Company's facility consist the development and fabrication of fuels for nuclear reactors. The particular operations have been previously described in References 1 and 2. The UO_2 fuel manufacturing process is unchanged from the process described in Reference 1, only the capacity has changed. The ENC requested and was granted NRC authorization to increase the capacity from 1.4 to 2 tons per day. Included in the licensing actions were requests to expand the storage lagoon system. Authorization was granted to

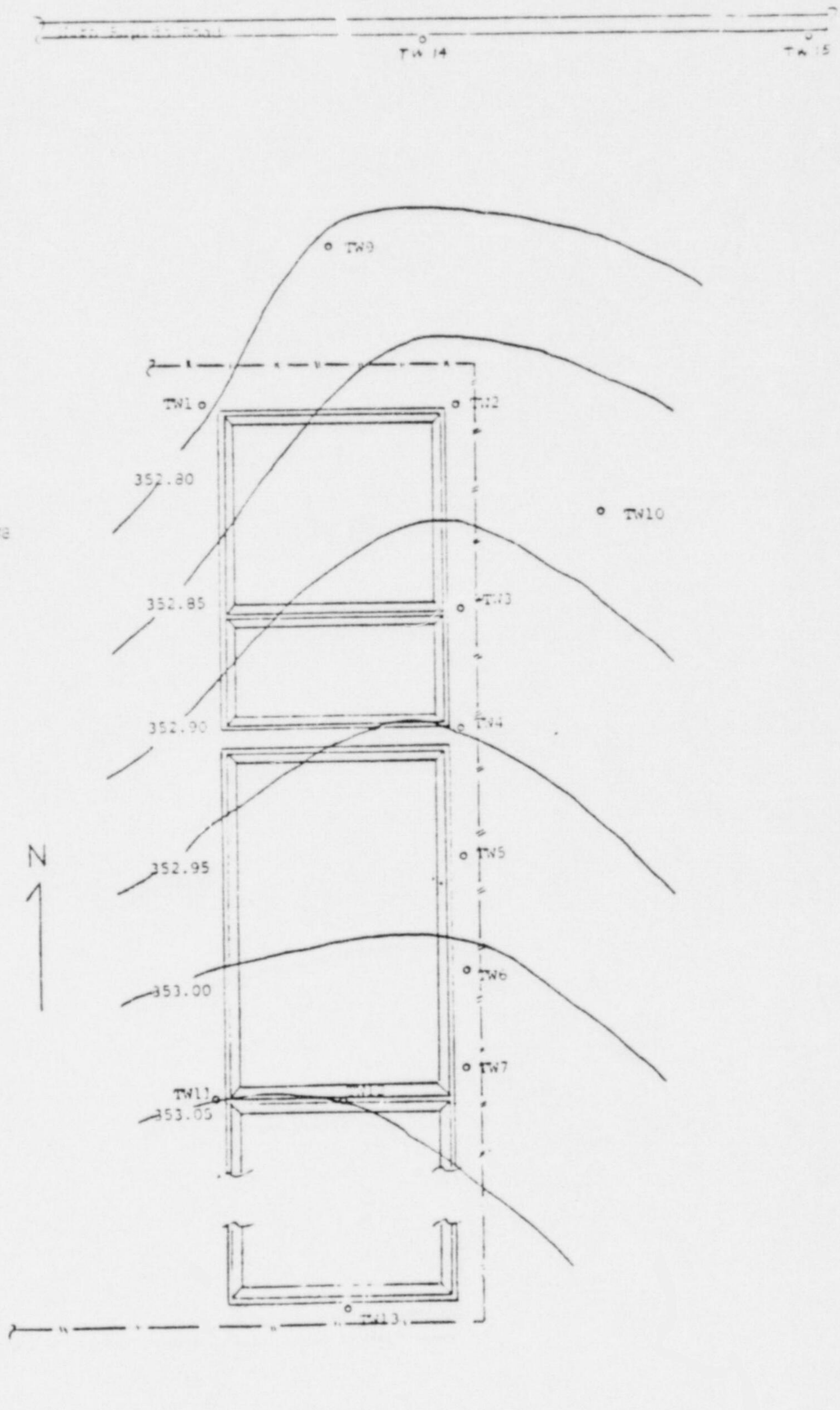


FIGURE 3.5 Isopiestic Lines.

expand the storage lagoon system. Presently the lagoon system consists of four lagoons (see Figure 3.5) measuring 228 x 201, 235 x 107, 346 x 208 and 244 x 202 feet.

3.3 ENVIRONMENTAL MONITORING AND OPERATIONAL DATA

The effluents from the Exxon nuclear plant consist of liquid, gaseous, and solid products, both radiological and non-radiological. The liquid effluents are sanitary wastes, process cooling water, and chemical wastes. Methods used to monitor these liquid effluents are briefly discussed below and the operational data tabulated in Section 3.3.1. The gaseous effluent is discharged via the stacks. The monitoring methods and operational data are presented in Section 3.3.2. In addition to stack monitoring samples a number of environmental monitoring stations are used to collect additional air samples as well as vegetation samples for various analyses. Data from the vegetation samplings are also presented in Section 3.3.2. Solid waste effluents are discussed in Section 3.3.3. The locations of off-site environmental monitoring stations are shown on Figure 3.6. The environmental surveillance program characteristics, type of sample, frequency of collection and analysis, etc., for the various environmental sampling stations are summarized in Table 3.7.

3.3.1 Liquid Effluents

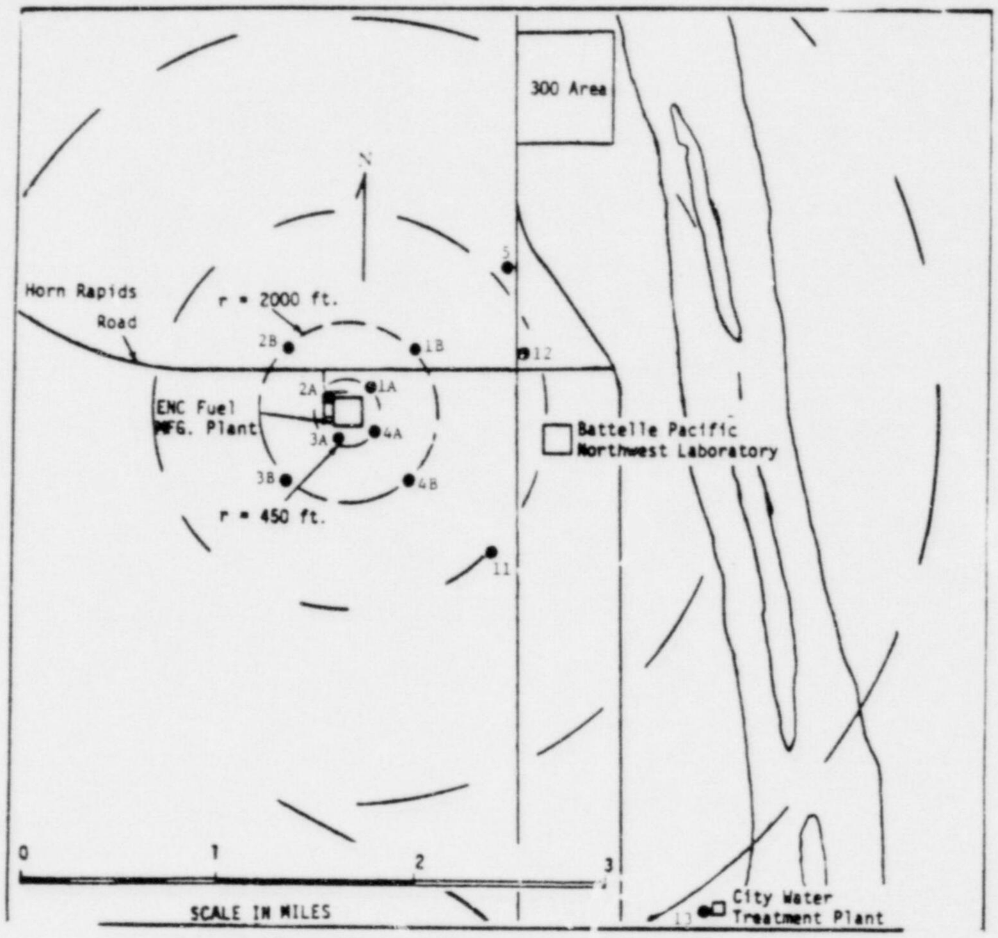
Liquid effluents from the plant consist primarily of process cooling water, chemical waste liquids, and sanitary wastewater. A schematic representation of the sources of and discharge routes for liquid effluents is shown in Figure 3.7.

3.3.1.1 Process Cooling Water.

Process cooling water is the largest component of the liquid effluents. This effluent is normally not contaminated with radioactive material. The thermal load of the cooling water system is generated by exothermic chemical reactions and heated process equipment. The heat from all of the UO_2 fuel manufacturing operations and ancillary systems is equivalent to about 1.2×10^7 Btu per day. The thermal load in cooling water is dissipated in storage. Cooling water discharges average about 178,000 gallons per day. During process chemical make-up which is about twice each week, the rate of cooling water discharge is increased to the maximum projected daily volume of cooling water flow which is about 688,000 gallons.

All flow into the liquid effluent retention tanks is through a single line from which a sample stream is continuously withdrawn and composited. The plant design offers alternatives to discharge of process cooling water to the sanitary sewer. The system provides three options for disposal of process cooling water: to the chemical process waste storage lagoon, to the Exxon Nuclear property irrigation system or to the Richland Municipal Sewage System.

The composite sample, which represents the composition of the full tank, is submitted to a laboratory for analysis before the contents of the tank are pumped to the sewer line. The sample is analyzed for uranium, fluoride, nitrates,



Exxon Nuclear Environmental Stations

Station No.	Direction from Site	Distance from Site
1A, 1B	NE	450, 2000 ft.
2A, 2B	NW	450, 2000 ft.
3A, 3B	SW	450, 2000 ft.
4A, 4B	SE	450, 2000 ft.
5	NE	1 mile
11	SE	1 mile
12	E	3/4 mile
13	SSE	3 miles

Figure 3.6 Offsite Environmental Station Locations

TABLE 3.7 Environmental Surveillance Program

Sample Station	Type of Sample	Collection Frequency	Analysis Frequency	Analyzed For	Min. Detection Level
1-A	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	Quarterly	Uranium	0.01 ppm
	Vegetation	Monthly(1)	Monthly	Uranium & Fluoride	0.01 ppm 1 ppm
1-B	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	Quarterly	Uranium	0.01 ppm
	Vegetation	Monthly(1)	Monthly	Uranium & Fluoride	0.01 ppm 1 ppm
2-B	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	(Held)	---	---
3-B	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	(Held)	---	---
4-B	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	(Held)	---	---
5	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	(Held)	---	---
	Vegetation	Quarterly(1)	Quarterly	Fluoride	1 ppm
11	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	(Held)	---	---
	Vegetation	Quarterly(1)	Quarterly	Fluoride	1 ppm
12	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Vegetation	Monthly(1)	Monthly	Fluoride	1 ppm
13	Air	Continuous	Monthly	Fluoride	0.02 ppb
	Soil	Quarterly	(Held)	---	---
	Vegetation	Quarterly(1)	Quarterly	Fluoride	1 ppm
ENC-City Lift Station (see Table 3.10)					
STP(2)	Liquid	Daily	Monthly	Uranium	0.1 ppm
	Sludge	Quarterly	Quarterly	Uranium	0.01 ppm
Yakima River(3)	Liquid	Monthly	Monthly	Uranium, Fluoride, Nitrate, Ammonia, Sulphates & pH	0.1 ppm 0.1 ppm 0.1 ppm 0.1 ppm 1 ppm 0.1 unit

TABLE 3.7 (continued)

Sample Station	Type of Sample	Collection Frequency	Analysis Frequency	Analyzed For	Min. Detection Level
Plant[4]					
Drinking Water	Liquid	Weekly	Weekly	Uranium, Fluoride, Nitrate, Ammonia, Sulphates & pH	0.1 ppm 0.1 ppm 0.1 ppm 0.1 ppm 1 ppm 0.1 unit
Test Wells(15)	Liquid	Monthly	Monthly	Conductivity[5]	0.1 µmhos/cm

(1) Collected monthly during the normal growing season.
(2) Richland Municipal Sewage Treatment Plant.
(3) Washington State Department of Ecology requirement.
(4) For purpose of background determinations.
(5) See Section 3.4.4 of ENC's "Application for Renewal of Special Nuclear Material License No. SNM-1227", Document No. XN-2, for Lagoon Leak Action Guides based upon conductivity levels in Test Well water. It should be noted that ENC previously collected weekly samples from each Test Well and analyzed them for uranium, fluoride, nitrate, ammonia, sulphates and pH.

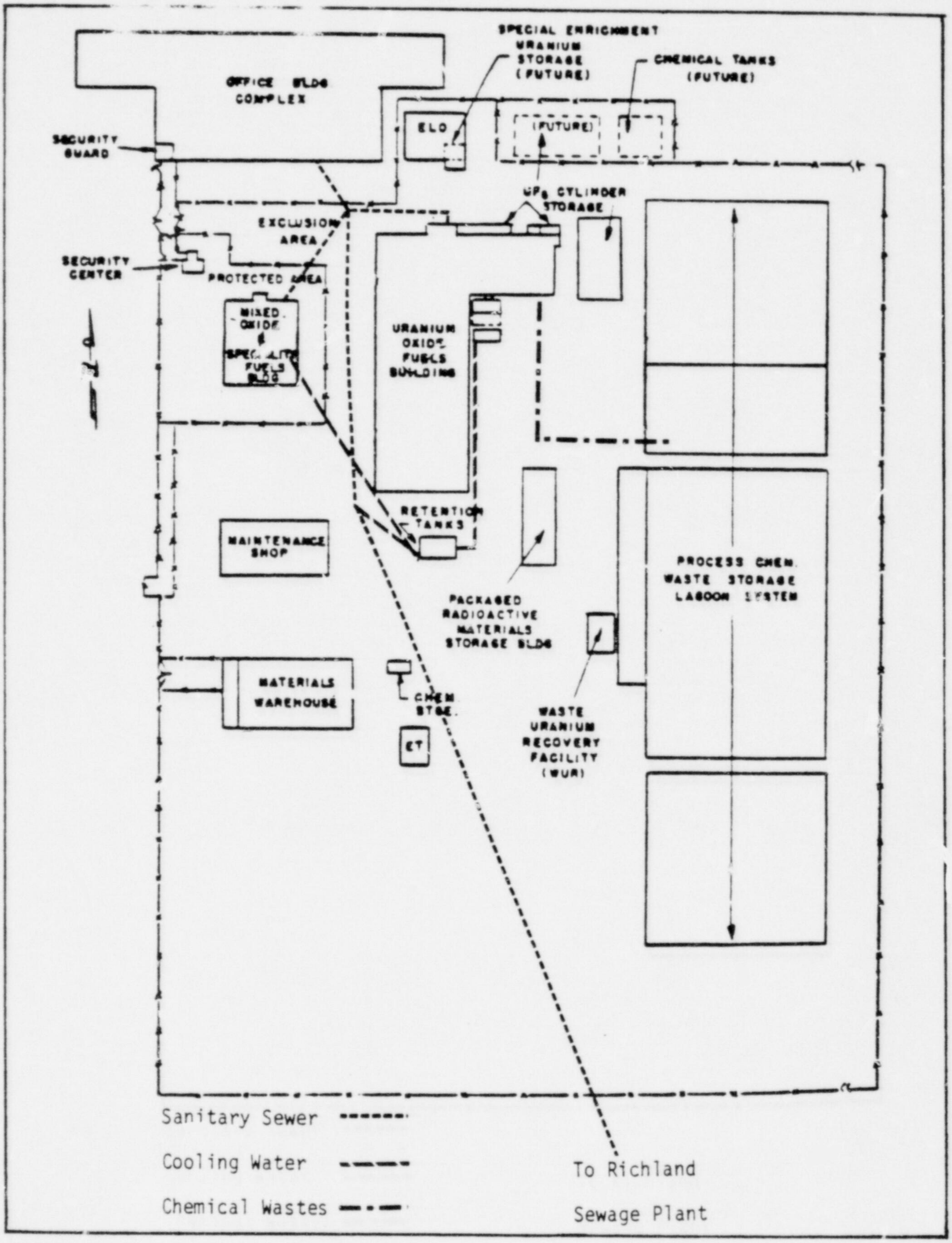


Figure 3.7 Liquid Effluent Discharge Routes

ammonia, sulphates, sodium, and pH. If the concentrations of any of these constituents exceed criteria based on the range of concentrations for the site water supply, the contents of the retention tanks are quarantined and consigned to a licensed waste disposal contractor for burial.

3.3.1.2 Chemical Wastes.

The Exxon Nuclear Company disposes of its process waters in four large evaporation lagoons. These lagoons are provided with impervious liners to prevent the contents from leaking into the ground and impacting the area groundwaters.

The estimated quantities of chemicals discharged to the lagoon in pounds per day per ton uranium are listed in Table 3.8. The actual flow of chemical waste to the lagoons has varied with production levels and been consistently lower than the predicted values. The minimum liquid level in the lagoon is a depth of one foot and this is maintained by diverting process cooling water, as required, from the flow to the municipal sewer system. The flow rate to the lagoon at maximum production levels is predicted to average 14,600 gallons of process chemical wastes per day. This volume is made up of the collected and neutralized process waste streams conveyed to the lagoon by the process sewer system. Measurements of concentrations of uranium, fluorides, nitrates and sulfates in the evaporation lagoons, taken during 1978, 1979 and 1980, show the average concentrations to be as follows:

Uranium (U)	178 ppm
Fluoride (F^-)	16,115 ppm
Nitrate (NO_3 and NH_3)	19,735 ppm
Sulfate (SO_4)	8,052 ppm.

Several test wells are used to monitor the groundwater near the lagoon. The locations of these wells are indicated on Figure 3.8. The test wells are sampled weekly. the samples are analyzed for following chemicals or ions: uranium, fluoride, NO_3, NH_3, and SO_4. The annual average concentrations of these chemicals and ions for 1977 through 1980 are summarized in Table 3.9. During 1977, test wells 1, 2 and 3 were sampled for uranium. In 1978 analysis for uranium was ceased, or no longer recorded as historically the uranium concentration had consistently been below the minimum detection level. New wells 9, 10 and 11 were sampled twice for uranium at commencement of their use. When wells 12 and 13 were put into operation, in 1979 they too were sampled and analysis for uranium was performed.

ENC staff prepare plots of the average monthly concentration of the fluoride, nitrates and sulfates for each of the test wells. Plots of the fluoride concentration in test wells 1, 2, 3 and 4 are presented on Figures 3.9, 3.10, 3.11 and 3.12 respectively. Plots of the nitrate and sulfate concentrations are presented in Appendix A for all test wells. On each plot the action level used

Table 3.8

Quantity of Chemicals Discharged to the Lagoon

Chemicals	Pounds/day/ton uranium
NH_3	786
F	379
NO_3	286
Na	21
SO_4	1150
Al	7
Zr	7
U	0.4

Figure 3.8

Test Well Locations
(Relative to ENC Lagoons)

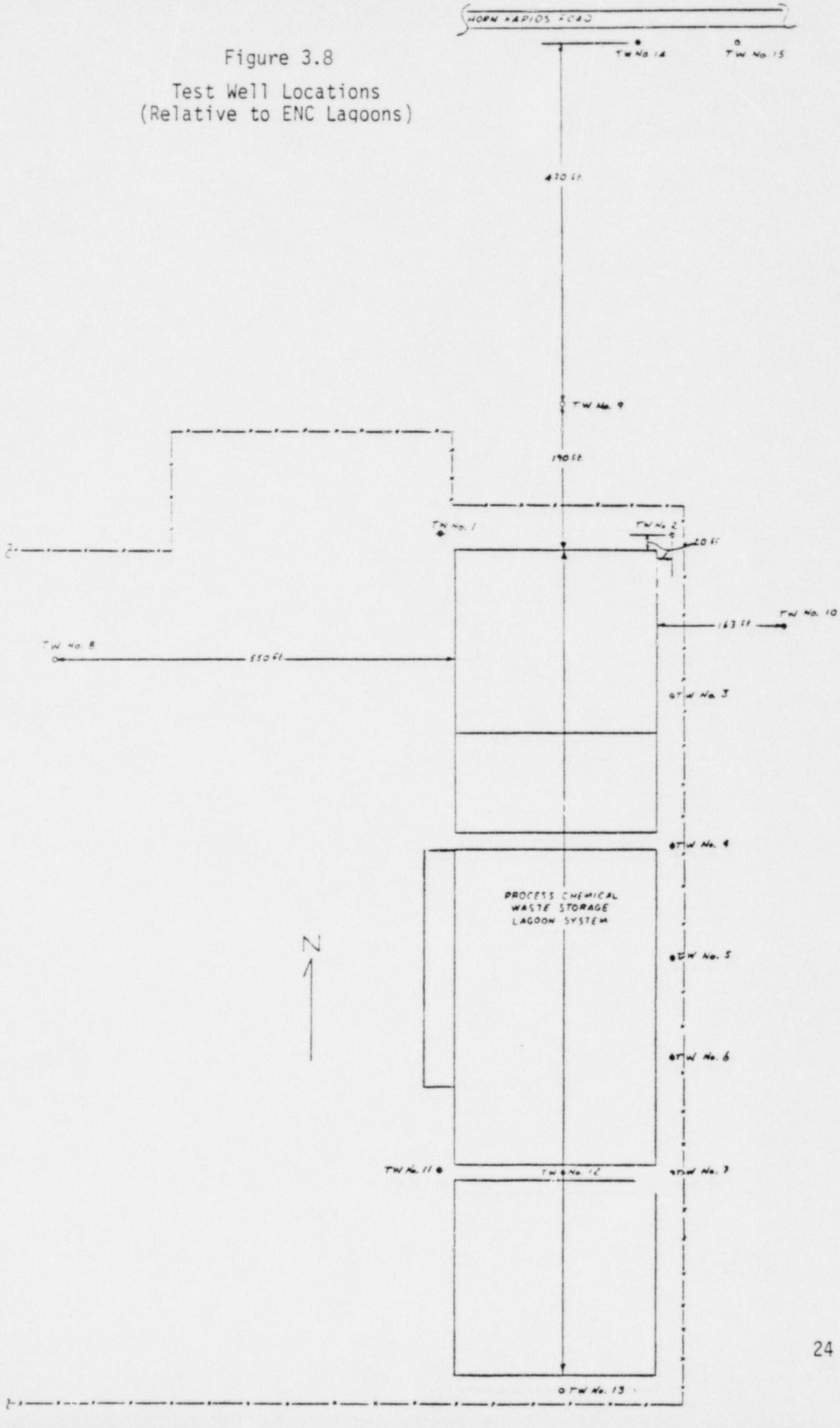


Table 3.9

Evaporation Lagoon System Test Well Results

Element Ions in ppm

	U	F^-	NO_3^- (as N)	NH_3 (as N)	$SO_4^=$
Test Well #1					
1977	<.1	5.39	40.55	24.68	60
1978		5.6	72	0.88	597.4
1979		4.8	33.79	0.13	214.7
1980		6.3	50.9	8.7	69.8
Test Well #2					
1977	<.1	41.5	145	995	1636.9
1978		84.6	120	261.9	1170
1979		27.7	76	187	819.5
1980		17.8	59.6	159	227.7
Test Well #3					
1977	<.1	4.8	14.4	39.4	479
1978		0.53	62	3.49	253
1979		1.05	35.7	0.12	67.9
1980		0.8	36.9	0.12	109
Test Well #4					
1977		0.69	4.57	0.73	23.6
1978		0.54	7.9	1.49	24.9
1979		0.85	8.67	0.12	43.59
1980		0.77	13.8	4.27	163
Test Well #5					
1977		1.09	6.67	0.67	25.5
1978		3.8	1.9	5.2	56.6
1979		0.48	2.06	1.47	44
1980		0.36	1.95	0.58	38.2

Table 3.9 (Cont'd)

Evaporation Lagoon System Test Well Results

Element Ions in ppm

	U	F^-	NO_3^- (as N)	NH_3 (as N)	$SO_4^=$
Test Well #6					
1977		0.67	1.74	1.73	27
1978		0.43	2.17	0.95	21.69
1979		0.67	6.5	1.97	58.75
1980		0.37	10.5	0.19	40
Test Well #7					
1977		0.57	1.32	2.69	18.57
1978		0.54	1.8	3.24	13.86
1979		0.70	0.18	0.60	52.25
1980		0.43	3.29	0.15	45.14
Test Well #8					
1977		0.63	2.12	4.04	13.25
1978		0.53	1.88	1.76	56.02
1979		0.73	1.48	4.85	12.38
1980		0.41	1.81	0.27	10.33
Test Well #9					
1978	<.1*	14.9	70.9	68.8	404.8
1979		18.7	71.3	96.6	350.4
1980		18.8	70.5	127.7	286.7
Test Well #10					
1978	<.1*	0.409	3.7	0.87	32.3
1979		0.69	4.2	0.19	42
1980		0.47	9.1	0.19	51

*Two samples at commencement of operation.

Table 3.9 (Cont'd)

Evaporation Lagoon System Test Well Results

Element Ions in ppm

	U	F^-	NO_3^- (as N)	NH_3 (as N)	$SO_4^=$
Test Well #11					
1978	<.1*	0.43	3.98	2.98	143.86
1979		0.53	4.5	0.12	19.66
1980		0.52	1.48	0.68	27.38
Test Well #12					
1979	<.1**	0.83	1.92	6.8	68.4
1980		0.59	2.38	19.35	100.6
Test Well #13					
1979	<.1**	0.68	1.19	3.5	23.4
1980		0.43	1.93	0.99	29.2

* Two samples at commencement of operation.

** One sample at commencement of operation.

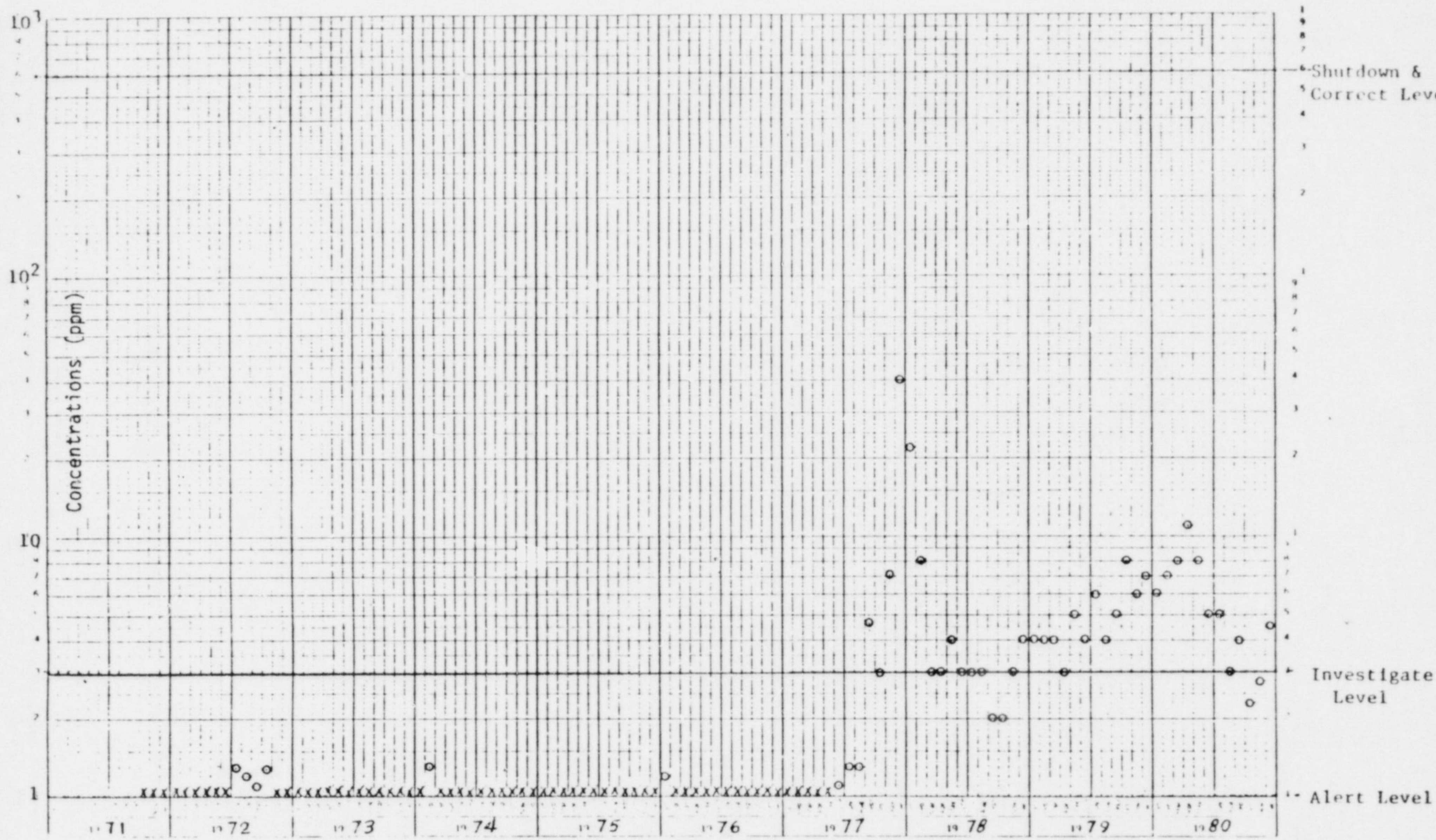


Figure 3.9 Average Monthly Flouride Concentrations (PPM) In Test Well No. 1.

Note: "X" signifies concentration below "Alert Level".

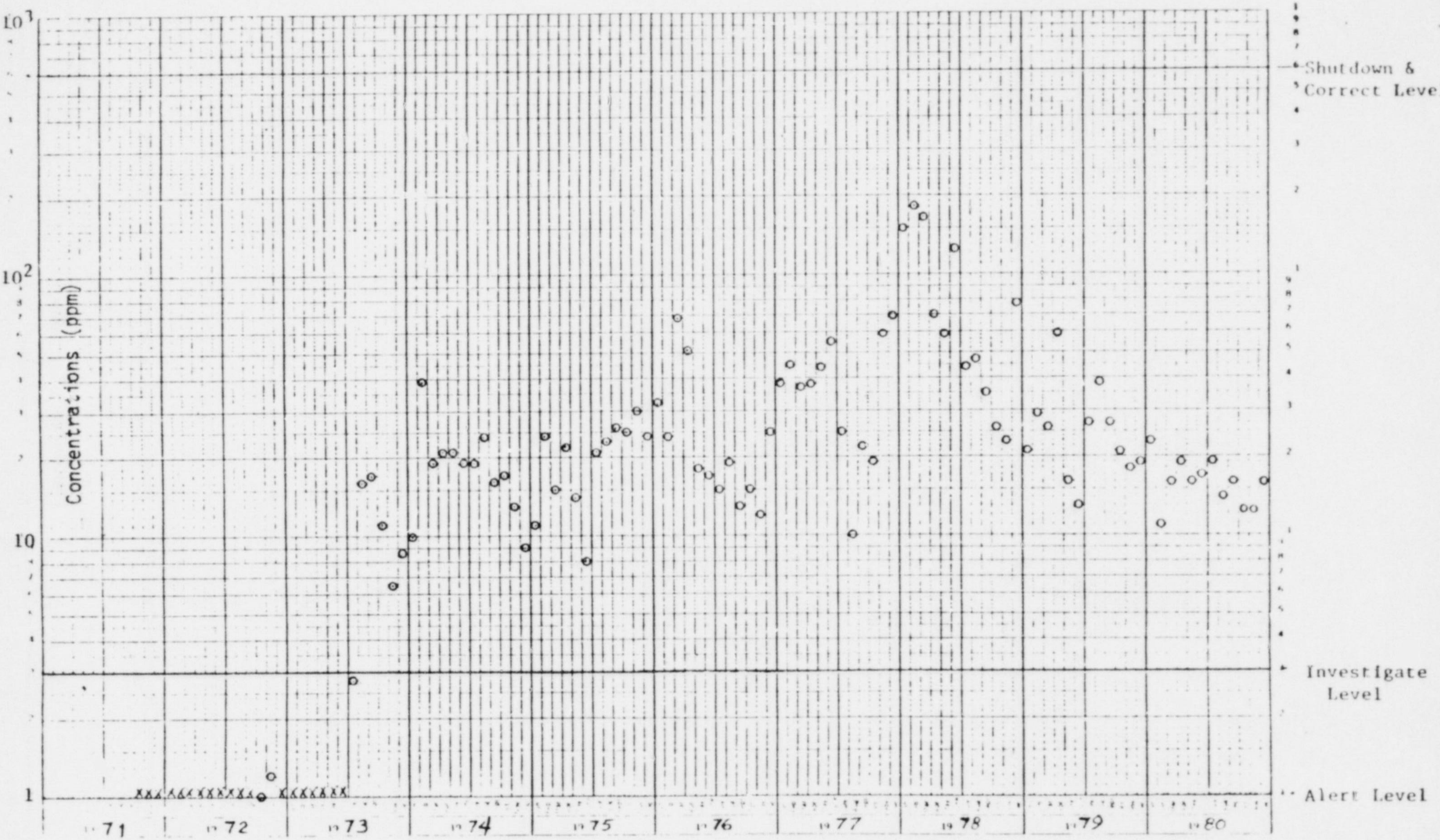


Figure 3.10. Average Monthly Flouride Concentrations (PPM) In Test Well No. 2.

Note: "X" signifies concentration below "Alert Level".

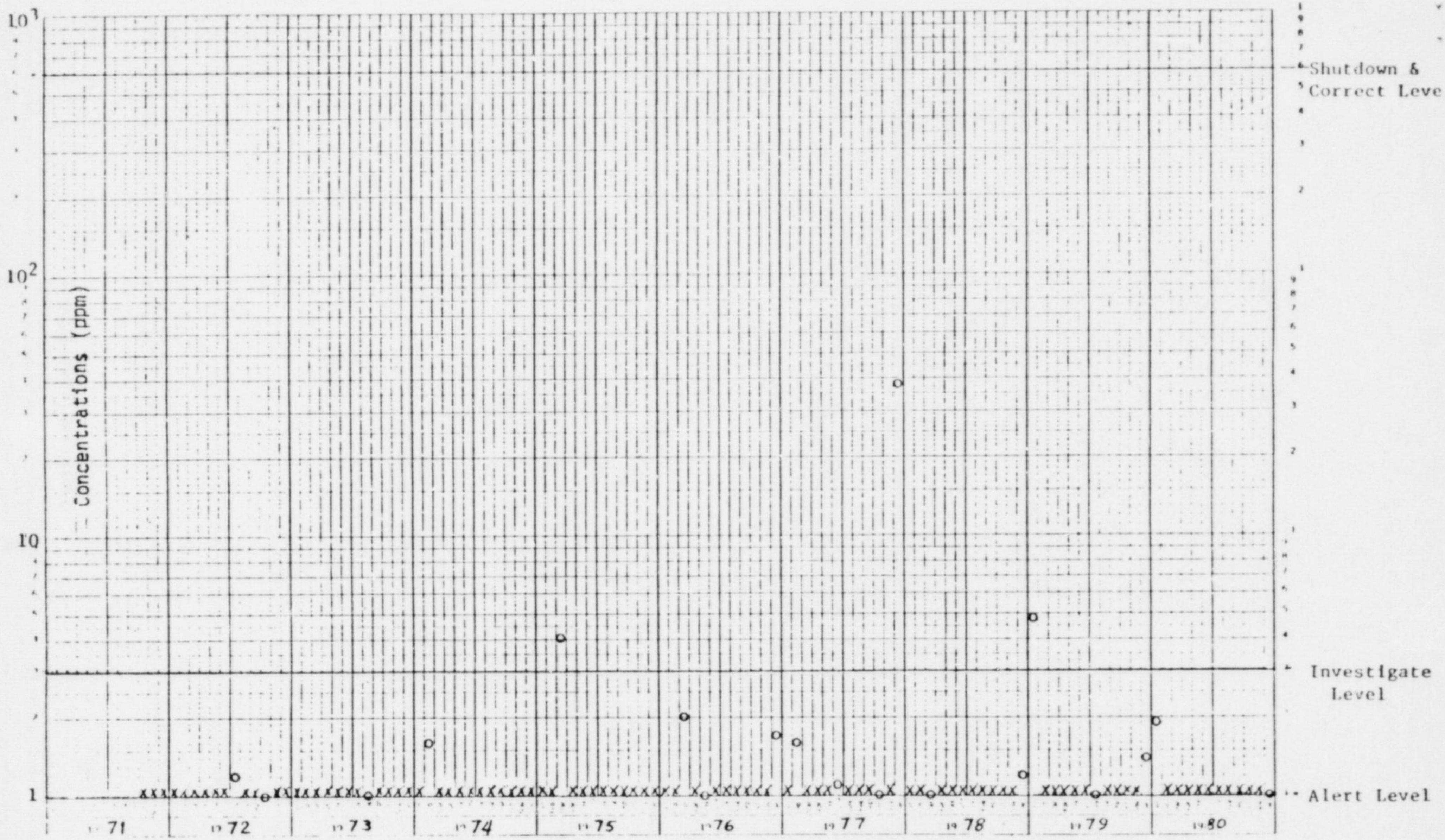


Figure 3.11. Average Monthly Flouride Concentrations (PPM) In Test Well No. 3.

Note: "X" signifies concentration below "Alert Level".

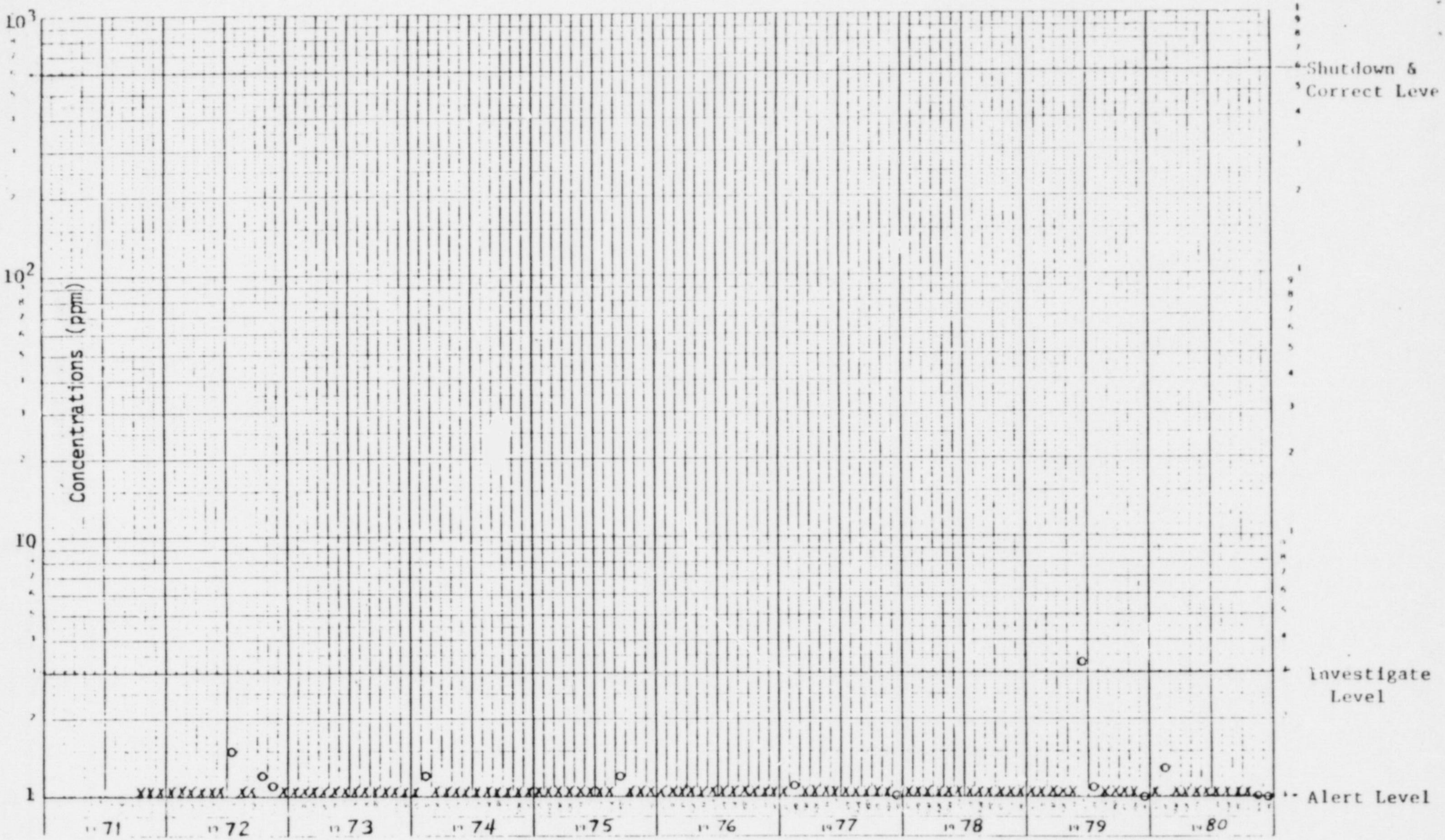


Figure 3.12. Average Monthly Flouride Concentrations (PPM) In Test Well No. 4 .

Note: "X" signifies concentration below "Alert Level".

by ENC are indicated. ENC staff have used these plots to identify leakages from the lagoons. For example, examination of Figure 3.10 shows a sharp rise in the fluoride concentration in test well 2 about mid-year 1973 and again late in 1977.

The leaks in the lagoon liners have been investigated by ENC and causes assigned. Generally the causes were due to either some foreign object (e.g., a survey stake and rocks) or the failure of the Petromat liner. ENC staff's solution, since 1977, has been to install a double-Hypalon liner system.

The double-Hypalon liner system consists of two layers of Hypalon material with a 4 to 6 inch thick intermediate layer of sand. Leak monitoring devices, like the one shown in Figure 3.13, are installed in the sand layer. There are presently 21, 10, 35 and 26 leak monitoring devices installed in lagoons number 1, 2, 3, and 4 respectively. In addition to the between liner leak detection system ENC has installed a total of 8 leak monitoring devices that are under both liners. ENC staff states that this leak monitoring system works, as they have detected a leak in the upper Hypalon liner in lagoon number 2 during 1980.

Examination of the concentration of sulfates and nitrates on test well 2 indicates the possibility of a downward trend beginning after 1977 and to a lesser extent in test well 9. ENC staff states that these apparent trends indicate that the problem of leaking lagoon liners has been solved.

As part of the ENC license renewal application, ENC staff proposes to change the analyses performed on the test well water samples. ENC proposes a conductivity measurement, on a monthly basis, to replace the measurement for specific chemical concentrations. ENC proposes that the investigative action level be established when the conductivity of the samples reaches 2000 umhos/cm. ENC also proposes shutdown and corrective action levels be as follows: $NO_3 + NH_3$ (as N), 4000 ppm; F, 600 ppm; SO_4, 100,000 ppm; and U, 2000 ppm. These proposed shutdown and correct action levels as well as the corresponding present limits, generally exceed, or are comparable to, the average concentration of the corresponding chemical species in the lagoon liquid stated above.

In practice the proposed measurement of conductivity would give less information about the composition of the groundwater since the lagoon liners have leaked and the contaminants from the liquid waste have been detected in the water taken from the test wells. The staff believes that the method of analysis should not be changed at this time. The proposed change of frequency of measurement, from weekly to monthly, was also considered. The staff concluded that the present method of analysis, with a monthly frequency for those wells with concentrations below the present investigative action levels and bi-weekly frequency of those wells with concentrations at or above the investigative action limits, is an adequate measuring program.

3.3.1.3 Sanitary Wastes.

Sanitary wastes are discharged to the City of Richland sewage system. The municipal system provides a sewage treatment process and ultimately discharges into the Yakima River at its confluence with the Columbia River. ENC's liquid effluent monitoring program for the ENC-city lift station is shown in Table 3.10. Composite samples are continuously collected from a sampling stream at the Exxon

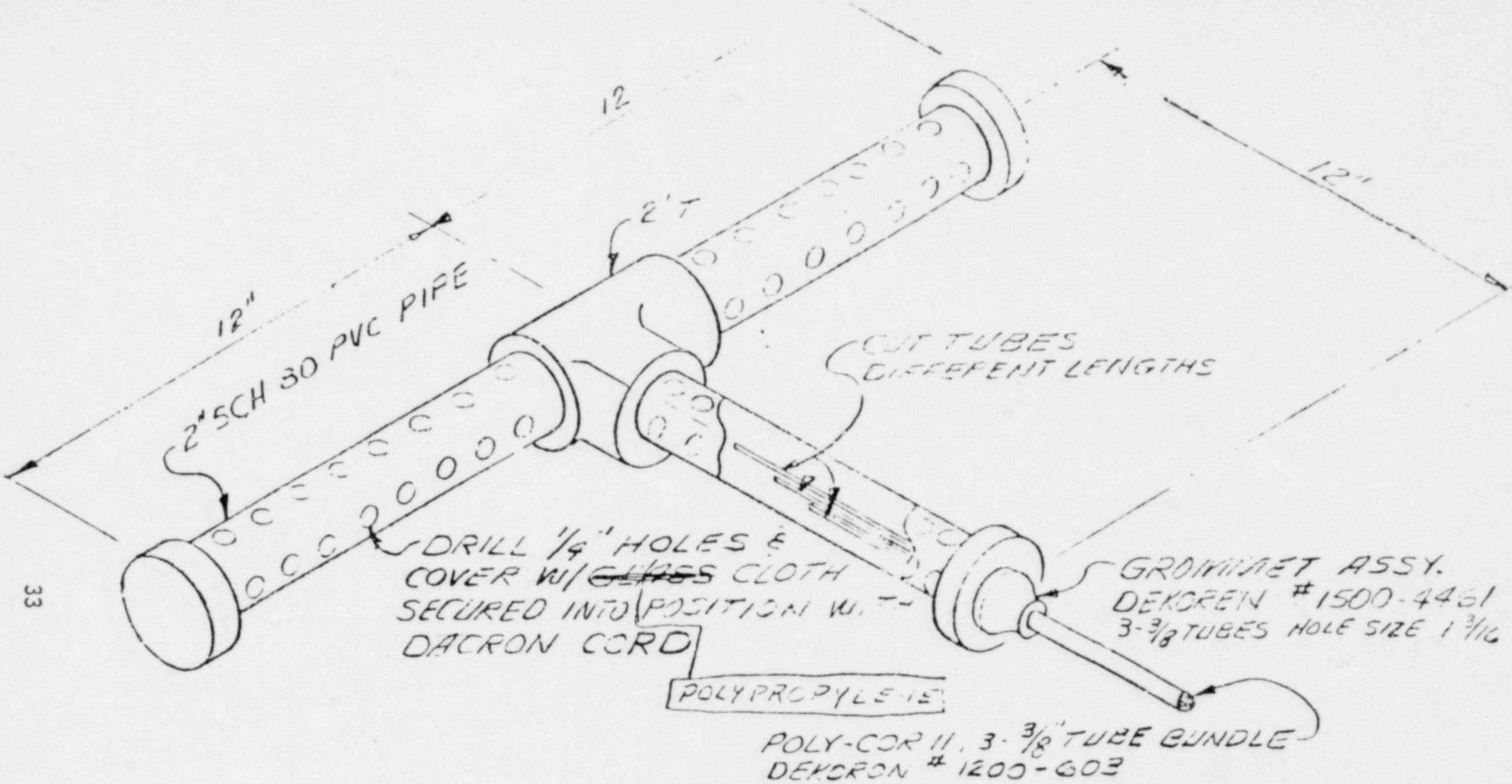


Figure 3.13

SAMPLING HEAD

LAGOON LEAKAGE MONITOR

TABLE 3.10 Liquid Effluent Monitoring Program

Discharge Point: ENC-City Lift Station

Sampling Point: ENC-City Lift Station

Sample Type: Liquid

Sample Collection Frequency: Continuous

Sample Analysis Frequency: Daily (Monday through Friday)

Samples Analyzed For	Analytical Method	Minimum Sensitivity	Investigate Level	Shutdown & Correct Level
Uranium	Fluorimetry	0.1 ± 0.1 ppm	> 0.1 ppm	1 ppm
Fluoride	Specific ion Electrode	0.1 ± 0.1 ppm	1 ppm	3 ppm
Nitrate	Specific ion Electrode	0.1 ± 0.1 ppm (as N)	10 ppm	--
Ammonia	Colorimetry-Nessler Reagent	0.1 ± 0.1 ppm (as N)	10 ppm	--
Sulfates	Turbidimetrically	1 ± 1 ppm (as SO_4)	50 ppm	--
pH	pH meter	0 to 14 in 0.1 units	< 6.5 or > 8.5	< 5 or > 10

Nuclear - City of Richland lift station and submitted daily to an analytical laboratory for analysis. As discussed in Section 3.3.1.1 an analysis of process cooling water is made before each discharge to the sewage system. Furthermore, daily liquid grab samples are also collected from the discharge of the municipal sewage treatment plant, and are analyzed monthly. Additionally, sludge grab samples are collected and analyzed quarterly for uranium. The results of these analyses of sanitary waste liquid effluent are summarized in Tables 3.11 and 3.12.

3.3.2 Gaseous Effluents

With one exception, all building air and process offgases are passed through two stages of HEPA filters in series before release through stacks approximately 50 feet above ground level (20 feet above roof level). The single gaseous effluent exception is the burner exhaust from the calciner furnace. Calciner burner offgas consisting of propane combustion products is discharged directly to the atmosphere because it is in a closed system isolated from the process with no potential for release of radionuclides. The HEPA filters are certified by the manufacturer to be at least 99.97% efficient for the removal of 0.3 micron particles.

Liquid scrubber systems followed by dryers are used to remove the corrosive offgases from the UF_6 conversion process and the acid etch tank ventilation exhaust and to protect the HEPA filters. Airborne alpha activity is continuously sampled after each stage of HEPA filtration. Additionally, a single sampling probe, designed to operate isokinetically, is located in the exhaust stack and continuously samples the exhaust stack. Each station draws a representative sample of air through a Gelman Type E glass fiber filter, which is assayed weekly for alpha activity. The sensitivity of the airborne effluent monitoring system is estimated to be 3×10^{-16} uCi/ml of alpha activity. The isokinetic stack exhaust sample is analyzed weekly for uranium. Results of these analyses are plotted on Figure 3.14 and they are summarized on a semi-annual basis and tabulated in Table 3.13. The high value, 112.38 uCi uranium, for the last part of 1978 is attributed, by ENC, to the startup of the second UF_6 to UO_2 conversion line. The sharp peak in 1976 was caused by a broken UF_6 transfer line that resulted in the estimated release of 40 kilograms of uranium inside the UO_2 building. An estimated 2.3 grams of uranium were released from the building in the 1976 release.

The principal process chemical airborne wastes released from the Exxon Nuclear UO_2 fuels plant are ammonium fluoride and hydrogen fluoride which are generated during the conversion of UF_6 to UO_2. Fluoride is removed from the conversion process by the process offgas systems. These offgases are liquid scrubbed to remove the fluoride from the air exhausted through the exhaust stacks. Despite the scrubbing system, fluorides are released to the air.

The stack exhaust from the UF_6 - UO_2 conversion process is continuously sampled for fluoride and analyzed at weekly intervals. Figure 3.15 shows the measured quantity of fluoride released per 1,000 kilograms of uranium processed. Additionally, the plant environmental surveillance program includes the collection of filter paper samples for fluoride analysis at selected locations

Table 3.11

Public Sewage Treatment Plant Liquid Sample

Year	pCi/liter	Concentration ppm				
	Pu*	U	F^-	NO_3^- (as N)	NH_3 (as N)	$SO_4^=$
1977	<13.5	< 1	0.48	7.56	13.23	40.8
1978	<13.5	<.1	1.21	9.2	18.0	311.75
1979	<13.5	<.1	0.539	16.08	13.87	304.2
1980	<13.5	<.1	0.595	3.55	38.33	42

*Use of plutonium at ENC was discontinued in July 1980.

Table 3.12

Semiannual Radiological Liquid Effluent Releases to the Public Sewer

Period	Uranium (mCi)
July - Dec. 1976	1.64
Jan. - June 1977	0.61
July - Dec. 1977	2.05
Jan. - June 1978	1.87
July - Dec. 1978	0.88
Jan. - June 1979	2.66

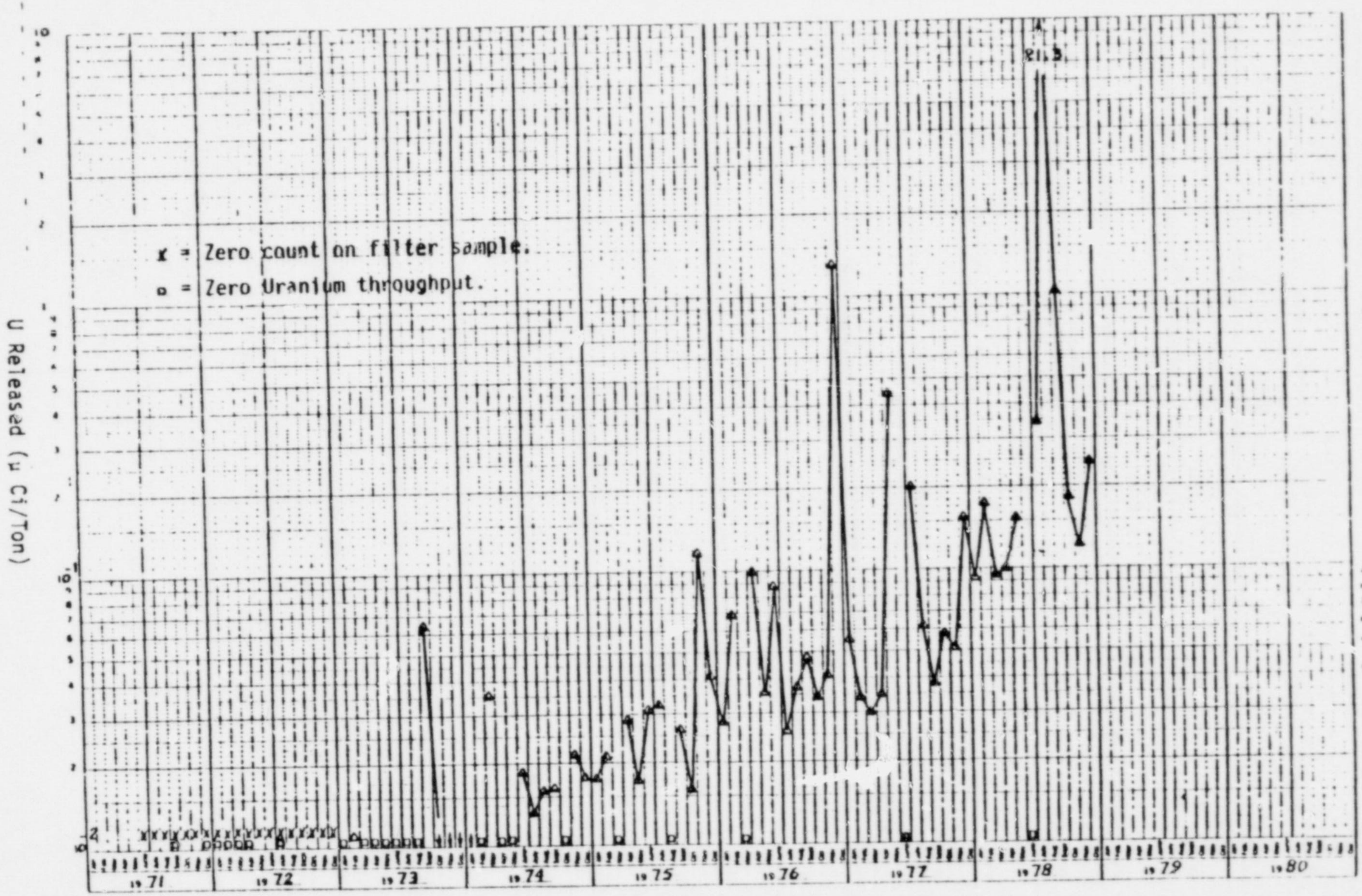


Figure 3.14- Uranium Released from UO_2 Building Exhaust Stacks Per Ton of Throughput

Table 3.13

Semiannual Radiological Air Effluent Releases

Period	Uranium (μCi)	Plutonium (μCi)
July - Dec. 1976	7.99	0.28
Jan. - June 1977	3.91	0.04
July - Dec. 1977	10.64	0.17
Jan. - June 1978	12.78	0.09
July - Dec. 1978	112.38	0.06
Jan. - June 1979	20.68	0.03*

*Subsequently the use of plutonium at the Exxon Nuclear Company has been discontinued.

on-site and off-site. The filter papers, treated with Na_2CO_3, are exposed for 30 days with analyses performed monthly. The treated filter paper method of sample collection is passive. No sample of air is drawn through the filter paper; thus the principal form of fluoride deposited on the papers would be the particulate forms. The data presented on Figure 3.15 indicates that the measured fluoride in the offgases is a maximum of about 12 grams and an average of about 6 grams per 1000 kg of uranium processed. Information provided by ENC indicates the scrubber efficiencies used in the UF_6 to UO_2 conversion operations to be 80 to 98%. Rough estimates indicate that the production of 1 ton of uranium per day would require about 1.5 tons of UF_6 as raw material and during the processing of UF_6, 480 kg of fluoride would be released. Assuming that the released fluoride during the processing is contained in the building and is scrubbed with water prior to release to the environment through stacks, it is estimated that the overall system, scrubber and filters, would have to have a removal efficiency of 99.998% in order to limit the final fluoride emission to 6 grams per ton of uranium processed. Based upon the efficiency of the offgas scrubber systems, this 6 gram average value appears to be small. An indirect measurement of the fluoride releases is the measurement of fluoride in vegetation samples.

Vegetation samples are usually collected quarterly for fluoride analysis. Results of the analysis of vegetation for fluoride are presented in Table 3.14 and summarized in Table 3.15. Table 3.14 shows the fluoride accumulation, measured monthly, at sampling stations 1A, 1B, 5, 11 and 12. This data indicates that on occasions concentrations of fluorides have exceeded 40 parts per million and during the summer of 1978 exceeded 60 parts per million for three consecutive months. Table 3.15 shows that during 1979, at four sampling stations 1A, 1B, 5, and 11, was at least 40 ppm the entire year.

The National Academy of Sciences[7] study of the effects of fluoride indicates that exposure of forage to an ambient air concentration of 0.5 ugm/m^3 of HF for 30 days would result in an accumulation of 40 ppm or more fluoride. The monthly average for 1980 at station 1B is 37 ppm. Station 1B is at a distance of 2000 ft. northeast of the ENC site. The annual average X/Q value for this location is approximately 10^{-5} sec/m^3.

Using this X/Q value and an ambient air concentration of 0.5 ugm/m^3 a release rate of 0.05 gm/sec fluoride is calculated. This release rate would correspond to 4,320 gm/day or, assuming that the ENC plant operates at the 2 ton/day capacity, 2,160 gm/ton uranium processed. The calculated release rate of 0.05 gm/sec assumes an ambient air concentration at Station 1B of 0.5 ugm/m^3; if the ambient air concentration is only 0.1 ugm/m^3 then the calculated release rate would be 0.01 gm/sec, corresponding to 864 gm/day or, further assuming the 2 ton/day production rate, 432 gm/ton uranium. It should be noted that in 1974 (reference 1) the estimated release rate for fluorides was 0.0112 gm/sec. The staff considers the calculated values of 0.01 or 0.05 gm/sec for the ENC plant is not unreasonable.

Thus, the staff concludes that the concentration of fluorides in vegetation measured as part of the ENC environment surveillance program is inconsistent with the ENC data on fluoride releases per ton uranium processed. The staff estimates that the fluoride releases are from a few hundred to a few thousand grams per ton uranium.

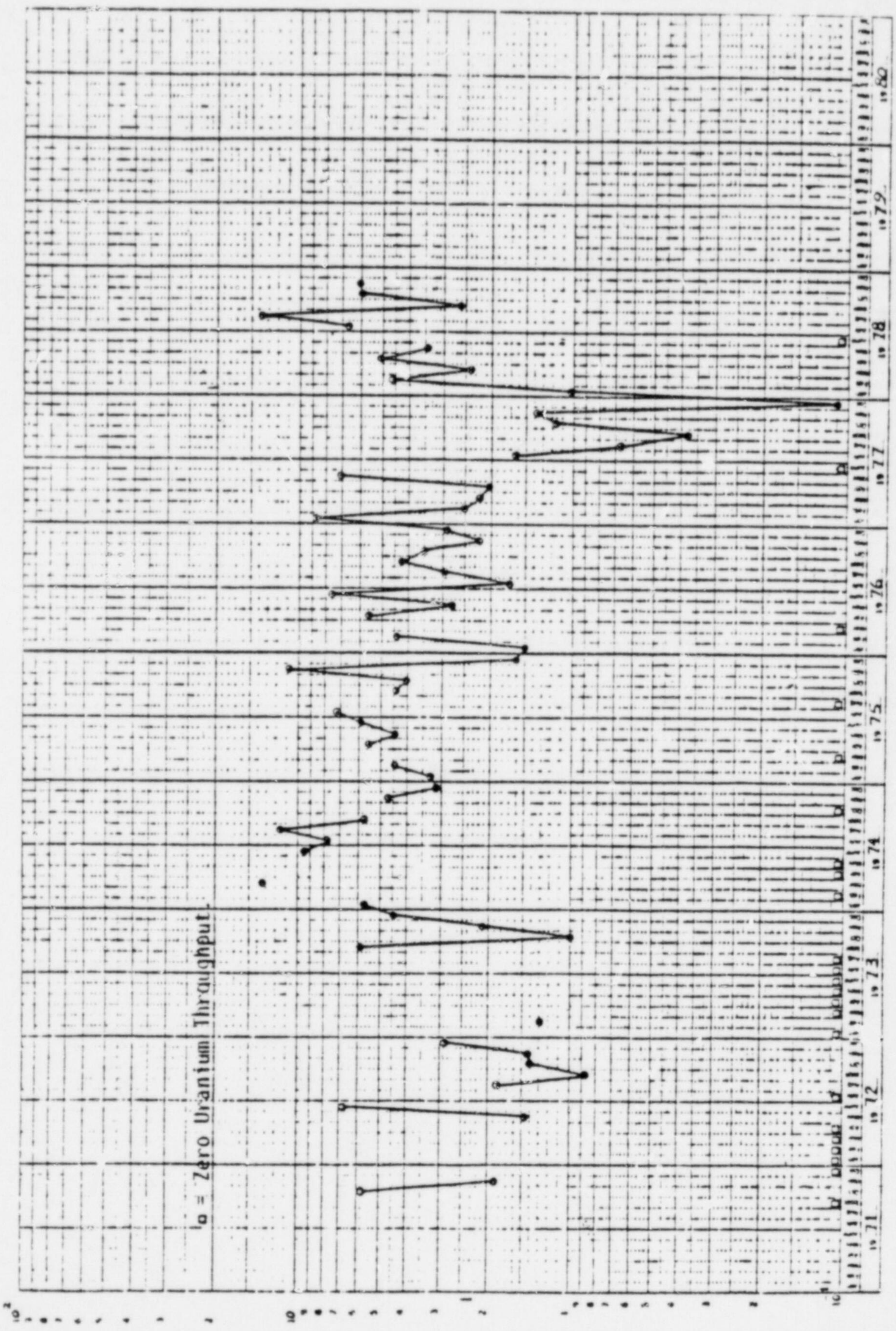


Figure 3.15 Fluoride Released from UO_2 Exhaust Stacks Per Ton of Uranium Throughput

Fluoride Concentration (grams/Ton)

Table 3.14

Micrograms Fluoride Per Gram Vegetation

Date	Station Number 1A	1B	5	11	12
08/71	10.5	14.4	29.5	17.5	10.5
09/71	6.5	--	--	--	6.0
10/71	21.0	14.5	--	--	10.5
12/71	--	22.8	20.0	16.8	30.0
01/72	--	27.5	--	--	27.6
02/72	--	10.2	--	--	11.9
03/72	--	22.1	5.1	6.8	14.0
04/72	--	29.6	--	--	16.2
05/72	--	20.8	--	--	27.3
06/72	--	19.4	19.5	16.4	12.7
07/72	--	50.0	--	--	57.4
08/72	--	20.4	--	--	20.9
09/72	--	13.5	13.5	14.3	14.7
10/72	--	29.2	--	--	46.0
11/72	--	14.0	--	--	21.0
12/72	--	27.6	33.3	41.2	47.5
04/73	--	13.0	12.7	8.6	19.1
05/73	--	38.5	--	--	16.0
06/73	--	--	--	--	13.9
07/73	--	12.1	17.3	7.9	11.4
08/73	--	26.5	--	--	16.0
09/73	--	53.1	--	--	20.8
10/73	--	32.1	45.1	46.1	30.3
03/74	--	3.0	2.0	5.0	2.0
05/74	0.7	0.3	--	--	0.3
06/74	3.0	7.0	--	--	2.0
07/74	10.5	7.5	2.5	2.5	10.8
08/74	4.0	4.0	--	--	4.0
09/74	4.8	6.8	--	--	4.4
10/74	7.2	5.8	3.2	5.6	7.2
11/74	1.0	1.0	--	--	1.0
12/74	5.2	6.0	--	--	--
05/75	4.0	2.3	--	--	1.0
06/75	9.2	3.2	--	--	21.0
07/75	3.8	2.0	--	--	--
08/75	16.0	2.5	0.6	1.9	3.9
09/75	8.3	4.4	--	--	3.8
10/75	11.0	0.6	--	--	1.5
11/75	6.6	2.4	7.0	6.8	4.0
12/75	29.3	14.0	--	--	23.0

Table 3.14(Cont'd)

Micrograms Fluoride Per Gram Vegetation

Date	Station Number 1A	1B	5	11	12
03/76	20.6	9.6	10.8	24.4	8.8
04/76	13.8	5.3	--	--	8.5
05/76	4.6	4.1	--	--	7.8
06/76	64.6	37.7	--	--	48.9
07/76	62.0	38.9	37.4	24.4	11.6
08/76	9.0	8.4	--	--	2.1
09/76	20.8	49.0	--	--	24.6
10/76	3.8	3.8	2.2	8.8	2.2
11/76	26.0	18.0	--	--	--
12/76	35.0	22.0	--	--	19.0
03/77	75.9	40.0	45.8	37.6	29.7
04/77	43.2	39.7	--	--	53.6
05/77	101.2	108.9	--	--	21.5
06/77	12.5	1.3	11.9	38.7	35.3
07/77	35.9	27.2	--	--	--
08/77	--	--	--	--	26.7
09/77	34.4	21.5	23.8	23.4	27.8
10/77	36.2	33.9	72.6	--	13.8
11/77	8.0	5.0	--	--	25.6
12/77	74.0	16.0	22.7	33.3	15.9
03/78	17.9	4.7	38.5	52.5	20.6
04/78	46.7	33.3	--	--	34.0
05/78	57.6	19.8	--	--	--
06/78	151.4	565.8	85.0	189.9	191.4
07/78	477.1	282.6	--	--	215.9
08/78	8.0	73.1	--	--	21.5
09/78	14.3	4.7	13.9	1.6	8.1
10/78	6.3	3.2	--	--	15.4
11/78	26.2	13.5	--	--	5.3

Table 3.15

Summary of Fluoride Content of Environmental Vegetation Samples

Sample Station	Year	Fluoride Content (ppm) High	Low	Mean	No. of Conditions Exceeding Standard
1-A	1976	65	4	21	-0-
	1977	101	8	36	-0-
	1978	477	6	26	-0-
	1979	89	67	81	-0-
	1980	90	37	73	-0-
1-B	1976	49	4	14	-0-
	1977	109	1	27	-0-
	1978	566	3	20	-0-
	1979	47	40	44	-0-
	1980	72	10	37	-0-
5	1976	37	2	11	-0-
	1977	73	12	24	-0-
	1978	85	14	39	-0-
	1979	133	41	87	-0-
	1980	34	20	29	-0-
11	1976	24	9	24	-0-
	1977	39	23	35	-0-
	1978	190	2	53	-0-
	1979	50	44	47	-0-
	1980	61	9	20	-0-
12	1976	49	2	10	-0-
	1977	54	14	27	-0-
	1978	216	<1	21	-0-
	1979	78	31	58	-0-
	1980	60	2	36	-0-
13	1980	29	17	21	-0-

3.3.3 Solid Wastes. Containers of contaminated solid waste from the plant are gamma-scanned prior to being released for burial. The sensitivity of the procedure for uranium measurement is roughly 1 gm of U-235 per container. Containers having very low uranium content are shipped to a licensed low-level waste burial site while containers having larger concentrations are stored on-site for possible further processing.

3.3.4 Conclusions and Recommendations, Environmental Monitoring Programs

Radiological. The environmental monitoring programs for radiological effluents is adequate. The release of radiological effluents via process ventilation system, process cooling water and sanitary waste systems are adequately monitored. The radiological monitoring systems provide sufficient and timely enough information that the licensee can assure conformance with the appropriate regulations. The groundwater monitoring system at the ENC site has consistently had uranium concentrations of less than 0.1 ppm. The only recommendations concerning the radiological environmental monitoring programs concern the test well monitoring program. First, it is required that the samples from the test wells be monitored for uranium, gross alpha, and gross beta activity. Analysis for uranium should be at least quarterly, and the analyses for alpha and beta monthly. If the gross beta activity in any of the well water exceeds 50 pCi/l, the licensee shall conduct isotopic analysis to verify the significant individual beta emitting nuclides.

Non-Radiological. With the exception of groundwater and fluoride air monitoring systems, it is the staff's conclusion that the non-radiological environmental program is adequate.

The fluoride air monitoring system consisting of samples collected on sodium carbonate-treated filter paper and determining a factor to relate particulate to gaseous fluoride is not equivalent to the EPA recommended impinger method nor the sodium carbonate tube method required by Washington State. Therefore, the staff requires that ENC modify this stack monitoring method for measuring total fluoride releases. The method should be acceptable to EPA or the State.

The staff's assessment of the groundwater monitoring led to the following conclusions. First, the shutdown and corrective action limits for the quality of the groundwater are set too high. Based upon historical data these limits would not have been exceeded even if the chemical waste had been pumped directly into the groundwater. Secondly, the knowledge of groundwater flow in the immediate area of the ENC site is not well known. ENC staff now believes that at the lagoon site the groundwater flow is generally eastward but under the lagoons they believe the flow is northward. And lastly, the test wells are not located in an arrangement that allows the tracking of a contaminated plume. The overall groundwater monitoring program is considered marginally adequate. This qualified approval of the groundwater monitoring program can be raised to adequate when the following recommendations are included.

Recommendations:

1) The between and below liners leak detection system be incorporated as part of the groundwater monitoring systems.

2) Action levels for the between and below liners leak detection system be prepared.

3) The licensee be required to notify NRC promptly whenever the investigate action level for the between or below liner leak detection system is exceeded. Furthermore, whenever the investigate action level is exceeded the licensee should prepare an initial assessment and describe the actions planned to correct the leakage. This assessment should be provided to NRC within 3 months and thereafter, while remaining the investigative range, should be documented and provided to NRC on a semiannual basis.

4) The licensee should establish a system of test wells to monitor the contaminated groundwater plume.

3.4 ALTERNATIVE ACTION

3.4.1 No Action

No action, in the context of this Environmental Assessment, would mean the denial of the application for license renewal (the proposed action). This alternative, if implemented, would result in plant shutdown.

To put this alternative into perspective, the ENC plant has been in operation since 1971 with insignificant environmental impact.

If the alternative were implemented then the plant would be decommissioned. During decommissioning more solid waste would be generated. A possible local environmental advantage might be attributable to denial of application for renewal, that is, a source of fluoride and uranium would be removed. However, as stated above, the release of fluoride and all radioactivity is controlled, monitored, and is a fraction of the applicable regulatory requirements.

The disadvantages to this alternative are several. For example, it would result in less American competition for the manufacture of low-enriched LWR fuels. ENC would have to find other means to meet the conditions of its fuel supply contracts with various companies. There would be local economic disruption in the Tri-Cities area, ENC would reduce employment, the local government would experience some reduction in its tax base. This alternative would also mean that an expensive facility designed for approximately a 30-year useful life would be abandoned or converted to some other use.

4.0 AFFECTED ENVIRONMENT

4.1 AFFECTED ENVIRONMENT OF THE PROPOSED ACTION

4.1.1 Air Quality

The ENC fuel fabrication site is located in an area where the quality of the ambient air meets the National Primary and Secondary Ambient Air Quality Standards, except for particulates. High concentrations of airborne dust, which originate primarily from agricultural activities, are characteristic of most of southeastern Washington State. Consequently, the Tri-Cities area is classified as a Priority I region with respect to suspended particulates. For the remaining air pollutants, Priority III is applicable, which places the region in general conformance with the national ambient air quality standards.

The normal operation of the Exxon fuel fabrication plant results in the release of very small amounts of airborne radioactivity. In terms of concentration, the 1976, 1977, and 1978 annual average exhaust air concentrations of uranium were $4x10^{-15}$, $6x10^{-15}$ and $5.5x10^{-14}$ uCi/ml respectively. All of these concentrations have remained well below the 10 CFR 20 limits for U-234 of $4x10^{-12}$ uCi/ml. The radiological consequences of normal gaseous releases are calculated in Section 5.1.

The normal operation of the ENC nuclear fuel plant also results in the release of fluorides. The fluoride monitoring data were discussed in Section 3. Using the staff's estimate of the grams fluoride released per second the average concentration of fluoride in the ambient air is estimated to be less than 0.5 ugm/m^3. This concentration, assuming that the average for the months of April through October is the same or less than the annual average estimate, is in compliance with Washington State requirements.

4.1.2 Water Quality

Both ground and surface water in the area of the Exxon Nuclear Company site is of good quality, both biologically and chemically, and is classed as grade A by Washington State.

Operation of the ENC does release small amounts of liquid radioactive effluents to the surface water (Columbia River) via the public sewage system.

Results of samples of the water arriving at the sewage plant from ENC were shown in Table 3.11 as yearly averages of element ions, in parts per million, except with plutonium, which has been counted in pCi/liter. The plutonium concentration is $1.35x10^{-8}$ uCi/ml that is well below the 10 CFR 20 limits of $1x10^{-4}$ uCi/ml per liter.

4.1.3 Terrestrial Quality

The fluoride accumulation in vegetation was discussed in Section 3. The data indicated that on occasions concentrations of fluorides have exceeded 40 parts per million and that during the summer of 1978 exceeded 60 parts per million for three consecutive months. Data presented in the previous section also showed that during 1979 at four sampling stations, the average fluoride concentration exceeded 40 ppm for the 12-month period. At the sampling locations no forage was being grown. Based upon the atmospheric dilution factors at distances in excess of two miles from the ENC site, where forage would have been growing, it is concluded that the Washington State fluoride concentration limits for forage would not have been exceeded at locations where forage was being grown.

4.2 AFFECTED ENVIRONMENT OF ALTERNATIVES

4.2.1 No Action, i.e., Denial of any License Renewal

Implementation of this alternative would obviate any further release of radioactive materials to the environment, provided the plant decommissioning and decontamination were effected without incident. There would be no further expenditure of energy nor use of natural resources. The primary impact would be socioeconomic. The ENC employees would suffer loss of employment, ENC would be out of business and the City of Richland note a reduction in tax base.

5.0 ENVIRONMENTAL CONSEQUENCES

Two types of impact were considered: radiological and non-radiological. In the radiological assessment, uranium was considered the material of major concern. The non-radiological assessment focused on the potential impacts caused by the direct releases of fluorides. For both types of assessment, impacts caused by routine plant operations and possible accidents were analyzed.

The radiological assessment was accomplished by comparing calculated results from plant operation information with established requirements stipulated in Title 40, Code of Federal Regulations, Part 190 (40 CFR 190). This code limits the individual dose for routine plant operation to 25 mrem/year to the whole body, 75 mrem/year to the thyroid, and 25 mrem/year to any other organ. The significant pathways considered in the assessment include air immersion, inhalation, food ingestion, and direct exposure to soil and water bodies.

The major activity involved in the assessment was to estimate the human exposure dosage by using models which were developed at Oak Ridge National Laboratory, and incorporated in the computer code AIRDOS II[8]. These models include atmospheric dispersion models and environmental exposure models which follow the requirements of United States Nuclear Regulatory Commission Regulatory Guide 1.109, "Calculation of annual doses to man from routine releases of reactor effluents for the purpose of evaluating compliance with 10 CFR Part 50, Appendix I," and Regulatory Guide 1.111, "Methods for estimating atmospheric transport and dispersion of gaseous effluents in routine release from light-water-cooled-reactors."

In the assessment of the impacts resulting from the release of fluoride, the guidelines for fluoride prepared by the State of Washington were used. The State of Washington regulation limits the emission of fluoride to an average 3.7 ug/m^3 for any 12-hour period; an average of 2.9 ug/m^3 for any 24-hour period; an average of 1.7 ug/m^3 for any 7 consecutive days; an average of 0.84 ug/m^3 for 30 consecutive days; and 0.5 ug/m^3 for the period March 1 through October 31 of any year. The OCGIH [9] recommends a value 2500 ug/m^3 for fluoride at the industrial workplace.

5.1 EFFECTS OF OPERATIONS

During routine plant operations, releases that could affect humans and the environment radiologically include gaseous and liquid effluents and solid wastes containing uranium radionuclides.

The impacts caused by radiological air effluents were assessed by estimating the maximum dose to the nearest resident of the plant, using available information on routine operational releases, and the AIRDOS II computer code for air releases. The maximum annual release of uranium is 112.8 uCi that occurred in 1978 (see Section 3.3.2). This value was used as the source term for an annual release. Table 5.1 presents calculated radiological dose equivalent that would be received by an adult residing in the residence nearest the fuel fabrication building assuming the 1978 uranium effluent data. The nearest resident is located about

Table 5.1 Dose Commitments Based Upon Normal Operating Gaseous Radiological Releases

	Organ Dose				
	Total Body	Kidney	Bone	GI Tract	Lung
Population Dose (50 mile) units person rem/yr	9.5×10^{-4}	3.1×10^{-3}	1.3×10^{-2}	9.5×10^{-4}	9.5×10^{-2}
Nearest Resident units rem/yr	1.2×10^{-7}	4.0×10^{-7}	1.6×10^{-6}	1.2×10^{-7}	1.2×10^{-5}
Site Boundary 1.8 mile to Southeast units rem/yr	1.9×10^{-7}	6.3×10^{-7}	2.5×10^{-6}	1.9×10^{-7}	1.9×10^{-5}

2-1/4 miles (about 3600 meters) to the southeast of the plant site. The pathways considered in the dose calculation include direct irradiation, direct inhalation, inhalation from resuspension and ingestion of vegetation, meat, etc.

The term "dose" referred to in this assessment is actually a 50-year dose commitment.* The critical organ considered in this assessment is the lungs of the nearest resident that is estimated to receive an annual dose of 0.012 mrem.

The critical individual would be an infant (0-1 yr age) in the inhalation pathway and the lung dose would be increased by a factor of 1.8 compared to adults. The estimated annual dose for such an infant is calculated to be 0.022 mrem. The dose to this critical individual is 0.09% of the 25 mrem limit specified in 10 CFR 190. Doses to the thyroid were not estimated as no radioactive iodine is present in the normal releases of the ENC plant.

Doses due to liquid pathways were not calculated. However, the NRC staff [10] had previously calculated an estimated dose (assuming a source term of 3.54 mCi per year) from the liquid pathways to be approximately 1.4×10^{-4} mrem (total-body) and 2.2×10^{-3} mrem (bone). Thus, it is concluded that the maximum individual dose at the nearest residence to a critical individual is well below the recommended limits, and therefore adverse impacts to humans and the surrounding environment are not expected.

The annual dose to the entire population within a 50-mile radius of the plant was calculated to be 9.5×10^{-4} person-rem to the whole body and 9.5×10^{-2} person-rem to the lung, without consideration of the dose that may result from resuspension of the uranium deposited.

For comparison, natural background radiation in the area near the ENC plant results in an annual whole body dose of about 135 mrem (reference 2). The annual dose that would be received from natural causes by the population of 250,220 living within a 50-mile radius of the plant would be 33,780 person-rem.

Another source that could affect the environment is the leaching of radiological waste water from holding ponds to the water table. Even though the ponds are lined with impermeable materials, various failures of the liners have resulted in some seepage of lagoon contents into the soil and non-radiological contaminants have been detected in the groundwaters. Less than 0.1 ppm of uranium, the limits of detectability for the analysis being used to monitor the groundwater, has been detected in the groundwater. It is concluded that the non-radiological, as well as the uranium, contamination of the soils under the lagoons poses no immediate impact to the environment because there is only a remote probability of the water entering the environment. This is concluded based upon (1) the nearest well used for drinking water is over 2 miles from the lagoons in a direction opposite the direction of groundwater flow; and (2) by the time the contaminated groundwater

* A 50-year dose commitment is the total dose to the reference organ from a one-year chronic intake of radionuclides which will accrue during the remaining lifetime (50 years) of an individual.

plume reaches the Columbia River there will have been considerable dilution of the contaminants and additional dilution would be provided by the river.

5.2 ACCIDENTS AND EFFECTS

Postulated accidents that have the potential for resulting in release of radioactive materials from the ENC plant were analyzed when special Nuclear Materials License SNM-1227 was issued to the licensee. Additional accident analyses have been performed to support license amendments to permit various plant modifications made since the plant began operation. The analyses performed have addressed those accidents that are considered to occur with the same frequency as with normal industrial plant operations. Analyses have also been performed to assess the consequences of severe accidents that are expected to occur rarely, if at all, if the consequences of the accidents could endanger the health and safety of the public. The accident analyses have been reviewed and it has been concluded that the analyses were performed in a rigorous manner and that the accident spectrum analyzed addressed the infrequent, severe accidents that could conceivably endanger the public. However, as was noted, the assumptions on the criticality accident analysis did not conform to the current NRC regulatory guidance. Consequently, a criticality accident analysis was performed. Also, the analysis of accidental release of a large quantity of UF_6 was also performed.

5.2.1 Analysis of Large UF_6 Release

The most severe radiological accident which can be postulated that could be initiated by an event typical of industrial operations would result from the release of the material contained in a uranium hexafluoride cylinder outside a building or when the ventilation system filters were inoperative at the time of the accident. UF_6 is a solid at room temperature. If a cylinder were to fail, the UF_6 would vaporize gradually. The consequences of an accidental release of UF_6 from a cylinder were calculated using the following assumptions.

FACTOR	VALUE USED.
Nearest Industrial Site:	
Distance	2000 m
Direction	E to ENE
Atmospheric Dilution Factor	2.2×10^{-4} sec/m^3
Nearest Residence:	
Distance	3600 m
Direction	SE
Atmospheric Dilution Factor	3.9×10^{-5} sec/m^3

UF_6 Released:	
Weight	540 Kg
Time	15 minutes
Uranium Released:	
Weight	365 Kg
Forms	soluble, uranium compound Class D
Particle Size	1 um
Building Wake Factor*	1
Breathing Rate	3.47×10^{-4} m^3/sec

*Release is assumed to occur at ground level.

The calculated doses to an individual at the nearest industrial site and at the nearest residence are given in Table 5.2. For an individual at approximately 2000 meters from the cylinder storage area at the time of the accidental release, the total body dose is calculated to be 0.11 rem and the dose to the bone is calculated to be 1.7 rem.

The maximum fluoride concentration at the nearest site boundary corresponding to this UF_6 accident is estimated to be 1.5 mg/m^3. This concentration is 60% of the OCGIH recommended limit of 2.5 mg/m^3.

5.2.2 Criticality Report

The accident analyses of a fuel manufacturing plant required under 10 CFR 70 must include the discussion of the effects of a postulated criticality accident. However, the possibility of such an accident at a low-enrichment uranium facility is remote. Historically, no accident of this kind has ever occurred in a low-enrichment fuel fabrication facility. Achievement of criticality with low-enriched uranium requires carefully controlled conditions and is not likely to happen accidentally. In addition, at the ENC plant. programs of design, review, procedural control, engineered safeguards, and audits are implemented routinely to prevent a criticality accident of this kind

The postulated criticality accident has the following characteristics (Regulatory Guide 3.34):

- The accident results in 10^{19} fissions produced in a series of pulses within a supercritical liquid system.
- The accident releases only the volatile fission products produced by the above number of fissions. At this time radioactive decay begins.

Table 5.2 Estimated Doses (REM) From Postulated Accidents

Organ	Large UF_6 Release		Accidental Criticality	
	Nearest Industrial Site	Nearest Resident	Nearest Industrial Site	Nearest Resident
Total Body	1.1E-1	6.4E-2	9.2E-3	3.7E-3
Kidneys	4.2E-1	2.5E-1	--	--
Bone	1.7E-0	1.1E-0	2.8E-2	1.5E-2
G.I. Tract	1.1E-1	6.4E-2	8.1E-1	1.5E-2
Thyroid	--	--	4.5E-0	1.7E-0
Lungs	3.3E-2	2.1E-2	1.7E-1	5.3E-2

In the event of a c. icality accident, an individual would receive exposure from internal as well as external sources of radiation. The doses to the individual resulting from direct exposure to prompt neutron and gamma radiation, from submersion in a cloud containing beta and gamma emitting fission products and from inhalation of the fission products in the cloud have been calculated using the following assumptions:

FACTOR	VALUE USED
Building Area	100,000 ft^2 Approximately
Building Wake Factor at 500 meters	1.0
Weather Stability Factor	F Stability
Wind Velocity	1 meter/sec
X/Q at 0<t<8 hr*	1.0×10^{-4} sec/m^3
X/Q at t>8 hr*	2.1×10^{-3} sec/m^3
Building Confinement	30 air changes/hr

*These values are for the nearest residence, values for the nearest industrial site are 2.2×10^{-4} and 3.8×10^{-5} sec/m^3 respectively.

The results of the calculations indicate that an individual at the nearest residence would be expected to receive a dose to the whole body of 3.7×10^{-3} rem, and a dose to the thyroid of 1.7 rem. An individual at the nearest industrial site would be expected to receive a whole body dose of 9.2×10^{-3} rem and a thyroid dose of 4.45 rem. These doses are below the limits of 1 rem to the whole body and 5 rem to the thyroid as specified in the EPA's Protective Action Guides.

6.0 MATERIALS AND PLANT PROTECTION

6.1 PHYSICAL PROTECTION AND MATERIAL ACCOUNTING

Current safeguards are set forth in 10 CFR Parts 70 and 73. The regulations in Part 70 provide for material accounting and control requirements with respect to facility organization, material control arrangements, accountability measurements, statistical controls, inventory methods, shipping and receiving procedures, material storage practices, records and reports, and management control.

The Commission's current regulations in 10 CFR Part 73 provide requirements for the physical security and protection of fixed sites and for nuclear material in transit. Physical security requirements for protecting highly strategic types and quantities of material, including 2 kilograms or more of plutonium, include the establishment and training of a security organization (including armed guards), provision for physical barriers, and establishment of response and safeguards contingency plans. Physical protection requirements for special nuclear material of moderate and low strategic significance (including low enriched uranium) include provision for establishment of controlled access areas, monitoring these areas to detect unauthorized penetration, and communications capabilities to notify offsite response forces of the need for assistance.

The Commission's regulations in 10 CFR Parts 70 and 73, described briefly above, are applied in the reviews of individual license applications. License conditions then are developed and imposed which translate the regulations into specific requirements and limitations that are tailored to fit the particular type of plant or facility involved.

The licensee has an approved material control and accounting plan and an approved physical security plan which meet the current requirements for the low enriched uranium which would be possessed at the site. Amendments to this security plan would have to be submitted and approved prior to the licensee's bringing onto the site large quantities of plutonium which the licensee may possess in the future. These amendments would also have to be in conformance with the current requirements of 10 CFR Parts 70 and 73. It is concluded, therefore, that the safeguards-related environmental impact of the proposed action is insignificant.

APPENDIX A

Plots prepared by ENC staff of the concentrations of nitrate in the test wells are presented on pages A.2 through A.14. Plots of the sulfate concentrations are presented on pages A.15 through A.27.

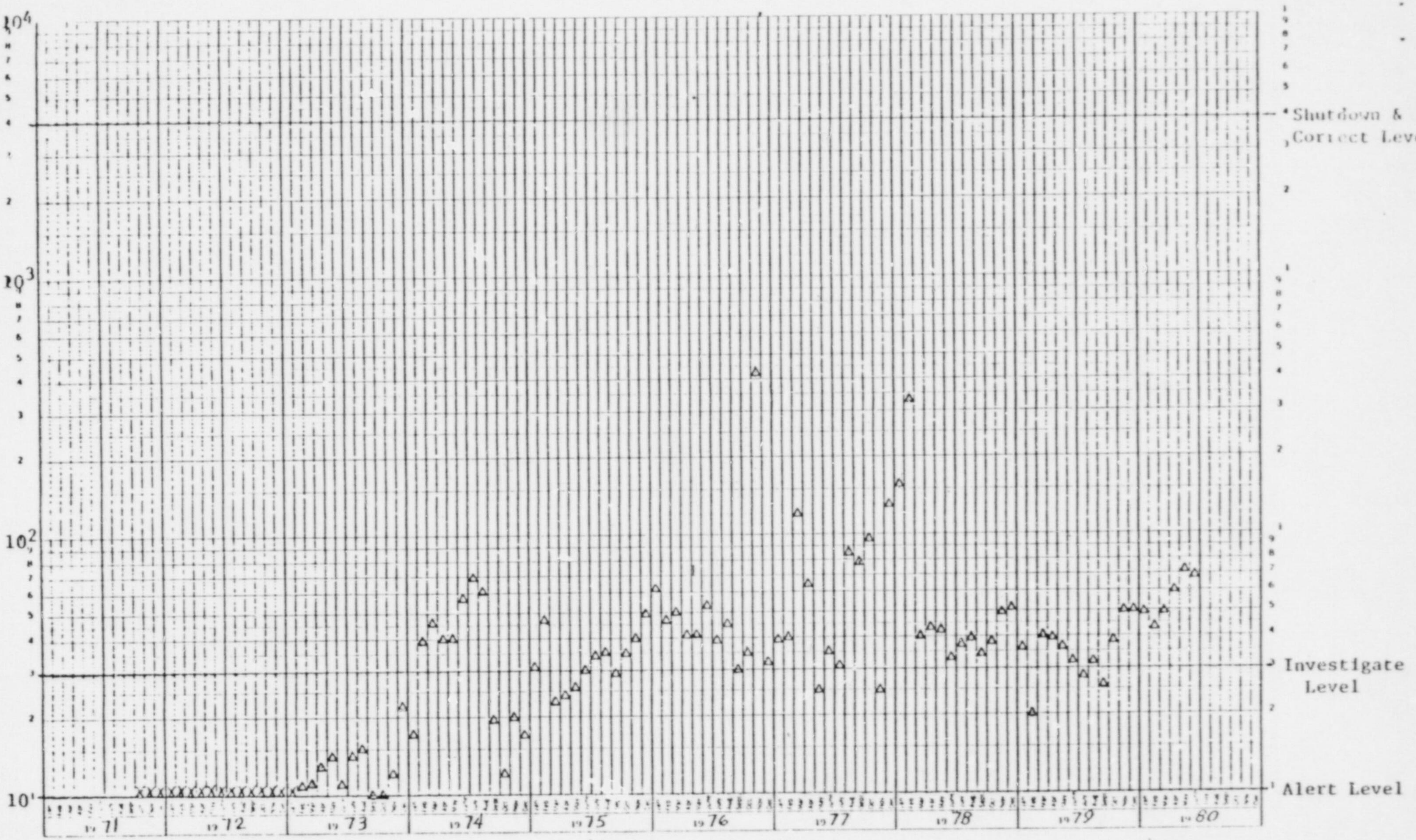


FIGURE *1N*: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 1.

Note: "X" signifies concentration below "Alert Level".

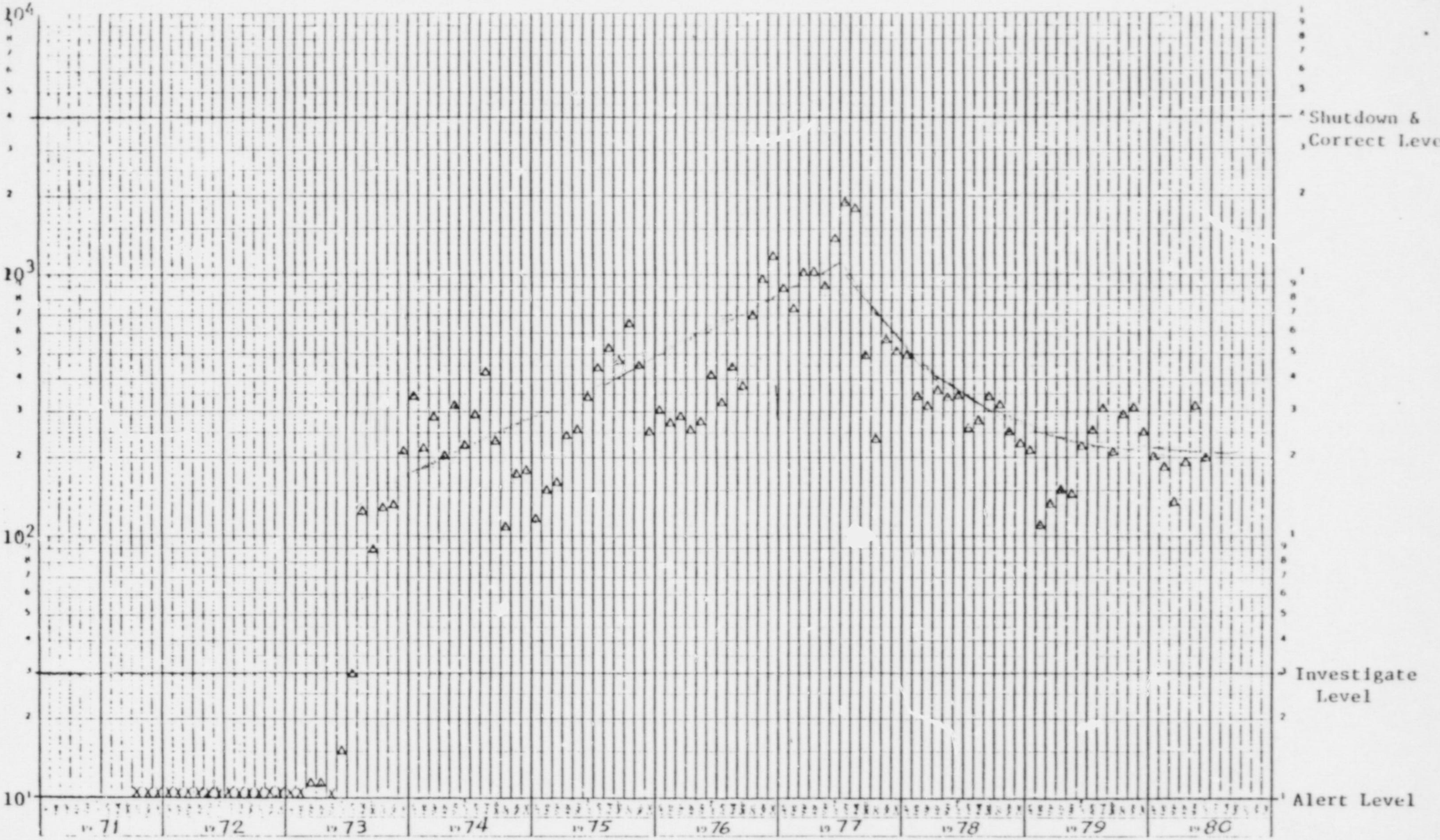


FIGURE 2N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 2.

Note: "X" signi'ies concentration below "Alert Level".

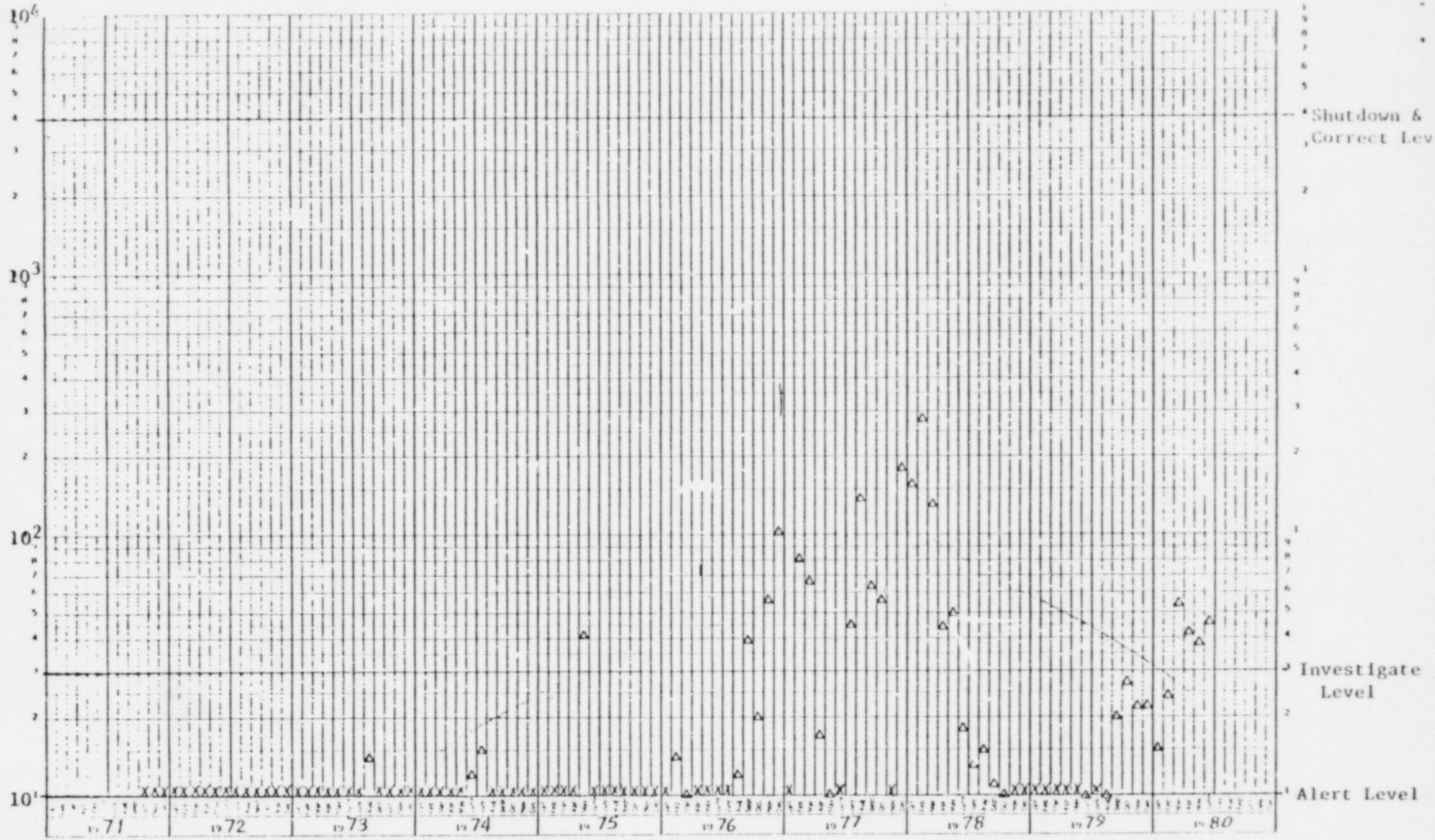


FIGURE 3N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 3.

Note: "X" signifies concentration below "Alert Level".

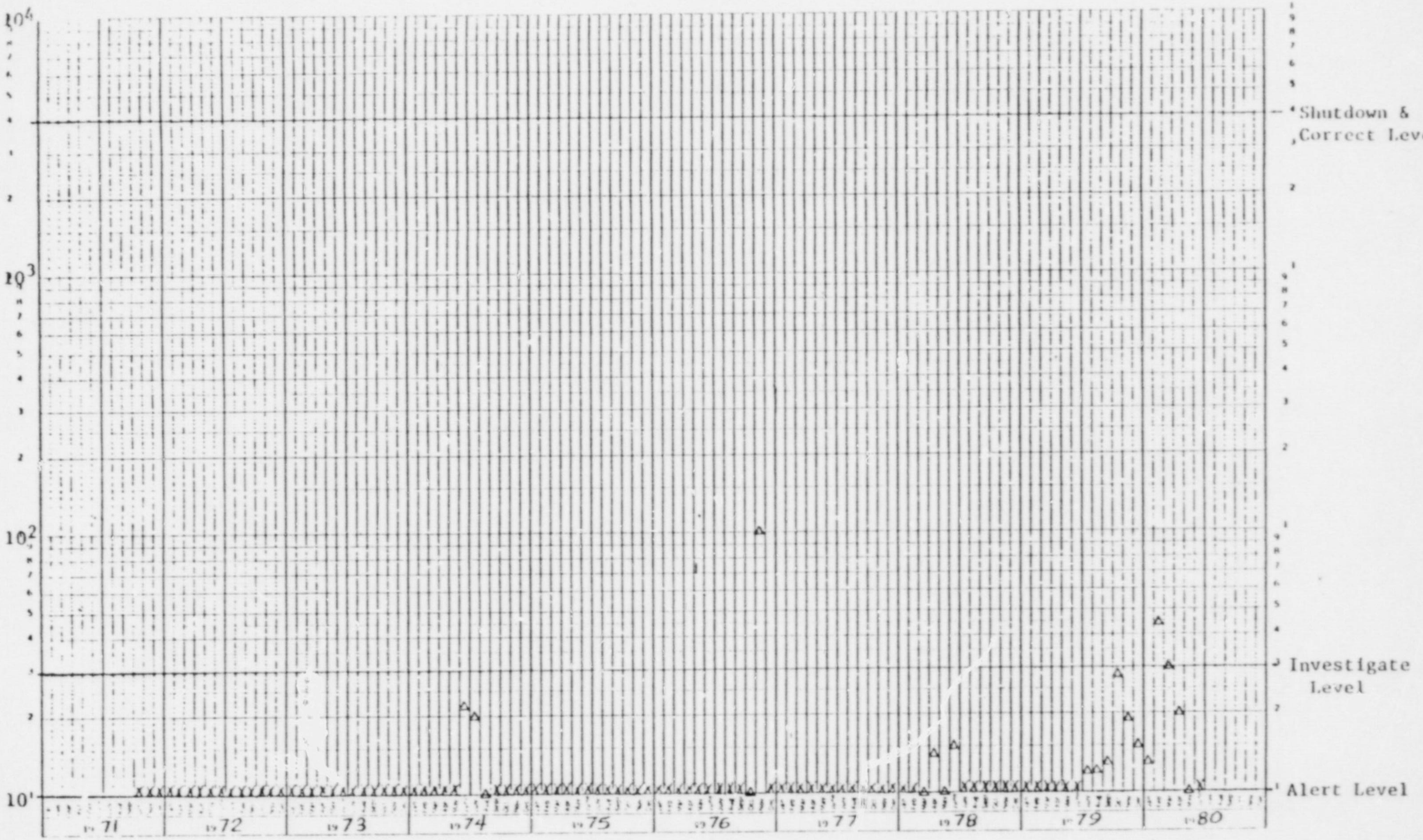


FIGURE 4N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 4.

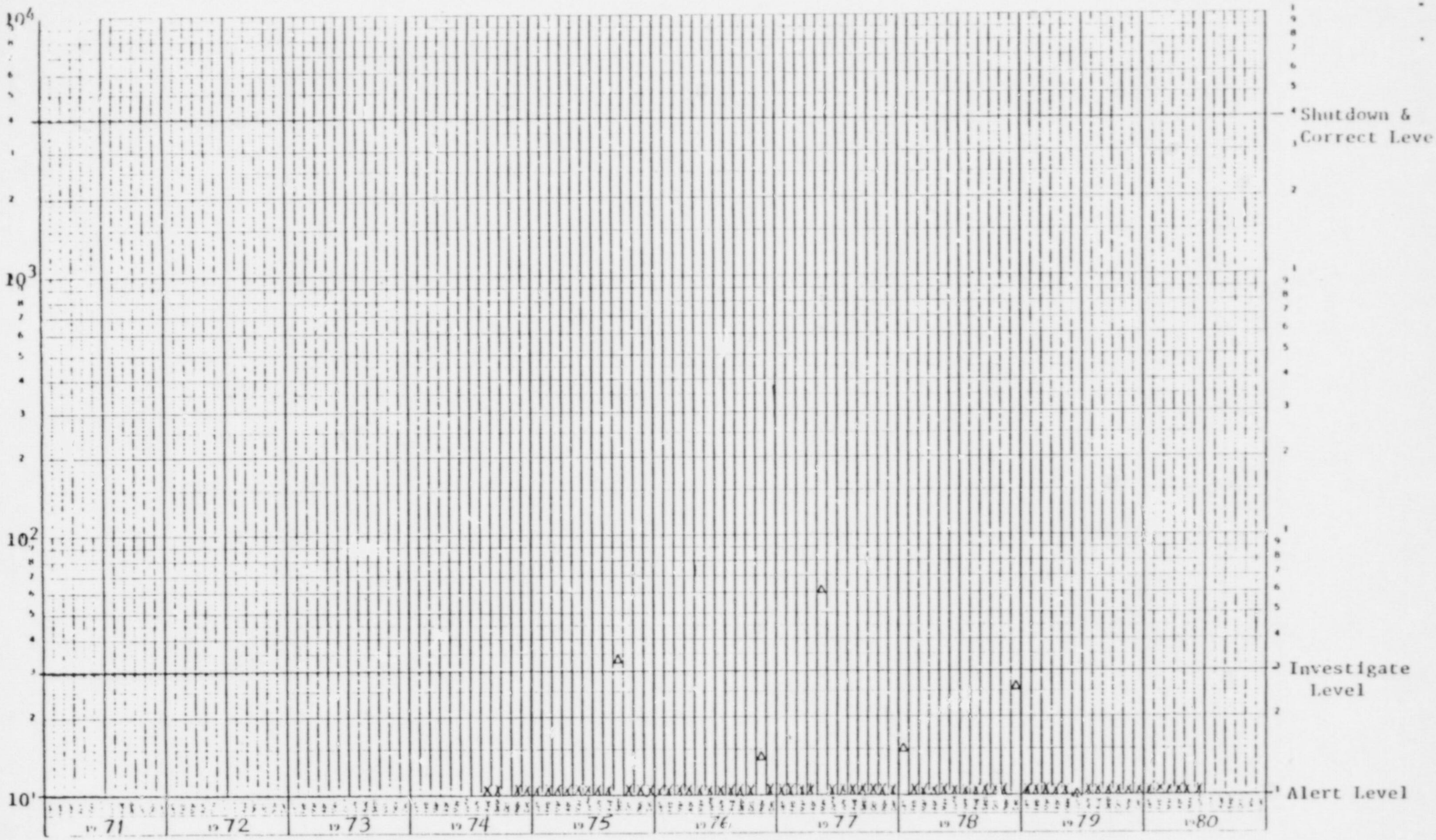


FIGURE 5N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 5.

Note: "X" signifies concentration below "Alert Level".

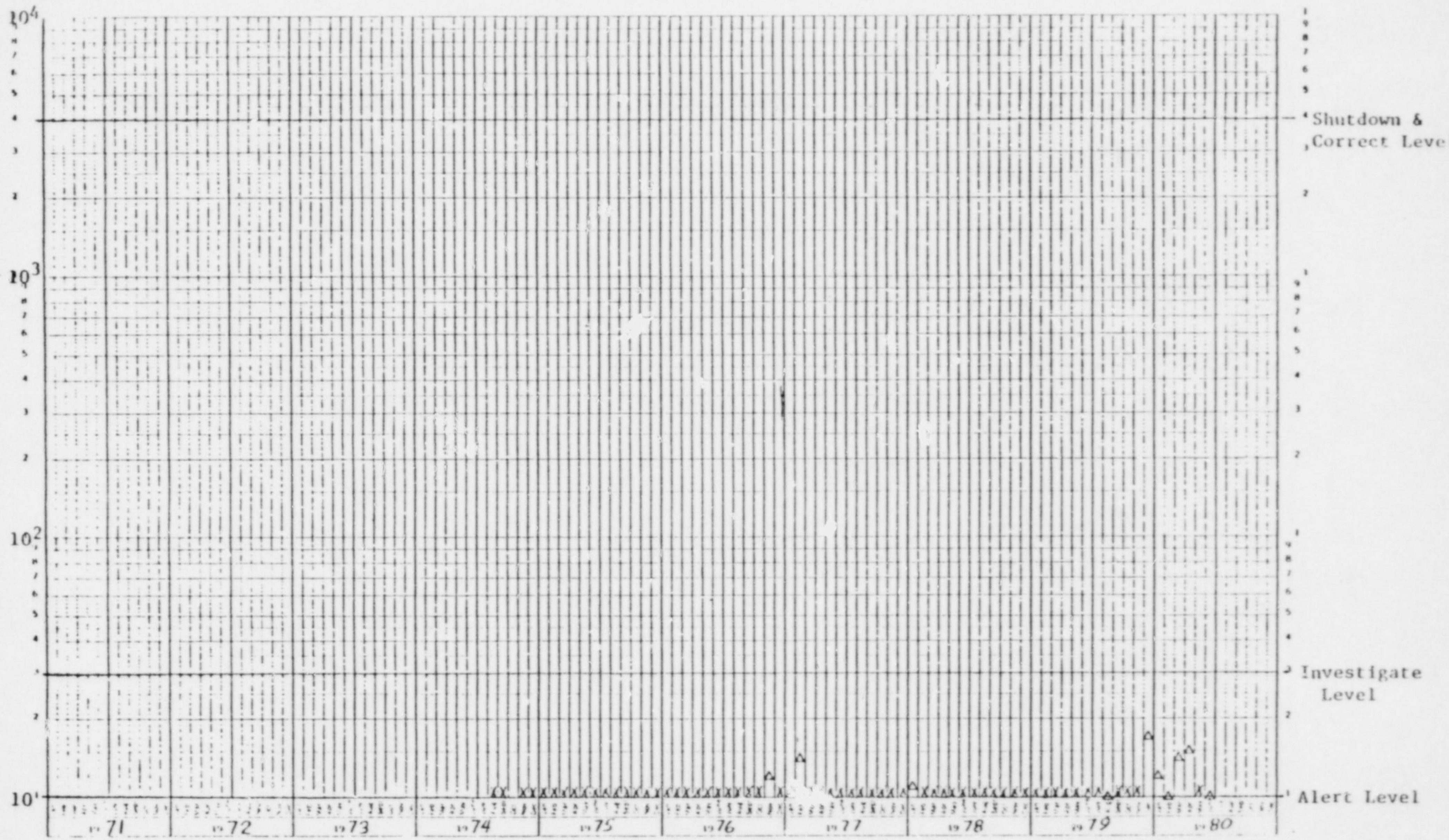


FIGURE 6N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 6.

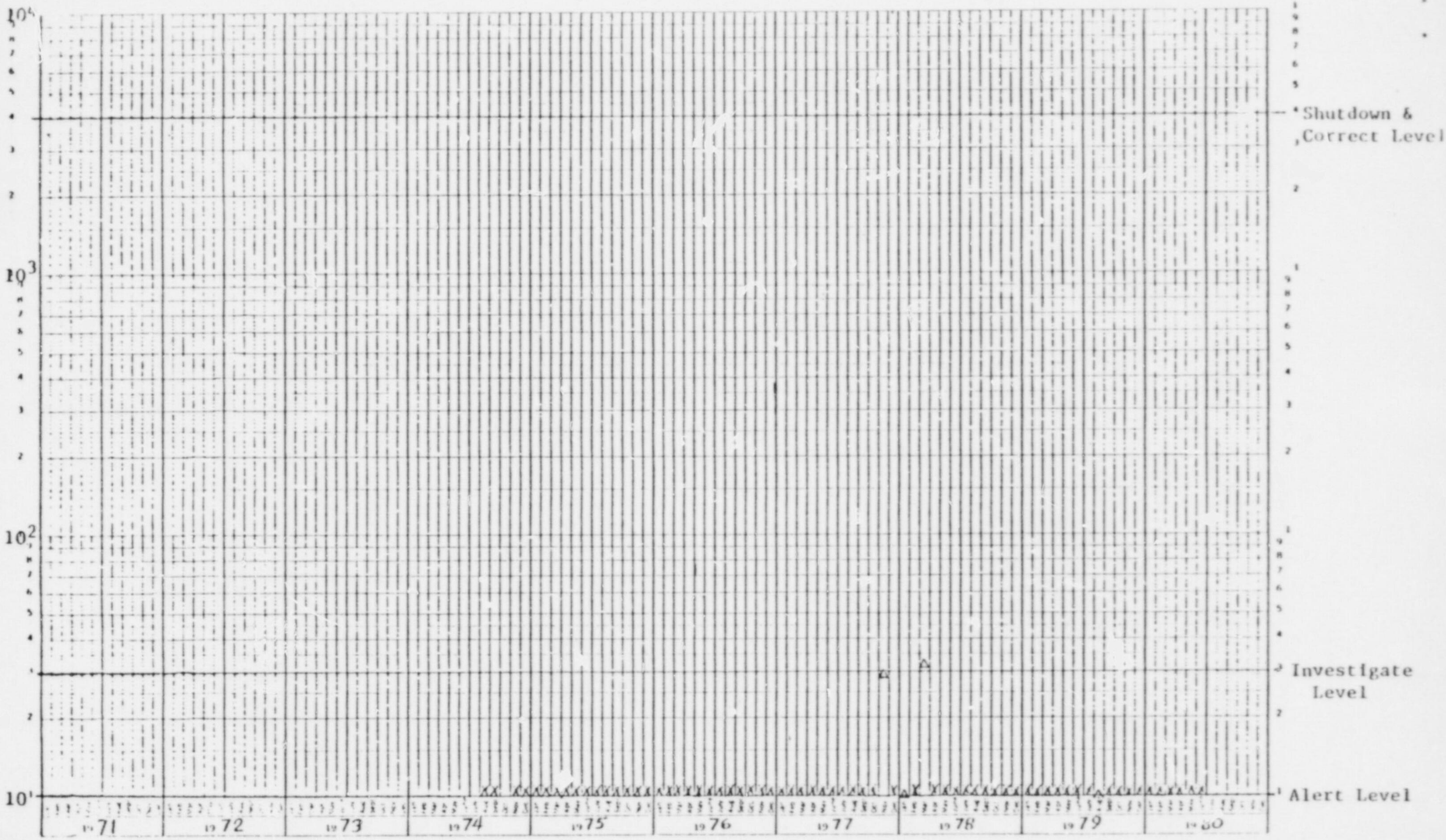


FIGURE 7N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 7.

Note: "X" signifies concentration below "Alert Level".

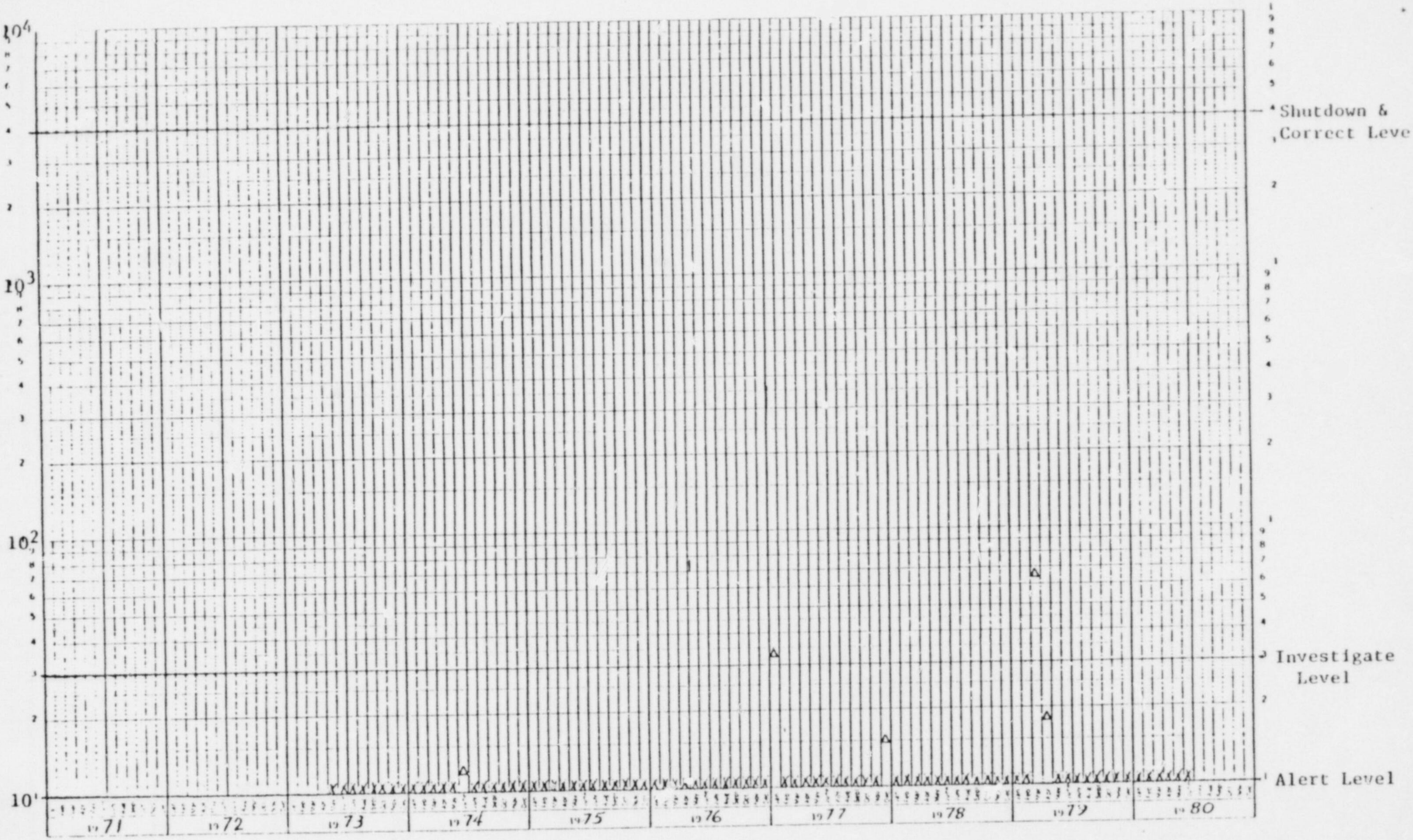


FIGURE 8N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 8.

"X" signifies concentration below "Alert Level".

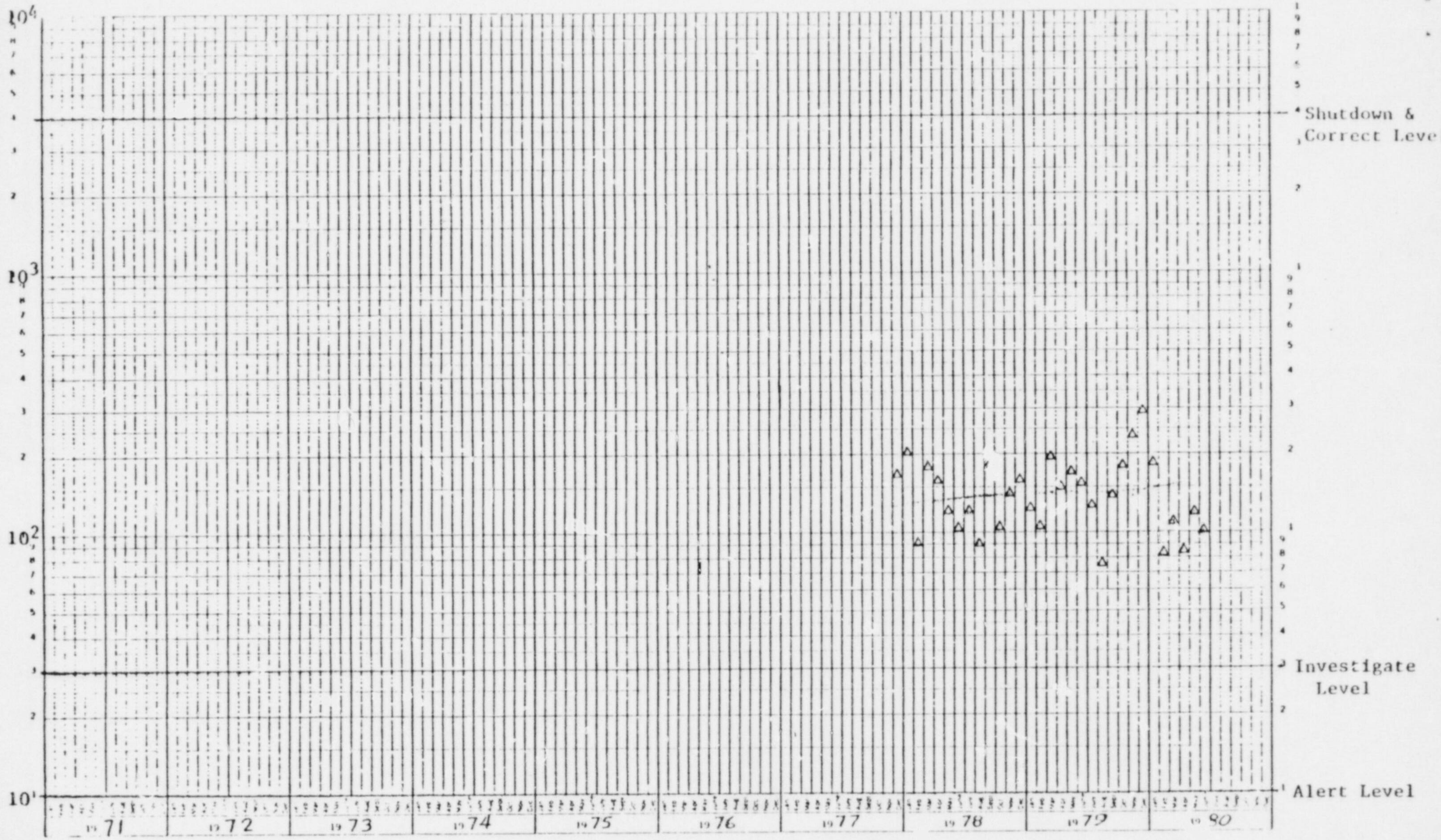


FIGURE 9N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 9.

Note. "X" signifies concentration below "Alert Level".

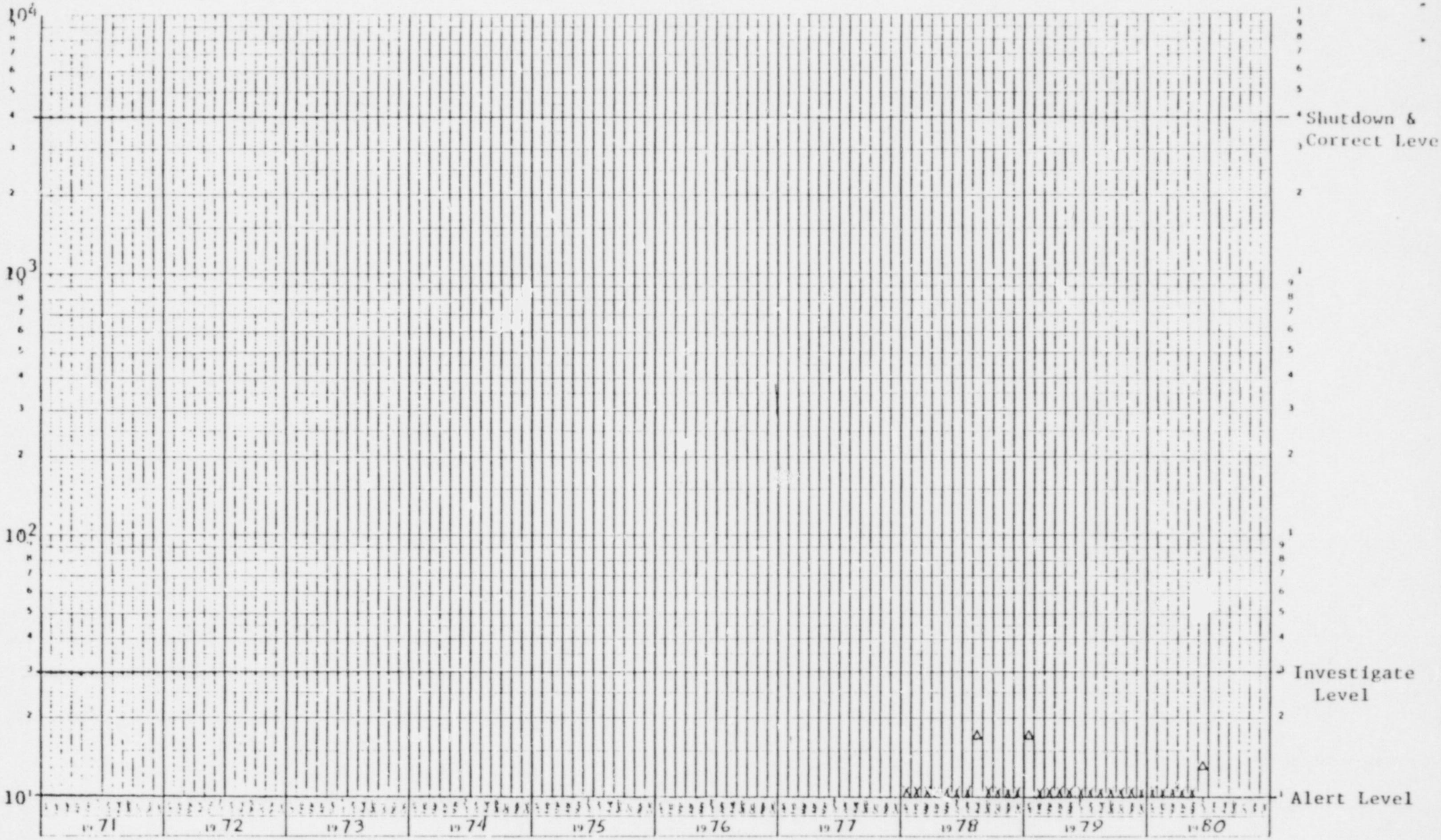


FIGURE 10N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 10.

Note: "X" signifies concentration below "Alert Level".

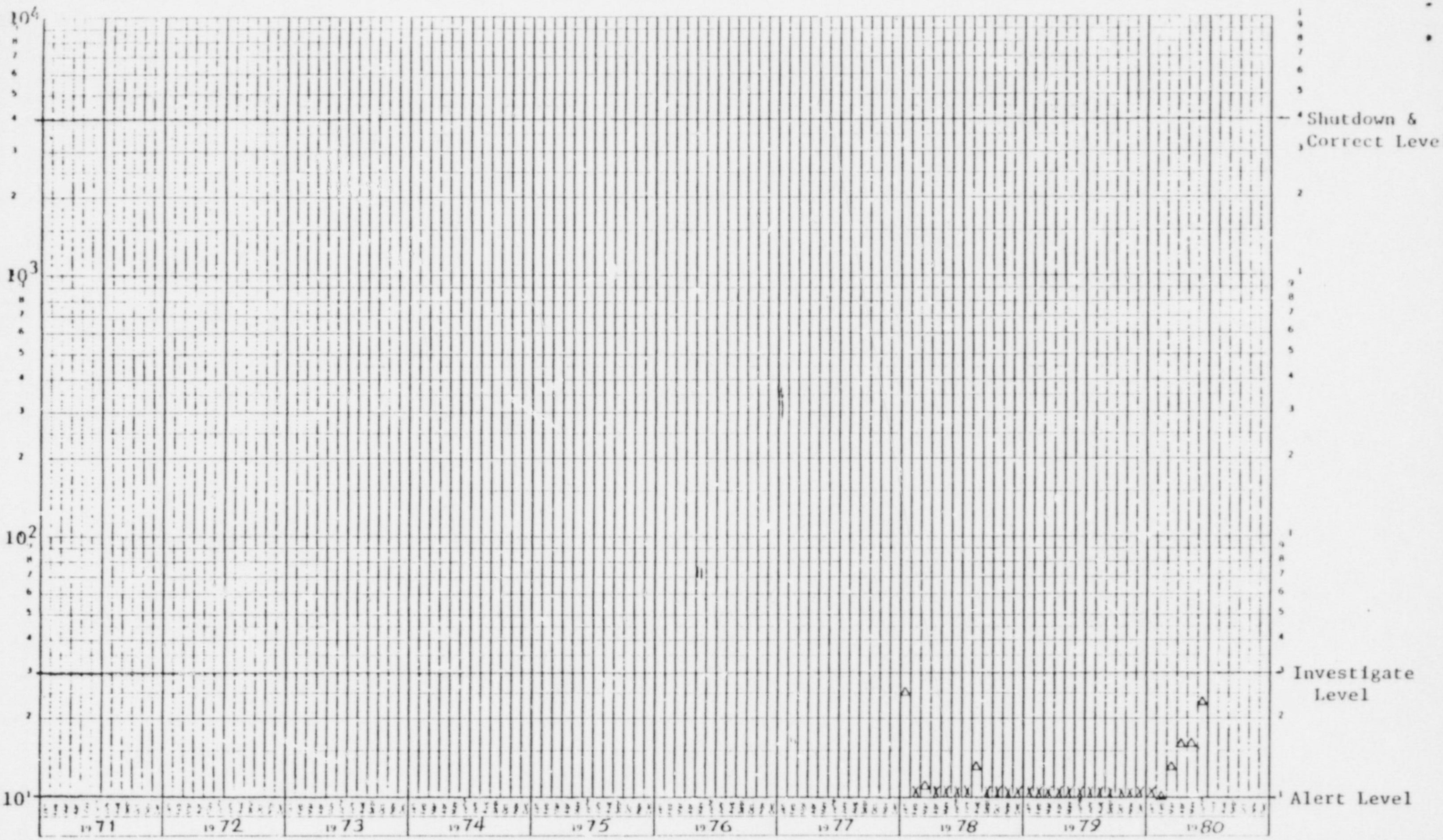


FIGURE *11N*: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 11.

Note: "X" signifies concentration below "Alert Level".

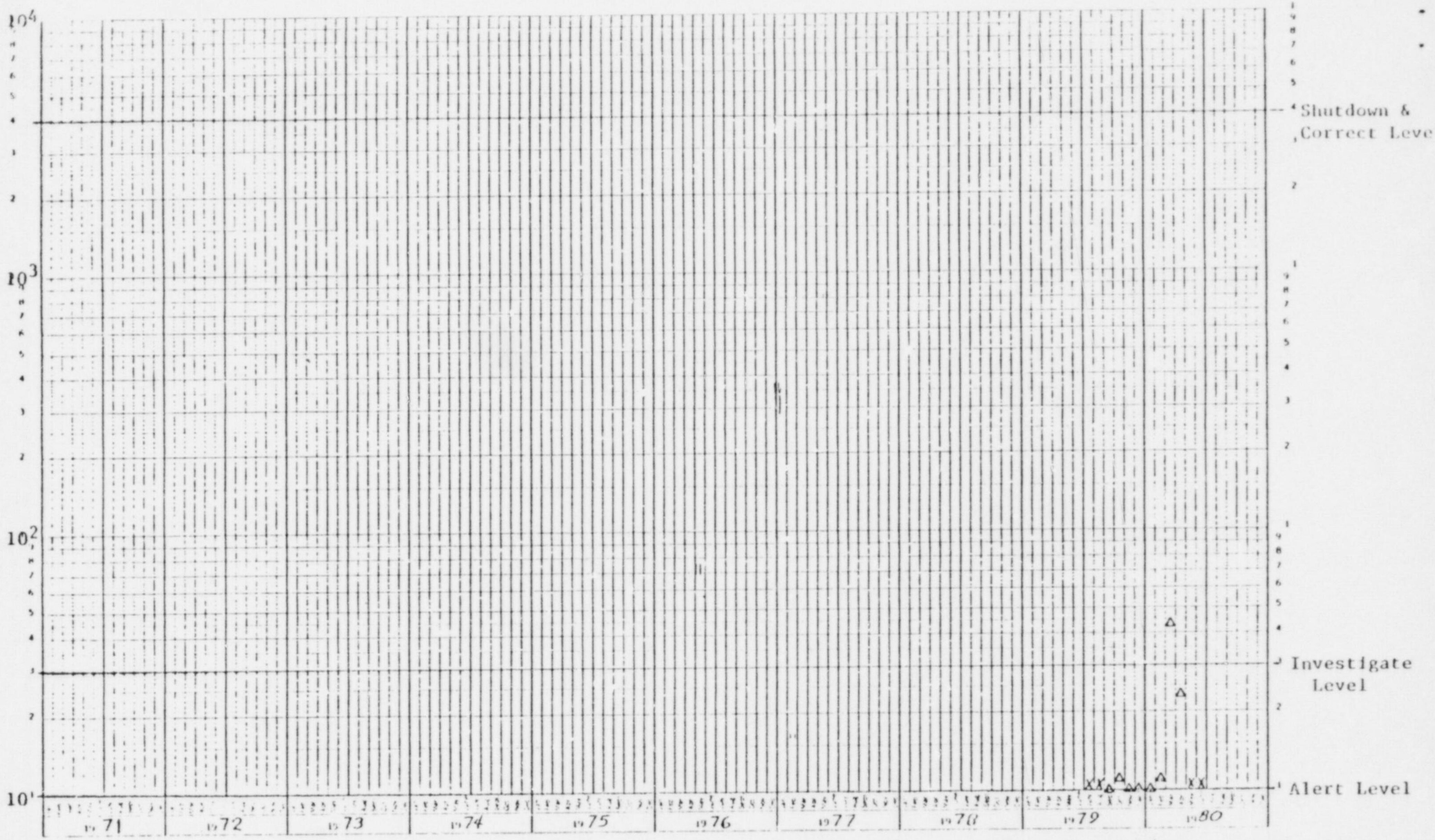


FIGURE 12N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 12.

Note: "X" signifies concentration below "Alert Level".

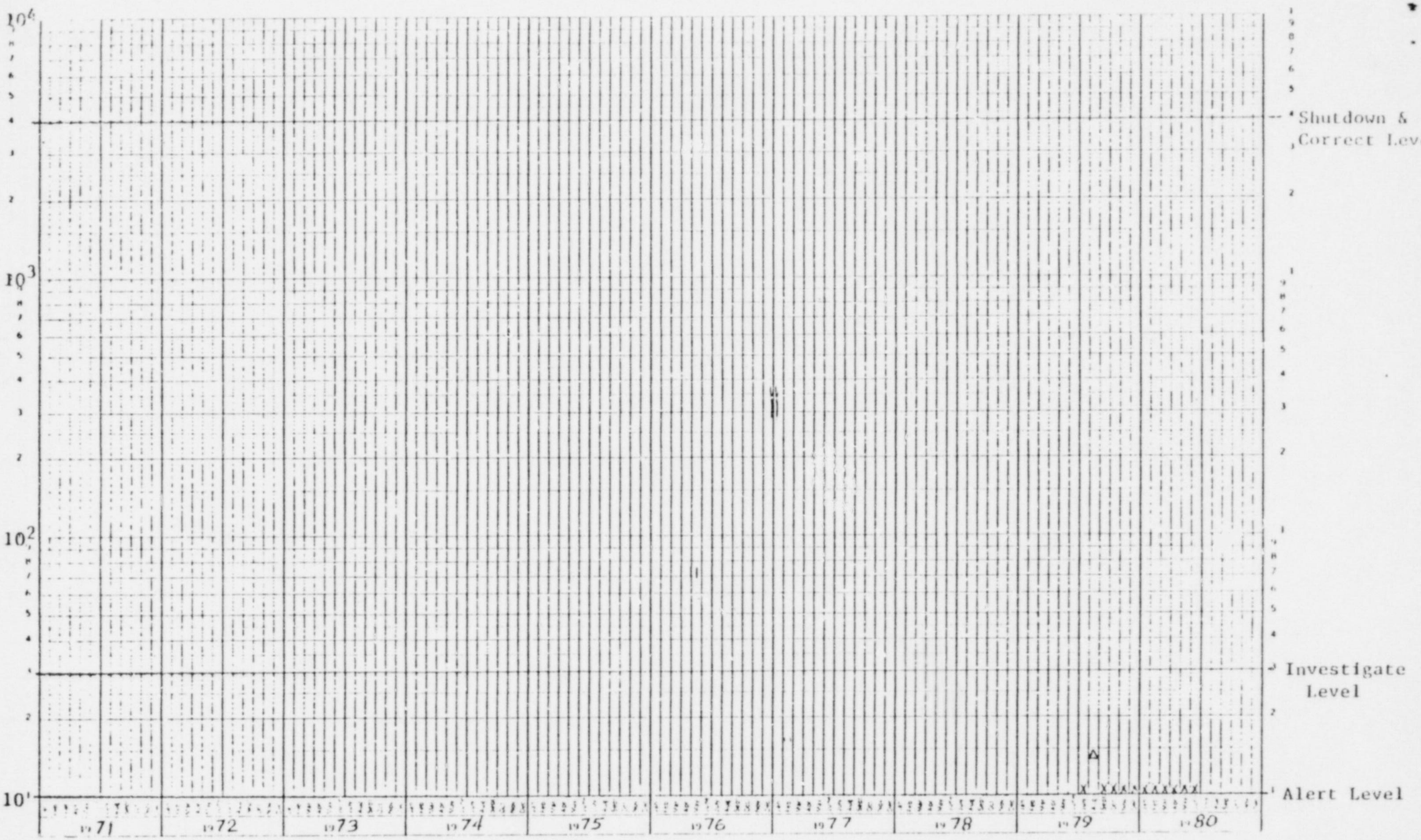


FIGURE 13N: Average Monthly NO_3 + NH_3 (as N) Concentrations (PPM) In Test Well No. 13.

Note: "X" signifies concentration below "Alert Level".

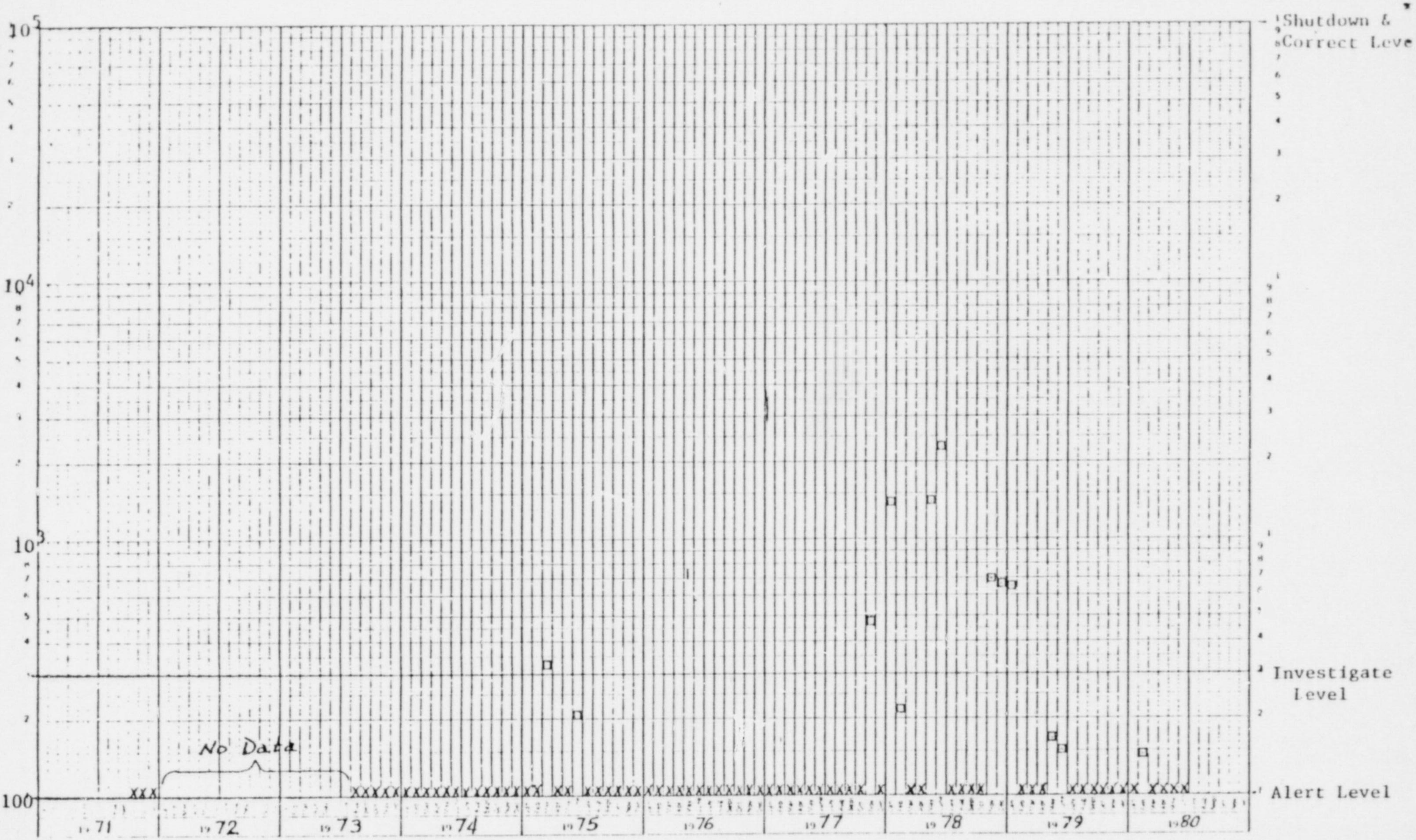


FIGURE 15 : Average Monthly Sulfate Concentration (PPM) in
Test Well No. 1 .

Note: "X" signifies concentration below "Alert Level".

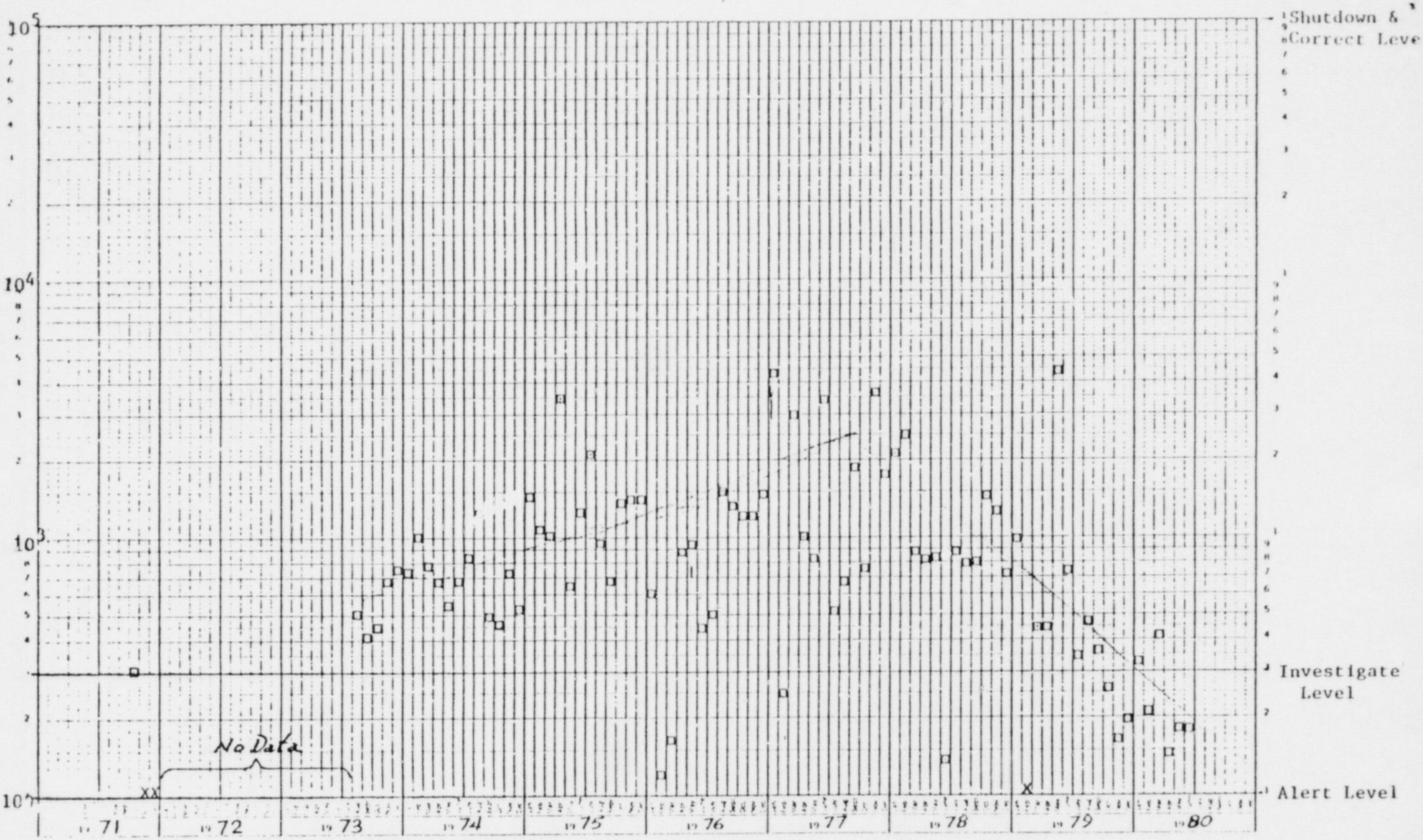


FIGURE 2S : Average Monthly Sulfate Concentration (PPM) in
Test Well No. 2 .

Note: "X" signifies concentration below "Alert Level".

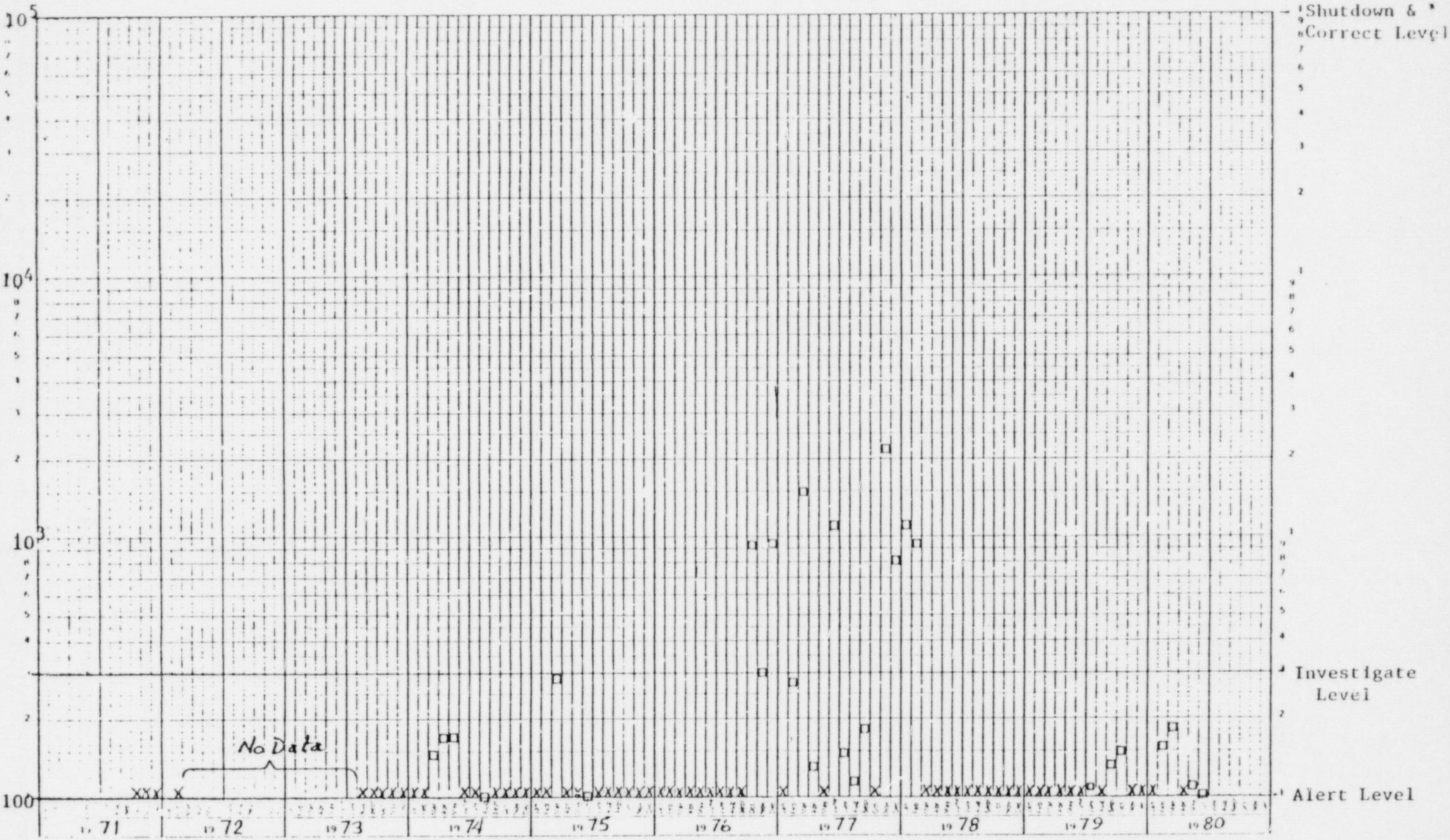


FIGURE 3S : Average Monthly Sulfate Concentration (PPM) in Test Well No. 3 .

Note: "X" signifies concentration below "Alert Level".

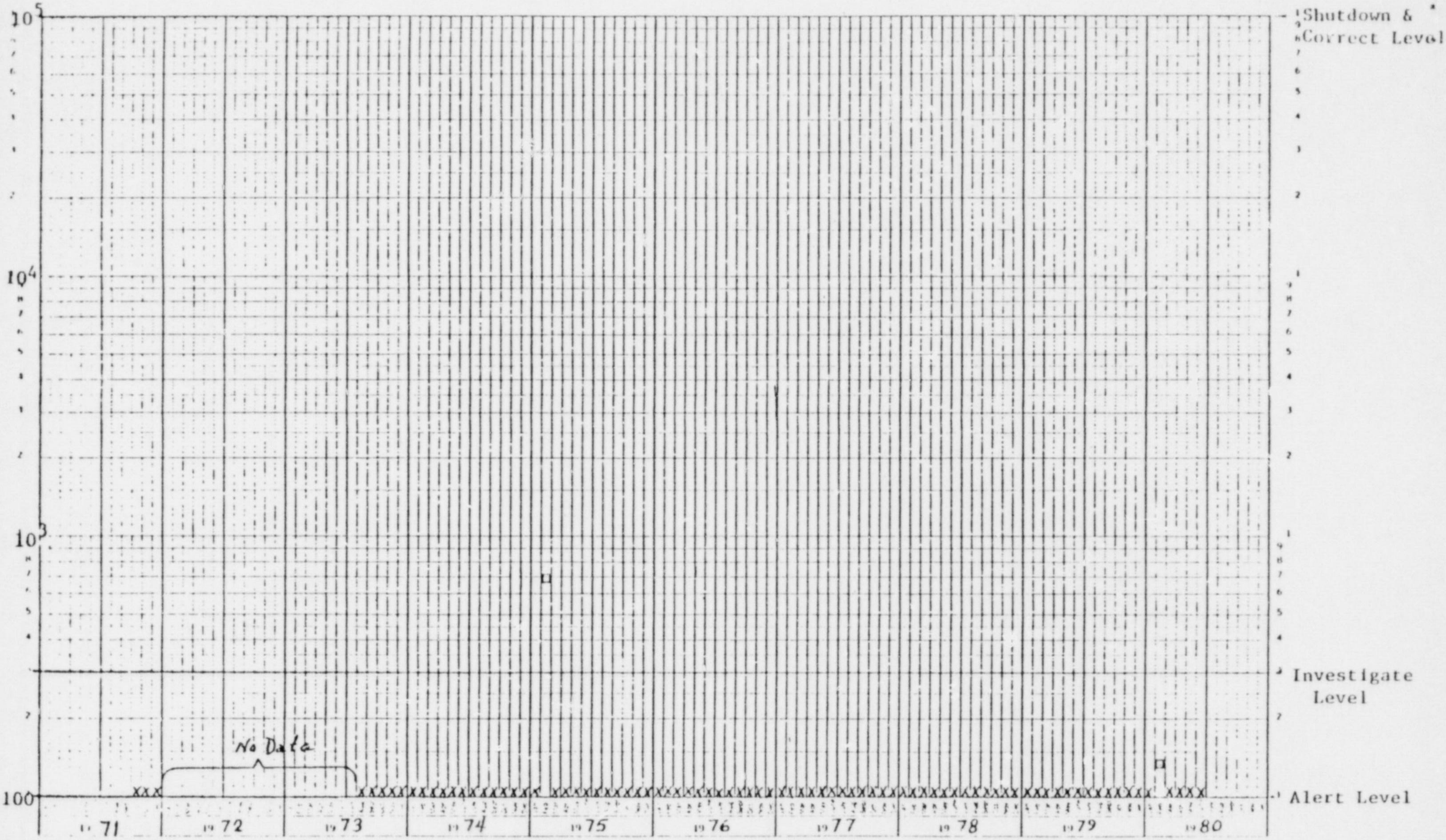


FIGURE 4S: Average Monthly Sulfate Concentration (PPM) in Test Well No. 4.

Note: "X" signifies concentration below "Alert Level".

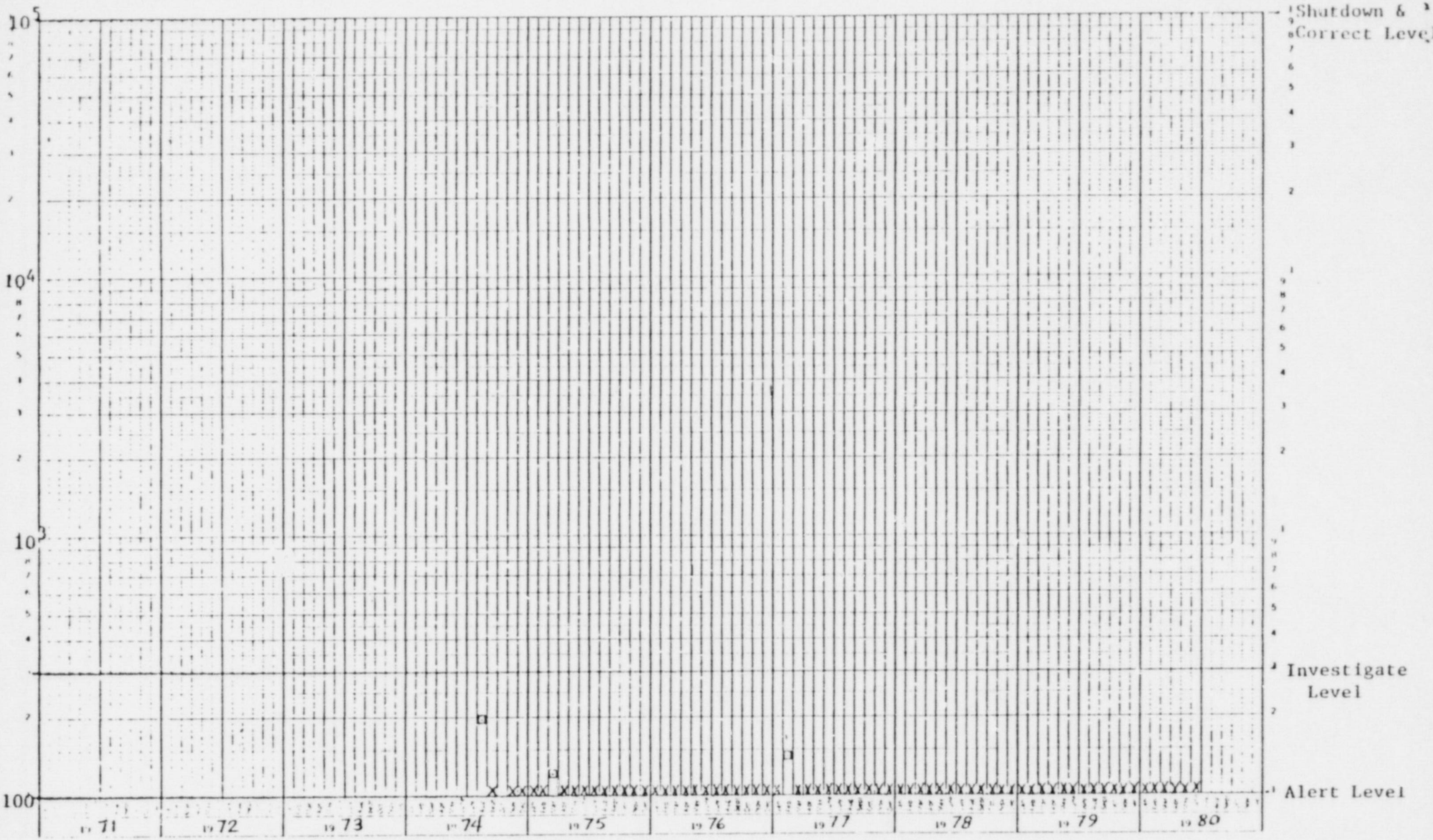


FIGURE 5S: Average Monthly Sulfate Concentration (PPM) in Test Well No. 5.

Note: "X" signifies concentration below "Alert Level".

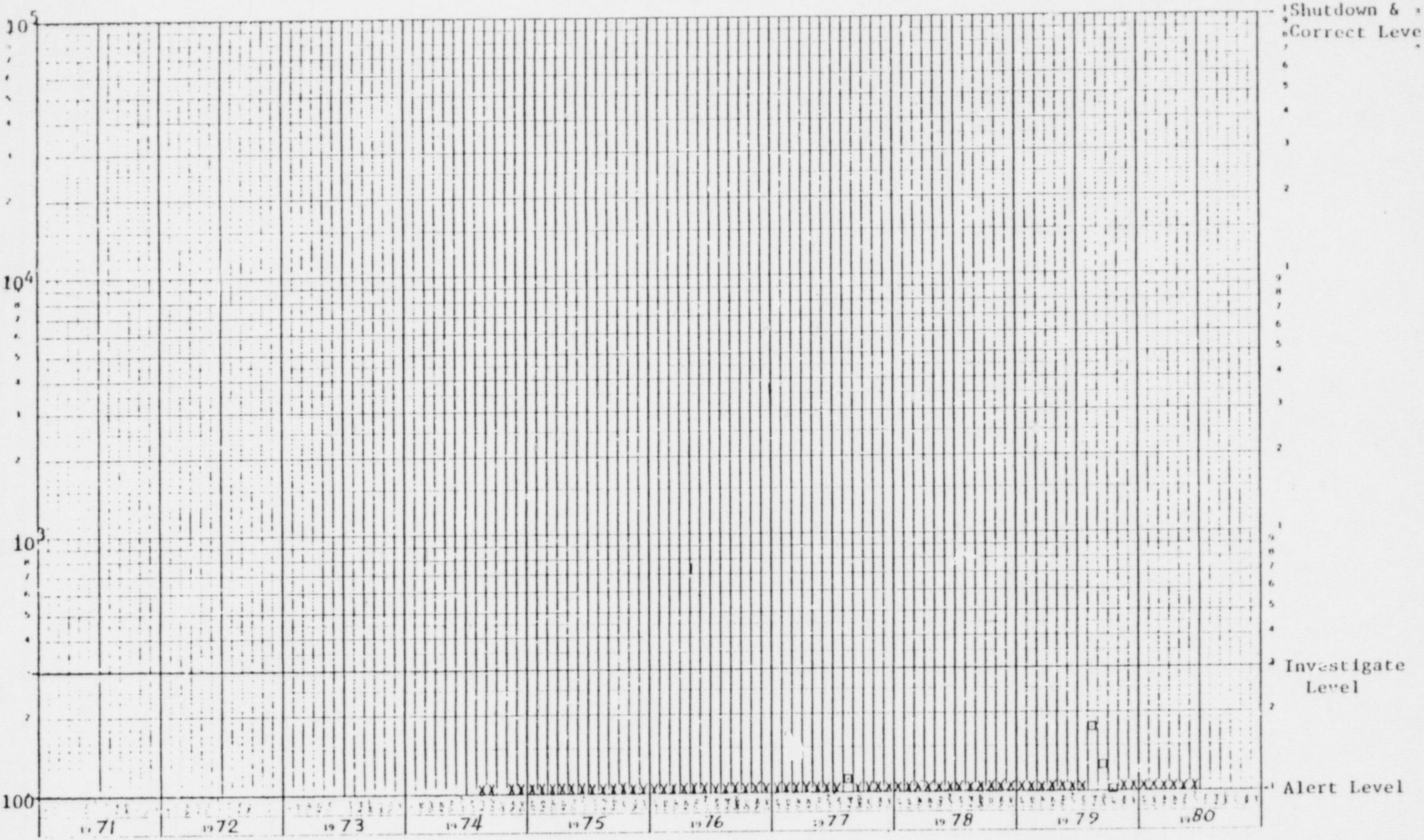


FIGURE 6S: Average Monthly Sulfate Concentration (PPM) in Test Well No. 6.

Note: "X" signifies concentration below "Alert Level".

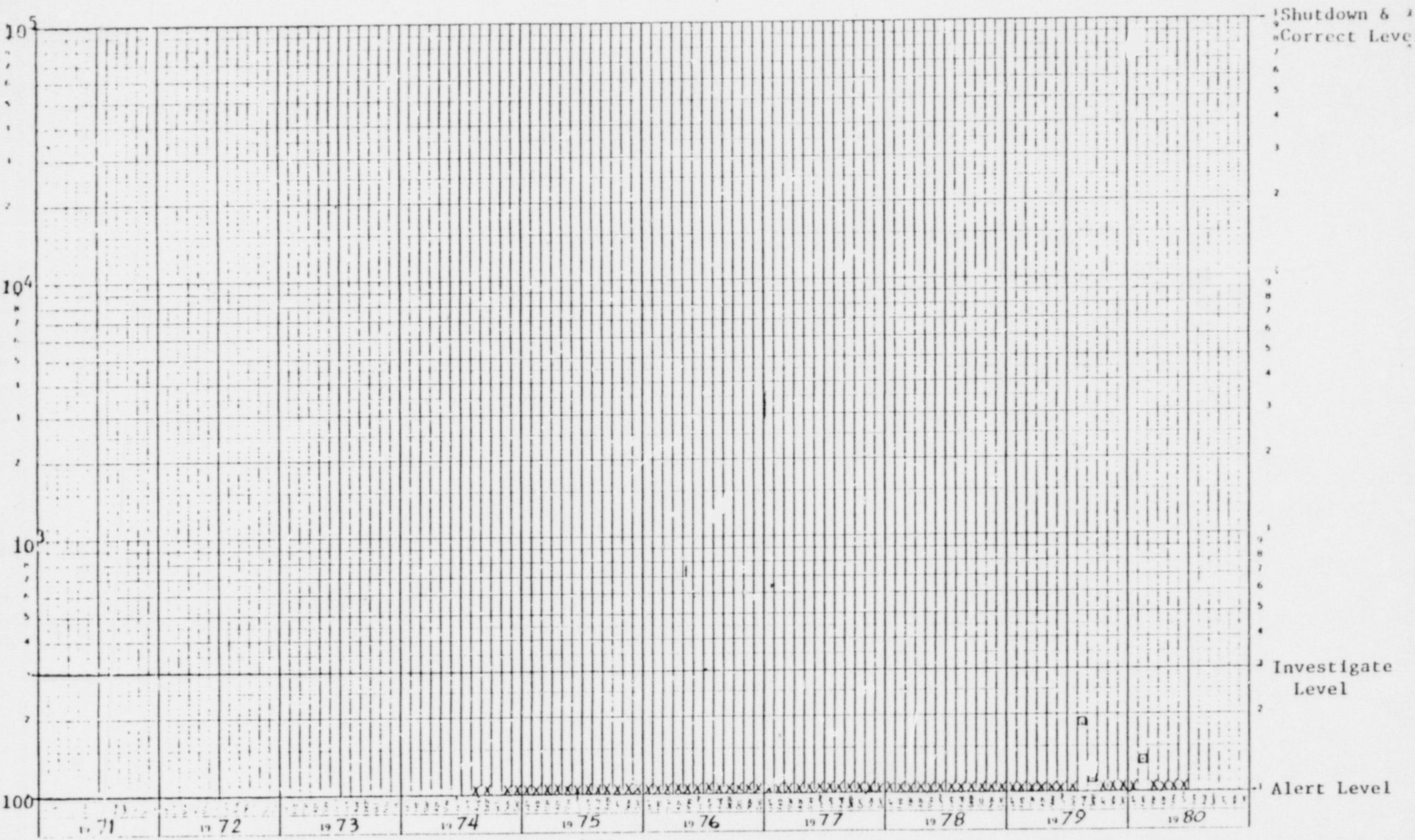


FIGURE 75': Average Monthly Sulfate Concentration (PPM) in Test Well No. 7.

Note: "X" signifies concentration below "Alert Level".

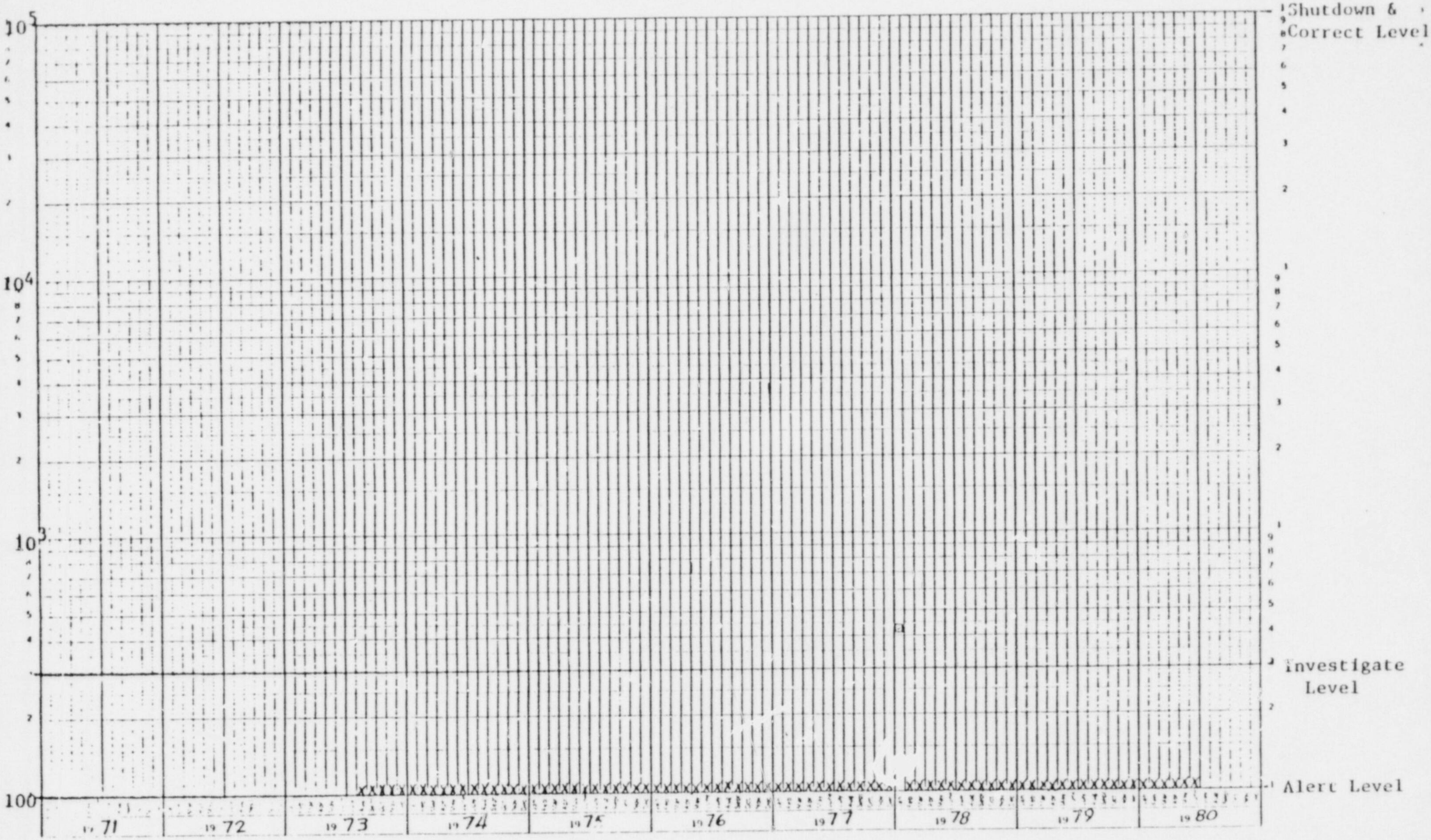


FIGURE 85: Average Monthly Sulfate Concentration (PPM) in Test Well No. 8.

Note: "X" signifies concentration below "Alert Level".

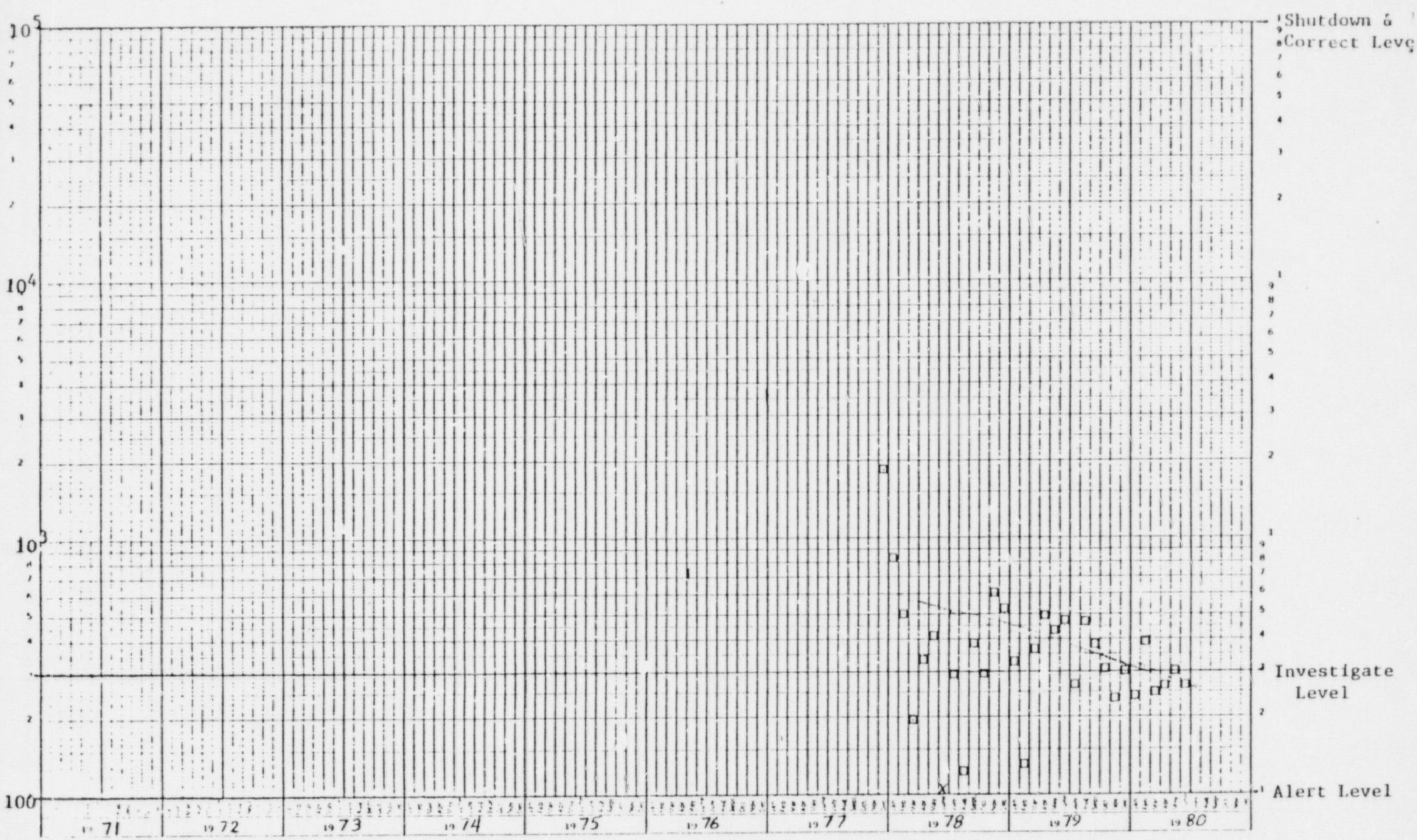


FIGURE 95: Average Monthly Sulfate Concentration (PPM) in Test Well No. 9.

Note: "X" signifies concentration below "Alert Level".

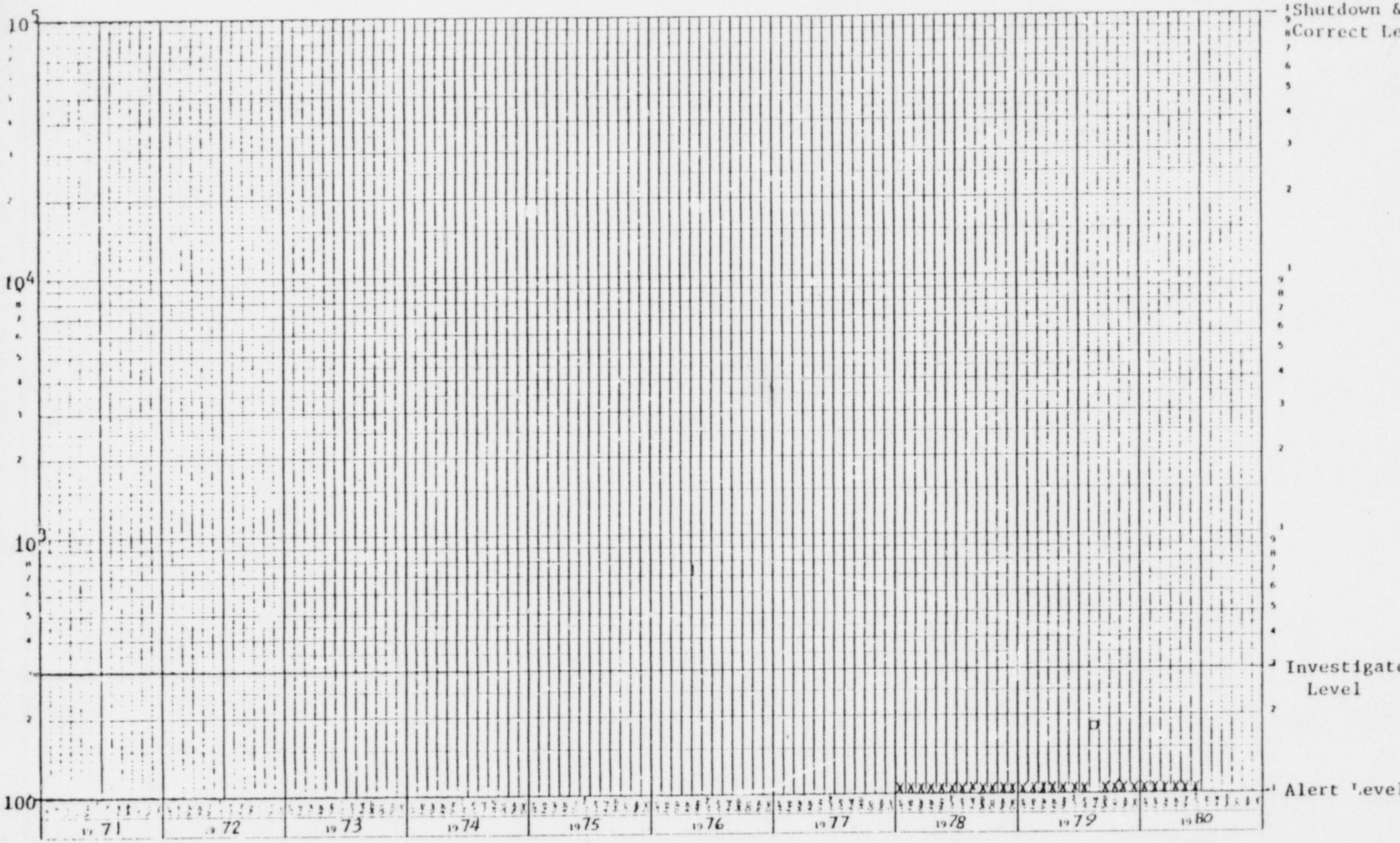


FIGURE 105: Average Monthly Sulfate Concentration (PPM) in Test Well No. 10.

Note: "X" signifies concentration below "Alert Level".

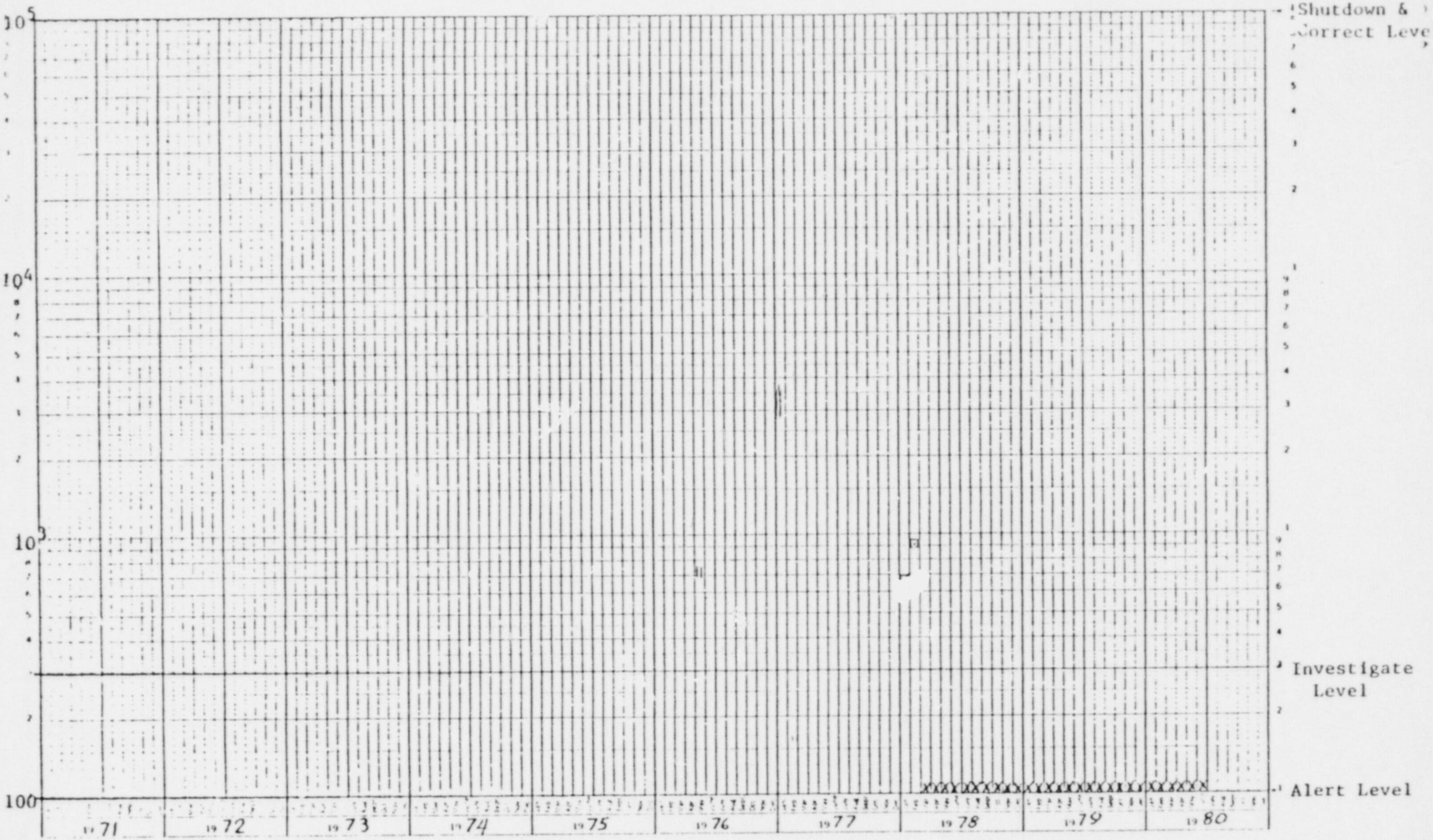


FIGURE 11S: Average Monthly Sulfate Concentration (PPM) in Test Well No. 11.

Note: "X" signifies concentration below "Alert Level".

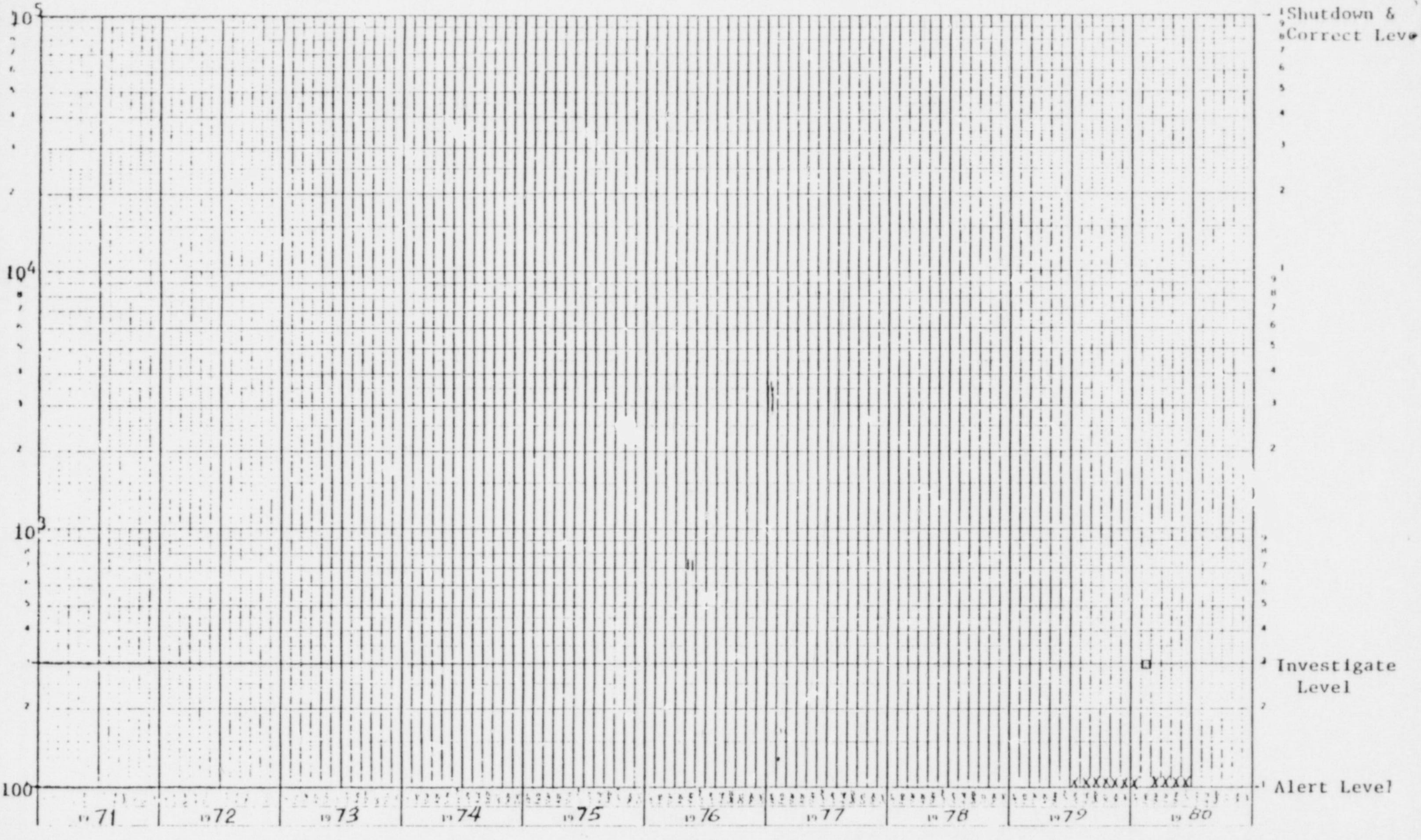


FIGURE 12S: Average Monthly Sulfate Concentration (PPM) in Test Well No. 12.

Note: "X" signifies concentration below "Alert Level".

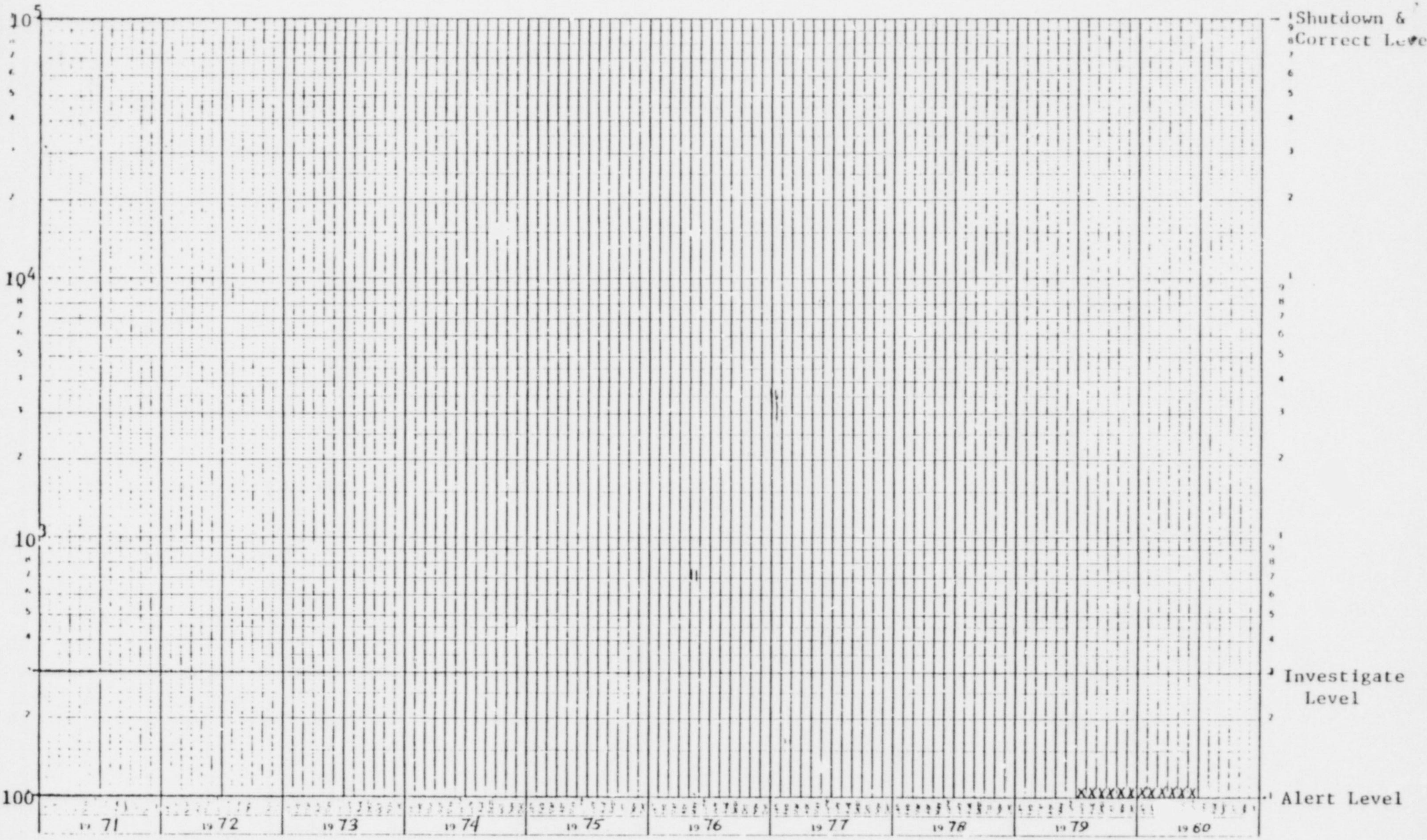


FIGURE 13S: Average Monthly Sulfate Concentration (PPM) in Test Well No. 13.

Note: "X" signifies concentration below "Alert Level".

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1. U.S. Atomic Energy Commission, Directorate of Licensing, Environmental Statement Related to Operation of Uranium Oxide Fuel Plant, Exxon Nuclear Company, Docket No. 70-1257, March 1974.

2. U.S. Atomic Energy Commission, Directorate of Licensing Fuels and Materials, Environmental Statement Related to Operation of Mixed Oxide Fabrication Plant, Exxon Nuclear Company, Docket No. 70-1257, June 1974.

3. Exxon Nuclear Company, Inc., Applicant's Supplemental Environmental Report, Uranium Oxide Fuel Plant Expansion (Phase II), JN-14 Addendum 3, July 1974.

4. Exxon Nuclear Company, Inc., Applicant's Environmental Report, Uranium Oxide Fuel Plant Expansion (Phase III), JN-14 Addendum 4, August, 1977.

5. State of Washington, Department of Ecology, Fluoride Standards, Chapter 18-48 WAC, February 4, 1971.

6. Letters:

   a. E. Y. Shum, U.S. Nuclear Regulatory Commission, to Mr. H. Paul Estey, Exxon Nuclear Company, "Questions Related to Environmental Information Submitted in Connection with Exxon's License Renewal Application (SNM-1227, Docket No. 70-1257)" Enclosure, October 8, 1980.

   b. H. Paul Estey, Exxon Nuclear Company, Inc., to E. Y. Shum, U.S. Nuclear Regulatory Commission, re: Time frame for reply to October 8 letter. October 21, 1980.

   c. H. Paul Estey, Exxon Nuclear Company, Inc., to E. Y. Shum, U.S. Nuclear Regulatory Commission January 9, 1981.

   d. H. Paul Estey, Exxon Nuclear Company, Inc., to E. Y. Shum, U.S. Nuclear Regulatory Commission, January 21, 1981.

   e. H. Paul Estey, Exxon Nuclear Company, Inc., to E. Y. Shum, U.S. Nuclear Regulatory Commission, January 30, 1981.

   f. H. Paul Estey, Exxon Nuclear Company, Inc., to E. Y. Shum, U.S. Nuclear Regulatory Commission, February 2, 1981.

7. National Academy of Sciences, Biologic Effects of Atmospheric Pollutants: Fluorides, 1971.

8. Moore, R.E., The AIRDOSII Computer Code for Estimating Radiation Dose to Man From Airborne Radionuclides in Areas Surrounding Nuclear Facilities, ORNL, 1977.

9. ACGIH 1972, "Threshold Limit Values for Substances in Workroom Air," adopted by ACGIH for 1972.

10. U.S. Nuclear Regulatory Commission, Order to Modify License in the Matter Exxon Nuclear Company, Docket No. 701257, Special Nuclear Material License No. SNM-1227, Amendment No. 22, January 28, 1980.