Environmental Report
Operating License Stage

Limerick Generating Station

Units 1 & 2

PHILADELPHIA ELECTRIC COMPANY

Vol. 2

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CHAPTER 2

THE SITE AND ENVIRONMENTAL INTERFACES

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(1) These tables have been omitted from this report because of the large number of pages.
They are presented in Reference 2.3.2-9.

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2.3 METEOROLOGY

2.3.1 REGIONAL CLIMATOLOGY

The regional climatology in the vicinity of the Limerick site has been analyzed using long-term data from the nearby National Weather Service (NWS) stations at the Philadelphia and Allentown, Pennsylvania airports. These data are available in several summarized forms (Refs 2.3.1-1 through 2.3.1-4) from the National Climatic Center. The Limerick site is located about midway between Philadelphia and Allentown with respect to both elevation above mean sea level and geographic location. Though Reading, Pennsylvania is the NWS station closest to the site, it was removed from service in 1969. Climatic summaries from Philadelphia and Allentown indicate that some extremes of record have occurred since 1969, which would not be included in any Reading summaries.

2.3.1.1 General Climate

2.3.1.1.1 Air Masses and Synoptic Features

The general climate of the Limerick site is best described as humid continental. The region is dominated by continental air masses in winter, and by alternating continental and maritime tropic air masses in the summer. The site is near the track of most eastwardly-moving low pressure systems which are brought from the interior of the U.S. by the prevailing westerlies. This generally produces a change in the prevailing weather system every three or four days. Coastal storms from the Atlantic Ocean can affect the site, causing heavy rains and severe flooding in the most extreme instances.

2.3.1.1.2 General Airflow

The prevailing winds in the region of the Limerick site are from the west. Table 2.3.1-1 compares the long-term annual wind distributions from Philadelphia and Allentown. While there are slight differences, the overall flow pattern is similar. Seasonal variations are evident, with the prevailing wind at both stations shifting to the WSW and SW in the summer months and to the WNW and NW during the winter. Annual average wind speeds are between 9 and 10 mph at both stations, but the frequency of measured calms (8%) is much larger at Allentown.

2.3.1.1.3 Temperature

Temperatures in the region of the Limerick site rarely exceed 100°F or drop below 0°F. Mean monthly temperatures from Philadelphia and Allentown are given in Table 2.3.1-2. The average temperatures at Allentown are approximately 3°F cooler than Philadelphia, but at times the differences may be as great as 10° or 15°F. This difference can be attributed almost entirely to local differences at the two NWS stations. Temperatures at Allentown are measured at an elevation 391 feet above mean sea level (MSL), while those at Philadelphia are obtained at 9 feet above MSL, in close proximity to the modifying influence of the Delaware Bay. Temperatures in the vicinity of the Limerick site normally fall somewhere between those at Allentown and Philadelphia.

2.3.1.1.4 Relative Humidity

Mean morning and afternoon values of relative humidity from Philadelphia and Allentown are summarized by month in Table 2.3.1-3. The 7:00 a.m. and 1:00 p.m. values from each station were selected as being representative of typical morning and afternoon conditions, respectively. As the table indicates, both stations recorded the highest morning values in September and lowest afternoon values in April. Though the differences are small the relative humidity values at Allentown are usually higher.

2.3.1.1.5 Precipitation

The Limerick site receives a moderate amount of precipitation, which is well distributed over the year. The precipitation distributions at Philadelphia and Allentown are summarized in Tables 2.3.1-4 and 2.3.1-5, respectively. Both stations indicate slightly more precipitation during the summer months. The only significant difference between the two locations is in the mean annual accumulation of snow and sleet, with Allentown receiving approximately 11 inches more per year. This is not unexpected considering the greater elevation and the inland location of Allentown.

2.3.1.1.6 Relationship Between Synoptic and Local Scale Meteorology

The Limerick site is situated in an inland region of rolling terrain where one would expect little local modification of synoptic scale weather systems. There are no large bodies of water near the site, and the Schuylkill River is much too small to significantly affect the local conditions. There is a slight channeling effect at low elevations in the river valley.

2.3.1.2 Seasonal and Annual Frequencies of Severe Weather Phenomenon

2.3.1.2.1 Hurricanes

Hurricanes are relatively rare at an inland site such as Limerick. These storms usually affect the inland regions of the mid-Atlantic states while moving in a path parallel to the coastline, or after coming ashore in the southern states. In the period from 1901 through 1963 only two hurricanes came ashore in the mid-Atlantic coastal region extending from Virginia to New Jersey. Another ten hurricanes affected this area either after coming ashore in the south or from a storm track parallel to the coast (Ref 2.3.1-5). During the 13-year period from 1955 through 1967, Pautz (Ref 2.3.1-6) reports 69 storms in the state of Pennsylvania where surface winds exceeded 74 mph. While 74 mph is the wind speed criteria used to designate a hurricane, this total reflects winds resulting from both tropical and extratropical storms.

The potentially heavy rains which can result from a hurricane or decaying tropical storm as it moves inland are a more serious consideration than strong winds in the Limerick area. Hurricane Agnes caused severe flooding in June of 1972, leaving 8 inches of rain over most of central and southern Pennsylvania. As much as 19 inches fell during the five-day period in western Schuylkill County approximately 40 miles northwest of the site.

2.3.1.2.2 Tornadoes

Summaries prepared by Pearson (Ref 2.3.1-7) indicate that there were 75 tornadoes within a 50-mile radius of the Limerick site in the period 1950 through 1976. The most severe occurred on March 22, 1955, 17 miles south of the site. This tornado had a path area of 1.2 square miles, with peak winds estimated to be in excess of 150 mph. The tornado reported closest to the site occurred on June 8, 1961, approximately six miles to the east. Peak winds from this storm were estimated to be in the excess of 110 mph.

Using the statistical methods of Thom, (Ref 2.3.1-8) the probability of a tornado striking any given point in the 1° latitude-longitude square surrounding the Limerick site is estimated to be once in every 9048 years. This is based upon a mean path area of .32 square miles and an annual frequency of 1.26 tornadoes per year in the 1° square.

2.3.1.2.3 Thunderstorms and Lightning

Thunderstorms are seasonal phenomena in the region of the Limerick site. Philadelphia and Allentown report 27 to 32 thunderstorm days per year respectively, with 90% of these occurring between the months of April and September. The monthly distribution of thunderstorm days is shown in Table 2.3.1-6.

Direct observation of lightning strikes is not a routine function at any of the standard observing stations. However, Uman (Ref 2.3.1-9) has developed a statistic which indicates that the number of lightning flashes (cloud to ground) per square mile per year is equal to between .05 and .8 times the number of thunderstorm days per year. A conservative estimate of the number of lightning strikes per year in the square mile containing the Limerick site is 26.

2.3.1.2.4 Hail

Hail storms are a relatively rare phenomenon in the Limerick site area. Pautz (Ref 2.3.1-6) reports that there were 57 occurrences of hail in the state of Pennsylvania in the 13-year period from 1955 through 1967. However, hail frequency is not uniform throughout the state. Baldwin (Ref 2.3.1-10) and Changnon (Ref 2.3.1-11) both report an annual frequency of one to two hail storms per year in the eastern region of the state. Changnon indicates that these storms are most likely to occur in the late spring.

Storm Data (Ref 2.3.1-12) from the period 1972 through 1976 indicate there were thirteen hailstorms in Montgomery and the surrounding counties. The most severe of these occurred in Schuylkill County on July 29, 1974, where egg-sized hail was reported.

2.3.1.2.5 Ice Storms and Freezing Rains

A survey by Bennett (Ref 2.3.1-13) indicates that ice or freezing rain may occur up to three to four times per year in the Limerick site region. However, glaze accumulations greater than .25 inches would be expected only once per year. In the five-year period from 1972 through 1976, eight cases of freezing rain were reported in the site area.

2.3.1.2.6 Peak Winds

The fastest mile winds which have been observed at Philadelphia and Allentown NWS Stations are shown in Table 2.3.1-7. At both stations the fastest mile occurred in June, though in separate years. While these summaries are a good indication of the peak winds which may be expected, they do not include the peak gusts, or the entire period of station record. The fastest mile of wind on record at Philadelphia was 88 mph from the north in July, 1931. A coastal storm produced gusts of 88 mph at Allentown on November 25, 1950.

2.3.1.3 Regional Air Quality

Air quality in the region surrounding the Limerick Generating Station has been monitored by the Commonwealth of Pennsylvania Department of Environmental Resources (DER) for several years (Ref 2.3.1-14). This monitoring effort began with an extensive network of Hi-Volume samplers to measure suspended particulate and sulfate ion concentrations, and was later augmented with the Commonwealth of Pennsylvania Air Monitoring System (COPAMS). The

COPAMS stations are equipped with more sophisticated sensors which measure sulfur dioxide, nitrogen dioxide, ozone, carbon monoxide, and non-methane hydrocarbons.

The DER monitoring locations which have been selected to describe the air quality in the Limerick site region are shown in Figure 2.3.1-1. Due to their close proximity to the plant site, the Pottstown and Phoenixville stations were chosen for the particulate and sulfate ion analysis. Fluoride and lead concentrations were available only from the Coatesville and Willow Grove stations respectively. All other pollutants were evaluated on a regional basis using the COPAMS data. Data from the COPAMS stations surrounding Philadelphia are summarized by the DER as the Southeast Pennsylvania Air Basin values. All reported averages are the maximum recorded among the three COPAMS stations. Data from the COPAMS sensor at Reading are referred to by the DER as the Reading Air Basin values.

Since the COPAMS stations are located in the more urban areas, the recorded pollution levels are somewhat higher than one would expect at Limerick. The Limerick site is located in a rural area where air quality should have no effect upon station operation.

The single most important source affecting the local air quality at the Limerick site is an industrial plant located in Pottstown. This facility is located approximately 1.5 miles upwind in the predominant WNW sector. Routine emissions from the plant include sulfur compounds, particulate matter, vinyl chloride, polyvinyl chloride, and organic solvents.

2.3.1.3.1 Summary of Regional Air Quality Data

Air quality data from the monitoring stations shown in Figure 2.3.1-1 has been summarized by the DER (Ref 2.3.1-14). Particulate data are summarized for the five-year period 1972 through 1976. All other pollutants are summarized for the calendar year 1976. The applicable state and federal standards against which these data have been checked for compliance are shown in Table 2.3.1-8.

The results of the total suspended particulate monitoring at Pottstown and Phoenixville for the period 1972 through 1976 are shown in Table 2.3.1-9. These data indicate that Pottstown did violate the annual particulate standard in 1976. Fluoride monitoring data from Coatesville and lead monitoring data from Willow Grove from 1976 are also included in Table 2.3.1-9. Both stations are well within the Pennsylvania standards.

Monitoring data from the COPAMS stations in the Southeast and Reading Air Basins from 1976 are summarized in Table 2.3.1-10. Sulfur dioxide and nitrogen dioxide standards were not exceeded in either air basin. However, the eight-hour carbon monoxide standard was exceeded one time in the Southeast Air Basin.

The standards for ozone and non-methane hydrocarbons were exceeded on numerous occasions in both air basins. These are pollutants normally attributed to automotive emissions, thus the effect should be somewhat less at a rural site such as Limerick. It has been noted by Guzewich (Ref 2.3.1-15) that the federal ozone standard can be exceeded by background concentrations in relatively secluded rural areas.

2.3.1.4 References

2.3.1-1 U.S. Department of Commerce, Local Climatological Data and Comparative Data-Philadelphia, Pennsylvania, published annually by the Environment Data Service, NOAA.

2.3.1-2 U.S. Department of Commerce, Local Climatological Data and Comparative Data-Allentown, Pennsylvania, published annually by the Environmental Data Service, NOAA.

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2.3.1-5 Cry, G.W., Tropical Cyclones of the North Atlantic Ocean, U.S. Weather Bureau Technical Paper No. 55, U.S. Department of Commerce (1965).

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2.3.1-8 Thom, H.C.S., "Tornado Probabilities," Monthly Weather Review, Vol. 91 (1963) pp. 730-736.

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2.3.1-11 Changnon, S.A., "The Scales of Hail," Journal of Applied Meteorology, Vol. 16, No. 6 (1977) pp. 626-648.

2.3.1-12 U.S. Department of Commerce, Storm Data-Pennsylvania, published monthly by the Environmental Data Service, NOAA.

2.3.1-13 Bennett, I., Glaze-Its Meteorology and Climatology, Geographical Distribution, and Economic Effects, Technical Report EP-105, U.S. Army Quartermaster Research and Engineering Command, Natick, Massachusetts (1959).

2.3.1-14 Commonwealth of Pennsylvania, Department of Environmental Resources, 1976 Pennsylvania Air Quality Surveillance System Air Quality Report (April 1977).

2.3.1-15 Guzewich, D.C., Pringle, W.J.B., and Kistner, S.L., Ozone Transport in the Rural Western United States, in the Proceedings of the Joint Conference on Applications of Air Pollution Meterology, Salt Lake City, Utah (1977) pp. 39-43.

2.3.2 LOCAL METEOROLOGY

The analysis of the local meteorology at the Limerick site has been based upon five years of site data collected at Weather Station No. 1 from January, 1972 through December, 1976. This is the primary onsite meteorological installation, and is located on high ground (base elevation 250 feet above mean sea level (MSL) approximately 3000 feet NNW of the reactor-turbine enclosure.

A second meterological tower, installed at Weather Station No. 2, is located in the Schuylkill River Valley (base elevation 121 feet MSL) approximately 3000 feet SSW of Tower 1, to allow comparison of the meteorological conditions in the shallow river valley with those on the adjacent hill. One year of data from April, 1972 through March, 1973 has been selected for this comparison, as it represents the best one-year cycle of concurrent data recovery between Weather Stations 1 and 2.

In addition, two years of data were obtained between January, 1975 and December, 1976 from a light wind sensor on the Satellite Meteorological Tower. This tower is located on the east side of the valley floor in a position to detect any downslope or drainage flow. The exact locations of all weather stations and instruments used in the analyses are shown in Figures 6.1-19 and 6.1-20. Data recovery from all instruments for each of the time periods summarized in the analyses is shown in Table 2.3.2-1. Selected tables of data summaries are presented both here and in Reference 2.3.2-9. All other tables listed are presented in Reference 2.3.2-9, as noted.

2.3.2.1 Normal and Extreme Values of the Meteorological Parameters

2.3.2.1.1 Wind Direction and Speed

The wind measurements at Limerick are unique in terms of both the locations and elevations of the sensors. The middle and upper level sensors on Tower 2 at Weather Station No. 2 are located at the same elevations above MSL as the lower and middle level sensors on Tower 1 at Weather Station No. 1, though their elevations above grade differ. As can be seen in Figure 6.1-20, the 159-foot level on Tower 2 and the 30-foot level on Tower 1 are both located 280 feet above MSL. For the purposes of this analysis, this MSL height has been designated as "level one." The 304-foot level on Tower 2 and the 175-foot level on Tower 1 are both located 425 feet above MSL. This elevation has been designated as "level two" in the subsequent analysis.

Distributions of wind speed and direction by atmospheric stability class are listed in the following tables of Ref 2.3.2-9. Wind directions have been grouped into 22-1/2° sectors. Atmospheric stability has been classified using both the Brookhaven turbulence classes of Singer and Smith (Ref 2.3.2-1) and the Pasquill stability classes as defined by the lapse rate criteria in Regulatory Guide 1.23 (Ref 2.3.2-2).

Table 2.3.2-2	Weather Station No. 1, Annual Wind Distribution by Brookhaven Turbulence Class, January 1972 - December 1976.
Table 2.3.2-3	Weather Station No. 1, Monthly Wind Distribution by Brookhaven Turbulence Class, January 1972 -December 1976.
Table 2.3.2-4	Weather Station No. 1, Annual Wind Distribution by NRC Lapse Rate Stability Class, 266-26 ft. Height Interval, January 1972 -December 1976.
Table 2.3.2-5	Weather Station No. 1, Monthly Wind Distribution by NRC Lapse Rate Stability Class, 266-26 ft. Height Interval, January 1972 - December 1976.
Table 2.3.2-6	Weather Station No. 1, Annual Wind Distribution by NRC Lapse Rate Stability Class, 171-26 ft. Height Interval, January 1972-December 1976.
Table 2.3.2-7	Weather Station No. 1, Monthly Wind Distribution by NRC Lapse Rate Stability Class, 171-26 ft. Height Interval, January 1972 - December 1976.
Table 2.3.2-8	Weather Station No. 1, Annual Wind Distribution by Brookhaven Turbulence Class, April 1972-March 1973.
Table 2.3.2-9	Weather Station No. 1, Monthly Wind Distribution by Brookhaven Turbulence Class, April 1972 - March 1973.
Table 2.3.2-10	Weather Station No. 1, Annual Wind Distribution by NRC Lapse Rate Stability Class, 266-26 ft. Height Interval, April 1972 - March 1973.
Table 2.3.2-11	Weather Station No. 1 Monthly Wind Distribution by NRC Lapse Rate Stability Class, 266-26 ft. Height Interval, April 1972 - March 1973.
Table 2.3.2-12	Weather Station No. 1, Annual Wind Distribution by NRC Lapse Rate Stability

Table 2.3.2-24 Satellite Tower, Annual Wind Distribution by NRC Lapse Rate Stability Class, 171-26 ft. Height Interval, January 1975 - December 1976.

Table 2.3.2-25 Satellite Tower, Monthly Wind Distribution by NRC Lapse Rate Stability Class, 171-26 ft. Height Interval, January 1975 - December 1976.

2.3.2.1.1.1 Five-Year Climatology of Wind Direction and Speed

Annual wind direction distributions from all levels at Tower 1 are summarized for the five-year period, 1/72 to 12/76 in Table 2.3.2-26 of Ref 2.3.2-9. The distribution is essentially the same at all levels, with the WNW and NW sectors being predominant. Wind directions are more or less evenly distributed among the remaining sectors. Seasonal variations at Tower 1 are small, but a slight increase in the frequency of south winds is evident at all levels during the summer months.

Monthly average wind speeds from Tower 1 are summarized in Table 2.3.2-27. The highest monthly average wind speeds occur in early spring, while lower speeds predominate during the summer months. The higher wind speeds measured at Tower 1 usually occur with wind directions from the predominant sectors. The maximum hourly average wind speed measured during the five-year period was 50 mph on December 2, 1974. This was the result of a low pressure system moving up the Atlantic coast.

2.3.2.1.1.2 The Effect of Terrain on Wind Direction and Wind Speed

In order to assess the influence of the Schuylkill River Valley on the low-level wind flow, a one-year comparison was made between wind measurements at Tower 1, located above the river valley, and Tower 2, located on the valley floor. Wind data from the Satellite Tower were also included in this comparison when appropriate. Though the satellite wind data are from a time period not concurrent with the other towers, these data do provide further insight into the valley circulation and are therefore included.

Annual wind direction distributions from Towers 1 and 2 for the period April, 1972 through March, 1973 are shown in Tables 2.3.2-28 and 2.3.2-29. The one-year wind direction distribution at Tower 1 is very similar to the five-year previously presented in Table 2.3.2-26 of Ref 2.3.2-9. The wind direction distribution at Tower 2 is somewhat more complex, with the distribution at the 30-foot level showing a preference for those directional sectors parallel to the river valley. Table 2.3.2-30 compares the wind direction distributions from Tower 1 and 2 along the equivalent MSL heights, "level one" and "level two." The directional distributions on each of these levels are nearly identical, indicating that winds at the middle and upper levels on Tower 2 are not affected by the underlying valley terrain.

A comparison of the wind direction distributions from the 30-foot sensors on Towers 1 and 2 for the one-year period is shown in Table 2.3.2-31. The two-year satellite tower wind distribution is also included for comparison. An increase in the wind directions centered about the NNW and SSE sectors, the orientation of the Schuylkill River Valley, is evident when the 30-foot directional distributions from Tower 2 and the Satellite Tower are compared with the low level directional distribution at Tower 1, situated above the river valley. This effect is most prevalent during low wind speed stable atmospheric conditions during the summer months.

A comparison of monthly average wind speeds from Tower 1, Tower 2, and the satellite tower is shown in Table 2.3.2-32. Average speeds at Tower 1 are very similar to the five-year wind speed record summarized in Table 2.3.2-27. Higher average winds occur in the spring, and lower wind speeds predominate in the summer months. A comparison of monthly average wind speeds along "level one" and "level two" shows that small differences exist between towers along each level, but they are usually less than 1 mph.

It should be noted that there is a preference for lower wind speeds at the low-level sensors located in the river valley. Both Tower 2 at the 30-foot level and the Satellite Tower wind speeds are significantly lower than the 30-foot wind speeds measured above the valley on Tower 1. This is reflected in the comparison of monthly average wind speeds shown in Table 2.3.2-32 as well as in the percentage of calm hours. Tower 2 at the 30-foot sensor, reported 21.5% calm, comparing well with the more sensitive satellite tower anemometer which reported 17.5% calm. In contrast, the 30-foot sensor on Tower 1 above the river valley reported only 8.1% calm. This comparison of low level wind speeds, along with the previously discussed comparison of low level wind directions, clearly indicates that the wind measurements obtained on the Satellite Tower are similar to those obtained at the 30-foot level on Tower 2, and that the Satellite Tower is representative of the low level wind flow in the Schuylkill River Valley.

2.3.2.1.1.3 Wind Direction Persistence

Wind direction persistance at the Limerick site has been analyzed using a technique which determines the number of consecutive hours the wind direction remains in the same 22-1/2° sector. This analysis is performed in a sliding technique, using each hour as the starting point in determining persistence. The results, which appear in the following tables of Ref 2.3.2-9, were derived by tabulating the number of times the wind direction at each level remains in the same sector for periods of 6, 12, 24, 36, and 48 hours.

Table 2.3.2-33	Annual Wind Direction Persistence, Weather Station No. 1, January 1972-December 1976.
Table 2.3.2-34	Monthly Wind Direction Persistence, Weather Station No. 1, January 1972-December 1976.
Table 2.3.2-35	Annual Wind Direction Persistence, Weather Station No. 1, April 1972 - March 1973.
Table 2.3.2-36	Monthly Wind Direction Persistence, Weather Station No. 1, April 1972 - March 1973.
Table 2.3.2-37	Annual Wind Direction Persistence, Weather Station No. 2, April 1972 - March 1973.
Table 2.3.2-38	Monthly Wind Direction Persistence, Weather Station No. 2, April 1972 - March 1973.

The five-year annual summary of Tower 1 wind direction persistence in Table 2.3.2-33 of Ref 2.3.2-9 indicates that the highest frequency of persistent winds occurs in the predominate WNW sector. Examination of the monthly distributions in Table 2.3.2-34 of Ref 2.3.2-9 indicates that the most persistent winds occurred during the months of June and August.

Wind directions persistence during the one-year period of concurrent data from Towers 1 and 2 is summarized in Tables 2.3.2-35 through 2.3.2-38 of Ref 2.3.2-9. Comparison of the annual distributions between the two towers shows that wind directions were more persistent at Tower 2 than at Tower 1. The 30-foot distribution at Tower 2 shows the most persistent winds in the NW and NNW sectors, which parallel the river valley.

The monthly summaries for this one-year period indicate that the most persistent winds occurred during January, not during the summer as one might expect. Examination of hourly meteorological data and synoptic charts indicates that these winds were caused by a strong gradient flow from a slow moving low pressure system, rather than any micrometeorological phenomenon.

2.3.2.1.1.4 Climatological Representativeness of the Limerick Wind Data

In order to assess the representativeness of the Limerick wind data, the five-year Tower 1 270-foot wind distribution has been compared with distributions from the Philadelphia and Allentown NWS stations, and from the Philadelphia Electric Company Peach Bottom Atomic Power Station Meteorological Tower. While the Philadelphia and Allentown data are not from the exact same time as the Limerick data, they are the most concurrent summaries available from the National Climatic Center.

The distance and directional orientations of these stations from the Limerick site are listed below.

Station	Distance and Orientation from Limerick
Philadelphia	31 miles SE
Allentown	31 miles N
Peach Bottom	48 miles SW

The annual wind direction distributions from Philadelphia (Ref 2.3.2-3), Allentown (Ref 2.3.2-4), and Peach Bottom are compared with Limerick in Figures 2.3.2-1 through 2.3.2-3. These comparisons indicate that both Philadelphia and Allentown have a larger frequency of winds from the south-westerly direction than Limerick. The predominant winds at Philadelphia and Allentown are from the SW and WSW respectively, as compared to a predominant WNW wind at Limerick. These distributions are similar in all nonpredominant sectors.

The comparison between the Limerick 270-foot and Peach Bottom 320-foot distributions shows a much closer agreement. This is to be expected since Peach Bottom is the only station of those compared with a sufficient sensor elevation to be free of local effects.

Due to the large discrepancy in sensor elevation and surface roughness between Limerick and the NWS stations, Peach Bottom is the only site with which meaningful wind speed comparisons can be made. A comparison of these two locations in Table 2.3.2-39 shows that the wind speed frequency distributions are almost identical. The Limerick 270-foot sensor has a mean wind speed of 10.4 mph, compared to 10.6 mph at the Peach Bottom 320-foot sensor.

An evaluation of the climatological representativeness of the time period in which the site data was obtained may be made from a comparison of the concurrent short-term data from the NWS stations with their long-term records. Ten-year wind directional distributions from Philadelphia (Ref 2.3.2-5) (1951-1960) and Allentown (Ref 2.3.2-6) (1964-1973) are compared with the short-term records from each station in Figures 2.3.2-4 and 2.3.2-5. The long and short-term records at Allentown are essentially identical. However, some differences are evident in the long and short-term Philadelphia comparison.

Several changes in both sensor elevation and location were made at Philadelphia in the period 1951 through 1960, which could account for some of the differences in the directional distributions.

2.3.2.1.2 Atmospheric Stability

2.3.2.1.2.1 Stability Class Breakdowns

Monthly and annual summaries of atmospheric stability have been incorporated into the wind roses previously presented in Tables 2.3.2-2 through 2.3.2-25. Annual breakdowns of atmospheric stability classes for the five-year record at Tower 1 and the one-year comparison of Towers 1 and 2 are summarized in the following tables.

Table 2.3.2-40	Annual Frequency Distribution of Brookhaven Turbulence Classes, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-41	Annual Frequency Distribution of Pasquill Stability Classes, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-42	Annual Frequency Distribution of Brookhaven Turbulence Classes, Weather Stations No. 1 and 2, April 1972 - March 1973.
Table 2.3.2-43	Annual Frequency Distribution of Pasquill Stability Classes, Weather Station No. 1 and 2, April 1972 - December 1973.

The Brookhaven turbulence classes have been determined using the method of Singer and Smith (Ref 2.3.2-1), which is based upon the short-term fluctuations of the Aerovane wind direction trace. The uppermost Aerovane on each tower was used to determine the turbulence class, i.e., the 270-foot sensor on Tower 1 and 304-foot sensor on Tower 2. The specific criteria used to define each turbulence class are given in Table 2.3.2-44. The Pasquill stability classes were determined using the temperature lapse rate criteria of Regulatory Guide 1.23 (Ref 2.3.2-2). Lapse rates were measured over the full height interval and between the middle and low levels of each tower.

In the five-year record at Tower 1, there are distinct differences between the two stability classification systems. The Brookhaven system classifies over 55% of the hours as unstable, compared to approximately 12% unstable as determined by delta temperature measurements over the full tower height. The lapse rate system predicts approximately 27% more neutral hours and 19% more stable hours than the Brookhaven system. When lapse rates over the lower portion of Tower 1 are used, the number of unstable hours according to the NRC system increases slightly, primarily at the expense of neutral hours. The frequency of stable hours as determined by lapse rate criteria remains about the same, regardless of which height interval on the tower is used.

When the stability class breakdowns from Towers 1 and 2 are compared for the April, 1972 through March, 1973 period, the same basic differences between the Brookhaven and NRC systems are evident. There are also significant differences between the two towers within each classification system.

When the Brookhaven stability breakdowns from the two towers are compared in Table 2.3.2-42, Tower 2 reports approximately 10% more unstable hours. This can be attributed primarily to the fact that the 304-foot Aerovane on Tower 2 is located 95 feet lower in reference to surrounding terrain than the 270-foot sensor on Tower 1, and is subject to increased turbulence due to surface friction.

A difference between Towers 1 and 2 is also seen in Table 2.3.2-43 when the Pasquill stability classes are contrasted. Regardless of which height interval is considered, Tower 2 categorizes over 65% of the hours as stable. This is an increase of approximately 15% as compared to Tower 1 for the same time period.

2.3.2.1.2.2 Temperature Inversion Persistence

Monthly and annual summaries of temperature inversion persistence at the Limerick site are presented in the following tables of Ref 2.3.2-9. A temperature lapse rate of greater than 0°C/100 m has been used to define inversion conditions. Strong inversions with a lapse rate greater than 1.5°C/100 m (Pasquill classes F and G) have also been tabulated.

Table 2.3.2-45	Annual Temperature Inversion Persistence, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-46	Monthly Temperature Inversion Persistence, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-47	Annual Temperature Inversion Persistence, Weather Station No. 1, April 1972 - March 1973.
Table 2.3.2-48	Monthly Temperature Inversion Persistence, Weather Station No. 1, April 1972 - March 1973.

Table 2.3.2-49 Annual Temperature Inversion Persistence, Weather Station No. 2, April 1972 - March 1973.

Table 2.3.2-50 Monthly Temperature Inversion Persistence, Weather Station No. 2, April 1972 - March 1973.

The most persistent inversion during the five years of measurements at Tower 1 occurred from 2100 August 24 through 0800 August 26, 1974. This inversion lasted for 36 consecutive hours, and was associated with a large high pressure system which descended from Canada. Winds at the site during this time were variable, coming from the SW through NNE direction. The second most persistent inversion lasted 29 hours, and was associated with a Canadian high pressure system which moved through the site area on July 16 and 17, 1974.

The more persistent inversions found during the five-year record usually occurred between the months of August and December.

A comparison of inversion persistence at Towers 1 and 2 for the period April, 1972 through March, 1973 shows that the inversions in the river valley at Tower 2 are more persistent. This comparison also shows that the more persistent inversions occur in the latter half of the year. In 1972 they were confined primarily to the period August through October.

2.3.2.1.2.3 Monthly Mixing Heights

No measurements of mixing height have been made at the Limerick site. The nearest NWS upper air station is at Kennedy Airport in New York City. The use of Kennedy data at Limerick would be unrealistic. Therefore, in the absence of measurements, the mean seasonal morning and afternoon mixing heights reported by Holzworth (Ref 2.3.2-7) are shown in Table 2.3.2-51. These data have been extracted from the plots in the Holzworth report, and are the best approximations available for mixing heights at Limerick.

2.3.2.1.3 Temperature

Ambient dry-bulb temperatures at the Limerick site have been summarized in the following tables. Table 2.3.2-52 and Tables 2.3.2-53 through 2.3.2-56 of Ref 2.3.2-9.

Table 2.3.2-52 Monthly and Annual Means and Extremes of Ambient Temperature, Weather Station No. 1, January 1972 - December 1976.

Table 2.3.2-53	Annual Frequency Distribution of Ambient Temperature, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-54	Monthly Frequency Distribution of Ambient Temperature, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-55	Annual Summary of Diurnal Temperature Variation, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-56	Monthly Summary of Diurnal Temperature Variation, Weather Station No. 1, January 1972 - December 1976.

The monthly means and extremes of temperature recorded at Weather Station No. 1 are shown in Table 2.3.2-52. The maximum hourly temperature measured at the site was 96.2°F on August 28, 1973. The minimum observed temperature was 0.7°F on January 16, 1972.

2.3.2.1.3.1 Climatological Representativeness of Limerick Temperature Data

Monthly mean temperatures from Limerick are compared with the concurrent and long-term records from the Philadelphia and Allentown NWS stations in Table 2.3.2-57 and 2.3.2-58. Both comparisons indicate that 1972 through 1976 was a normal period in terms of temperatures. Both NWS stations show little deviation from the long-term record. Temperatures at Allentown are usually slightly cooler than those at Philadelphia, while temperatures at Limerick usually fall in between the values from the two NWS stations.

2.3.2.1.4 Precipitation

Precipitation from the Limerick site has been summarized in the following, Table 2.3.2-59 and Tables 2.3.2-60 through 2.3.2-65 of Ref 2.3.2-9.

Table 2.3.2-59	Monthly Precipitation Distribution Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-60	Annual Precipitation Wind Roses by Precipitation Rate Class, Weather Station No. 1, January 1972 - December 1976.
Table 2.3.2-61	Monthly Precipitation Wind Roses by Precipitation Rate Class, Weather Station No. 1, January 1972 - December 1976.

As Table 2.3.2-59 indicates, the monthly variation of precipitation at the site is small. The annual mean precipitation measured during the five years of record was 59.57 inches. The maximum hourly precipitation (2.25 inches) was recorded during hurricane Agnes in June, 1972. The maximum monthly total (14.23 inches) was in November, 1972, as a result of several moderate rainfalls.

Wind roses by precipitation rate class indicate a predominantly east to northeasterly flow at the site during precipitation hours. This does not vary seasonally or by precipitation rate class.

Precipitation rate distributions and precipitation intensity versus duration summaries in Tables 2.3.2-62 through 2.3.2-65 of Ref 2.3.2-9 indicate that the majority of the precipitation at the site has an intensity of ≤.05 inches per hour. However, hourly totals exceeding one inch were recorded nine times during the five-year record, and continuous rainfalls of >.10 inches per hour have been observed for up to 12 hours in duration.

2.3.2.1.4.1 Climatological Representativeness of Limerick Precipitation Data

Monthly average precipitation values from Limerick are compared with the concurrent and long-term records from the Philadelphia and Allentown NWS stations in Tables 2.3.2-66 and 2.3.2-67. These comparisons indicate that even though the 1972 through 1976 period was characterized by abnormally high precipitation amounts, significantly higher precipitation totals were recorded at the site as compared to the NWS stations.

2.3.2.1.5 Humidity

Relative and absolute humidity, dewpoint temperature, and wet-bulb temperature from Weather Station No. 1 are summarized in the following tables of Ref 2.3.2-9.

Table 2.3.2-68	Annual Frequency Distribution of Relative Humidity
Table 2.3.2-69	Monthly Frequency Distribution of Relative Humidity
Table 2.3.2-70	Annual Summary of Diurnal Relative Humidity Variation
Table 2.3.2-71	Monthly Summary of Diurnal Relative Humidity Variation
Table 2.3.2-72	Annual Frequency Distribution of Absolute Humidity
Table 2.3.2-73	Monthly Frequency Distribution of Absolute Humidity
Table 2.3.2-74	Annual Summary of Diurnal Absolute Humidity Variation
Table 2.3.2-75	Monthly Summary of Diurnal Absolute Humidity Variation
Table 2.3.2-76	Annual Frequency Distribution of Dew Point Temperature
Table 2.3.2-77	Monthly Frequency Distribution of Dew Point Temperature
Table 2.3.2-78	Annual Summary of Diurnal Dew Point Variation
Table 2.3.2-79	Monthly Summary of Diurnal Dew Point Variation
Table 2.3.2-80	Annual Cumulative Frequency Distribution of Wet-Bulb Temperature
Table 2.3.2-81	Monthly Cumulative Frequency Distribution of Wet-Bulb Temperature
Table 2.3.2-88	Joint Frequency Distribution of Relative Humidity, Wind Direction, Wind Speed and Atmospheric Stability Class.

The annual frequency distribution of relative humidity is shown in Table 2.3.2-68 of Ref 2.3.2-9. This distribution is skewed toward the higher humidities, with the 90 through 100% grouping containing approximately 30% of the total hours. A seasonal trend is evident in the monthly frequency distributions of relative humidity shown in Table 2.3.2-69 of Ref 2.3.2-9, as conditions of high relative humidity (90 through 100%) are more common in the summer and fall months.

A joint frequency distribution of relative humidity, wind direction, wind speed, and atmospheric stability class is given in Table 2.3.2-88 of Reference 2.3.2-9. Wind speed and direction from the 270-ft. level of Weather Station No. 1 are combined with temperature lapse rate stability classes determined from the 266-26 ft. delta temperature. The distribution within each stability class is then broken down into relative humidity classes using the same categories as Table 2.3.2-68.

In addition, the 70-79% relative humidity class has been divided into 70 to 75% and 76 to 79% categories to accommodate the droplet evaporation schemes found in some of the more common cooling tower drift depositon models. The joint frequency distribution shows the expected trend of low relative humidity occurring during unstable hours, and high relative humidity occurring during stable conditions.

The annual frequency distribution of absolute humidity from Weather Station No. 1 is shown in Table 2.3.2-72 of Ref 2.3.2-9. Absolute humidity is expressed in grams of water vapor per cubic meter of air. The maximum frequency is in the 3.01 to 4.00 g/m^3 category, but the values are quite evenly distributed. There is also a large seasonal variation in absolute humidity as Table 2.3.2-73 of Ref 2.3.2-9 shows. This is what one would expect as the ability of dry air to hold water vapor is temperature-dependent.

The annual frequency distribution of dewpoint temperatures from the site is shown in Table 2.3.2-76 of Ref 2.3.2-9. The largest frequency of hours occurs in the 60.0 to 64.9°F category, but the distribution is quite even between 20 and 65°F. The seasonal trend in dewpoint temperatures is self-evident.

Cumulative frequency distributions of wet-bulb temperature from the site are given for the annual and monthly cases in Tables 2.3.2-80 and 2.3.2-81 of Ref 2.3.2-9. Due to the unusually long period of record at the site (five years), the cumulative frequency distributions of wet-bulb temperature have been computed using onsite data rather than the Philadelphia or Allentown NWS data.

2.3.2.1.5.1 Climatological Representativeness of Humidity Data

Because of its sensitivity to changes in temperatures and elevation, comparisions of relative humidity data from site to site are difficult. Some idea of the climatological representativeness of the Limerick data can be seen in Table 2.3.2-82 where mean morning (7:00 a.m.) and afternoon (1:00 p.m.) values of relative humidity from Philadelphia, Allentown, and Limerick are compared. As the table shows, in most months the mean values from the three sites are within a few percent. Limerick and Allentown are the most similar, with Philadelphia usually a few percent lower, especially in the morning.

Another indication of the climatological representativeness of the Limerick relative humidity data can be seen from the summaries of daily average relative humidity given in Ref 2.3.2-8.

In this analysis, two and one half years (1/72 through 6/74) of Limerick daily average relative humidity data were compared with the concurrent and long-term (34 years) records from Philadelphia. These daily average relative humidity data are summarized in the frequency distribution in Table 2.3.2-83. This

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table shows that Limerick has a higher frequency of days in the 90 through 100% range, and that the concurrent data are representative of long-term conditions at the site. A comparison of frequency distributions of hourly relative humidity values between Limerick and Philadelphia is shown in Table 2.3.2-84. This comparison also indicates that Limerick has a larger frequency of high relative humidity values.

2.3.2.1.6 Fog

No measurements of natural fog or visibility have been made at the Limerick site. However, an approximation of the fog and visibility characteristics of the site can be obtained from the Philadelphia and Allentown NWS data. Table 2.3.2-85 compares the mean number of days with heavy fog at these two stations. Heavy fog is defined as fog causing visibility to decrease to one-quarter mile or less.

This comparison shows surprisingly little difference between the two sites, with Philadelphia averaging 25 days of heavy fog per year, compared to 29 for Allentown. It is reasonable to assume that a similar frequency of heavy fog would be found at Limerick.

2.3.2.2 Topography

The topography of the region surrounding the site out to a distance of 50 miles is summarized in Table 2.3.2-86 which lists the offsite terrain elevation in feet above mean sea level versus distance from a point midway between the Limerick vents. The value listed is the maximum elevation on or outside the site boundary which occurs within each of the sixteen 22-1/2° sectors at the distance listed. These terrain elevations were obtained from U.S. Geological Survey maps.

Onsite terrain elevations are provided in Table 2.3.2-87 which lists the onsite terrain elevation in feet above mean sea level versus distance from a point midway between the Limerick vents. The value listed is the maximum elevation on the site which occurs within each of the sixteen 22-1/2° sectors at the distance listed. The elevations listed represent the most recent data available with respect to final plant grade.

Figures 2.1-2 and 2.1-4 depict onsite and neighboring topographical features. The most recent data available with respect to final plant grade are provided in these figures.

2.3.2.3 References

2.3.2-1 Singer I.A. and Smith M.E., "Relation of Gustiness to Other Meteorological Parameters," Journal of Meteorology, Vol 10 (1953) pp. 121-126.

2.3.2-2 USNRC, Regulatory Guide 1.23, Onsite Meteorological Programs (1972).

2.3.2-3 Star Program, Philadelphia, Pennsylvania, 1971-1975, Job No. 13739, NOAA Environmental Data Service, National Climatic Center, Ashville, N.C.

2.3.2-4 Star Program, Allentown, Pennsylvania, 1973, Job. No. 15347, NOAA Environmental Data Service, National Climatic Center, Ashville, N.C.

2.3.2-5 Decennial Census of United States Climate, Summary of Hourly Observations, Philadelphia, Pennsylvania, 1951-1960, NOAA Environmental Data Service, National Climatic Center, Ashville, N.C.

2.3.2-6 Star Program, Allentown, Pennsylvania, 1964-1973, Job No. 14737, NOAA Environmental Data Service, National Climatic Center, Ashville, N.C.

2.3.2-7 Holzworth G.C., Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, USEPA, Office of Air Programs (1972).

2.3.2-8 Philadelphia Electric Company, Final Safety Analysis Report, Limerick Generating Station, Section 2.3.1.2.3.1 Docket Nos. 50-352 and 50-353.

2.3.2-9 Philadelpha Electric Company, "Micrometeorological Data and Analyses for the Limerick Generating Station," Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, Section 2.3.2 (Data period: Jan 1972 - Dec 1976)

TABLE 2.3.1-1

COMPARISON OF ANNUAL

WIND DIRECTION FREQUENCY DISTRIBUTION (%)

DIRECTION	PHILADELPHIA (1967-1974)	ALLENTOWN (1964-1974)
NNE	2.9	2.0
NE	3.4	4.7
ENE	5.8	2.5
E	6.2	6.3
ESE	3.2	2.8
SE	3.2	2.0
SSE	3.6	1.6
S	7.0	4.9
SSW	5.0	3.6
SW	11.8	7.7
WSW	7.6	10.6
W	10.8	12.3
WNW	8.7	8.5
NW	7.1	7.3
NNW	5.2	5.1
N	8.1	5.1
Calm	.5	8.3
Average Wind Speed (mph)	9.9	9.1

Table 2.3.1-2

MEAN MONTHLY TEMPERATURE COMPARISON (°F)

	PHILADELPHIA (1874-1976)	ALLENTOWN (1944-1976)
JAN	33.0	27.8
FEB	33.8	29.7
MAR	41.7	38.4
APR	52.2	49.6
MAY	63.0	59.7
JUNE	71.9	69.2
JUL	76.6	73.9
AUG	74.7	71.8
SEP	68.4	64.5
OCT	57.5	53.8
NOV	46.2	42.3
DEC	36.1	31.2
ANNUAL	54.6	51.0

TEMPERATURE EXTREMES (°F)

Philadelphia	106	Aug. 1908[1]
	-11	Feb. 1934[1]
Allentown	105	Jul. 1966
	-12	Jan. 1961

(1) Extreme value recorded in the local area, but not at the official measurement site.

Table 2.3.1-3

COMPARISON OF MEAN MORNING
AND AFTERNOON RELATIVE HUMIDITY(%)

PERIOD OF RECORD: PHILADELPHIA 1960-1976
ALLENTOWN 1951-1976

	MORNING (7 am)		AFTERNOON (1 pm)	
	Philadelphia	Allentown	Philadelphia	Allentown
JAN	74	77	60	62
FEB	71	76	57	59
MAR	71	76	53	55
APR	69	76	48	51
MAY	75	78	53	53
JUN	78	80	55	54
JUL	79	82	54	52
AUG	81	87	54	55
SEP	83	89	56	57
OCT	81	87	53	55
NOV	76	83	55	60
DEC	74	80	60	64
ANNUAL	76	81	55	56

Table 2.3.1-4

DISTRIBUTION OF PRECIPITATION

PHILADELPHIA INTERNATIONAL AIRPORT

PERIOD OF RECORD: 1872-1976 TOTAL PRECIPITATION
1943-1976 SNOWFALL

	TOTAL PRECIPITATION (inches of water)		SNOW AND SLEET (inches)	
	Mean	Maximum	Mean	Maximum
JAN	3.17	6.06	5.4	19.7
FEB	3.10	5.43	6.1	18.4
MAR	3.51	6.27	3.8	13.4
APR	3.28	6.68	0.2	4.3
MAY	3.35	7.41	T	T
JUN	3.65	7.88	0.0	0.0
JUL	4.10	8.33	0.0	0.0
AUG	4.48	9.70	0.0	0.0
SEP	3.40	8.78	0.0	0.0
OCT	2.80	5.21	T	T
NOV	3.07	9.06	0.7	8.8
DEC	3.19	7.23	4.2	18.8
ANNUAL	41.10		20.4	

Greatest Rainfall - Monthly: 12.10, Aug., 1911[1]
24-Hours: 5.89, Aug., 1898[1]

Greatest Snowfall - Monthly: 31.5, Feb., 1899[1]
24-Hours: 21.0, Dec., 1909[1]

(T = Trace of precipitation)
[1] Extreme value recorded in the local area, but not at the official measurement site.

Table 2.3.1-5

DISTRIBUTION OF PRECIPITATION

ALLENTOWN AIRPORT

PERIOD OF RECORD: 1944-1976

	TOTAL PRECIPITATION (inches of water)		SNOW AND SLEET (inches)	
	Mean	Maximum	Mean	Maximum
JAN	3.19	6.16	7.7	24.1
FEB	2.94	5.44	8.6	22.4
MAR	3.66	7.21	6.1	30.5
APR	3.84	10.09	0.4	3.1
MAY	3.86	7.88	T	T
JUN	3.69	8.58	0.0	0.0
JUL	4.30	10.42	0.0	0.0
AUG	4.28	12.10	0.0	0.0
SEP	4.03	7.69	0.0	0.0
OCT	2.74	6.84	T	1.4
NOV	3.66	9.69	1.4	7.8
DEC	3.71	7.89	7.4	28.4
ANNUAL	43.90		31.6	

Greatest Rainfall - Monthly: 12.10, Aug., 1955
24-Hours: 4.79, Aug., 1955

Greatest Snowfall - Monthly: 43.2, Jan., 1925(1)
24-Hours: 17.5, Mar., 1958

(T = Trace of precipitation)
(1) Extreme value obtained in the local area but not at the official measurement site.

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Table 2.3.1-6

MEAN NUMBER OF THUNDERSTORMS

DAYS PER YEAR

PERIOD OF RECORD: PHILADELPHIA 1941-1976
ALLENTOWN 1944-1976

	PHILADELPHIA	ALLENTOWN
JAN	(1)	(1)
FEB	(1)	(1)
MAR	1	1
APR	2	2
MAY	4	5
JUN	5	6
JUL	6	7
AUG	5	6
SEP	2	3
OCT	1	1
NOV	1	1
DEC	(1)	(1)
ANNUAL	27	32

(1) Indicates less than 1

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Table 2.3.1-7

FASTEST MILE OF WIND (MPH)

PERIOD OF RECORD: PHILADELPHIA 1941-1976
ALLENTOWN 1949-1976

	PHILADELPHIA	ALLENTOWN
JAN	61	55
FEB	59	58
MAR	56	58
APR	59	60
MAY	56	58
JUN	73	81
JUL	47	55
AUG	67	58
SEP	49	46
OCT	66	49
NOV	60	55
DEC	47	52
ANNUAL	73	81

Table 2.3.1-8

APPLICABLE STATE AND FEDERAL

AMBIENT AIR QUALITY STANDARDS

Federal Standards	PRIMARY		SECONDARY	
	$\mu g/m^3$	ppm	$\mu g/m^3$	ppm
Sulfur Dioxide				
Annual average, arithmetic mean	80	.03		
Maximum 24-hour average	365	.14		
Maximum 3-hour average			1,300	.50
Total Suspended Particulate				
Annual geometric mean	75		60	
Maximum 24-hour average	260		150	
Nitrogen Dioxide				
Annual average, arithmetic mean	100	.05		
Carbon Monoxide				
Maximum 8-hour average	10,000	9.0		
Maximum 1-hour average	40,000	35.0		
Photochemical Oxidants				
Maximum 1-hour average	160	.08		
Hydrocarbons				
Maximum 3 hours (6-9 am)	160	.24		
Pennsylvania Standards				
Sulfate Ion				
Maximum 30-day average	10			
Maximum 24-hour average	30			
Fluoride				
Maximum 24-hour average	5.0			
Lead				
Maximum 30-day average	5.0			

Table 2.3.1-9

SUMMARY OF SOUTHEAST

PENNSYLVANIA AIR BASIN

AIR QUALITY DATA

1972-1976

SUSPENDED PARTICULATE MATTER

(Micrograms Per Cubic Meter)

		Total Particulate				Sulfate		
			Geometric					
Location	Year	No. Obs.	Mean	St.D.	Max. Obs.	No. Obs.	Avg.	Max. Obs.
Pottstown	1972	36	74	1.58	242	36	13.6	47.5
	1973	53	48	1.67	155	53	6.2	15.8
	1974	44	62	1.42	125	54	8.5	17.7
	1975	57	65	1.61	294	56	8.0	25.6
	1976	61	77	1.49	192	61	8.8	35.7
Phoenixville	1972	34	58	1.46	116	34	14.1	31.6
	1973	46	70	1.71	352	46	11.7	34.2
	1974	49	69	1.82	242	52	12.1	25.8
	1975	59	55	1.75	182	60	9.0	23.9
	1976	60	57	1.68	139	60	9.7	36.3

1976

FLUORIDE

(Micrograms Per Cubic Meter)

	Maximum		Annual
Location	Day	Month	Average
Coatesville	0.68	.36	.08

1976

LEAD

(Micrograms Per Cubic Meter)

	Maximum		Annual
Location	Day	Month	Average
Willow Grove	2.17	1.33	.89

Table 2.3.1-10

SUMMARY OF COPAMS [1]

AIR QUALITY DATA (page 1 of 2)

1976

SULFUR DIOXIDE
(Parts Per Million)

	Annual Avg	Max 24-hr Avg	No. of Times 24-hr Avg Standard Exceeded
Southeast PA Air Basin	0.026	0.128	0
Reading Air Basin	0.016	0.073	0

NITROGEN DIOXIDE
(Parts Per Million)

	Annual Avg
Southeast PA Air Basin	0.028
Reading Air Basin	0.029

OXIDANTS
(Measured as Ozone)
(Parts Per Million)

	Maximum 1-hr Ave	No. of Times Standard Exceeded	No. of Days on Which Standard was Exceeded
Southeast PA Air Basin	0.276	1049	83
Reading Air Basin	0.134	112	25

Table 2.3.1-10 (Cont') (page 2 of 2)

CARBON MONOXIDE
(Parts Per Million)

	Max 8-Hr Avg	Max 1-Hr Avg	No. of Times 8-Hr Avg Over Standard	No. of Times 1-Hr Avg Over Standard
Southeast PA Air Basin	9.36	21.7	1	0
Reading Air Basin	8.30	13.4	0	0

NON-METHANE HYDROCARBONS
(Parts Per Million)

	Maximum 6-9 AM Avg	No. of Times Standard Exceeded	No. of Days Standard Exceeded
Southeast PA Air Basin	6.29	481	271
Reading Air Basin	2.94	266	266

[1] Commonwealth of Pennsylvania Air Monitoring System

Table 2.3.2-1

LIMERICK GENERATING STATION

PERCENT DATA RECOVERY FOR METEOROLOGICAL SENSORS

WEATHER STATION NO. 1	PERCENT DATA RECOVERY		
Instrument	1/72 - 12/76	4/72 - 3/73	1/75 - 12/76
30 ft Wind Speed	95.3	97.7	
30 ft Wind Direction	93.7	97.7	
175 ft Wind Speed	93.2	96.6	
175 ft Wind Direction	92.6	93.8	
270 ft Wind Speed	98.1	98.9	
270 ft Wind Direction	98.1	99.2	
Satellite Wind Speed			70.2
Satellite Wind Direction			82.5
Bivane Azimuth	61.4		
Bivane Elevation	53.2		
266-26 ft Delta Temperature	90.5	99.4	
171-26 ft Delta Temperature	90.4	99.4	
26 ft Temperature	90.8	99.4	
5 ft Temperature	91.8		
Hygrothermograph Temperature	97.6		
Building Temperature	92.0		
Relative Humidity	94.6		
Precipitation	91.9		
Barograph	93.5		

WEATHER STATION NO. 2	PERCENT DATA RECOVERY
Instrument	4/72 - 3/73
30 ft Wind Speed	96.4
30 ft Wind Direction	97.5
159 ft Wind Speed	97.1
159 ft Wind Direction	93.0
304 ft Wind Speed	97.8
304 ft Wind Direction	99.0
300-26 ft Delta Temperature	93.2
171-26 ft Delta Temperature	44.5
26 ft Temperature	69.4

Tables 2.3.2-2 to 2.3.2-25

These tables are provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan, 1972 - Dec. 1976)

Table 2.3.2-26

LIMERICK GENERATING STATION

COMPARISON OF ANNUAL WIND DIRECTION FREQUENCY DISTRIBUTIONS (%)

WEATHER STATION NO. 1

PERIOD OF RECORD: JANUARY 1972 - DECEMBER 1976

DIRECTIONAL SECTOR	30 ft	175 ft	270 ft
NNE	3.5	3.5	3.4
NE	3.7	3.1	3.4
ENE	5.5	4.1	4.2
E	7.6	6.1	5.6
ESE	4.5	3.7	3.6
SE	4.3	3.6	3.6
SSE	4.8	4.6	4.3
S	6.9	7.4	7.2
SSW	6.0	7.0	7.0
SW	4.7	5.0	5.7
WSW	5.1	5.1	5.4
W	8.4	8.3	9.5
WNW	14.8	16.6	16.1
NW	10.7	12.0	11.2
NNW	5.2	5.1	5.2
N	4.4	4.6	4.7

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TABLE 2.3.2-27

LIMERICK GENERATING STATION

MONTHLY AVERAGE WIND SPEEDS (MPH)

WEATHER STATION NO. 1

PERIOD OF RECORD: JANUARY 1972 - DECEMBER 1976

	30 ft	175 ft	270 ft
JAN	6.6	9.4	11.1
FEB	8.0	10.7	12.3
MAR	8.5	11.4	12.9
APR	7.2	11.0	12.3
MAY	6.0	9.0	9.9
JUN	5.1	7.8	9.1
JUL	4.5	7.1	8.0
AUG	4.0	6.8	7.5
SEP	4.6	7.8	9.0
OCT	5.3	8.8	9.9
NOV	6.4	10.3	11.4
DEC	6.3	9.8	11.7
ANNUAL	6.0	9.1	10.4
ANNUAL % CALM	9.9	1.7	1.2

Table 2.3.2-28

LIMERICK GENERATING STATION

COMPARISON OF ANNUAL WIND DIRECTION FREQUENCY DISTRIBUTIONS (%)

WEATHER STATION NO. 1

PERIOD OF RECORD: APRIL 1972 - MARCH 1973

DIRECTIONAL SECTOR	30 ft	175 ft	270 ft
NNE	4.5	4.9	4.7
NE	3.8	3.3	3.9
ENE	7.0	5.0	5.4
E	8.7	7.4	6.9
ESE	5.1	4.1	4.4
SE	3.5	3.0	3.3
SSE	5.0	4.7	4.4
S	6.8	7.7	8.1
SSW	5.7	6.8	6.6
SW	3.6	4.0	4.7
WSW	4.6	4.7	4.9
W	7.6	6.8	8.1
WNW	13.7	14.3	13.1
NW	8.4	10.3	8.8
NNW	6.4	6.9	6.9
N	5.5	6.1	5.9

LGS EROL

Table 2.3.2-29

LIMERICK GENERATING STATION

COMPARISON OF ANNUAL WIND DIRECTION FREQUENCY DISTRIBUTIONS (%)

WEATHER STATION NO. 2

PERIOD OF RECORD: APRIL 1972 - MARCH 1973

DIRECTIONAL SECTOR	30 ft	159 ft	304 ft
NNE	4.3	4.4	4.5
NE	2.2	2.7	3.1
ENE	4.8	5.0	5.5
E	5.9	7.3	6.1
ESE	5.8	5.4	4.4
SE	4.6	4.8	3.5
SSE	10.3	6.7	5.0
S	7.9	6.7	7.5
SSW	4.3	5.6	6.1
SW	2.1	2.9	4.0
WSW	3.2	4.4	4.7
W	4.8	7.4	6.9
WNW	10.7	10.9	12.7
NW	11.5	11.0	11.6
NNW	11.2	8.8	8.3
N	6.3	6.2	6.1

Table 2.3.2-30

LIMERICK GENERATING STATION

COMPARISON OF ANNUAL WIND DIRECTION FREQUENCY DISTRIBUTIONS (%)

FROM EQUIVALENT MEAN SEA LEVEL HEIGHTS

PERIOD OF RECORD: APRIL 1972 - MARCH 1973

DIRECTIONAL SECTOR	LEVEL ONE (280 ft MSL) TOWER 1 30 ft	LEVEL ONE (280 ft MSL) TOWER 2 159 ft	LEVEL TWO (425 ft MSL) TOWER 1 175 ft	LEVEL TWO (425 ft MSL) TOWER 2 304 ft
NNE	4.5	4.4	4.9	4.5
NE	3.8	2.7	3.3	3.1
ENE	7.0	5.0	5.0	5.5
E	8.7	7.3	7.4	6.1
ESE	5.1	5.4	4.1	4.4
SE	3.5	4.8	3.0	3.5
SSE	5.0	6.7	4.7	5.0
S	6.8	6.7	7.7	7.5
SSW	5.7	5.6	6.8	6.1
SW	3.6	2.9	4.0	4.0
WSW	4.6	4.4	4.7	4.7
W	7.6	7.4	6.8	6.9
WNW	13.7	10.9	14.3	12.7
NW	8.4	11.0	10.3	11.6
NNW	6.4	8.8	6.9	8.3
N	5.5	6.2	6.1	6.1

Table 2.3.2-31

LIMERICK GENERATING STATION

COMPARISON OF ANNUAL WIND DIRECTION FREQUENCY DISTRIBUTIONS (%)

LOW-LEVEL SENSORS

PERIODS OF RECORD: TOWER 1 APRIL 1972 - MARCH 1973
TOWER 2 APRIL 1972 - MARCH 1973
SATELLITE JANUARY 1975 - DECEMBER 1976

DIRECTIONAL SECTOR	TOWER 1 30 ft	TOWER 2 30 ft	SATELLITE TOWER 32 ft	PERCENT DIFFERENCES Tower 2-Tower 1	Sat.-Tower 1
NNE	4.5	4.3	1.9	-0.2	-2.6
NE	3.8	2.2	1.7	-1.6	-2.1
ENE	7.0	4.8	2.8	-2.2	-4.2
E	8.7	5.9	8.8	-2.8	[+0.1]
ESE	5.1	5.8	6.7	[+0.7]	[+1.6]
SE	3.5	4.6	6.6	[+1.1]	[+3.1]
SSE	5.0	10.3	8.2	[+5.3]	[+3.2]
S	6.8	7.9	7.5	[+1.1]	[+0.7]
SSW	5.7	4.3	3.1	-1.4	-2.6
SW	3.6	2.1	2.1	-1.5	-1.5
WSW	4.6	3.2	3.1	-1.4	-1.5
W	7.6	4.8	5.3	-2.8	-2.3
WNW	13.7	10.7	11.6	-3.0	-2.1
NW	8.4	11.5	15.5	[+3.1]	[+7.1]
NNW	6.4	11.2	10.0	[+4.8]	[+3.6]
N	5.5	6.3	5.0	[+0.8]	-0.5

Bracketed sectors indicate increased flow in the river valley.

LGS EROL

Table 2.3.2-32

LIMERICK GENERATING STATION

COMPARISON OF MONTHLY AVERAGE WIND SPEEDS (MPH)

PERIODS OF RECORD: TOWER 1 APRIL 1972 - MARCH 1973
TOWER 2 APRIL 1972 - MARCH 1973
SATELLITE JANUARY 1975 - DECEMBER 1976

	TOWER 1			TOWER 2			SATELLITE TOWER
	30 ft	175 ft	270 ft	30 ft	159 ft	304 ft	32 ft
JAN	6.8	10.6	11.5	5.2	7.6	10.9	6.0
FEB	8.8	11.3	13.0	6.0	6.5	9.9	5.1
MAR	7.5	9.8	12.0	6.8	9.1	11.2	6.8
APR	6.7	10.2	11.1	5.3	7.7	10.0	6.8
MAY	5.7	9.0	9.5	4.1	6.0	8.7	4.0
JUN	5.8	9.0	10.0	4.0	6.1	9.0	3.2
JUL	4.4	6.5	7.6	3.0	4.3	6.8	2.6
AUG	4.8	6.8	8.0	3.2	4.6	7.2	3.1
SEP	4.6	7.8	8.7	3.4	5.5	7.8	3.5
OCT	5.7	9.0	10.4	4.3	6.8	9.5	3.3
NOV	6.6	9.9	11.5	5.2	7.2	10.3	3.4
DEC	6.0	9.7	11.2	4.3	7.7	9.3	4.7
ANNUAL	6.0	9.1	10.3	4.5	6.5	9.2	4.7
ANNUAL % CALM	8.1	2.0	.9	21.5	9.0	1.9	17.5

Tables 2.3.2-33 to 2.3.2-38

These tables are provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan, 1972 - Dec. 1976)

Table 2.3.2-39

COMPARISON OF WIND SPEED FREQUENCY DISTRIBUTIONS (%)

SITE	WIND SPEED GROUP (MPH) 0-3	4-7	8-12	13-18	19-23	24+	MEAN WIND SPEED (mph)
Limerick Tower 1 270-ft level 1/72 - 12/76	9.8	25.6	33.8	21.2	5.8	3.7	10.4
Peach Bottom Tower 2 320-ft level 1/72 - 12/76	11.0	22.1	33.0	24.3	6.5	3.1	10.6

LGS EROL

Table 2.3.2-40

LIMERICK GENERATING STATION

ANNUAL FREQUENCY DISTRIBUTION OF BROOKHAVEN TURBULENCE CLASSES

WEATHER STATION NO. 1

PERIOD OF RECORD: JANUARY 1972 - DECEMBER 1976

TURBULENCE CLASS	PERCENT FREQUENCY
I	0.0
II	55.4
III	2.6
IV	12.7
V	29.3

Table 2.3.2-41

LIMERICK GENERATING STATION

ANNUAL FREQUENCY DISTRIBUTION OF PASQUILL

STABILITY CLASSES BY NRC LAPSE RATE CRITERIA

WEATHER STATION NO. 1

PERIOD OF RECORD: JANUARY 1972 - DECEMBER 1976

PASQUILL STABILITY CLASS	PERCENT FREQUENCY 266-26 ft interval	PERCENT FREQUENCY 171-26 ft interval
A	2.2	8.4
B	3.4	4.4
C	6.2	6.0
D	39.6	31.2
E	32.5	30.2
F	12.1	13.4
G	4.0	6.4

Table 2.3.2-42

LIMERICK GENERATING STATION

ANNUAL FREQUENCY DISTRIBUTION OF BROOKHAVEN TURBULENCE CLASSES

PERIOD OF RECORD: APRIL 1972 - MARCH 1973

TURBULENCE CLASS	PERCENT FREQUENCY Tower 1	PERCENT FREQUENCY Tower 2
I	0.0	0.0
II	44.8	54.0
III	3.3	3.7
IV	14.6	13.6
V	37.3	28.6

Table 2.3.2-43

LIMERICK GENERATING STATION

ANNUAL FREQUENCY DISTRIBUTION OF PASQUILL

STABILITY CLASSES BY NRC LAPSE RATE CRITERIA

PERIOD OF RECORD: APRIL 1972 - MARCH 1973

PASQUILL STABILITY CLASS	PERCENT FREQUENCY			
	TOWER 1		TOWER 2	
	266-26 ft interval	171-26 ft interval	300-26 ft interval	155-26 ft interval
A	.6	4.2	.3	2.4
B	1.3	3.4	.2	1.1
C	4.6	6.3	.7	3.1
D	45.6	34.6	33.6	28.0
E	33.0	33.0	42.6	41.5
F	11.0	12.4	15.4	14.3
G	4.1	6.1	7.2	9.6

Table 2.3.2-44

BNL TURBULENCE CLASSIFICATION

Turbulence Class	Brookhaven National Laboratory Classification [1]	Description of Wind Trace
I - Extremely Unstable	A	Fluctuations of the wind direction during the course of 1 hour exceed 90 degrees.
II - Unstable	B_1	Fluctuations are confined to a lower limit of 15 degrees and an upper limit of 45 degrees.
III - Very Unstable	B_2	Trace is similar to I and II, but the upper and lower limits are 90 and 45 degrees.
IV - Neutral	C	The lower limit of the fluctuations is 15 degrees, and no upper limit is imposed. The case is distinguished by an unbroken solid core, through which a straight line can be drawn for the entire hour, without touching "open space" on the chart.
V - Stable	D	The trace approximates a line, and short-term fluctuations do not exceed 15 degrees. Direction may vary gradually over a wide angle during the hour.

(1) Reference 2.3.2-1

Tables 2.3.2-45 to 2.3.2-50

These tables are provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan, 1972 - Dec. 1976)

Table 2.3.2-51

LIMERICK GENERATING STATION

MEAN MORNING AND AFTERNOON MIXING HEIGHTS (Meters)

	am	pm
Spring	700	1800
Summer	550	1800
Fall	700	1400
Winter	800	1000
Annual	650	1500

Table 2.3.2-52

LIMERICK WEATHER STATION NO. 1 TEMPERATURE MEANS AND EXTREMES

PERIOD OF RECORD: JANUARY 1972 - DECEMBER 1976 (°F)

	MONTHLY MEAN	MONTHLY MAXIMUM	MONTHLY MINIMUM
JAN	31.6	67.9	0.7
FEB	30.2	67.2	3.4
MAR	40.8	75.5	11.6
APR	51.2	91.5	21.4
MAY	60.3	88.0	31.1
JUN	69.0	91.1	40.1
JUL	73.2	90.9	51.0
AUG	72.2	96.2	45.1
SEP	64.5	91.6	36.0
OCT	53.4	85.2	25.0
NOV	44.5	80.3	11.8
DEC	34.5	65.9	5.9
ANNUAL	51.8	96.2	0.7

Tables 2.3.2-53 to 2.3.2-56

These tables are provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan, 1972 - Dec. 1976)

TABLE 2.3.2-57

COMPARISON OF MONTHLY MEAN TEMPERATURES

LIMERICK VERSUS PHILADELPHIA(°F)

	LIMERICK[1]	PHILADELPHIA	
	1972-1976	1972-1976	1937-1976
JAN	31.6	34.3	33.0
FEB	30.2	34.9	33.8
MAR	40.8	43.7	41.7
APR	51.2	52.8	52.2
MAY	60.3	63.1	63.0
JUN	69.0	72.2	71.9
JUL	73.2	76.8	76.6
AUG	72.2	76.7	74.7
SEP	64.5	68.4	68.4
OCT	53.4	56.1	57.5
NOV	44.5	46.5	46.2
DEC	34.5	37.0	36.1
ANNUAL	51.8	55.2	54.6

[1] Tower No. 1 temperature at 26-feet.

TABLE 2.3.2-58

COMPARISON OF MONTHLY MEAN TEMPERATURES

LIMERICK VERSUS ALLENTOWN (°F)

	LIMERICK[1]	ALLENTOWN	
	1972-1976	1972-1976	1937-1976
JAN	31.6	29.6	28.7
FEB	30.2	31.0	29.7
MAR	40.8	40.2	38.4
APR	51.2	49.5	49.6
MAY	60.3	59.8	59.7
JUN	69.0	69.3	69.2
JUL	73.2	73.7	73.9
AUG	72.2	72.5	71.8
SEP	64.5	63.6	64.5
OCT	53.4	52.1	53.8
NOV	44.5	43.0	42.3
DEC	34.5	33.0	31.2
ANNUAL	51.8	51.4	51.0

(1) Tower No. 1 temperature at 26 feet.

TABLE 2.3.2-59

LIMERICK WEATHER STATION NO. 1

MONTHLY PRECIPITATION DISTRIBUTION

(inches of water)

PERIOD OF RECORD: JANUARY 1972 - DECEMBER 1976

	5-YEAR TOTAL	MEAN[1]	MAXIMUM MONTH	MAXIMUM HOUR
JAN	18.09	4.19	6.11	1.22
FEB	15.34	3.07	4.39	.45
MAR	23.45	4.89	6.39	.86
APR	25.75	5.54	8.74	.55
MAY	28.35	5.74	7.63	1.19
JUN	38.13	7.78	12.40	2.25
JUL	16.16	4.01	7.66	1.90
AUG	16.94	3.69	6.29	1.50
SEP	25.09	5.39	6.91	1.17
OCT	18.91	4.26	6.53	.55
NOV	18.93	4.13	14.23	.50
DEC	28.72	6.64	10.10	.65
ANNUAL	273.86	59.57		

[1] Mean values are obtained through a weighting procedure which discounts missing hours.

Tables 2.3.2-60 to 2.3.2-65

These tables are provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan, 1972 - Dec. 1976)

TABLE 2.3.2-66

COMPARISON OF MONTHLY MEAN PRECIPITATION
LIMERICK VERSUS PHILADELPHIA
(inches)

	LIMERICK	PHILADELPHIA	
	1972-1976	1972-1976	1937-1976
JAN	4.19	3.54	3.17
FEB	3.07	2.95	3.10
MAR	4.89	3.64	3.51
APR	5.54	3.71	3.28
MAY	5.74	4.16	3.35
JUN	7.78	5.82	3.65
JUL	4.01	3.49	4.10
AUG	3.69	2.80	4.48
SEP	5.39	3.77	3.40
OCT	4.26	3.08	2.80
NOV	4.13	2.79	3.07
DEC	6.64	4.02	3.19
ANNUAL	59.57	43.77	41.10

TABLE 2.3.2-67

COMPARISON OF MONTHLY MEAN PRECIPITATION
LIMERICK VERSUS ALLENTOWN
(inches)

	LIMERICK	ALLENTOWN	
	1972-1976	1972-1976	1937-1976
JAN	4.19	4.05	3.19
FEB	3.07	2.93	2.94
MAR	4.89	3.54	3.66
APR	5.54	3.67	3.84
MAY	5.74	4.59	3.86
JUN	7.78	5.38	3.69
JUL	4.01	3.85	4.30
AUG	3.69	4.67	4.28
SEP	5.39	5.26	4.03
OCT	4.26	3.56	2.74
NOV	4.13	3.45	3.66
DEC	6.64	4.59	3.71
ANNUAL	59.57	49.53	43.90

Tables 2.3.2-68 to 2.3.2-81

These tables are provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan, 1972 - Dec. 1976)

TABLE 2.3.2-82

COMPARISON OF MEAN MORNING AND AFTERNOON RELATIVE HUMIDITY(%)

PERIOD OF RECORD: LIMERICK 1972-1976
PHILADELPHIA 1960-1976
ALLENTOWN 1951-1976

	MORNING (7 am)			AFTERNOON (7 am)		
	Limerick	Phila	Allentown	Limerick	Phila	Allentown
JAN	79	74	77	63	60	62
FEB	76	71	76	56	57	59
MAR	74	71	76	54	53	55
APR	74	69	76	51	48	51
MAY	80	75	78	56	53	53
JUN	85	78	80	60	55	54
JUL	82	79	82	55	54	52
AUG	84	81	87	54	54	55
SEP	89	83	89	59	56	57
OCT	88	81	87	56	53	55
NOV	82	76	83	56	55	60
DEC	78	74	80	61	60	64
ANNUAL	81	76	81	57	55	56

TABLE 2.3.2-83

COMPARISON OF FREQUENCY DISTRIBUTIONS OF DAILY AVERAGE RELATIVE HUMIDITY VALUES

RELATIVE HUMIDITY (%)	FREQUENCY OF OCCURRENCE (%) LIMERICK (1/72-6/74)	PHILADELPHIA (1/72-6/74)	PHILADELPHIA (1-41-12/74)
90-100	12.3	7.9	6.3
80-89	17.7	17.3	15.7
70-79	29.4	22.9	24.7
60-69	20.1	23.7	26.2
50-59	14.7	17.5	18.5
<50	4.8	10.7	8.6

LGS EROL

TABLE 2.3.2-84

COMPARISON OF ANNUAL FREQUENCY DISTRIBUTIONS

OF HOURLY RELATIVE HUMIDITY VALUES

RELATIVE HUMIDITY	FREQUENCY OF OCCURRENCE (%)	
	LIMERICK WEATHER STATION NO. 1 (1972-1976)	PHILADELPHIA (1951-1960)
90-100	29.4	16.7
80-89	11.4	15.4
70-79	11.6	14.8
50-69	30.0	31.3
30-49	16.8	19.9
<30	0.7	1.9

TABLE 2.3.2-85

MEAN NUMBER OF DAYS WITH HEAVY FOG[1]

	PHILADELPHIA (1940-1976)	ALLENTOWN (1943-1976)
JAN	3	3
FEB	3	3
MAR	2	3
APR	1	2
MAY	1	2
JUN	1	1
JUL	1	1
AUG	1	2
SEP	2	3
OCT	4	3
NOV	3	3
DEC	3	3
ANNUAL	25	29

[1] Heavy fog is defined by visibility of 1/4 mile or less.

TABLE 2.3.2-86

OFFSITE ELEVATION VS. DISTANCE FROM LIMERICK VENTS

OFF SITE ELEVATION (IN FEET ABOVE MSL) VS DISTANCE (FT.) FROM LIMERICK VENTS (PA. COORD. N 331,844,E 2,603,786.5) FOR EACH OF SIXTEEN 22.5 DEGREE SECTORS. MAXIMUM ELEVATION ACROSS EACH SECTOR IS LISTED. THE LAST COLUMN LISTS THE HIGHEST ELEVATION FOR ALL DIRECTIONS.

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
2500					285	190	150		110	130					150		285	0.473	762.000
2600		270	270	290	290	200	140		110	130				125	150		290	0.492	792.480
2700		265	280	290	290	210	130		110	130				130	150		290	0.511	822.960
2800		260	275	290	290	200	150		110	130		160	155	130	150		290	0.530	853.440
2900	235	260	270	295	290	195	155		120	130	160	170	155	140	150	220	295	0.549	883.920
3000	230	255	270	295	290	190	170		130	130	165	175	160	140	150	250	295	0.568	914.400
3100	230	250	265	300	290	200	180		130	130	165	175	160	150	190	250	300	0.587	944.880
3200	235	250	260	300	240	200	190		130	130	170	180	160	150	200	250	300	0.606	975.360
3300	240	250	255	300	250	200	195	160	130	130	175	180	160	150	200	250	300	0.625	1005.840
3400	240	250	250	300	260	200	210	200	130	130	185	180	160	160	200	250	300	0.644	1036.320
3500	240	250	250	295	270	205	210	205	130	130	185	185	160	170	145	250	295	0.663	1066.800
3600	240	250	250	300	290	210	215	210	130	130	190	190	160	160	145	245	300	0.682	1097.280
3700	240	250	250	305	295	225	220	210	130	130	190	190	165	160	150	240	305	0.701	1127.760
3800	235	250	250	310	290	235	230	210	130	130	190	190	165	160	155	235	310	0.720	1158.240
3900	230	250	255	310	290	240	235	210	130	140	190	185	165	160	160	230	310	0.739	1188.720
4000	215	250	260	310	290	250	230	210	130	145	190	190	170	160	160	215	310	0.758	1219.200
4100	220	250	260	310	290	250	230	205	130	150	195	190	170	160	160	205	310	0.777	1249.680
4200	225	250	260	310	285	250	230	200	130	155	195	195	170	170	160	195	310	0.795	1280.160
4300	230	250	260	310	285	250	230	190	130	160	195	195	170	170	155	180	310	0.814	1310.640
4400	220	250	250	310	260	250	220	190	110	150	180	200	170	170	120	170	310	0.833	1341.120
4600	230	260	260	310	260	250	220	190	110	150	180	200	180	160	110	150	310	0.871	1402.080
4800	230	260	260	300	250	250	210	190	110	150	200	200	180	170	110	180	300	0.909	1463.040
5000	240	260	270	290	260	250	200	200	110	160	210	200	180	170	115	190	290	0.947	1524.000
5200	240	260	270	290	260	250	200	210	110	175	210	200	180	170	120	200	290	0.985	1584.960
5400	240	260	270	280	260	250	200	220	120	200	210	200	190	170	120	210	280	1.023	1645.920
5600	240	270	270	280	265	250	200	220	120	200	220	200	200	170	130	220	280	1.061	1706.880
5800	250	280	270	280	265	250	200	230	130	200	230	200	200	130	135	230	280	1.099	1767.840
6000	250	280	270	280	265	250	200	220	140	200	230	200	200	130	140	250	280	1.136	1828.800
6200	260	290	280	280	270	250	200	190	140	200	240	200	200	130	230	270	290	1.174	1889.760
6400	250	300	300	280	270	250	200	180	130	180	240	200	210	140	230	260	300	1.212	1950.720

LGS EROL

TABLE 2.3.2-86
(Cont'd)

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
6600	240	300	300	260	270	240	190	160	140	200	240	200	200	150	235	250	300	1.250	2011.680
6800	240	280	310	250	270	240	160	160	140	220	240	200	200	150	230	230	310	1.288	2072.640
7000	220	270	320	250	270	250	160	160	150	220	250	200	200	150	225	230	320	1.326	2133.600
7200	200	270	320	250	280	250	200	160	150	240	250	250	210	160	190	220	320	1.364	2194.560
7400	230	260	320	260	280	260	200	160	150	240	240	250	210	160	175	240	320	1.402	2255.520
7600	240	260	310	260	280	260	200	160	150	240	240	250	220	170	185	260	310	1.439	2316.480
7800	240	260	310	260	280	260	200	160	150	240	230	250	230	170	200	260	310	1.477	2377.440
8000	250	270	300	280	280	250	200	160	150	240	230	260	230	180	220	260	300	1.515	2438.400
8200	250	279	300	280	280	240	200	170	150	220	230	260	220	190	200	260	300	1.553	2499.360
8400	250	279	300	280	280	240	200	170	150	200	220	260	210	200	190	260	300	1.591	2560.320
8600	250	260	300	290	280	240	200	170	150	175	220	260	220	200	190	260	300	1.629	2621.280
8800	240	260	300	290	280	250	130	170	150	150	220	260	230	210	200	240	300	1.667	2682.240
9000	230	260	300	300	280	250	130	180	150	125	220	260	230	200	200	240	300	1.705	2743.200
9200	230	260	300	300	280	230	140	180	130	150	220	260	230	200	190	240	300	1.742	2804.160
9400	250	255	300	300	280	250	140	180	120	175	210	250	230	180	175	270	300	1.780	2865.120
9600	270	240	300	300	280	250	140	190	120	200	230	250	220	170	165	280	300	1.818	2926.080
9800	270	210	300	300	290	250	140	180	150	240	230	250	150	170	160	280	300	1.856	2987.040
10000	270	200	300	300	290	240	140	180	150	240	230	250	200	160	190	260	300	1.894	3048.000
10200	260	210	300	300	290	240	150	180	150	250	230	240	210	140	210	240	300	1.932	3108.960
10400	260	220	300	300	290	250	160	170	150	260	230	250	230	150	200	260	300	1.970	3169.920
10600	260	225	300	310	290	250	160	170	170	260	240	250	230	140	200	240	310	2.008	3230.880
10800	260	240	300	320	300	260	180	170	190	260	240	250	240	140	200	220	320	2.046	3291.840
11000	260	240	320	320	300	260	180	160	200	260	240	250	250	130	200	240	320	2.083	3352.800
11200	260	250	320	320	300	260	170	150	200	260	240	250	240	150	200	240	320	2.121	3413.760
11400	270	240	320	320	300	260	180	190	200	260	240	250	240	160	200	220	320	2.159	3474.719
11600	270	240	310	320	300	270	200	210	200	260	250	250	240	170	200	240	320	2.197	3535.680
11800	270	240	300	320	300	270	210	230	200	280	270	250	240	180	200	260	320	2.235	3596.640
12000	280	260	300	320	300	270	220	230	210	280	270	250	250	180	200	280	320	2.273	3657.600
12200	290	300	290	320	320	270	210	210	230	280	270	250	250	180	200	280	320	2.311	3718.560
12400	300	310	300	330	320	270	210	230	230	280	260	250	250	180	200	280	330	2.349	3779.520
12600	300	320	300	330	320	270	210	250	240	280	260	250	240	180	210	260	330	2.386	3840.479
12800	320	340	290	340	320	260	210	290	250	280	260	260	250	180	220	280	340	2.424	3901.439
13000	320	380	300	340	320	260	210	300	260	280	260	260	250	180	230	260	380	2.462	3962.400
13200	310	400	360	350	320	260	220	320	260	280	280	264	250	200	230	240	400	2.500	4023.360
13400	310	410	380	350	320	260	240	330	250	300	290	250	250	210	240	260	410	2.538	4084.320

LGS EROL

TABLE 2.3.2-86
(Cont'd)

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
13600	310	440	400	360	320	266	230	340	250	300	300	250	260	220	240	260	440	2.576	4145.277
13800	310	480	400	360	320	266	230	340	250	300	300	250	260	220	240	280	480	2.614	4206.238
14000	320	500	400	350	320	266	220	350	260	300	300	250	260	210	235	290	500	2.652	4267.199
14200	330	500	400	350	300	266	210	350	270	300	300	260	270	210	230	290	500	2.689	4328.156
14400	330	490	400	350	300	266	210	330	280	300	300	270	280	210	230	300	490	2.727	4389.117
14600	320	480	400	350	300	250	240	330	300	300	290	260	280	210	230	320	480	2.765	4450.078
14800	340	460	400	350	300	220	240	330	300	300	290	280	280	210	220	340	460	2.803	4511.039
15000	360	440	400	350	300	240	230	310	300	300	290	280	290	210	230	380	440	2.841	4571.996
15200	400	430	400	350	300	240	230	290	300	300	290	300	290	210	230	400	430	2.879	4632.957
15400	420	400	400	350	300	230	230	290	300	300	290	300	290	210	220	420	420	2.917	4693.918
15600	440	390	400	350	300	240	220	290	300	300	290	300	280	210	220	440	440	2.955	4754.879
15800	440	370	400	350	300	250	200	280	300	300	290	300	280	210	225	420	440	2.993	4815.836
16000	460	350	400	350	300	250	200	300	300	320	280	300	270	210	230	420	460	3.030	4876.797
16200	480	370	400	350	320	250	200	300	300	340	270	300	270	220	220	400	480	3.068	4937.758
16400	480	390	400	360	320	250	210	280	300	340	260	300	270	240	230	440	480	3.106	4998.719
16600	500	390	400	360	300	250	210	290	300	340	270	300	270	250	250	480	500	3.144	5059.676
16800	500	400	400	360	300	250	210	290	300	320	280	300	270	250	260	420	500	3.182	5120.637
17000	520	400	400	360	300	250	210	290	300	330	290	320	270	250	280	390	520	3.220	5181.598
17200	540	400	400	360	300	240	210	300	300	330	300	330	270	250	280	420	540	3.258	5242.559
17400	550	400	400	360	300	240	210	300	300	330	300	340	280	240	280	440	550	3.296	5303.520
17600	560	400	380	360	290	230	210	290	300	330	300	360	290	220	280	460	560	3.333	5364.477
17800	560	400	380	360	290	240	210	300	300	320	280	390	310	220	280	460	560	3.371	5425.438
18000	520	400	400	360	290	240	210	310	300	300	290	400	320	200	280	460	520	3.409	5486.398
18200	500	400	400	360	290	230	210	300	290	360	310	424	320	210	260	480	500	3.447	5547.359
18400	500	440	400	360	280	220	210	290	280	350	330	400	320	210	260	480	500	3.485	5608.316
18600	480	460	400	360	290	210	230	280	300	370	340	400	310	220	260	460	480	3.523	5669.277
18800	480	500	400	360	290	240	240	270	300	370	350	390	300	220	260	460	500	3.561	5730.238
19000	480	530	400	360	290	240	240	270	300	370	350	380	290	220	260	480	530	3.599	5791.199
19200	480	540	400	350	290	240	240	270	310	370	350	370	300	210	260	480	540	3.636	5852.156
19400	480	540	400	350	300	240	230	260	320	380	350	360	300	210	280	460	540	3.674	5913.117
19600	460	520	420	350	300	230	220	250	320	400	350	350	290	210	300	480	520	3.712	5974.078
19800	460	540	460	350	300	240	240	250	330	420	360	360	290	210	320	460	540	3.750	6035.039
20000	440	560	480	350	290	250	240	250	340	440	360	380	310	210	340	460	560	3.788	6095.996
20200	440	560	500	360	280	250	240	260	350	460	370	396	320	210	360	480	560	3.826	6156.957
20400	420	540	500	360	270	260	240	260	350	480	400	350	310	210	370	480	540	3.864	6217.918

LGS EROL

TABLE 2.3.2-86
(Cont'd)

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
20600	420	510	500	360	260	265	230	250	360	490	430	340	310	210	390	520	520	3.902	6278.879
20800	420	465	480	360	300	270	230	240	360	450	430	330	320	210	400	520	520	3.940	6339.836
21000	400	420	480	400	290	270	230	240	350	440	440	360	340	210	420	540	540	3.977	6400.797
21200	380	400	440	400	290	270	230	250	360	400	440	380	350	210	430	540	540	4.015	6461.758
21400	380	380	440	400	300	270	240	250	360	400	440	400	360	200	440	540	540	4.053	6522.719
21600	360	400	440	400	300	270	230	260	360	380	450	400	370	200	440	520	520	4.091	6583.676
21800	360	400	440	400	300	280	220	270	360	320	440	400	380	190	440	500	500	4.129	6644.637
22000	360	390	420	400	300	280	210	270	350	350	440	400	390	180	460	480	480	4.167	6705.598
22200	360	370	400	400	300	280	200	270	350	340	440	400	430	200	460	470	470	4.205	6766.559
22400	360	350	400	400	300	280	190	270	350	380	440	400	470	200	480	470	480	4.243	6827.516
22600	340	340	380	400	300	280	200	270	350	380	440	400	500	200	480	460	500	4.280	6888.477
22800	360	340	380	400	300	290	170	260	350	400	440	400	515	200	480	440	515	4.318	6949.438
23000	360	340	360	400	300	295	200	260	350	420	450	400	500	200	500	440	500	4.356	7010.398
23200	360	340	360	400	280	300	200	260	340	420	460	400	500	190	500	440	500	4.394	7071.359
23400	360	340	400	400	260	300	200	280	356	440	460	350	490	190	500	470	500	4.432	7132.316
23600	350	340	400	400	280	300	200	290	350	440	460	350	490	180	500	490	500	4.470	7193.277
23800	360	330	400	400	280	300	200	310	350	440	460	350	480	190	520	490	520	4.508	7254.238
24000	360	320	400	400	280	300	210	320	350	440	460	350	460	200	520	510	520	4.546	7315.199
24200	360	340	400	400	300	300	210	330	350	440	490	330	440	200	540	520	540	4.583	7376.156
24400	360	320	400	400	300	300	210	340	350	400	500	330	430	200	540	540	540	4.621	7437.117
24600	340	300	400	400	300	320	210	370	350	380	507	350	430	210	540	540	540	4.659	7498.078
24800	340	300	400	420	300	320	220	380	350	360	490	370	420	210	540	540	540	4.697	7559.039
25000	340	300	400	420	300	340	220	390	350	340	480	390	400	210	540	540	540	4.735	7619.996
25200	340	300	380	420	300	340	220	400	350	340	470	410	380	210	540	540	540	4.773	7680.957
25400	320	300	380	420	300	340	220	390	350	340	470	430	370	210	540	540	540	4.811	7741.918
25600	310	300	360	420	300	340	230	390	350	340	470	460	380	210	540	540	540	4.849	7802.879
25800	300	300	340	420	300	340	240	390	330	330	470	470	390	210	520	530	530	4.887	7863.836
26000	300	280	340	460	320	340	240	390	320	330	480	485	400	210	520	530	530	4.924	7924.797
26200	280	260	340	480	340	340	250	370	300	320	490	500	420	240	500	520	520	4.962	7985.758
26400	280	250	340	500	360	340	260	360	290	310	500	500	430	240	480	510	510	5.000	8046.719
26900	300	260	360	500	360	320	260	320	270	300	500	540	430	240	460	470	540	5.095	8199.117
27400	320	300	380	480	360	340	270	300	260	280	480	550	450	240	520	440	550	5.190	8351.516
27900	340	300	400	520	360	320	270	300	260	270	450	620	450	240	400	440	620	5.284	8503.918
28400	320	310	440	540	360	320	270	270	280	280	410	640	470	240	380	440	640	5.379	8656.316
28900	280	310	440	540	280	300	280	260	290	270	440	720	510	240	360	440	720	5.474	8808.719

LGS EROL

TABLE 2.3.2-86
(Cont'd)

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
29400	300	280	400	520	310	300	290	290	290	300	450	750	535	320	320	440	750	5.568	8961.117
29900	300	280	310	520	320	300	290	260	300	400	450	800	520	360	320	440	800	5.663	9113.516
30400	300	280	310	540	310	300	290	260	260	500	450	800	520	380	360	460	800	5.758	9265.918
30900	300	280	310	480	310	300	300	260	290	600	400	750	530	380	360	540	750	5.852	9418.316
31400	300	300	300	380	290	300	290	320	270	600	400	750	530	420	360	580	750	5.947	9570.719
31900	300	300	320	350	280	300	280	290	300	660	530	700	590	440	400	600	700	6.042	9723.117
32400	320	300	300	400	280	290	280	260	350	670	610	700	680	460	420	570	700	6.137	9875.516
32900	320	320	320	380	300	280	280	240	350	680	600	700	710	480	440	530	710	6.231	10027.918
33400	320	340	320	310	280	260	280	230	350	650	650	764	700	480	460	530	764	6.326	10180.316
33900	320	340	300	330	270	260	280	260	350	660	660	740	730	440	480	540	740	6.421	10332.719
34400	320	320	260	330	270	260	300	280	350	670	640	750	780	440	460	560	780	6.515	10485.117
34900	330	340	220	320	260	270	300	260	350	670	620	750	780	440	440	510	780	6.610	10637.516
35400	340	360	260	300	250	250	300	240	350	650	600	750	790	460	360	490	790	6.705	10789.918
35900	340	360	300	280	240	240	300	220	496	640	600	750	790	400	340	510	790	6.799	10942.316
36400	340	360	320	250	270	220	300	220	400	600	606	750	780	400	440	560	780	6.894	11094.719
36900	340	380	360	240	240	200	310	240	350	590	650	700	780	320	520	570	780	6.989	11247.117
37400	330	400	380	220	220	200	320	250	350	580	680	670	770	320	500	580	770	7.084	11399.516
37900	330	420	380	260	200	200	300	240	300	560	660	670	780	320	460	600	780	7.178	11551.918
38400	340	440	360	280	270	200	340	220	350	540	650	700	790	320	460	580	790	7.273	11704.316
38900	340	460	340	300	260	200	360	240	350	560	630	700	790	320	440	510	790	7.368	11856.719
39400	350	460	360	380	270	200	370	250	350	590	640	700	790	320	440	560	790	7.462	12009.117
39900	370	480	380	460	260	200	380	270	400	590	650	700	770	300	380	580	770	7.557	12161.516
40400	390	480	400	500	250	200	380	300	360	600	690	700	760	320	340	580	760	7.652	12313.918
40900	400	500	420	500	260	200	370	370	360	600	700	700	750	320	360	560	750	7.746	12466.316
41400	420	500	440	440	250	190	360	440	380	590	719	750	770	320	380	580	770	7.841	12618.719
41900	500	500	440	420	250	180	370	480	420	580	700	750	810	340	400	640	810	7.936	12771.117
42400	510	560	380	380	250	180	380	480	400	573	680	800	860	360	420	700	860	8.031	12923.516
42900	520	580	380	340	260	190	360	533	533	590	690	800	890	340	480	740	890	8.125	13075.918
43400	560	550	400	340	270	200	360	400	480	580	690	850	910	360	540	820	910	8.220	13228.316
43900	530	410	410	340	260	220	350	320	400	570	690	850	920	340	580	800	920	8.315	13380.719
44400	390	380	380	340	290	230	340	310	400	550	650	850	900	340	600	780	900	8.409	13533.117
44900	350	400	300	340	300	240	320	320	400	600	640	850	912	340	660	820	912	8.504	13685.516
45400	350	400	300	340	300	240	270	350	430	620	650	750	890	340	680	690	890	8.599	13837.918
45900	410	400	360	340	300	250	270	370	460	647	640	700	890	340	720	700	890	8.693	13990.316
46400	480	440	360	340	290	250	260	250	440	625	650	700	940	340	820	760	940	8.788	14142.719

LGS EROL

TABLE 2.3.2-86
(Cont'd)

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
46900	560	400	360	360	280	250	230	350	480	590	750	700	990	340	940	900	990	8.883	14295.117
47400	490	460	340	340	300	250	230	380	490	590	760	700	1002	340	1020	1040	1040	8.978	14447.516
47900	460	500	380	340	300	240	230	380	470	550	770	600	990	380	900	980	990	9.072	14599.918
48400	500	600	400	340	300	280	190	420	480	550	810	600	980	420	920	860	980	9.167	14752.316
48900	560	620	440	380	320	360	160	460	490	570	800	600	910	420	1080	840	1080	9.262	14904.715
49400	580	620	440	380	320	400	170	450	527	600	740	600	920	420	1020	760	1020	9.356	15057.117
49900	580	620	440	380	320	400	200	480	520	690	700	600	920	380	900	740	920	9.451	15209.516
50400	620	620	440	360	300	400	210	460	490	740	720	590	900	440	930	700	930	9.546	15361.918
50900	650	620	440	340	320	450	200	500	480	720	750	620	880	440	820	680	880	9.640	15514.316
51400	690	620	440	360	340	450	200	550	470	660	840	633	860	440	720	700	860	9.735	15666.715
51900	720	620	440	340	340	450	200	530	514	620	830	648	840	540	620	720	840	9.830	15819.117
52400	700	640	440	320	340	450	200	500	480	560	800	680	780	600	780	800	800	9.925	15971.516
52800	640	640	440	340	320	450	200	510	480	562	760	720	770	640	780	820	820	10.000	16093.438
79200	650	400	500	300	300	200	400	500	500	500	500	500	600	500	400	700	700	15.000	24140.156
105600	773	500	500	600	464	300	500	250	250	500	500	1000	500	500	1000	600	1000	20.001	32186.875
132000	500	1000	500	500	385	300	300	250	250	500	750	1000	547	500	500	500	1000	25.001	40233.594
158400	500	500	500	500	375	300	50	50	250	500	500	500	500	1000	500	600	1000	30.001	48280.313
184800	500	500	800	500	300	120	50	50	250	450	750	500	900	500	1500	1500	1500	35.001	56327.035
211200	1000	500	900	500	230	50	50	100	50	350	500	500	1000	1500	1000	1000	1500	40.001	64373.754
237600	1000	696	800	300	213	50	150	140	50	350	500	500	900	1300	1000	1500	1500	45.001	72420.438
264000	1591	1500	700	500	108	50	150	100	50	300	500	700	800	1500	1600	1500	1600	50.002	80467.188

TABLE 2.3.2-87

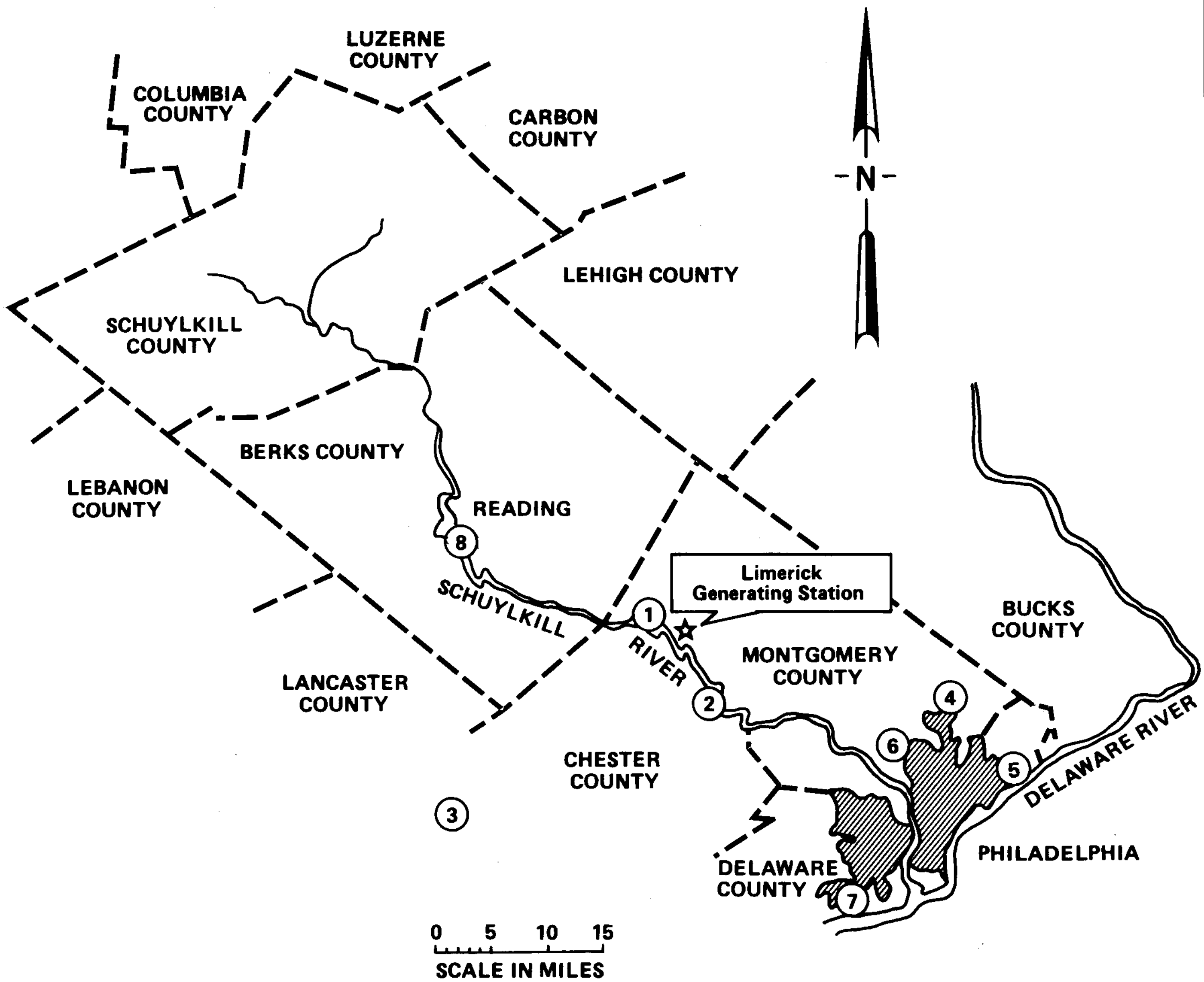
ONSITE ELEVATIONS VERSUS DISTANCE FROM VENT

DISTANCE FROM SOURCE IN FEET	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	ALL	DISTANCE FROM SOURCE IN MILES	DISTANCE FROM SOURCE IN METERS
0	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	0.0	0.0
200	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	0.038	60.960
400	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	217	0.076	121.920
600	266	266	217	217	217	210	192	186	202	202	210	215	216	216	229	266	266	0.114	182.880
800	266	266	266	224	215	152	150	130	160	166	160	160	216	228	240	266	266	0.152	243.840
1000	266	266	266	230	200	150	178	178	150	140	140	140	228	228	242	266	266	0.189	304.800
1200	258	266	266	247	166	192	206	200	160	137	137	140	160	228	243	266	266	0.227	365.760
1400	262	274	264	257	192	216	220	208	166	116	110	110	110	215	238	260	274	0.265	426.720
1600	274	278	268	258	220	226	224	200	162	112	110	110	110	170	245	262	278	0.303	487.680
1800	270	280	275	250	240	270	220	180	140	110	115	120	115	110	225	260	280	0.341	548.640
2000	280	280	280	250	250	270	210	170	120	110	120	130	130	110	230	250	280	0.379	609.600
2200	260	280	280	270	240	250	190	170	110	110	140	140	140	110	230	250	280	0.417	670.560
2400	260	260	280	280	260	230	180	160	110	120	140	150	150	120	230	260	280	0.455	731.520
2500	260	270	285	280	285	210	160	140	110	130	120	150	140	120	220	245	285	0.473	762.000
2600	250	270	280	280	285	200	150	140	110	130	130	150	150	125	210	245	285	0.492	792.480
2700	250	265	250	280	280	210	135	140	110		130	160	150	125	210	245	280	0.511	822.960
2800	240	240	250	250	280		120	140	110		150	160	150	130	200	250	280	0.530	853.440
2900	240	240		250	290		135	150	110		160	150	150	140	200	250	290	0.549	883.920
3000	225			290	290		150	170	110		160		150		190	250	290	0.568	914.400
3100	230			295	290		160	170	110		160				190	250	295	0.587	944.880
3200	220			295	290		170	170	110		150					250	295	0.606	975.360
3300	200			295	290		180	160	110							250	295	0.625	1005.840
3400				295	290		200	180	110							250	295	0.644	1036.320
3500				300	290		210	200	110							250	300	0.663	1066.800
3600				300	290		215	140	110							240	300	0.682	1097.280
3700				290	295		220	130	110								295	0.701	1127.760
3800				300	295		225	120	110								300	0.720	1158.240
3900							200	120	110								200	0.739	1188.720
4000							210	120	110								210	0.758	1219.200
4100								120	110								120	0.777	1249.680
4200									110								110	0.795	1280.160
4300									110								110	0.814	1310.640

NOTE: Onsite elevation (in feet above MSL) vs distance (ft.) from Limerick vents (Pa. coord. N 331,844, E 2,603,786.5) for each of sixteen 22.5 degree sectors. Maximum elevation across each sector is listed. The last column lists the highest elevation for all directions.

Table 2.3.2-88

This table is provided in a separate report, Micrometeorological Data and Analysis for the Limerick Generating Station Environmental Report - Operating License Stage, and Final Safety Analysis Report Submittals, (Section 2.3.2) (Data Period: Jan. 1972 - Dec. 1976)



1. POTTSTOWN - SUSPENDED PARTICULATES
2. PHOENIXVILLE - SUSPENDED PARTICULATES
3. COATESVILLE - FLUORIDE
4. WILLOW GROVE - LEAD
5. BRISTOL (COPAMS #12)
6. NORRISTOWN (COPAMS #13)
7. CHESTER (COPAMS #2)
8. READING (COPAMS #9)

COPAMS - MONITORING STATION MEASURE SULFURE DIOXIDE, OZONE, NITROGEN OXIDE, CARBON MONOXIDE AND NON-METHANE HYDROCARBONS.

LIMERICK GENERATING STATION
UNITS 1 AND 2
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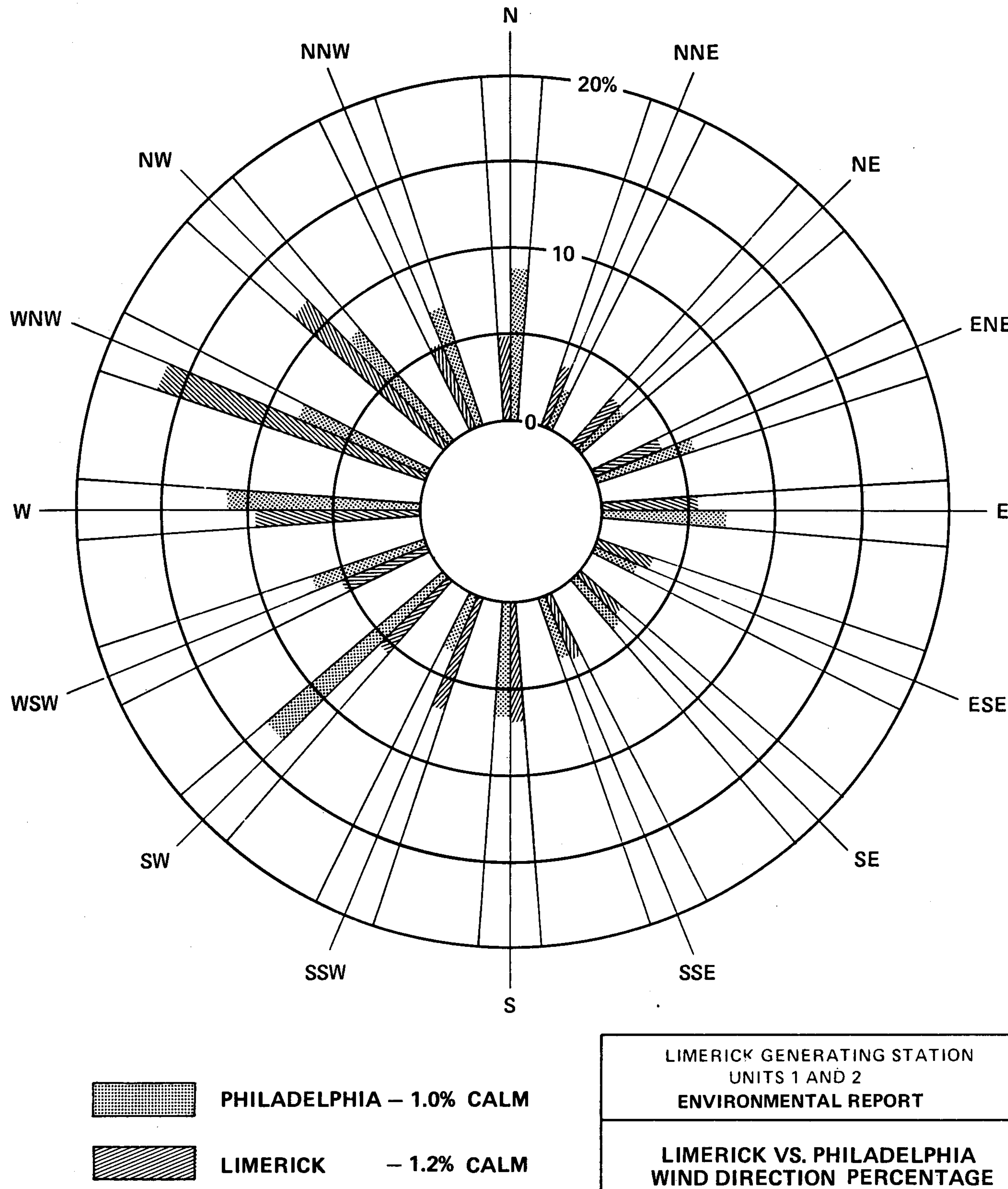
PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES
AIR QUALITY MONITORING LOCATIONS

FIGURE 2.3.1-1

LIMEREICK
1/72-12/76
HEIGHT 270 FT.

VS

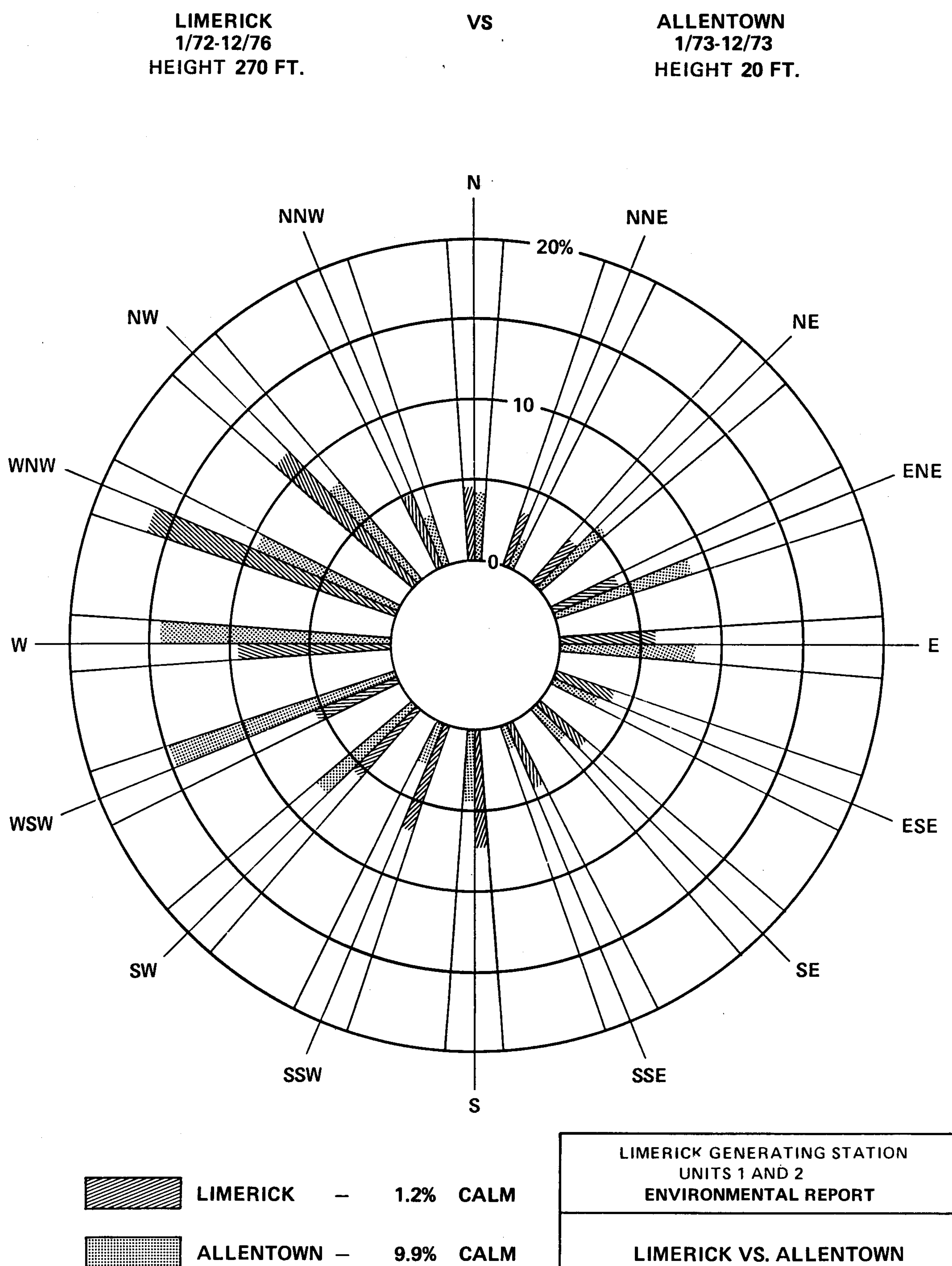
PHILADELPHIA
1/71-12/75
HEIGHT 20 FT.



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

LIMERICK VS. PHILADELPHIA WIND DIRECTION PERCENTAGE

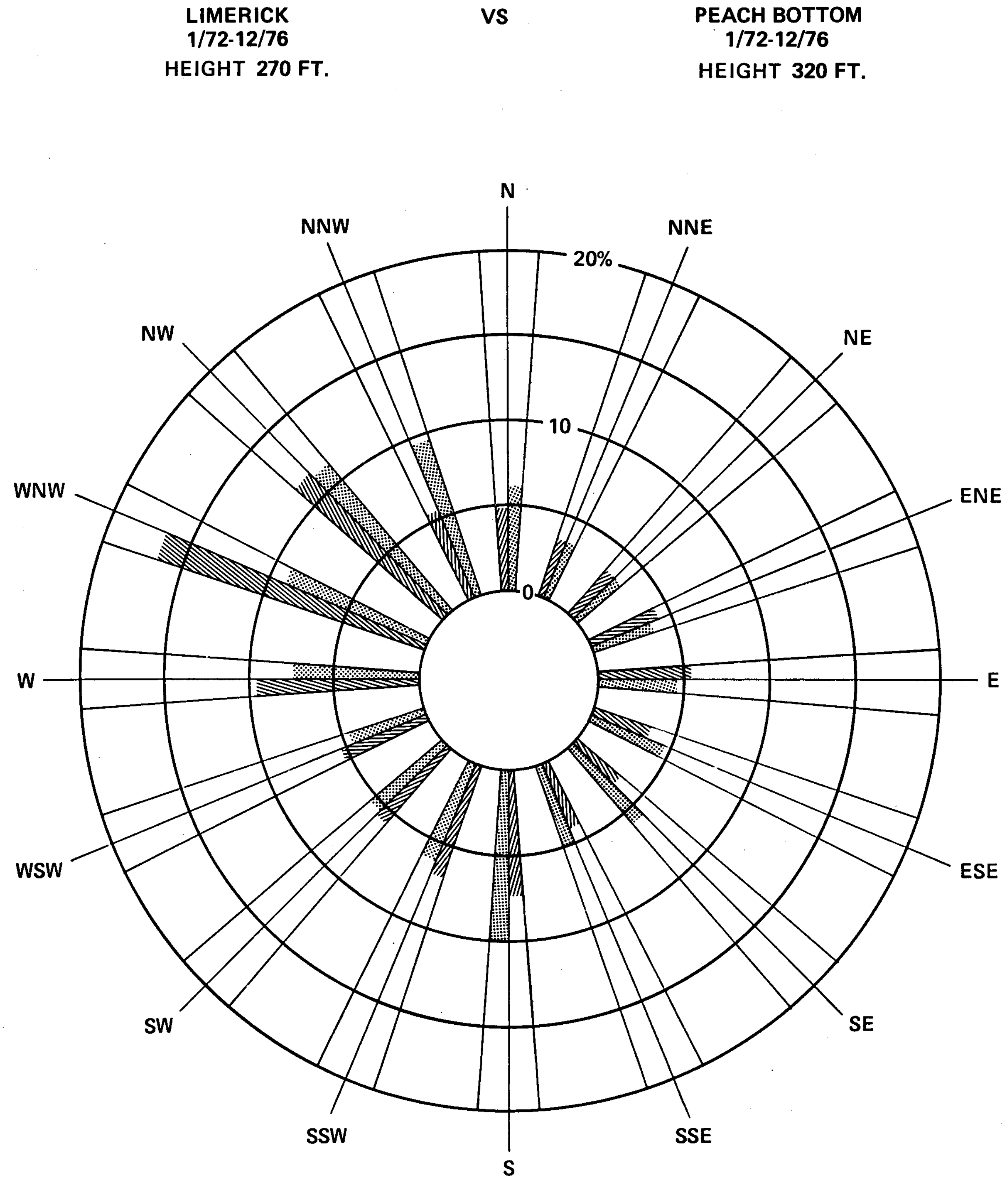
FIGURE 2.3.2-1



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

LIMERICK VS. ALLENTOWN WIND DIRECTION PERCENTAGE

FIGURE 2.3.2-2



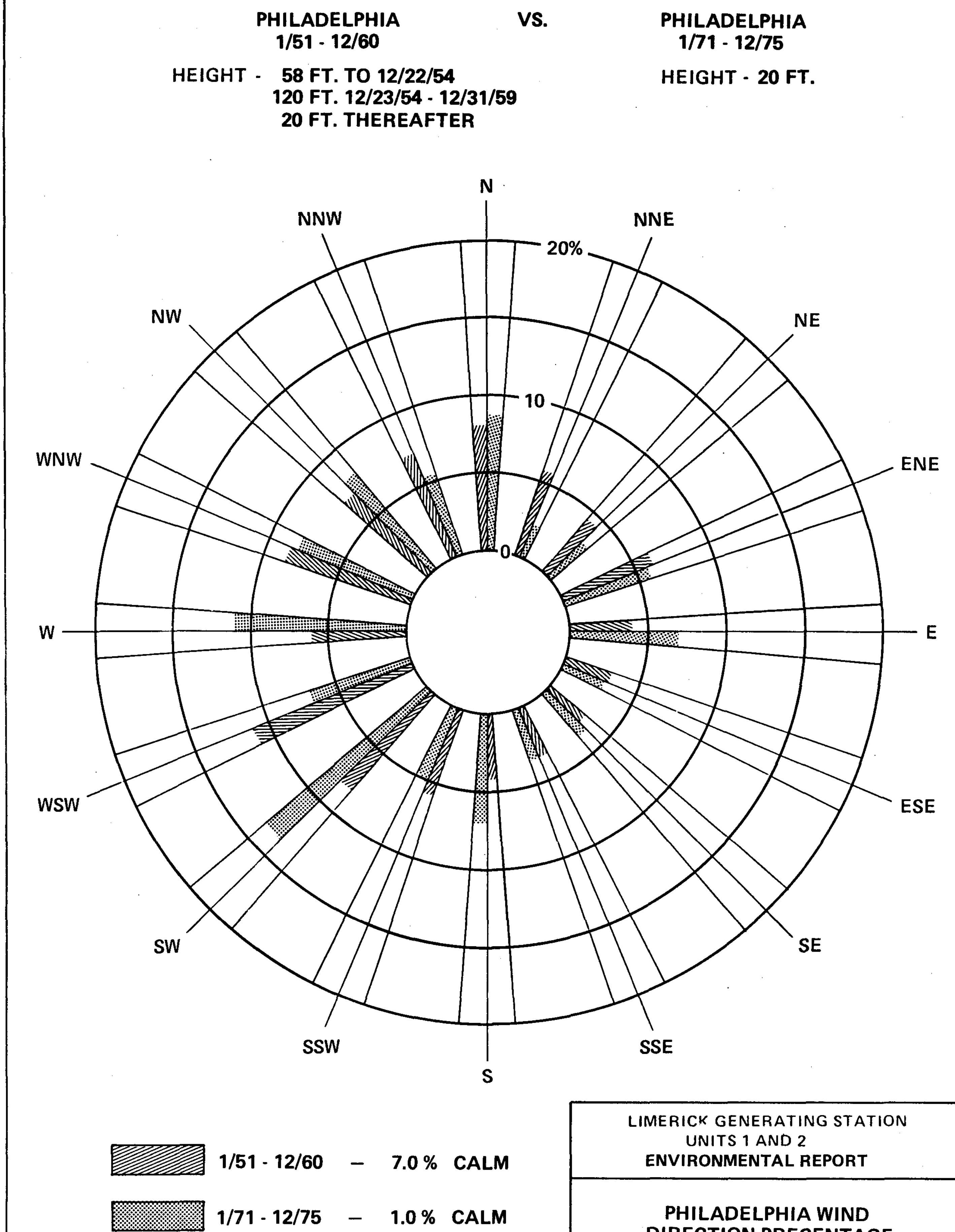
LIMERICK – 1.2% CALM

PEACH BOTTOM – 2.0% CALM

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

LIMERICK VS. PEACH BOTTOM WIND DIRECTION PERCENTAGE

FIGURE 2.3.2-3



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

PHILADELPHIA WIND DIRECTION PRECENTAGE

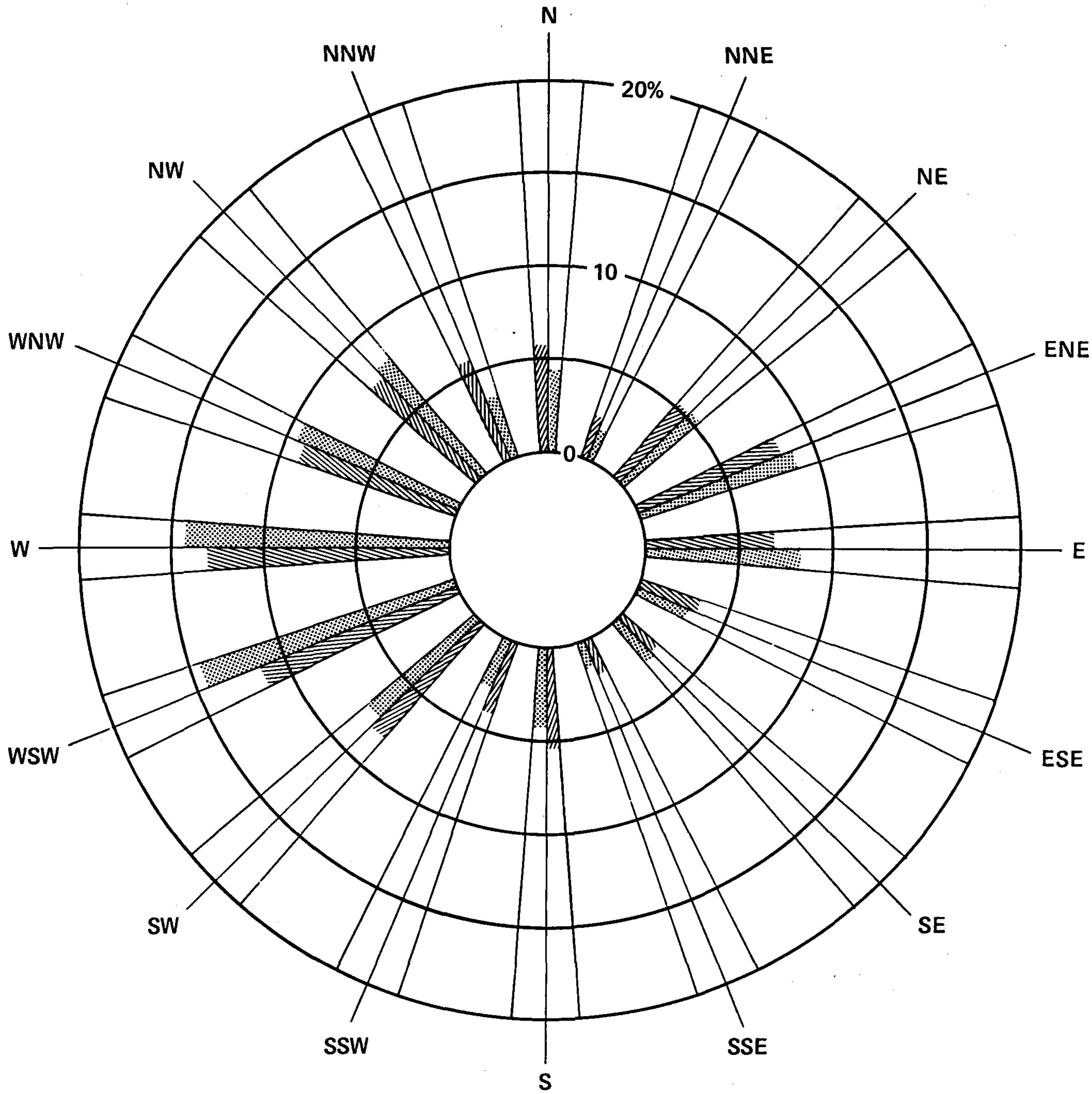
FIGURE 2.3.2-4

ALLENTOWN VS ALLENTOWN

1/64 - 12/73 — 1/73 - 12/73

HEIGHT - 69 FT. TO 12/1/65
20 FT. THEREAFTER

HEIGHT - 20FT.



1/64 - 12/73 — 8.1 % CALM

1/73 - 12/73 — 9.9 % CALM

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

ALLENTOWN VS. ALLENTOWN
WIND DIRECTION PERCENTAGE
AT 20 AND 270 FEET

FIGURE 2.3.2-5

2.4 HYDROLOGY

2.4.1 SURFACE WATER HYDROLOGY

The Limerick Generating Station is located on the east bank of the Schuylkill River, near river mile 48 (measured from the confluence of the Schuylkill with the Delaware River), at latitude 40° 13' 3" N and longitude 75° 35' 15" W, approximately 5.5 miles downstream from Pottstown, Pennsylvania. The drainage area of the Schuylkill River at this point is 1168 square miles, with riverbed elevations ranging from about 1750 feet above mean sea level (MSL) near the source, to about 105 feet (MSL) near the plant site.

The drainage basin of the Schuylkill River, from head to mouth, is about 80 miles long and 25 miles wide, and encompasses an area of 1909 square miles up to its confluence with the Delaware River at Philadelphia, Pennsylvania. As shown in Figure 2.4-1, the entire drainage area lies in southeastern Pennsylvania.

The principal towns and cities along the course of the Schuylkill River are Pottsville (river mile 123), Reading (river mile 71), Pottstown (river mile 54), Phoenixville (river mile 36), Norristown (river mile 24), Conshohocken (river mile 20), and Philadelphia (river mile 0).

The principal tributaries of the Schuylkill River are listed in Table 2.4-1.

Flow data for various gauging stations on the Schuylkill River are available in USGS publications (Ref 2.4-1 to 2.4-5). Active stream gaging stations upstream of the plant site are listed in Table 2.4-2. The locations of these gaging stations are shown in Figure 2.4-2.

Near the plant site, the Schuylkill is a meandering stream having a bed slope of 2 to 2.5 feet/mile. It is flanked by flood plains comprised of about 10% builtup areas, 30% forest growth, and 60% cultivated or fallow fields. There are nine bridges on the river in the reach between Pottstown (river mile 54) and Cromby (river mile 39.4).

A list of minor dams upstream of the plant site is given in Table 2.4-3. A list of dams on the main stream of the Schuylkill River, downstream of the Limerick Generating Station, is given in Table 2.4-4.

The dam nearest to the Limerick Site is the Vincent Dam, which is 3.3 miles downstream. It is an old, free overflow, rock-filled timber crib structure about 12 feet high with the crest at elevation 103.5 feet (MSL). It is used for recreation and

1.5 million gallons per day (Mgd) of water supply. This dam also serves as a sediment trap.

Three major dams, Blue Marsh, Ontelaunee, and Maiden Creek, exist or are currently planned in the Schuylkill River basin upstream of Limerick Generating Station (see Figure 2.4-2). Blue Marsh is a newly constructed (1979) U. S. Army Corps of Engineers dam, located about 35 miles upstream of Limerick on the Tulpehockan Creek. It has a total storage capacity of 50,000 acre-feet, of which 22,900 acre-feet are reserved for flood control. The maximum height of this dam is 96 feet.

Ontelaunee dam is owned by the city of Reading. It is located on Maiden Creek, about 37 miles upstream of Limerick. This dam is 52 feet high, with a storage capacity of 11,900 acre-feet.

The Maiden Creek Dam, authorized for future construction by the U.S. Army Corps of Engineers, will be located on the Maiden Creek, about 5 miles upstream of Ontelaunee dam. The height of this dam will be 110 feet. It was planned to have a storage capacity of 114,000 acre-feet, of which 38,000 acre-feet are reserved for flood control. Plans for construction of Maiden Creek Dam have been indefinitely deferred and the project is considered inactive at this time.

2.4.2 GROUNDWATER HYDROLOGY

2.4.2.1 Historic Floods

Major floods in the area are usually associated with tropical disturbances from the Gulf Coast, while snowmelt floods occur annually.

In June 1972, Hurricane Agnes produced record floods on many streams in Pennsylvania. On the Schuylkill River at Pottstown, the USGS estimated the record flood of 1972 as 95,900 cubic feet per second (cfs) (Ref 2.4-1). The peak stages and discharges for major historic floods at various stations on the Schuylkill River are given in Table 2.4-5. Until June 1972, the 1902 flood with a peak discharge of 53,900 cfs was the largest known flood at Pottstown. However, stage-discharge data for Reading and Philadelphia (Table 2.4-5) indicate that the 1902 flood could have been exceeded by the 1869, 1850, and 1839 floods.

The drainage area of the Schuylkill River at Limerick is about 2% greater than that at the Pottstown gaging station. Therefore, it is assumed that the streamflows at Limerick (river mile 48) are the same as those at Pottstown (river mile 54).

The flood frequency curve of the Schuylkill River at Pottstown is shown in Figure 2.4-3. This curve is based upon the regional flood discharge relationships contained in Ref 2.4-6. Recorded annual peak flows for the Schuylkill River at Pottstown for 1928 through 1961 were used in preparing the curve along with the estimated peak flow for 1902. Subsequently, recorded annual peak flows for 1962 through 1980 were added to the originally-used flows, and new flood-frequency values were computed. The curve of Figure 2.4-3 was found to be conservative estimate of peak flood flows for any given recurrence interval when compared to recorded values.

2.4.2.2 Low Streamflows

June, July, August, September, and October are generally the months of low streamflows on the Schuylkill River. The average discharge over a period of 54 years (1927 - 1980) at Pottstown is 1910 cfs (Ref 2.4-1). The instantaneous and average daily minimum flows of the Schuylkill River at Pottstown from 1927 to 1980 are listed in Table 2.4-6. The instantaneous minimum flow for the period of record was 87 cfs on August 13, 1930 (Ref 2.4-1). The frequency curves of low flows at Pottstown for 1, 3, 7, 14, 30, 60, and 120 consecutive days are shown in Figure 2.4-4. A curve for the annual minimum instantaneous flows is also shown in Figure 2.4-4. The data used to develop the curves of Figure 2.4-4 included the effects of existing controls on the Schuylkill River. The effect of regulation provided by Blue Marsh Dam is included starting in 1979. It is estimated that the completion of Blue Marsh Dam will augment the low flows of the Schuylkill River by about 65 cfs (Ref 2.4-7). Based on information received from the Philadelphia District of the U.S. Army Corps of Engineers, the low flow augmentation on the days of minimum flow occurrence for 1979 and 1980 was 25 cfs. A flow duration table for the Schuylkill River at Pottstown is given in Table 2.4-7, and the corresponding flow duration curve is shown in Figure 2.4-5. The data used to develop this curve were the observed mean daily flows at Pottstown, and so included the effects of existing upstream controls. However, the effect of regulation provided by Blue Marsh Dam is not included.

The 7-day, 10-year low flow at Limerick is estimated to be 260 cfs (Figure 2.4-4). Philadelphia Electric does not plan to construct any upstream storage reservoirs to augment Schuylkill River flows, because flow augmentation is not required. Low flows may be augmented in future years by controlled releases from storage dams constructed in the Schuylkill River Basin upstream from Pottstown gaging station. As discussed in Section 2.4.1, the Blue Marsh Dam has recently been completed. The long-term average monthly flows are given in Table 2.4-8.

2.4.2.3 Perkiomen Creek and Delaware River Flows

As explained later in Section 2.4.6, the Perkiomen Creek and Delaware River are supplementary sources of water for the Limerick Generating Station. June, July, August, September, and October are generally the months of low streamflows for these two rivers. Duration tables for the Perkiomen Creek flows at Graterford (D.A = 279 mi^2) and the Delaware River at Trenton (D.A. = 6780 mi^2) are given in Table 2.4-7. Perkiomen Creek flows are regulated by the Green Lane Reservoir (D.A. = 70.9 mi^2) constructed in 1956. The Delaware River flows are regulated by Lakes Wallenpaupack, Hopatcong, Pepacton, Cannonsville, Swinging Bridge, Toronto, Cliff, Neversink, Wild Creek, and several other smaller reservoirs (Ref 2.4-1). Long-term monthly average flows of the Perkiomen Creek at Graterford, and the Delaware River at Trenton are listed in Table 2.4-8. The low flow frequency curves at these two stations for 1, 3, 7, 14, 30, 60, and 120 consecutive days is shown in Figures 2.4-4a and 2.4-4b, respectively.

2.4.3 WATER LEVELS

2.4.3.1 Schuylkill River

To determine the elevation of the June 1972 flood at Limerick, Philadelphia Electric Company commissioned a special survey in July 1972. About seven hours before the peaking of the June 1972 flood, an oil lagoon at Pottstown was overtopped by the flood waters. This produced an oil slick along the river that left oil marks for a considerable distance downstream. In the above-mentioned survey, readings were taken on the top of the oil marks along the east bank of the Schuylkill River from Sanatoga (1.4 miles upstream from Limerick) to Cromby (8.6 miles downstream of Limerick). Assuming that the upper envelope of these readings represents the actual high-water profile, it was concluded that the 1972 flood elevation at Limerick was about 131 feet (MSL).

Figure 2.4-6 shows the expected water surface elevations at the plant site for flows ranging from 80 cfs to 356,000 cfs. This rating curve is based upon values given in Table 2.4-9. Low-flow portions of this curve were developed using the slope-area method. The cross-section of the river near the site was taken from a survey conducted in 1969. The roughness coefficient was estimated from the average water surface slope shown in Ref 2.4-9. The low-stage computations were verified with field observations in December 1969. For flows over 20,000 cfs, the water levels were computed using the U. S. Army Corps of Engineers Standard Step Backwater Program (Ref 2.4-10). The computations covered a 14.1-mile reach of the river from Pottstown (5.5 miles upstream of the plant site) to Cromby (8.6 miles downstream of the plant site). It is not expected that this discharge rating curve, and consequently, the estimated water levels, would change significantly during the course of plant operations.

Computed water surface profiles between Sanatoga Highway Bridge (about 4800 feet upstream from the plant site) and Linfield Railroad Bridge (about 7500 feet downstream from the plant site) for flood flows of 21,000 cfs, 28,000 cfs, and 99,000 cfs are shown in Figure 2.4-7. The average annual flood on the Schuylkill River at Pottstown is 21,000 cfs based on 42-years (1928-1969) and 24,300 cfs based on 53 years of record (1928-1980). The regional data, presented in Ref. 2.4-6, indicates for Pottstown an average annual flood flow of 28,000 cfs and 100-year peak flow of 99,000 cfs. The estimated probable maximum peak flood flow is 500,000 cfs which would result in a maximum water surface elevation of 174 ft at the Limerick plant site. Plant grade elevation is 217 ft.

It should be noted that a recent flood study performed for the Federal Insurance Administration (FIA) (Ref. 2.4-13) indicates a substantially lower value for the 100-year peak flow at the vicinity of the plant site, equal to about 79,000 cfs. This lower flood estimate appears to be the result of using a different statistical distribution in the flood frequency analysis. The floodplain in the vicinity is relatively flat and consists of about 60% of cultivated or fallow fields, about 30% thick forest growth, and about 10% built-up areas. At the pumping station, the width of the floodplain measures about 1800 feet. The 100-year flood level was estimated to be about 129 feet mean sea level (MSL) for the pre-project conditions. The 100-year flood level was also estimated for the post-project conditions including the construction of the Schuylkill pumping station. The method suggested by Chow (Ref 2.4-15) was followed, and the level was found to be about 128.3 feet MSL. For practical purposes, the 100-year floodplain was found to be unchanged before and after the construction of the project. Figure 2.4-7a shows the extent of the 100-year floodplain on the left bank of the river for these conditions. As indicated in this same figure, the only plant structure located in the floodplain of the Schuylkill River is the pumping station. Work on this pumping station was started in October 1977 and was essentially completed in 1981.

2.4.3.2 Perkiomen Creek

In the vicinity of the pumping station, the floodplain of Perkiomen Creek measures about 2000 feet wide. It is relatively flat and sparsely wooded with scattered mature trees. There are few houses scattered in the floodplain within a one-mile radius of the pumping station. From a recent flood study report published by FIA (Ref 2.4-14), the 100-year peak discharge at this location was estimated to be about 42,300 cfs and the 100-year flood level to be 125.7 feet MSL for the pre-project conditions. The 100-year flood level was also estimated for the post-project conditions with the construction of the Perkiomen pumping station following a method suggested by Chow (Ref 2.4-15). It was found to be 125.8 feet MSL. For practical purposes, the 100-year floodplain at the Perkiomen Creek in the vicinity of the Perkiomen pumping station was found to be unchanged before and after the construction of the project. Figure 2.4-7b shows the extent of the 100-year floodplain on the right bank of the Perkiomen Creek for these conditions. As indicated in the same figure, the only plant structure located in the floodplain of the Perkiomen Creek is the pumping station. Work on this pumping station is expected to start in late 1982 or early 1983 and to be completed during 1984.

2.4.3.3 East Branch of Perkiomen Creek

On the basis of a 1971 flood study report published by the U.S. Army Corps of Engineers (Ref. 2.4-16), the 100-year flood peak discharge at this location was estimated to be about 2,600 cfs and the 100-year flood level to be at 361 feet MSL. Because no significant change in the floodplain is caused by the construction of this discharge structure, the 100-year flood level after the construction of the project will remain unchanged. Figures 2.4-7c and 2.4-7d show the extent of the 100-year flood plain for the east branch of the Perkiomen Creek at this location. As indicated in these figures, the only project facility located in the floodplain is the discharge structure. Work on this structure is expected to start in late 1982 or early 1983 and to be completed during 1984.

2.4.3.4 Delaware River

From a flood study report published by FIA (Ref. 2.4-17), the 100-year flood discharge at this location was estimated to be 284,000 cfs, and the 100-year flood level to be 103 feet MSL for the pre-project conditions. Because only the intake screen assembly and part of the gate well of the intake structure are situated below the 100-year flood level, occupying less than 1% of the overall flow cross-sectional area for this discharge, the 100-year flood level of the Delaware River at this location after the construction of the Point Pleasant Pumping Station will remain unchanged. Figure 2.4-7e shows the extent of the 100-year floodplain on the left bank of the river at this location. As mentioned previously, the only structures located in the floodplain are the intake screen assembly and part of the gate well. Work on these structures is expected to start in late 1982 or early 1983 and to be completed during 1984.

2.4.4 HYDROLOGIC DESCRIPTION OF THE SITE ENVIRONMENT

The plant site is located between Sanatoga Creek and Possum Hollow Run, both of which are tributaries to the Schuylkill River. Sanatoga Creek drains an area of less than 10 square miles, just north of the plant site. At a point 1400 feet upstream of its confluence with the Schuylkill River, the creek is nearest to the plant site. At this location, the thalweg of the creek is at approximately el 127 feet. The spray pond (see Section 2.4.8) is located mostly within the Sanatoga Creek Basin. The cooling towers are located on a ridge that rises in an ENE direction, and separates the cooling towers from the spray pond area. The same ridge forms the drainage boundary between Sanatoga Creek and Possum Hollow Run, and isolates the

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turbine-reactor area from Sanatoga Creek. Possum Hollow Run drains an area of 1.3 square miles. It rises approximately 2.5 miles northeast of the Limerick site, flows in a southwesterly direction, and finally enters the Schuylkill River through a gorge on the south side of the station. The bed slope of the Possum Hollow Run is very steep, approximately 2%.

2.4.5 SURFACE WATER USERS

Domestic and industrial users of surface water on the Schuylkill River downstream of Limerick Generating Station are listed in Tables 2.4-10 and 2.4-11, respectively. The entitlement and approximate location of each user are indicated in the respective tables. The total entitlement for domestic use is 470 cfs, out of which 28 cfs is for consumptive use. The total entitlement for industrial use is 1020 cfs, out of which 20 cfs is for consumption. The nearest user, the Citizens Utility Home Water Company, is 2.3 miles downstream of the plant site.

According to the Delaware River Basin Commission, the data presented in Tables 2.4-10 and 2.4-11 represent volumes of water for which entitlement was identified as of 1978. No new entitlements had been recognized as of August 1980.

2.4.6 PLANT WATER REQUIREMENT

The plant circulating water and service water systems will be closed loop with natural draft cooling towers. The water requirements of the plant are discussed in Section 3.3.

The Schuylkill River flows cannot support the requirements of the plant and downstream users at all times. To supplement the supply available from the Schuylkill River, water will be withdrawn from the Delaware River via Perkiomen Creek. This system is shown in Figure 2.4-8. To authorize this withdrawal, the Delaware River Basin Commission has issued a water use approval (D-69-210 CP) for the Limerick Generating Station. The terms and conditions of this permit are given in Appendix 2.4A.

The Delaware River Basin Commission (DRBC) has exclusive jurisdiction over the necessity for and approval of compensating water storage capacity for Limerick Generating Station. An application for such capacity has been submitted at the request of the DRBC and is now under consideration by the DRBC. With regard to the water supply aspects of the facility, the station will be operated under the terms and conditions imposed by the DRBC whether or not compensating water storage capacity is required.

2.4.7 WATER QUALITY

2.4.7.1 Chemical Characteristics of Surface Water Bodies

2.4.7.1.1 Chemical Characteristics of the Schuylkill River

The Schuylkill has been beset with water quality problems since early recorded history. These along with the stresses they exert on indigenous biological communities are summarized in Section 2.2. Water quality studies in relation to LGS were initiated in May 1974, and a summary of the program is given in Section 6.1.

Table 2.4-12 is a summary of Schuylkill River water quality data which covers the period 1975 through 1978. The data in this table, collected at S77660, are grouped in four time blocks as follows: December, January, February; March, April, May; June, July, August; and September, October, November. This grouping was selected so that the Schuylkill River source water quality might be examined in seasonal periods with and without diversion.

These data depict a typical hard warmwater stream which is moderately polluted. The Schuylkill River ionic base is sulfate, and the water generally contains high concentrations of major cations.

The major cations (sodium, potassium, calcium, and magnesium) and major anions (sulfate, carbonate, and chloride) are conservative with respect to flow; that is, as the flow decreases the concentrations of these elements increases. Therefore, these elements are at their highest concentrations July through November (Table 2.4-12). The Schuylkill also has a number of the ions that are considered essential plant nutrients (i.e. ammonia, nitrite, nitrate, and phosphate). While these parameters generally behave conservatively with respect to flow, they are influenced by man's activities, and are subject to increases during periods of high flow as a result of increased runoff and increased discharge of domestic and industrial wastes during increased flow periods. The transition series elements present in highest concentration in the Schuylkill at LGS are iron, manganese, zinc, copper, and chromium (Table 2.4-6) all of which can be toxic in high concentrations.

2.4.7.1.2 Chemical Characteristics of the Perkiomen Creek

Water quality studies in relation to LGS were initiated in May 1974. Table 2.4-13 is a summary of Perkiomen Creek water quality data covering 1975 through 1978. These data were collected at P14390 as part of the program described in Section 6.1. The data are reflective of a moderately hard warmwater stream that receives moderate amounts of pollution. The mainstem Perkiomen Creek has an ionic base which fluctuates between sulfate and carbonate, and like the Schuylkill contains high concentrations of major cations and anions. The major cations and anions are at their highest concentrations July through November (Table 2.4-13). The essential plant nutrients are present in high concentrations in Perkiomen Creek water and pose quality problems as discussed in Section 2.2. All transition series elements are found in low concentrations (Table 2.4-13).

2.4.7.1.3 Chemical Characteristics of the East Branch Perkiomen Creek

Water quality studies of the East Branch in relation to LGS were initiated in May 1974. While data were collect at four stations (Section 6.1), only two, the upper, E32300, and the lower, E2800, will be used in this discussion. Table 2.4-14 is a summary of water quality data from E32300 covering the period 1975 through 1978 and Table 2.4-15 is a summary of data from E28000 covering the same period. The water quality of the East Branch ranges from good at E32300 to highly degraded at E2800. This shift in quality is a result of allochthonous inputs from sources to mouth as described in Section 2.2. The ionic base of the uppwer East Branch is carbonate and shifts to sulfate in the lower reaches. The East Branch has high concentrations of major cations and anions in the middle and lower reaches (Table 2.4-15); especially July through November when flow becomes intermittent. Th lower reaches also have high concentrations of the ions considered essential plant nutrients and of certain transition series element (i.e. iron, manganese, zinc, copper, and chromium). The quality of the upper East Branch is not unlike that of the Delaware River at Point Pleasant while the quality of the lower East Branch is similar to that of the Schuylkill near LGS.

2.4.7.1.4 Chemical Characteristics of the Delaware River

Water quality studies of the Delaware River in relation to LGS were initiated in May 1974. A summary of the program is given in Section 6.1. The water quality of the Delaware 1975 through 1978 is summarized in Table 2.4-16. Data in this table was collected at A11263 and depiet a moderately hard warmwater stream with a carbonate ionic base. The quality of Delaware water is relatively good in that it is well buffered and does not contain excessively high concentrations of major cations and anions or ions considered essential plant nutrients (Table 2.4-16). Lead and zinc are the only transition series elements present in significant quantities. While temporal changes in Delaware water quality do occur, they are not as severe as the shifts on smaller streams because of the greater flow.

2.4.7.2 Water Temperatures

A summary of the monthly maximum, minimum, and average temperatures of the Schuylkill River water at Pottstown for the period 1957-74 is given in Table 2.4-17.

2.4.7.3 Sediment Characteristics

Records of suspended sediment discharge in the Schuylkill River at Manayunk (river mile 14.2) are available from 1947. This station is about 34 miles downstream of the Limerick plant site. The maximum and minimum suspended sediment concentration in the river flow at this station has varied from 4910 mg/l (December 30, 1948) to 1 mg/l (frequently). The observed maximum and minimum daily sediment loads since 1947 are 650,000 tons on August 19, 1955, and less than 0.05 ton on September 2, 1966, respectively. Daily suspended sediment discharge, and mean concentration for water year 1975-76 are shown in Table 2.4-18. A duration table for suspended sediment concentration at Manayunk is given in Table 2.4-19. A double mass curve of cumulative annual suspended sediment discharge against cumulative annual water discharge at Manayunk, for the period 1948-76, is shown in Figure 2.4-9 (Ref 2.4-1). There has been a marked decrease in the rate of suspended sediment transported by the Schuylkill River since 1955. This is due to restoration activities in the upper catchment conducted by the Commonwealth of Pennsylvania. These restoration activities included dredging of the river channel, construction of "on-stream desilting basins," and regulation of coal mining activities in the basin.

2.4.8 WATER IMPOUNDMENTS

There are no major lakes or ponds in the site vicinity. A spray pond has been constructed at the site to serve as the ultimate heat sink for the plant. The bottom of this pond is at 241 feet (MSL). The pond was constructed by excavation only. At the bottom, it is a 600-foot by 400-foot rectangle, with semicircular ends of a radius of 200 feet. From this spray pond, water is pumped to the plant for the residual heat removal and emergency service water systems. After circulation through coolers and heat exchangers, warm water is returned to the spray pond through a network of spray nozzles. The water surface area of the pond at the operating elevation of 251 feet (MSL) is 9.9 acres. An additional 7.6 acres of the surrounding area, including roads, cut surfaces, and natural terrain, drain toward the pond. Runoff from the cut faces is intercepted by a drainage ditch along the outside edge of a peripheral service road at 255 feet (MSL), and is diverted to culverts that discharge into the spray pond. Along the north edge of the pond, the roadway slopes to 252 feet (MSL) for a length of 60 feet, with a 9% upward slope at either end to connect it to 255 ft (MSL). This depressed portion of the roadway is designed to function as the crest of an uncontrolled emergency spillway. The spill is directed to a draw that drains northward into Sanatoga Creek.

Water, in small quantities, will spill over the emergency spillway from the spray pond to Sanatoga Creek. The capacity of the spray pond is such that these spills would occur only if a storm of severity higher than a 25-year, 24-hour storm occurred at a time when the pond was at the normal operating level of 251 feet (MSL).

2.4.9 CONCLUSION

Information regarding the ambient water quality of surface water bodies in the site vicinity has been presented. Low flow characteristics of the Schuylkill River, which is the stream receiving the blowdown discharge from the plant, are described. The locations of downstream users who could be affected by plant discharges, and of river control structures that may affect the dilution and travel time of effluents, are identified. This information would be useful in analyzing the transport of effluents in water required to meet the criteria of 10 CFR 50, Appendix I.

2.4.10 GROUNDWATER HYDROLOGY

Investigation of regional and local groundwater conditions indicates that the construction and normal operation of the Limerick Generating Station will have no adverse effects upon the groundwater resources in the region and at the site.

2.4.10.1 Description of Aquifers

Groundwater in the region occurs in sedimentary rocks of the Triassic Newark Group. This group includes the Stockton Formation and overlying Lockatong, Hammer Creek, and Brunswick lithofacies (Ref 2.4-11).

Although other units provide some groundwater in the region, the Brunswick is the most widespread source and the only significant aquifer at the plant site. The Stockton Formation is at great depth beneath the plant site, and is not of hydrologic importance in the site area.

The Brunswick, Hammer Creek, and Lockatong lithofacies are time equivalent units. The Hammer Creek lithofacies do not occur in the site area, and the Lockatong lithofacies only ocur in the northern part of the plant site.

The Brunswick is composed of red shale, sandstone, and siltstone locally interbedded with a few thin zones of the Lockatong, a dark gray argillite. Bedding ranges from a few inches to a few feet thick, with an average thickness of about 2 feet.

The rocks of the Brunswick lithofacies are very fine-grained, and primary permeability due to porosity is small. Most of the ground water movement within the Brunswick follows secondary openings, primarily fractures and joints. The fractures that parallel the bedding planes are usually tight and, probably, contribute little to the permeability; most important are the nearly vertical joint planes. Where present, joints provide an interconnected series of channels through which ground water can flow, giving the material low to moderate permeability (Ref 2.4-12). The number and width of the joints vary; consequently, the permeability differs from one location to another. For example, in a series of beds 100 feet thick there may be only a few beds in which the joints are well-developed.

In the Brunswick, unconfined water is encountered at shallow depth; deeper wells may encounter water under confined conditions. Yields from wells that penetrate the Brunswick vary widely because of lateral and vertical variations in lithology, uneven spacing of joints, and locally complex structure. Fault zones in the Triassic rocks have been found to be barriers to the flow of ground water; wells located near them generally have very low yields. The median yield of drilled municipal and industrial wells in the Brunswick is about 110 gallons per minute (gpm); the median transmissivity is 1100 gpd/foot. Yields in excess of 300 gpm are rare, and obtained from wells that intersect a larger number of water-bearing zones (Ref 2.4-12).

Recharge to the Brunswick occurs when infiltration of precipitation into the relatively impervious soil percolates down through weathered rock. The water table generally follows the profile of the land surface; groundwater flow is from high to low topographic areas. Groundwater movement is prevalent only in the upper portion of the Brunswick, where the fracture density is greatest. Poor water quality, and low yields in wells below a depth of about 600 feet, indicate little groundwater movement below that depth.

2.4.10.2 Site Groundwater Occurrence

Water levels are monitored in observation wells at the spray pond and in the power block area as part of a continuing program to monitor the direction of groundwater movement and water table elevations. The locations of observation wells are shown in Figure 2.4-11.

Shallow borings completed in the upper weathered zone encounter unconfined groundwater. Deeper borings (more than about 150 feet) penetrate sandstone layers with fine-grained interbeds that contain water under confined conditions. A pumping test at the site indicated that hydraulic connection between sandstone layers is very poor, depending upon open, interconnected fractures of the fine-grained interbeds. Static water levels vary greatly over short distances, depending upon the depth of each boring, and the number of joints intersected.

Groundwater recharge is primarily from infiltration of precipitation through the overlying soil. Groundwater levels at the site were measured intermittently from 1973 through 1979. During this period, precipitation was average for the region; therefore, the groundwater levels measured probably represent average conditions. Levels are not expected to be significantly higher than those measured during this period; however, records have not been kept long enough to establish long-term trends.

2.4.10.2.1 Aquifer Parameters

A pumping test and other permeability tests were performed to evaluate the groundwater hydrology of the plant site. Six observation wells, located at various distances from a test well, were used to measure changes in water levels as a result of pumping. Using the time-drawdown data from the pumping test and the Theis nonequilibrium formula, bedrock transmissivity (T) was computed to be 2550 gpd/ft.

Constant-head permeability tests were performed in auger holes and boreholes to estimate the permeability at the spray pond. Calculated permeabilities, listed in Table 2.4-20, range from 4 feet per year to 1247 feet per year. The average permeabilities calculated for the soil, the contact zone between the soil and bedrock, and the bedrock are 3.5, 14, and 214 feet per year, respectively. The greatest range of permeability values were determined from test data in bedrock, where the permeability is dependent upon the number of fractures the boring intercepts. More than 84% of the permeabilities measured in bedrock were less than 390 feet per year.

2.4.10.2.2 Water Quality

Chemical analyses of groundwater are available for wells completed in the Brunswick lithofacies in Montgomery County (Table 2.4-21). The median dissolved solids content of samples from these wells is 302 ppm, and the median hardness as $CaCO_3$ is 218 ppm. Groundwater from the Brunswick is largely of the calcium bicarbonate type, although water samples having concentrations of dissolved solids greater than 500 ppm are commonly of the calcium sulfate type. Groundwater from the Brunswick is of good quality for most domestic and municipal uses, although it may need to be treated for hardness.

Water quality analyses of samples from wells 1,3, and 4 at the plant site (Table 2.4-22) indicate the water is a calcium sulfate type, with a pH ranging from 7.5 to 8. The water is moderately hard, ranging from 134 to 618 ppm as $CaC0_3$, and contains total dissolved solids ranging from 199 to 1052 ppm.

2.4.10.2.3 Ground Water Levels and Fluctuations

Depth to water in the observation wells at the site ranges from 15 to 95 feet below ground surface. The potentiometric surface determined from levels measured in May 1979, as shown in Figure 2.4-11, indicates the water table is at 250 feet (MSL) east of the spray pond, and decreases in elevation to 120 feet (MSL) southwest of the power block.

Hydrographs of observation wells in the spray pond area, shown in Figure 2.4-10, indicate seasonal water level fluctuations, with the lowest levels occurring in the fall and early winter, and the highest levels occurring in the spring. These records indicate a maximum fluctuation of 17 feet (P5 and P22), with most levels fluctuating less than 12 feet.

Hydrographs of observation wells in the power block area, shown in Figure 2.4.10b, exhibit greater water level fluctuations than those in the spray pond area. These fluctuations are closely related to precipitation, as illustrated in Figure 2.4-10c. Wells P12 and P15 do not show large fluctuations, because the water table is below the screened intervals during low periods. When the water table drops below the screen, the level measured in the well is of the water remaining in the sump, a 5-foot length of casing below the screen. Thus, only the highest water levels reflect the water table (fluctuation peaks) at these two observation wells.

The observation wells in the power block area are adjacent to open trenches, or to plant excavations that are backfilled with relatively permeable materials. Precipitation that collects in the open trenches, or infiltrates the permeable backfill, provides abnormal amounts of recharge to the water table. Upon completion of the project, when the open trenches are filled and an asphalt, or other relatively impermeable surface will be placed over these backfilled areas, infiltration of precipitation in those areas will be nearly eliminated, and water table fluctuations reduced. Future water level fluctuations at the power block should then be similar to those at the spray pond.

2.4.10.2.4 Direction of Groundwater Flow

Groundwater in the shale and siltstone strata immediately underlying the site flows in fractures and joints. The direction of flow is from topographically high areas to topographically low areas (Figure 2.4-11). A groundwater divide occurs beneath a topographic ridge north of the plant. North of the divide, groundwater flows northward, discharging to tributaries of the Schuylkill River. Groundwater beneath the plant flows in a southwesterly direction, eventually discharging into the Schuylkill River. Because of the low permeability, poor hydraulic connection between beds in the bedrock, and topographic control, the influence of the plant site upon the regional groundwater is negligible.

2.4.10.2.5 Seepage From the Spray Pond

Groundwater levels measured in observation wells, indicate that seepage from the planned spray pond, shown in Figure 2.4-12, will flow in two directions; southwest, toward the Schuylkill River, and to the north. The seepage may cause a groundwater mound beneath the pond, and minor, local reversals of flow direction, as suggested by the flow net construction shown in Figure 2.4-12. This would increase the groundwater flow to the north, but the general directions of flow would remain the same. Groundwater levels beneath the plant site will not be significantly affected by these seepage losses.

Seepage losses from the spray pond were calculated for an unlined pond by taking the difference between the preconstruction groundwater underflows, and the total underflows expected after the spray pond is constructed. Two methods were used to calculate the total underflows using Darcy's law: (1) computation of underflow through a cross flow area, and (2) construction and analysis of a flow net.

After the spray pond is operating, the differential head between the spray pond surface and the Schuylkill River will be 140 feet. For flow in a northward direction, the differential head between the spray pond surface and the discharge area is estimated to be 50 feet. An effective thickness of potential aquifer (the saturated thickness will depend upon how high the groundwater mound rises) of 140 feet was used because of the reduction in number and size of fractures at that approximate depth, as observed in the cored holes. A permeability of 200 feet per year was used as an effective value for the residual soils and bedrock materials.

Using these parameters, underflows were determined by analysis of the flow net in Figure 2.4-12 to be 5.3 x 10^6 ft^3/yr towards the Schuylkill River, and 1.6 x 10^6 ft^3/yr toward the north, giving a total underflow of 6.9 x 10^6 ft^3/yr. The second method of analysis, the cross-sectional area method, Q = KIA, indicates that 4.5 x 10^6 ft^3/yr will flow toward the Schuylkill River, and 1.7 x 10^6 ft^3/yr will flow toward the north, giving a total underflow of 6.2 x 10^6 ft^3/yr.

Preconstruction underflow was calculated using Darcy's Law: Q = KIA. The hydraulic gradient (I) was determined from equipotential contours of the groundwater table, shown in Figure 2.4-11. The thickness of saturated material above a depth of 140 feet, the effective aquifer thickness, is estimated to be 110 feet. The permeability (K) is 200 feet per year, as described above. Based upon these parameters, present underflow beneath the pond was estimated to be 2.74×10^6 ft^3/yr toward the Schuylkill River, and 0.54×10^6 ft^3/yr toward the north. Total preconstruction (natural) underflow, then is the sum of these, or 3.3×10^6 ft^3/yr. Therefore, the estimated seepage loss from an unlined spray pond is:

$(6.9 \times 10^6) - (3.3 \times 10^6) = 3.6 \times 10^6$ ft^3/yr (flow net method) (2.4-1)

$(6.2 \times 10^6) - (3.3 \times 10^6) = 2.9 \times 10^6$ ft^3/yr (cross-sectional area method) (2.4-2)

Actual steady-state seepage losses could be higher if untreated open joints or fractures were present in the pond bottom. It would be difficult to preclude this possibility, even with intensive surface and subsurface investigations to determine localized fracture permeabilities; therefore, the spray pond was lined with a soil-bentonite liner 1 foot thick, having a permeability of less than 1 foot per year. This ensures that the seepage loss calculations are conservative, by preventing potentially higher rates of seepage through localized fracture zones.

Monitoring of water levels in the observation wells during plant operation will provide information on variations in the potentiometric surface resulting from recharge through precipitation, and from operation of the spray pond, and will provide additional data on the direction of groundwater movement.

2.4.11 REFERENCES

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Appendix 2.4A

TERMS AND CONDITIONS OF DRBC APPROVAL FOR WATER USE AT LIMERICK GENERATING STATION

a. Schuylkill River

Schuylkill River water at the plant site may be used for nonconsumptive use whenever the effluent discharged back to the river meets all applicable water quality standards.

Schuylkill River water at the plant may be used for consumptive use when flow (not including future augmentations of flow from commission-sponsored projects) as measured at the Pottstown gage is in excess of 530 cfs (342 Mgd) with one unit in operation and 560 cfs (362 Mgd) with two units in operation with the following exceptions:

1. There shall be no withdrawals when river water temperatures below the Limerick station are above 15° C except during April, May, and June when the flow as measured at the Pottstown gage is in excess of 1791 cfs (1158 Mgd).

2. Use of the Schuylkill River will be limited to a withdrawal that will result in an effluent that meets all applicable water quality standards.

The constraints on nonconsumptive use of Schuylkill River water are necessary to prevent violation of total dissolved solids, stream quality objectives, and effluent quality requirements of the Commission's water quality regulations. The constraint on consumptive use of Schuylkill River water is to protect water quantity and water quality below the Limerick Generating Station. Both sets of constraints would be suspended in the event of any operational emergency requiring a shutdown of the plant.

b. Perkiomen Creek

Perkiomen Creek water may be used when flows as measured at the Graterford gage are in excess of 180 cfs (116 Mgd) with one unit in operation and 210 cfs (136 Mgd) with two units in operation, exclusive of any water pumped from the Delaware River.

The constraint on the use of Perkiomen Creek water would permit the use only when the flow at Graterford was above the long-term median flow of 150 cfs.

c. Delaware River

The Delaware River, as augmented for the purpose of water supply by upstream reservoirs, may be used via the Point Pleasant pumping facilities, a pipeline, the East Branch of Perkiomen Creek, and Perkiomen Creek with the limitations that such use will not reduce the flow as measured at the Trenton gage below 3000 cfs (1940 Mgd), and that such use will not be permitted when the flow as measured at the Trenton gage is less than 3000 cfs (1940 Mgd), provided that annually after pumping from the Delaware River has commenced, the rate of pumping will be maintained at not less than 27 cfs (17.5 Mgd) throughout the normal low flow season for the protection of aquatic life in Perkiomen Creek and its East Branch regardless of ultimate downstream consumptive use requirements. During periods of high natural flow in East Branch Perkiomen Creek, pumping from Point Pleasant shall be kept at a level so as not to aggravate high water levels.

This constraint would prohibit the use of the Delaware River water when such use would reduce the flow in the river at the Trenton gage below 3000 cfs, which is required to meet the salinity objective in the estuary of 250 mg/l at mile 92.47 (mouth of the Schuylkill River).

TABLE 2.4-1

PRINCIPAL TRIBUTARIES OF THE SCHUYLKILL RIVER

NO.	NAME	CONFLUENCE AT RIVER MILE	RIGHT OR LEFT BANK (LOOKING DOWNSTREAM)
1.	Big Creek	133.85	Right
2.	Silver Creek	129.02	Right
3.	Mill Creek	125.15	Right
4.	West Branch Schuylkill	119.65	Right
5.	Mahannon Creek	114.3	Left
6.	Red Creek	113.35	Right
7.	Plum Creek	112.25	Right
8.	Pine Creek	108.8	Left
9.	Bear Creek	108.0	Right
10.	Stony Creek	104.75	Right
11.	Little Schuylkill River	102.1	Left
12.	Mill Creek	95.1	Right
13.	Pigeon Creek	92.5	Left
14.	Irish Creek	89.5	Right
15.	Maiden Creek	86.7	Left
16.	Bernhart Creek	78.29	Left
17.	Tulpehocken Creek	76.8	Right
18.	Angelica Creek	73.2	Right
19.	Seidel Creek	67.0	Right
20.	Antietam Creek	66.1	Left
21.	Indian Corn Creek	65.58	Right
22.	Heisters Creek	65.1	Left
23.	May Creek	63.1	Right
24.	Six Penny Creek	61.1	Right
25.	Monocacy Creek	60.8	Left
26.	Manatawny Creek	54.15	Left
27.	Sanatoga Creek	49.15	Left
28.	Possum Hollow Run	48.0	Left
29.	Brooke Evans Creek	47.6	Left
30.	Pigeon Creek	46.5	Right
31.	Mingo Creek	40.7	Left
32.	French Creek	35.6	Right
33.	Pickering Creek	34.4	Right
34.	Perkiomen Creek	32.3	Left
35.	Valley Creek	30.6	Right
36.	Trent Creek	27.5	Right
37.	Indian Creek	26.5	Left
38.	Crow Creek	25.8	Right
39.	Stony Creek	24.3	Left
40.	Matsunk Creek	21.6	Right
41.	Gulph Creek	20.6	Right
42.	Plymouth Creek	20.5	Left
43.	Arrowmink Creek	20.1	Right
44.	Mill Creek	16.2	Right
45.	Wissa Lickon Creek	12.8	Left

TABLE 2.4-2

SURFACE WATER GAUGING STATIONS UPSTREAM FROM LIMERICK SITE

LOCATION(1) NO.	STATION NAME	STATION NO.	DRAINAGE AREA (sq mi)	PERIOD OF RECORD: DAILY OR MONTHLY (CALENDAR YEAR)	PERIOD OF RECORD: ANNUAL PEAK (WATER YEARS)	PERIOD OF RECORD: LOW-FLOW MEASUREMENTS (WATER YEARS)
1	Schuylkill River at Pottsville, PA	4675	53.4	1943-		
2	West Branch Schuylkill River at Cressona, PA	4679.5	52.5	1964-1965		
3	Schuylkill River at Landingville, PA	4685	133	1947-1953; 1963-1965		
4	Schuylkill River at Auburn, PA	4690	160	1947-1951		
	Little Schuylkill River					
5	Still Creek Reservoir near Hometown, PA	4692	8.5	1933-		
6	Little Schuylkill River at Tamaqua, PA	4695	42.9	1916-1919; 1919-		
7	Little Schuylkill River at Drehersville, PA	4700	122	1947-1951; 1963-1965		
8	Schuylkill River at Berne, PA	4705	355	1947-		
9	Maiden Creek near Lenhartsville, PA	4707	75.5			1943; 1946-57
10	Maiden Creek Tributary at Lenhartsville, PA	4707.2	7.46	1965-	1962-1965	
11	Sacony Creek at Virginville, PA	4707.5	55.5			1958-
	Tulpehocken Creek					
12	Mill Creek near Bernville, PA	4707.8	11.9			1959-

TABLE 2.4-2 (Cont'd)

LOCATION(1) NO.	STATION NAME	STATION NO.	DRAINAGE AREA (sq mi)	PERIOD OF RECORD DAILY OR MONTHLY (CALENDAR YEAR)	ANNUAL PEAK (WATER YEARS)	LOW-FLOW MEASUREMENTS (WATER YEARS)
13	Tulpehocken Creek at Bernville, PA	4708	84.8			1943; 1946-57
14	Northmill Creek at Bernville, PA	4709	42.0			1943; 1946-57
15	Tulephocken Creek at Blue Marsh Damsite near Reading, PA	4709.6	175	1965-		
16	Tulpehocken Creek near Reading, PA	4710	211	1950-		
17	Schuylkill River at Reading, PA	4715	880	1914-1915; 1915-1919; 1919-1930		
18	Allegheny Creek at Beckersville, PA	4716	11.3			1946-1957
19	Monocacy Creek at Limekiln, PA	4717	6.68			1946-1957
	Manatawny Creek					
20	Pine Creek near Manatawny, PA	4718	15.6		1961-	
21	Manatawny Creek at Earlville, PA	4719	60.0			1946-1957
22	Schuylkill River at Pottstown, PA	4720	1147	1926-		

(1) Locations shown on Figure 2.4-1

TABLE 2.4-3

MINOR DAMS UPSTREAM OF LIMERICK GENERATING STATION

NAME	STREAM	HEIGHT ft	VOLUME ac-ft	DRAINAGE AREA sq-mi
Still Creek	L. Schuylkill - Trib.	48	767	8.5
PA-422	L. Schuylkill - Trib.	87	3850	15.6
PA-422A	L. Schuylkill - Trib.	55	925	3.1
PA-424	L. Schuylkill - Trib.	35	459	2.2
PA-423	L. Schuylkill - Trib.	98	1965	13.1
Tamaqua - 1	L. Schuylkill - Trib.	28	123	2.7
Tamaqua - 2	L. Schuylkill - Trib.	38	954	1.7
PA-425	L. Schuylkill - Trib.	21	229	1.1
Minersville - 1	Schuylkill - Trib.	24	55	4.4
Minersville - 2	Schuylkill - Trib.	33	196	2.6
Crystal	Schuylkill - Trib.	40	200	5.1
Indian Run	Schuylkill - Trib.	14	15	2.4
Silver Creek	Schuylkill - Trib.	47	712	1.1
Auburn	Schuylkill River	16	1900	157.0
Dear Lake	Schuylkill - Trib.	9	55	13.6
Kernsville	Schuylkill River	17	583	340
PA-476	Schuylkill - Trib.	38	63	0.5
PA-477	Schuylkill - Trib.	47	206	1.59
PA-478	Schuylkill - Trib.	51	664	1.39
Felix	Schuylkill River	24	1470	647
Bernhart	Schuylkill - Trib.	30	129	2.6
Antietam	Schuylkill - Trib.	60	310	5.4
Green Hills	Schuylkill - Trib.	17	187	15.3

NOTE: These data compiled from Ref 2.4-7, and from a tabulation furnished by the Dam Safety Section, Division of Dams and Encroachments, Department of Environmental Resources, Commonwealth of Pennsylvania, P. O. Box 2063, Harrisburg, PA 17120, Dated March 1, 1977.

TABLE 2.4-4

DAMS ON THE MAIN STEM OF THE SCHUYLKILL RIVER DOWNSTREAM OF LIMERICK SITE[1]

NO.	NAME	HEIGHT (ft)	VOLUME (10^6 gallons/ac-ft)	DRAINAGE AREA (sq miles)	LOCATION (RIVER MILE)
1.	Fairmount Dam	13	1200/3680	1893	8.49
2.	Flat Rock Dam	17	257/789	1809	15.6
3.	Plymouth Dam	8	426/1307	1774	20.7
4.	Norristown Dam	16	<0.5/1.5	1765	23.95
5.	Black Rock Dam	12	72/221	1295.5	36.6
6.	Vincent Dam	7	27/83	1250	44.7

(1) Commonwealth of Pennsylvania, Department of Forests and Waters, Harrisburg, Pa., Water Resources Bulletin No. 5, Dams, Reservoirs, and Natural Lakes, Comprehensive Water Resources Inventory No. 1, 1970.

TABLE 2.4-5

MAJOR FLOODS AT SELECTED STATIONS ON SCHUYLKILL RIVER[1][2]

		BERNE (River mile 95.6) D.A. - 335 sq mi		READING (River mile 74.9) D.A. - 880 sq mi		POTTSTOWN (River mile 53.75) D.A. - 1147 sq mi		PHILADELPHIA (River mile 0) D.A. - 1893 sq mi	
YEAR	DATE	Gauge Ht (feet)	Peak Q (cfs)	Gauge Ht (feet)	Peak Q (cfs)	Gauge Ht (feet)	Peak Q (cfs)	Gauge Ht (feet)	Peak Q (cfs)
1972[4]	22-23 June	19.0	42,800			29.97	95,900	14.65	103,000
1955	19 Aug.	15.73	29,400			17.98	42,300	14.32	90,100
1950	26 Nov.	14.52	23,300			17.90	42,000	14.32	89,800
1942	23 May	15.0	26,900	21.6[3]		20.15	50,800	12.44	61,400
1933	24 Aug.					19.2	47,800	14.7	98,200
1902	28 Feb.			21.5	70,600	21.0	53,900	14.8	98,000
1869	4 Oct.			21.6	71,200			17.0	135,000
1850	2 Sept.			23.0	80,000			16.42	125,000
1839	26 Jan.			13.9	33,300			15.8	114,000
1757	15 July			15.0	37,200				

(1) U.S. Army Corps of Engineers, Emergency employment of Army and Other Resources, NAPDR-500-1-1, Philadelphia District Office, March 1970.
(2) U.S. Army Corps of Engineers, Land, Acquisition Procedure for Blue Marsh Dam and Reservoir, Philadelphia District Office, January 1970.
(3) Estimated
(4) Reference 2.4-1

TABLE 2.4-6 (PAGE 1 OF 2)

INSTANTANEOUS AND AVERAGE DAILY MINIMUM FLOWS OF THE SCHUYLKILL RIVER AT POTTSTOWN, PENNSYLVANIA (cfs)

WATER YEAR	DAY	INSTANTANEOUS	AVERAGE DAILY
1927-28	October 3	406	535
29	July 13	300	468
30	August 13	87	196
31	October 20	97	202
32	September 19	117	175
33	October 2	107	181
34	September 3	386	453
35	September 27	348	461
36	September 23	303	354
37	November 29	265	331
38	October 13,18	353	435,423
39	September 20	248	292
40	August 4,25	352	398,374
41	September 28	121	220
42	October 8	128	217
43	September 28	236	268
44	October 14	292	327
45	October 7	268	395
46	September 17,19	422	453,458
47	December 3	379	505
48	October 28	370	420
49	July 3	170	232
50	August 29	257	501
51	October 6	461	479
52	October 6	414	434
53	August 31	374	399
54	August 1	213	242
55	August 4	239	274
56	January 28	451	507
57	September 7	268	290
58	October 2,3,4	295	325,320,309
59	August 4	346	368
60	October 22	458	476
61	September 29,30	452	471,471
62	August 4	288	306
63	September 25	277	292
64	September 27	199	204
65	July 29	189	212
66	September 2	179	201
67	October 12	298	327
68	September 2	344	373
69	October 6	411	424
70	September 26	396	423
71	October 4	390	450
72	September 17,18	499	513,589

TABLE 2.4-6 (Cont'd)

WATER YEAR	DAY		INSTANTANEOUS	AVERAGE DAILY
73	October	17,18	572	586,586
74	July	22,23	436	457,449
75	November	11	576	589
76	September	15	562	576
77	September	12,15	432	442,444
78	July	24,25	679	709,709
79	September	2	549	569
80	September	10	350	365

TABLE 2.4-7

DURATION TABLE OF DAILY FLOWS FOR THE
SCHUYLKILL RIVER, PERKIOMEN CREEK, AND DELAWARE RIVER (cfs)[1]

PERCENT OF TIME EQUALED OR EXCEEDED	SCHUYLKILL RIVER AT POTTSTOWN, PA USGS 01472000 Period 1928-80	PERKIOMEN CREEK AT GRATERFORD, PA USGS 01473000 Period 1915-80	DELAWARE RIVER AT TRENTON, NJ USGS 01463500 Period 1913-80
2	7600	2700	45,000
5	5300	1400	33,000
10	3900	800	25,000
20	2700	440	17,000
30	2100	310	13,000
40	1650	230	10,000
50	1300	170	8,000
60	1050	120	6,300
70	820	90	5,100
80	640	67	4,000
90	460	48	2,900
95	370	36	2,300
98	300	27	1,860

(1) U.S. Geological Survey

TABLE 2.4-8

LONG-TERM AVERAGE MONTHLY FLOWS OF THE SCHUYLKILL RIVER, PERKIOMEN CREEK, AND DELAWARE RIVER (cfs)

MONTH	SCHUYLKILL RIVER AT POTTSTOWN, PA USGS 01472000 (Oct 1926-Sep 1980)	PERKIOMEN CREEK AT GRATERFORD, PA USGS 01473000 (Jun 1914-Sep 1980)	DELAWARE RIVER AT TRENTON, NJ USGS 01463500 (Oct 1912-Sep 1980)
Jan	2244	528	12,752
Feb	2457	628	12,690
Mar	3217	771	21,431
Apr	2900	546	22,552
May	2218	350	13,962
Jun	1513	221	8,900
Jul	1248	234	7,170
Aug	1090	216	6,105
Sep	1080	191	5,693
Oct	1154	187	6,890
Nov	1701	336	10,578
Dec	2093	463	12,301
Annual	1910	389	11,748

TABLE 2.4-9

OBSERVED AND ESTIMATED WATER SURFACE ELEVATIONS OF THE

SCHUYLKILL RIVER AT LIMERICK SITE

OCCURRENCE	DISCHARGE cfs	WS ELEV AT PLANT SITE
Observed 12/5/69	566	105.3
Observed 12/18/69	1,610	106.5
Observed 6/23/72	95,900	131[1]
COMPUTED FLOODS		
Average Annual (Pottstown Records)	21,000	117.4
Average Annual (WSP 1672)	28,000	119.5
Maximum Observed before 1972	53,900	125.7
100-Year (WSP 1672)	99.000	134.8
Additional Discharge for Rating Curve	200,000	145.0
Additional Discharge for Rating Curve	356,000	158.0

[1]Estimated.

TABLE 2.4-10

DOMESTIC WATER USERS ON THE SCHUYLKILL RIVER

DOWNSTREAM OF LIMERICK SITE[4]

NO.	WATER USER[1]	1971 USE[2]	ENTITLEMENT[2] TOTAL	NON-CONSUMPTIVE	CONSUMPTIVE	CONSUMPTIVE USE AS A PERCENTAGE OF TOTAL	APPROXIMATE LOCATION (River Mile)[3]
1.	Philadelphia Water Dept., Belmont Water Treatment Plant	5,145.250 (The quantities above include users No. 1 and 2.)	7,843.200	7,451.040	392.160	5	10.21
2.	Philadelphia Water Dept., Queen Lane Water Treatment Plant						12.61
3.	Keystone Water Co., Norristown Dist.	258.333	510.720	459.648	51.072	10	24.30
4.	Philadelphia Suburban Water Co.	11.650	608.000	528.960	79.040	13	34.40
5.	Phoenixville Borough	144.827	212.800	191.520	21.280	10	35.50
6.	Citizens Utility Home Water Co.	35.649	60.800	54.720	6.080	10	45.70

(1) Refer to Figure 2.4-2 for locations of water users.
(2) Water use is given in 10^6 gallons per month (1 month = 30.4 days).
(3) Measured from the confluence of the Schuylkill River with the Delaware River.
(4) Source: Delaware River Basin Commission (DRBC), Trenton, N.J., and U.S. Environmental Protection Agency, Region III, Philadelphia, Pa.

TABLE 2.4-11

INDUSTRIAL WATER USERS ON SCHUYLKILL RIVER DOWNSTREAM OF LIMERICK SITE[4]

No.[1]	Water User[2]	1971[3] Use	ENTITLEMENT[3] Total	Non-Consumptive	Consumptive	Consumptive Use as a Percentage of Total	River Distance From Station (mi)
7.	Connelly Containers Inc, Philadelphia Plant	1.160	1.751	1.576	0.175	10	34.4
8.	Container Corp of America, Philadelphia Plant, Mill Div	247.333	328.320	321.754	6.566	2	33.0
9.	Nicolet Industries Inc, Norristown Plant	1.700	13.133	12.520	0.613	4.67	30.0
10.	PECo, W Conshohocken Gas Plant	26.250	55.750	55.192	0.558	1	27.2
11.	National Gypsum Co (Allentown Portland Cement Co) W Conshohocken Plant	66.666	66.666	65.999	0.667	1	27.05
12.	Lukens Steel Co[5]		54.602	52.107	2.495	4.6	25.70
13.	PECo, Barbadoes Generating Station	2,949.083	4,403.866	4,352.429	51.437	1.168	23.7
14.	Synthane-Taylor Corp	24.417	39.398	39.004	0.394	1	17.4
15.	Phoenix Steel Corp (Phoenixville Plant)	250.000	509.490	407.592	101.898	20	12.4
16.	PECo, Cromby Generating Station	10,089.250	11,162.880	11,074.470	88.410	0.792	8.9
17.	Keystone Coke Co[5]		65.362	49.506	15.856	24.3	26.10

(1) These serial numbers are a continuation of those in Table 2.4-4.
(2) See Figure 2.4-2 for locations of water users.
(3) Water use is given in 10^6 gallons per month (1 month = 30.4 days).
(4) Source: Delaware River Basin Commission (DRBC), Trenton N.J., and U.S. Environmental Protection Agency, Region III, Philadelphia, Pa.
(5) No entitlement, rather a fee is paid for water withdrawn from the river

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TABLE 2.4-12

SUMMARY OF SCHUYLKILL RIVER WATER QUALITY 1975 THROUGH 1978 (1)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
TEMPERATURE (C)	0.5	3.0	8.5	1.0	8.0	24.5	18.0	24.5	29.0	4.0	13.5	22.5
DISSOLVED OXYGEN (mg/l)	9.6	11.4	12.5	6.2	9.6	15.4	4.6	6.7	8.0	5.6	8.0	11.0
BIOCHEMICAL OXYGEN DEMAND (mg/l)	0.7	2.0	4.2	1.3	2.1	4.6	1.1	2.6	5.9	1.0	1.7	5.2
TOTAL ORGANIC CARTON (mg/l)	0.0	0.3	20.7	0.0	5.2	19.5	2.2	7.7	18.0	0.0	0.0	11.7
FLOW (CMS)	19	43	264	28	71	206	16	33	160	17	36	240
pH	7.43	7.69	7.90	7.49	7.67	8.18	7.54	7.81	8.16	7.36	7.60	8.24
TOTAL INORGANIC CARBON (mg/l)	41.8	65.1	97.0	29.0	57.4	89.7	59.4	80.6	100.0	35.1	76.1	109.9
TOTAL ALKALINITY (mg/l)	39.1	62.6	94.3	27.9	55.2	87.4	56.4	79.9	97.5	32.8	62.4	103.2
FREE CARBON DIOXIDE (mg/l)	1.1	2.3	4.3	0.6	2.8	5.0	0.5	2.5	11.0	1.4	3.5	7.0
TOTAL HARDNESS (mg/l)	93.5	126.9	212.2	72.5	115.0	179.4	126.9	158.5	193.9	71.6	169.7	256.3
SPECIFIC CONDUCTANCE (USM/CM)	231	344	472	171	282	451	315	386	470	202	354	581
TURBIDITY (JTU)	3.5	9.0	21.0	3.1	7.4	170.0	1.8	6.8	100.0	0.8	4.5	54.0
TOTAL SUSPENDED SOLIDS (mg/l)	1	10	37	3	10	377	0	13	240	4	10	124
TOTAL DISSOLVED SOLIDS (mg/l)	147	215	299	32	190	311	205	270	427	57	272	422
CHLORIDE (mg/l)	11.30	24.20	37.54	10.50	17.50	39.00	15.50	22.23	34.16	10.30	19.80	40.00
FLUORIDE (mg/l)	0.09	0.17	0.31	0.00	0.17	0.27	0.00	0.27	0.67	0.07	0.26	0.41
SULFATE (mg/l)	38.5	66.8	119.1	36.0	56.0	97.5	59.7	88.9	117.1	35.1	102.4	209.7
SODIUM (mg/l)	7.56	12.40	25.39	6.91	12.09	19.48	12.03	17.71	26.11	5.98	12.94	31.47
POTASSIUM (mg/l)	1.88	2.40	3.38	1.71	2.18	2.94	2.51	2.83	4.34	2.38	2.99	4.18
CALCIUM (mg/l)	22.66	34.30	49.28	20.92	30.00	44.71	31.24	39.37	70.10	20.11	36.93	62.30
MAGNESIUM (mg/l)	8.73	14.10	21.45	7.54	11.37	17.81	12.57	16.10	20.96	7.34	15.55	27.30

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
AMMONIA-NITROGEN (mg/l)	0.14	0.48	1.41	0.00	0.25	0.62	0.00	0.08	0.22	0.01	0.19	0.53
NITRITE NITROGEN (mg/l)	0.02	0.05	0.10	0.02	0.09	0.16	0.03	0.07	0.14	0.03	0.07	0.23
NITRATE NITROGEN (mg/l)	1.79	2.48	3.59	1.15	2.19	3.11	2.00	2.62	3.21	1.45	2.64	3.61
TOTAL PHOSPHATE PHOSPHORUS (mg/l)	0.12	0.20	0.44	0.11	0.17	0.42	0.19	0.31	0.74	0.12	0.29	0.64
ORTHO PHOSPHATE PHOSPHORUS (mg/l)	0.09	0.16	0.37	0.07	0.11	0.22	0.12	0.22	0.34	0.05	0.16	0.42
ARSENIC (mg/l)	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.002
BERYLLIUM (mg/)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BORON (mg/l)	0.00	0.12	0.23	0.05	0.14	0.21	0.00	0.13	0.21	0.03	0.15	0.27
CADMIUM (mg/l)	0.000	0.000	0.012	0.000	0.001	0.001	0.000	0.000	0.003	0.000	0.000	0.004
CHROMIUM (mg/.l)	0.002	0.004	0.011	0.002	0.004	0.014	0.001	0.006	0.043	0.002	0.005	0.020
COPPER (mg/l)	0.004	0.011	0.046	0.007	0.013	0.027	0.006	0.015	0.110	0.002	0.009	0.042
IRON (mg/l)	0.123	0.297	0.980	0.201	0.420	6.680	0.108	0.413	13.560	0.090	0.230	3.440
LEAD (mg/l)	0.000	0.002	0.007	0.000	0.004	0.027	0.000	0.004	0.348	0.000	0.001	0.013
MANGANESE (mg/l)	0.190	0.326	0.675	0.159	0.303	0.640	0.050	0.113	1.380	0.060	0.224	1.185
NICKEL (mg/l)	0.00	0.00	0.06	0.00	0.00	0.02	0.00	0.00	0.09	0.00	0.00	0.05
SELENIUM (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZINC (mg/l)	0.000	0.035	0.160	0.015	0.045	0.146	0.015	0.027	0.194	0.001	0.031	0.113
MERCURY (µg/l)	0.000	0.000	0.400	0.000	0.000	0.400	0.000	0.100	1.200	0.000	0.000	0.500
COBALT (mg/l)	0.001	0.001	0.006	0.001	0.002	0.005	0.000	0.000	0.045	0.000	0.000	0.000

(1)STATION S 77660

TABLE 2.4-13

SUMMARY OF PERKIOMEN CREEK WATER QUALITY 1975 THROUGH 1978 (1)

PARAMETER	DEC, JAN, FEB MIN	MED	MAX	MAR, APR, MAY MIN	MED	MAX	JUN, JUL, AUG MIN	MED	MAX	SEP, OCT, NOV MIN	MED	MAX
TEMPERATURE (C)	0.0	0.5	5.0	0.0	10.0	26.0	16.0	22.5	29.0	2.0	13.0	22.0
DISSOLVED OXYGEN (mg/l)	11.0	13.0	15.6	8.0	12.1	17.0	5.0	7.7	10.4	7.4	10.4	14.4
BIOCHEMICAL OXYGEN DEMAND (mg/l)	0.1	1.2	2.9	0.1	1.7	6.5	0.4	1.7	5.0	0.0	1.1	4.6
TOTAL ORGANIC CARBON (mg/l)	0.0	4.1	44.4	0.0	7.8	15.3	0.0	9.2	27.1	0.0	3.7	17.7
FLOW (CMS)	3	9	42	4	8	108	2	7	14	2	4	92
pH	7.34	7.59	8.62	7.24	7.77	9.54	7.43	8.06	8.61	7.39	7.94	9.03
TOTAL INORGANIC CARBON (mg/l)	31.9	52.5	81.4	24.4	39.7	58.1	7.2	60.9	79.5	35.0	68.0	92.8
TOTAL ALKALINITY (mg/l)	29.4	49.6	78.4	21.9	39.4	58.1	6.6	62.2	78.6	32.2	66.6	91.8
FREE CARBON DIOXIDE (mg/l)	0.0	2.0	5.0	0.0	1.0	3.0	0.0	1.0	4.4	0.0	1.5	3.5
TOTAL HARDNESS (mg/l)	57.0	80.0	129.3	49.4	73.7	96.2	67.3	86.0	106.4	48.8	102.0	120.7
SPECIFIC CONDUCTAMCE (USM/CM)	167	215	339	136	194	288	180	247	336	155	277	332
TURBIDITY (JTU)	2.4	5.7	210.0	2.8	6.0	312.0	2.3	5.5	296.0	0.9	4.2	70.0
TOTAL SUSPENDED SOLIDS (mg/l)	0	6	251	0	7	717	0	9	274	0	6	69
TOTAL DISSOLVED SOLIDS (mg/l)	61	147	224	0	135	190	79	174	466	132	189	310
CHLORIDE (mg/l)	12.40	24.70	46.69	8.86	17.00	40.10	14.60	21.23	50.30	12.10	26.60	37.97
FLUORIDE (mg/l)	0.00	0.16	0.55	0.04	0.11	0.50	0.02	0.21	0.51	0.00	0.21	0.31
SULFATE (mg/l)	18.7	32.2	48.0	19.3	27.5	38.0	18.7	30.1	53.6	22.1	32.9	71.9
SODIUM (mg/l)	7.67	10.50	22.80	6.89	9.37	17.42	7.41	13.34	19.95	5.46	10.67	19.05
POTASSIUM (mg/l)	1.73	2.94	5.30	1.66	2.38	5.26	2.21	4.39	12.99	2.37	5.68	11.70
CALCIUM (mg/l)	13.30	19.21	36.61	12.93	18.04	28.40	16.19	23.45	39.90	12.97	24.26	37.90
MAGNESIUM (mg/l)	5.78	8.21	12.53	5.10	7.16	10.31	6.23	8.60	10.57	5.05	9.13	14.80

TABLE 2.4-13 (Cont'd)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
AMMONIA-NITROGEN (mg/l)	0.00	0.15	0.89	0.00	0.02	0.19	0.00	0.01	0.20	0.00	0.02	0.11
NITRITE NITROGEN (mg/l)	0.02	0.02	0.05	0.02	0.03	0.06	0.01	0.02	0.11	0.00	0.02	0.09
NITRATE NITROGEN (mg/l)	0.75	1.76	3.14	0.47	1.30	2.00	0.28	0.83	2.75	0.00	1.04	2.07
TOTAL PHOSPHATE PHOSPHORUS (mg/l)	0.06	0.12	0.24	0.05	0.09	0.61	0.09	0.17	0.94	0.07	0.15	0.35
ORTHO PHOSPHATE PHOSPHORUS (mg/l)	0.05	0.08	0.18	0.02	0.07	0.17	0.04	0.12	0.23	0.06	0.15	0.31
ARSENIC (mg/l)	0.000	0.000	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.000	0.000
BERYLLIUM (mg/)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BORON (mg/l)	0.00	0.17	0.59	0.06	0.15	0.24	0.00	0.12	0.41	0.00	0.16	0.31
CADMIUM (mg/l)	0.000	0.000	0.002	0.000	0.000	0.005	0.000	0.000	0.004	0.000	0.000	0.009
CHROMIUM (mg/.l)	0.000	0.002	0.005	0.000	0.001	0.014	0.000	0.001	0.010	0.000	0.002	0.007
COPPER (mg/l)	0.003	0.008	0.017	0.001	0.007	0.033	0.003	0.007	0.122	0.000	0.007	0.012
IRON (mg/l)	0.090	0.269	2.814	0.091	0.270	8.988	0.089	0.280	7.487	0.102	0.277	1.119
LEAD (mg/l)	0.000	0.001	0.012	0.000	0.001	0.027	0.000	0.002	0.079	0.000	0.001	0.012
MANGANESE (mg/l)	0.004	0.054	0.197	0.012	0.042	0.666	0.000	0.063	0.272	0.005	0.029	0.272
NICKEL (mg/l)	0.00	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01
SELENIUM (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZINC (mg/l)	0.000	0.012	0.119	0.000	0.010	0.076	0.000	0.012	0.092	0.000	0.006	0.045
MERCURY (μg/l)	0.000	0.000	0.905	0.000	0.000	0.300	0.000	0.000	0.400	0.000	0.000	0.500
COBALT (mg/l)	0.000	0.000	0.003	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000

(1)Station P 14390

LGS EROL
TABLE 2.4-14

SUMMARY OF EAST BRANCH PERKIOMEN CREEK WATER QUALITY 1975 THROUGH 1978 (1)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
TEMPERATURE (C)	0.0	0.0	3.5	0.0	9.0	23.0	15.0	21.5	27.5	0.5	12.0	20.0
DISSOLVED OXYGEN (mg/l)	9.2	12.8	14.2	6.4	10.6	13.6	4.9	6.9	9.8	5.0	9.0	12.8
BIOCHEMICAL OXYGEN DEMAND (mg/l)	0.0	0.8	5.2	0.0	1.1	5.7	0.2	1.6	4.3	0.0	1.4	6.3
TOTAL ORGANIC CARBON (mg/l)	0.0	0.1	14.9	0.0	7.4	11.8	0.0	8.6	93.4	0.0	3.5	29.1
FLOW (CMS)	0.15	0.48	3.23	0.08	0.34	2.08	0.00	0.11	0.91	0.00	0.07	2.53
pH	7.11	7.25	7.84	6.94	7.47	8.26	7.30	7.63	7.98	6.97	7.46	8.19
TOTAL INORGANIC CARBON (mg/l)	21.0	40.4	74.6	16.3	34.3	66.5	29.9	71.1	98.0	21.7	61.7	105.4
TOTAL ALKALINITY (mg/l)	18.0	35.4	72.4	13.0	32.0	60.1	28.9	69.8	93.0	19.8	62.4	95.7
FREE CARBON DIOXIDE (mg/l)	1.0	2.5	5.0	0.7	2.2	6.0	0.4	3.0	57.0	0.8	3.5	5.3
TOTAL HARDNESS (mg/l)	49.6	80.1	134.5	38.7	67.8	97.9	62.0	97.4	121.4	36.5	92.7	142.0
SPECIFIC CONDUCTANCE (USM/CM)	144	197	495	99	190	297	187	266	327	122	244	361
TURBIDITY (JTU)	2.4	6.3	200.0	3.2	6.5	276.0	1.7	5.3	50.0	1.2	4.7	110.0
TOTAL SUSPENDED SOLIDS (mg/l)	0	5	350	1	6	552	0	7	31	0	5	185
TOTAL DISSOLVED SOLIDS (mg/l)	89	141	294	0	119	250	124	183	241	120	182	261
CHLORIDE (mg/l)	11.70	20.66	109.40	7.80	17.01	35.70	9.51	25.50	47.38	7.90	24.88	41.47
FLUORIDE (mg/l)	0.00	0.01	0.40	0.00	0.02	0.11	0.00	0.10	0.46	0.00	0.10	0.21
SULFATE (mg/l)	20.6	35.8	49.0	20.3	31.0	40.1	24.9	32.3	38.6	21.5	34.8	82.1
SODIUM (mg/l)	7.28	9.85	57.21	5.12	9.22	18.31	8.27	14.10	28.80	4.27	10.71	18.05
POTASSIUM (mg/l)	1.53	2.16	3.80	1.33	1.89	3.14	1.91	2.86	5.45	1.76	2.99	47.91
CALCIUM (mg/l)	10.26	15.44	28.68	7.97	16.20	23.10	13.60	21.80	35.50	9.50	20.80	31.13
MAGNESIUM (mg/l)	5.65	9.88	15.94	4.57	8.70	12.35	8.00	11.25	14.73	4.67	12.04	16.14

LGS EROL
TABLE 2.4-14 (Cont'd)

PARAMETER	DEC, JAN, FEB MIN	MED	MAX	MAR, APR, MAY MIN	MED	MAX	JUN, JUL, AUG MIN	MED	MAX	SEP, OCT, NOV MIN	MED	MAX
AMMONIA-NITROGEN (mg/l)	0.00	0.00	0.14	0.00	0.01	0.15	0.00	0.00	0.14	0.00	0.00	0.06
NITRITE NITROGEN (mg/l)	0.00	0.01	0.04	0.00	0.01	0.08	0.00	0.01	0.40	0.00	0.01	0.09
NITRATE NITROGEN (mg/l)	0.62	1.82	4.08	0.00	1.20	2.57	0.00	0.15	1.55	0.00	0.42	2.78
TOTAL PHOSPHATE PHOSPHORUS (mg/l)	0.01	0.04	0.25	0.01	0.04	0.46	0.02	0.04	0.25	0.00	0.04	0.38
ORTHO PHOSPHATE PHOSPHORUS (mg/l)	0.00	0.02	0.09	0.00	0.03	0.08	0.00	0.02	0.07	0.00	0.02	0.18
ARSENIC (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BERYLLIUM (mg/)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BORON (mg/l)	0.00	0.11	0.23	0.06	0.10	0.26	0.00	0.09	0.44	0.02	0.12	0.24
CADMIUM (mg/l)	0.000	0.000	0.001	0.000	0.000	0.005	0.000	0.000	0.005	0.000	0.000	0.004
CHROMIUM (mg/l)	0.000	0.001	0.005	0.000	0.001	0.008	0.000	0.001	0.004	0.000	0.001	0.006
COPPER (mg/l)	0.002	0.007	0.080	0.000	0.007	0.024	0.002	0.006	0.018	0.000	0.005	0.024
IRON (mg/l)	0.047	0.240	3.441	0.066	0.224	8.375	0.108	0.250	0.831	0.050	0.234	2.104
LEAD (mg/l)	0.000	0.001	0.134	0.000	0.002	0.025	0.000	0.003	0.009	0.000	0.001	0.012
MANGANESE (mg/l)	0.021	0.051	0.300	0.000	0.035	0.347	0.012	0.049	0.252	0.005	0.032	0.442
NICKEL (mg/l)	0.00	0.00	0.03	0.00	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.01
SELENIUM (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZINC (mg/l)	0.000	0.012	0.050	0.000	0.010	0.410	0.000	0.008	0.032	0.000	0.008	0.046
MERCURY (µg/l)	0.000	0.000	1.990	0.000	0.000	0.500	0.000	0.000	20.000	0.000	0.000	4.900
COBALT (mg/l)	0.000	0.000	0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000

(1) Station E 32300

LGS EROL
TABLE 2.4-15

SUMMARY OF EAST BRANCH PERKIOMEN CREEK WATER QUALITY 1975 THROUGH 1978 (1)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
TEMPERATURE (C)	0.0	0.0	5.5	0.0	10.0	26.0	15.5	22.5	28.0	1.0	12.0	21.0
DISSOLVED OXYGEN (mg/l)	9.6	12.7	15.8	8.8	11.8	18.8	4.0	8.0	11.1	7.2	10.0	15.0
BIOCHEMICAL OXYGEN DEMAND (mg/l)	0.2	1.2	3.2	0.5	1.4	8.7	0.3	1.4	4.0	0.0	1.1	6.3
TOTAL ORGANIC CARBON (mg/l)	0.0	2.4	98.6	0.0	8.0	15.8	0.0	11.6	17.6	0.0	4.6	21.9
FLOW (CMS)	0.41	1.80	12.13	0.20	1.17	5.88	0.00	0.28	1.47	0.00	0.29	3.20
pH	7.36	7.51	8.60	7.24	7.84	9.80	7.63	8.15	8.87	7.32	9.03	8.79
TOTAL INORGANIC CARBON (mg/l)	27.9	63.0	144.3	13.9	46.8	83.2	46.4	87.7	136.4	35.6	80.1	149.8
TOTAL ALKALINITY (mg/l)	26.0	60.4	132.1	12.3	48.3	83.2	44.1	88.4	133.1	32.2	87.4	148.3
FREE CARBON DIOXIDE (mg/l)	0.0	2.0	8.3	0.0	1.0	3.0	0.0	1.0	6.0	0.0	1.9	7.5
TOTAL HARDNESS (mg/l)	65.5	109.4	194.5	42.9	90.0	148.6	65.8	134.9	222.8	56.0	140.0	232.9
SPECIFIC CONDUCTANCE (USM/CM)	188	324	684	148	279	555	193	428	892	171	444	731
TURBIDITY (JTU)	2.0	6.7	210.0	1.6	4.9	284.0	1.1	4.0	140.0	0.7	3.4	105.0
TOTAL SUSPENDED SOLIDS (mg/l)	0	4	331	0	3	707	0	7	157	0	4	149
TOTAL DISSOLVED SOLIDS (mg/l)	107	205	460	45	177	341	149	288	380	169	297	458
CHLORIDE (mg/l)	19.14	40.80	103.00	14.20	32.30	87.20	10.01	56.18	79.70	22.50	50.90	105.70
FLUORIDE (mg/l)	0.00	0.07	0.45	0.00	0.09	0.21	0.03	0.19	0.41	0.00	0.17	0.34
SULFATE (mg/l)	24.6	47.0	99.9	19.3	38.7	64.0	22.1	55.0	118.7	34.1	61.5	813.6
SODIUM (mg/l)	10.19	23.55	68.57	8.78	18.20	46.59	11.20	38.13	62.06	9.38	22.60	73.82
POTASSIUM (mg/l)	1.84	3.13	6.53	1.90	2.93	5.06	3.08	5.14	8.15	2.69	4.90	8.02
CALCIUM (mg/l)	12.82	22.84	47.38	11.88	21.52	35.99	16.10	31.74	82.60	12.97	30.80	47.60
MAGNESIUM (mg/l)	7.62	12.20	21.84	4.63	9.88	16.10	7.10	12.58	18.01	5.74	14.67	22.00

TABLE 2.4-15 (Cont'd)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
AMMONIA-NITROGEN (mg/l)	0.00	0.28	3.98	0.00	0.07	0.75	0.00	0.00	0.62	0.00	0.02	0.15
NITRITE NITROGEN (mg/l)	0.01	0.04	0.30	0.02	0.03	0.26	0.00	0.02	0.17	0.00	0.02	0.11
NITRATE NITROGEN (mg/l)	1.46	2.94	4.30	0.22	1.87	3.63	0.00	0.79	2.38	0.00	1.76	3.67
TOTAL PHOSPHATE PHOSPHORUS (mg/l)	0.08	0.42	2.04	0.07	0.32	1.00	0.25	0.72	1.72	0.25	0.55	1.64
ORTHO PHOSPHATE PHOSPHORUS (mg/l)	0.05	0.33	1.87	0.11	0.23	0.71	0.14	0.57	1.60	0.23	0.45	1.32
ARSENIC (mg/l)	0.000	0.000	0.003	0.000	0.000	0.006	0.000	0.000	0.007	0.000	0.000	0.006
BERYLLIUM (mg/)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BARON (mg/l)	0.00	0.19	0.56	0.10	0.18	0.27	0.07	0.23	1.73	0.00	0.18	0.50
CADMIUM (mg/l)	0.000	0.002	0.006	0.000	0.001	0.004	0.000	0.002	0.009	0.000	0.001	0.013
CHROMIUM (mg/.l)	0.000	0.006	0.020	0.001	0.003	0.037	0.000	0.003	0.011	0.000	0.004	0.068
COPPER (mg/l)	0.003	0.009	0.026	0.005	0.012	0.109	0.004	0.009	0.447	0.001	0.009	0.021
IRON (mg/l)	0.010	0.187	2.971	0.000	0.147	8.808	0.005	0.227	3.698	0.006	0.125	1.787
LEAD (mg/l)	0.000	0.001	0.010	0.000	0.001	0.027	0.000	0.003	0.060	0.000	0.001	0.016
MANGANESE (mg/l)	0.004	0.042	0.197	0.000	0.028	0.507	0.000	0.047	0.250	0.000	0.023	0.321
NICKEL (mg/l)	0.00	0.00	0.05	0.00	0.00	0.03	0.00	0.00	0.25	0.00	0.00	0.02
SELENIUM (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZINC (mg/l)	0.000	0.018	0.057	0.000	0.010	0.092	0.000	0.014	0.340	0.000	0.009	0.046
MERCURY (μg/l)	0.000	0.000	1.500	0.000	0.000	0.400	0.000	0.000	0.700	0.000	0.000	0.500
COBALT (mg/l)	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000

(1)Station E 2800

LGS EROL
TABLE 2.4-16

SUMMARY OF DELAWARE RIVER WATER QUALITY 1975 THROUGH 1978 (1)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
TEMPERATURE (C)	0.0	1.0	4.5	0.0	9.5	22.5	17.0	23.0	29.0	2.0	13.0	24.0
DISSOLVED OXYGEN (mg/l)	11.4	12.6	14.4	7.6	10.4	13.0	6.2	7.5	13.8	7.0	9.4	12.4
BIOCHEMICAL OXYGEN DEMAND (mg/l)	0.0	1.0	5.5	0.3	1.3	5.2	0.3	2.0	5.0	0.0	1.2	4.0
TOTAL ORGANIC CARBON (mg/l)	0.0	2.1	19.2	0.0	7.2	13.7	0.0	7.9	31.0	0.0	3.6	12.9
FLOW (CMS)	156	277	1862	264	419	841	132	226	541	98	268	741
pH	7.27	7.58	7.89	7.31	7.53	7.97	7.52	7.85	9.22	7.26	7.52	8.42
TOTAL INORGANIC CARBON (mg/l)	25.5	40.6	57.8	15.6	27.6	47.7	27.1	49.3	61.4	22.6	41.4	66.0
TOTAL ALKALINITY (mg/l)	23.4	38.6	54.0	14.3	26.3	45.9	26.1	47.4	60.3	11.4	38.8	62.5
FREE CARBON DIOXIDE (mg/l)	0.5	1.5	5.0	0.5	1.3	3.5	0.0	1.5	7.0	0.0	2.0	4.3
TOTAL HARDNESS (mg/l)	36.6	58.9	74.5	35.6	49.4	76.4	45.4	70.1	85.0	31.4	50.9	88.4
SPECIFIC CONDUCTANCE (USM/CM)	89	155	216	92	127	205	122	181	235	100	143	224
TURBIDITY (JTU)	2.0	3.4	21.0	1.7	4.8	68.0	1.1	4.2	35.0	0.5	3.5	43.0
TOTAL SUSPENDED SOLIDS (mg/l)	0	4	54	0	9	99	0	7	93	0	8	86
TOTAL DISSOLVED SOLIDS (mg/l)	47	100	166	0	97	133	91	117	160	66	108	317
CHLORIDE (mg/l)	7.44	11.34	22.21	4.90	9.07	26.79	7.01	11.70	18.77	1.00	11.62	32.07
FLUORIDE (mg/l)	0.00	0.01	0.47	0.00	0.03	0.10	0.00	0.10	0.64	0.00	0.07	0.26
SULFATE (mg/l)	12.3	21.1	35.8	14.6	20.0	28.5	14.1	27.3	31.5	7.8	21.8	38.5
SODIUM (mg/l)	3.44	6.50	10.76	3.29	5.47	8.32	4.99	7.05	19.29	3.05	5.06	10.34
POTASSIUM (mg/l)	1.07	1.44	2.10	0.93	1.26	2.06	1.23	1.63	2.71	1.18	1.71	3.09
CALCIUM (mg/l)	8.93	14.01	18.81	9.34	12.35	19.16	10.68	17.99	31.90	7.51	13.64	22.00
MAGNESIUM (mg/l)	3.31	5.75	7.16	2.67	4.74	7.49	3.40	6.99	9.41	2.55	5.18	9.20

TABLE 2.4-16 (Cont'd)

PARAMETER	DEC, JAN, FEB			MAR, APR, MAY			JUN, JUL, AUG			SEP, OCT, NOV		
	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX	MIN	MED	MAX
AMMONIA-NITROGEN (mg/l)	0.07	0.26	0.55	0.00	0.10	1.00	0.00	0.03	0.18	0.00	0.06	0.29
NITRITE NITROGEN (mg/l)	0.01	0.02	0.04	0.01	0.02	0.05	0.02	0.04	0.08	0.01	0.04	0.07
NITRATE NITROGEN (mg/l)	0.59	0.89	1.52	0.32	0.64	1.21	0.38	0.96	1.35	0.11	0.75	1.54
TOTAL PHOSPHATE PHOSPHORUS (mg/l)	0.05	0.09	0.13	0.04	0.07	0.17	0.06	0.12	0.27	0.05	0.13	0.28
ORTHO PHOSPHATE PHOSPHORUS (mg/l)	0.02	0.06	0.23	0.01	0.04	0.09	0.02	0.06	0.13	0.03	0.07	0.17
ARSENIC (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BERYLLIUM (mg/)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
BARON (mg/l)	0.00	0.11	0.56	0.03	0.08	0.21	0.00	0.08	0.26	0.00	0.08	0.20
CADMIUM (mg/l)	0.000	0.000	0.003	0.000	0.000	0.003	0.000	0.000	0.010	0.000	0.000	0.003
CHROMIUM (mg/l)	0.000	0.001	0.005	0.000	0.001	0.004	0.000	0.001	0.011	0.000	0.002	0.006
COPPER (mg/l)	0.003	0.006	0.067	0.003	0.006	0.024	0.001	0.008	0.027	0.000	0.007	0.021
IRON (mg/l)	0.080	0.218	1.962	0.080	0.261	2.064	0.073	0.267	1.900	0.050	0.259	2.996
LEAD (mg/l)	0.000	0.001	0.006	0.000	0.002	0.010	0.000	0.004	0.020	0.000	0.002	0.012
MANGANESE (mg/l)	0.005	0.069	0.330	0.027	0.066	0.151	0.031	0.073	0.256	0.005	0.051	0.483
NICKEL (mg/l)	0.00	0.00	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.06
SELENIUM (mg/l)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ZINC (mg/l)	0.027	0.060	0.153	0.019	0.034	0.072	0.004	0.028	0.096	0.008	0.032	0.215
MERCURY (μg/l)	0.000	0.000	0.300	0.000	0.000	0.400	0.000	0.000	0.400	0.000	0.000	0.400
COBALT (mg/l)	0.000	0.000	0.003	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000

(1)Station A 11263

TABLE 2.4-17

SUMMARY OF SCHUYLKILL RIVER WATER TEMPERATURE AT POTTSTOWN[1]
(Pottstown Municipal Water Intake, 1957 to 1975)

		JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT	OCT	NOV	DEC
	MAX							87.8	86.9	83.3	72.5	64.4	55.4
1957	AVG							82.7	80.6	77.1	64.4	55.5	46.6
	MIN							78.8	75.2	62.6	55.4	49.1	40.1
	MAX	44.6	47.7	50.9	69.8	71.6	81.5	87.8	86.9	84.2	68.0	59.9	44.6
1958	AVG	41.2	41.0	47.3	58.5	64.7	75.0	83.2	81.6	75.7	62.7	55.0	40.5
	MIN	36.5	35.6	42.8	49.1	52.6	68.0	77.0	73.4	65.3	57.2	42.8	37.4
	MAX	46.4	45.5	56.3	66.2	86.0	95.0	93.2	93.2	86.0	80.6	62.6	50.0
1959	AVG	41.4	42.0	68.9	59.2	73.2	79.9	85.8	85.1	79.0	70.3	54.1	45.1
	MIN	37.4	37.4	42.8	53.6	62.6	71.6	78.8	77.0	69.8	57.2	46.4	39.2
	MAX	46.4	51.8	55.4	73.4	71.6	82.4	86.0	89.6	82.4	68.0	60.8	55.4
1960	AVG	43.4	44.8	45.8	60.7	66.7	76.4	81.6	83.1	73.3	64.6	54.7	43.3
	MIN	39.2	41.0	39.2	50.0	59.0	69.8	77.0	78.8	66.2	57.2	50.0	37.4
	MAX	44.6	46.4	57.2	66.2	71.6	84.2	86.0	84.2	87.8	75.2	71.6	50.0
1961	AVG	40.2	42.7	49.6	54.9	65.3	77.6	80.8	79.5	80.5	68.2	57.3	44.8
	MIN	35.6	37.4	44.6	48.2	59.0	69.9	77.0	75.2	68.0	60.8	46.4	39.2
	MAX	44.6	46.4	60.8	75.2	80.6	86.0	86.0	86.0	86.0	69.8	53.6	48.2
1962	AVG	41.5	42.1	47.3	58.3	72.1	80.9	81.2	81.5	73.5	63.6	49.5	41.3
	MIN	39.2	39.2	41.0	48.2	62.6	73.4	75.2	71.6	64.4	51.8	44.6	37.4
	MAX	42.4	42.8	55.4	68.0	73.4	87.8	89.6	84.2	-	73.4	62.6	50.0
1963	AVG	39.4	40.0	46.2	60.2	68.3	78.6	84.5	81.0	-	68.6	58.5	44.1
	MIN	35.6	35.6	39.2	53.6	59.0	71.0	77.0	77.0	-	59.0	51.8	39.2
	MAX	44.6	44.6	53.6	60.8	78.8	82.4	89.6	82.4	80.6	68.0	60.8	50.0
1964	AVG	40.8	42.2	47.0	54.3	67.0	74.2	82.0	78.1	74.1	61.3	55.2	44.5
	MIN	35.6	41.0	41.0	46.4	51.8	66.2	73.4	71.6	68.0	55.4	46.4	39.2
	MAX	44.6	44.6	50.0	60.8	78.8	82.4	82.4	82.4	84.2	69.8	59.0	51.8
1965	AVG	39.4	40.9	45.9	54.9	71.6	75.6	77.8	76.8	76.0	64.1	55.2	47.1
	MIN	35.6	35.6	41.0	46.4	62.6	69.8	73.4	69.8	69.8	57.2	48.2	42.8
	MAX	48.2	46.4	55.4	59.0	73.4	84.2	86.0	84.2	82.4	68.0	62.6	59.0
1966	AVG	41.9	40.5	47.3	54.3	63.1	76.9	83.1	80.9	74.5	64.1	56.1	47.0
	MIN	35.6	33.8	41.0	48.2	55.4	66.2	80.6	77.0	66.3	57.2	50.0	39.2
	MAX	50.0	48.2	53.6	64.4	68.0	84.2	84.2	82.4	77.0	73.4	60.8	51.8
1967	AVG	44.1	42.7	45.4	57.0	61.4	77.7	80.5	77.7	73.2	64.9	54.6	47.4
	MIN	41.0	37.4	39.2	51.8	55.4	66.2	77.0	69.8	64.4	55.4	44.6	41.0

TABLE 2.4-17 (Cont'd)

		JAN	FEB	MAR	APR	MAY	JUNE	JUL	AUG	SEPT	OCT	NOV	DEC
1968	MAX	48.4	50.0	57.2	66.2	66.2	77.0	86.0	84.2	80.6	73.4	60.8	50.0
	AVG	42.0	44.7	50.3	61.3	63.3	71.1	81.5	82.6	76.3	67.2	54.0	43.2
	MIN	35.6	39.2	42.8	57.2	59.0	62.6	75.2	78.8	69.8	59.0	48.2	37.4
1969	MAX	46.6	46.4	55.4	60.8	75.2	82.4	84.2	82.4	80.6	71.6	62.6	-
	AVG	40.8	42.5	48.2	56.2	67.4	77.2	79.4	77.5	75.0	65.6	55.3	-
	MIN	35.6	39.2	42.8	48.2	60.8	73.4	75.2	73.4	68.0	59.0	48.2	-
1970	MAX	42.8	44.6	48.2	64.4	72.6	77.0	84.2	82.4	82.4	73.4	64.4	53.6
	AVG	39.9	41.8	45.0	52.0	66.4	72.6	77.2	78.8	77.4	66.3	57.3	47.3
	MIN	37.4	39.2	41.0	44.6	60.8	68.0	73.4	71.6	71.6	62.6	48.2	41.0
1971	MAX	42.8	51.8	51.8	66.2	69.8	82.4	84.2	78.8	78.8	71.6	66.2	55.4
	AVG	40.5	43.1	47.7	57.1	64.0	74.7	80.0	76.4	74.4	66.5	55.5	49.2
	MIN	35.6	33.8	41.0	48.2	59.0	64.4	78.8	71.6	66.2	62.6	48.2	42.8
1972	MAX	53.6	48.2	53.6	60.8	69.8	75.2	84.2	84.2	78.8	69.8	60.8	53.6
	AVG	46.0	42.5	48.1	55.0	64.7	70.8	76.0	79.0	75.0	62.2	53.7	47.3
	MIN	39.2	39.2	42.8	44.6	59.0	68.0	66.2	75.2	49.8	53.6	46.6	42.8
1973	MAX	50.0	46.4	55.4	64.4	64.4	77.0	82.4	84.2	84.2	71.6	62.6	53.6
	AVG	44.5	42.7	50.6	55.4	60.7	71.2	76.9	79.1	75.2	66.2	56.2	49.1
	MIN	39.2	39.2	44.6	48.2	55.4	62.6	68.0	75.2	69.8	60.8	51.8	42.8
1974	MAX	48.2	48.2	51.8	66.2	71.6	77.0	84.2	82.4	80.6	68.0	66.2	48.2
	AVG	43.8	43.6	48.4	54.9	65.8	73.4	79.3	80.2	72.7	61.8	55.9	45.8
	MIN	39.2	39.2	44.6	44.6	59.0	68.0	69.8	77.0	60.8	55.4	46.4	42.8

Temperatures are in °F. All temperatures are daily averages.

TABLE 2.4-18

DAILY SUSPENDED SEDIMENT DISCHARGE OF THE SCHUYLKILL RIVER AT MANAYUNK, PA
(FOR WATER YEAR 1975-1976)

	OCTOBER			NOVEMBER			DECEMBER			JANUARY		
DAY	MEAN DISCHARGE (cfs)	MEAN CONCENTRATION (mg/L)	SEDIMENT DISCHARGE (Tons/Day)	MEAN DISCHARGE (cfs)	MEAN CONCENTRATION (mg/L)	SEDIMENT DISCHARGE (Tons/Day)	MEAN DISCHARGE (cfs)	MEAN CONCENTRATION (mg/L)	SEDIMENT DISCHARGE (Tons/Day)	MEAN DISCHARGE (cfs)	MEAN CONCENTRATION (mg/L)	SEDIMENT DISCHARGE (Tons/Day)
1	4970	20	268	2380	10	64	2410	5	33	13400	176	7050
2	4240	17	195	2270	10	61	2540	5	34	8300	80	1790
3	3640	12	118	2230	9	54	2320	4	25	5870	26	412
4	3140	10	85	2180	9	53	2110	2	11	6790	19	348
5	2850	11	85	2050	10	55	1990	1	5.4	4590	12	149
6	2620	13	92	1950	12	63	1950	1	5.3	3600	7	68
7	2410	12	78	1850	11	55	1940	2	10	3360	8	73
8	2220	8	48	1960	14	74	1900	2	10	4810	18	234
9	2150	9	52	2280	10	62	1810	1	4.9	3730	8	81
10	2120	10	57	2180	8	47	1860	1	5.0	2630	7	50
11	2250	8	49	3260	12	106	1900	1	5.1	2390	5	32
12	2780	12	90	4070	17	187	1770	1	4.8	2480	6	40
13	2550	10	69	13500	95	3460	1660	1	4.5	2350	10	63
14	2090	11	62	13200	143	5100	1620	2	8.7	6780	130	2380
15	1890	12	61	8640	83	1940	1620	1	4.4	6690	105	1900
16	1770	14	67	6410	47	813	1650	1	4.5	3670	55	545
17	1740	10	47	5200	25	351	1640	1	4.4	2820	19	145
18	4930	95	1260	4380	10	118	1530	1	4.1	2120	10	57
19	16600	279	13200	3820	8	83	1420	1	3.8	1700	7	32
20	13400	170	6150	3450	7	65	1290	1	3.5	1620	6	26
21	9890	150	4010	3700	12	120	1270	3	10	1580	7	30
22	7240	57	1110	4460	16	193	1240	4	13	1510	9	37
23	6450	30	552	3990	8	86	1220	4	13	1480	8	32
24	4860	18	236	3260	7	62	1200	2	6.5	1430	10	39
25	4370	17	201	3040	5	41	1180	2	6.4	1660	10	45
26	4030	16	174	2870	5	39	4420	60	716	2140	55	318
27	3670	15	149	2760	4	30	8100	95	2080	38100	1130	122000
28	3280	14	124	2850	4	31	5330	30	432	44800	640	77400
29	3000	11	89	2680	3	22	3830	15	155	15000	180	7290
30	2770	12	90	2460	3	20	3210	6	52	9320	770	1760
31	2510	10	68	-	-	-	4710	20	254	6920	33	617
TOTAL	132430	-	28906	119330	-	13455	72640		3929.3	213640		225043

TABLE 2.4-18 (Cont'd)

DAY	FEBRUARY MEAN DISCHARGE (cfs)	FEBRUARY MEAN CONCENTRATION (mg/L)	FEBRUARY SEDIMENT DISCHARGE (Tons/Day)	MARCH MEAN DISCHARGE (cfs)	MARCH MEAN CONCENTRATION (mg/L)	MARCH SEDIMENT DISCHARGE (Tons/Day)	APRIL MEAN DISCHARGE (cfs)	APRIL MEAN CONCENTRATION (mg/L)	APRIL SEDIMENT DISCHARGE (Tons/Day)	MAY MEAN DISCHARGE (cfs)	MAY MEAN CONCENTRATION (mg/L)	MAY SEDIMENT DISCHARGE (Tons/Day)
1	5710	25	385	2970	15	120	8500	150	3440	2090	25	141
2	12800	190	6570	2820	13	99	10700	115	3320	3760	20	203
3	6700	120	2170	2730	10	74	7410	43	860	3420	18	166
4	5310	45	645	2860	9	69	5900	26	414	2370	14	90
5	4790	22	285	3150	10	85	5210	13	183	1960	13	69
6	4170	16	180	3260	15	132	4280	10	116	1760	14	67
7	3640	15	147	2730	23	170	3700	9	90	1690	15	68
8	3430	13	120	2520	22	150	3290	10	89	1600	14	60
9	3240	10	87	2420	8	52	3020	9	73	1480	15	60
10	2990	12	97	2570	2	14	2760	8	60	1350	14	51
11	3240	20	175	2670	3	22	2550	8	55	1390	12	45
12	4370	25	295	3210	4	35	2440	8	53	1610	15	65
13	3270	20	177	5620	27	410	2260	9	55	1610	17	74
14	3240	25	219	6560	42	744	2110	8	46	1400	16	60
15	2930	14	111	4840	13	170	2000	6	32	1260	15	51
16	2740	10	74	4320	6	70	1990	11	59	1220	15	49
17	5530	20	299	4610	10	124	1860	9	45	1540	17	71
18	6000	50	810	3890	5	53	1820	8	39	2560	30	207
19	5730	165	2550	3310	3	27	1730	9	42	3030	30	245
20	5060	50	683	3130	4	34	1670	11	50	2420	20	131
21	4370	26	307	2970	7	56	1540	13	54	2220	21	126
22	5210	25	352	2930	9	71	1710	17	78	2870	22	170
23	5440	40	588	2770	10	75	1530	12	50	2530	21	143
24	4430	25	299	2490	8	54	1450	10	39	2190	22	130
25	4100	18	199	2340	7	44	1390	18	68	1980	22	118
26	4010	16	173	2260	6	37	1650	13	58	1800	21	102
27	3820	12	124	2170	7	41	1980	11	59	1680	21	95
28	3420	11	102	2350	8	51	1680	10	45	1560	20	84
29	3170	11	94	2540	8	55	1440	9	35	1460	19	75
30	-	-	-	2240	8	48	1350	8	29	1520	22	90
31	-	-	-	2100	11	62	-	-	-	1650	21	94
TOTAL	132860	-	18317	97350	-	3248	90920		9636	60980		3200

TABLE 2.4-18 (Cont'd)

DAY	JUNE MEAN DISCHARGE (cfs)	JUNE MEAN CONCENTRATION (mg/L)	JUNE SEDIMENT DISCHARGE (Tons/Day)	JULY MEAN DISCHARGE (cfs)	JULY MEAN CONCENTRATION (mg/L)	JULY SEDIMENT DISCHARGE (Tons/Day)	AUGUST MEAN DISCHARGE (cfs)	AUGUST MEAN CONCENTRATION (mg/L)	AUGUST SEDIMENT DISCHARGE (Tons/Day)	SEPTEMBER MEAN DISCHARGE (cfs)	SEPTEMBER MEAN CONCENTRATION (mg/L)	SEPTEMBER SEDIMENT DISCHARGE (Tons/Day)
1	1640	19	84	2610	40	282	1410	22	84	594	14	22
2	2510	23	156	4400	50	594	1010	21	57	595	15	24
3	2700	21	153	2400	38	246	880	20	48	625	16	27
4	1800	18	87	2440	36	237	790	18	38	630	15	26
5	1420	13	50	2150	36	209	710	15	29	651	11	19
6	1280	10	35	1640	41	182	653	15	26	607	10	16
7	1180	12	38	1500	40	162	771	16	33	552	10	15
8	1250	10	34	1580	36	154	1260	25	85	489	10	13
9	1150	11	34	1820	34	167	1820	36	177	457	11	14
10	1010	11	30	1580	24	102	3630	56	549	456	13	16
11	916	10	25	2300	35	217	2660	33	237	537	14	20
12	800	10	22	3100	40	335	1820	21	103	614	13	22
13	752	11	22	1880	38	193	1350	20	73	603	12	20
14	797	11	24	1390	34	128	1740	28	132	519	11	15
15	759	10	20	1220	25	82	2450	25	165	448	11	13
16	762	11	23	1140	21	65	1920	23	119	540	11	16
17	1420	23	88	1200	19	62	2140	33	191	2070	33	184
18	1760	22	105	1100	19	56	1700	29	133	3760	27	274
19	1240	18	60	980	16	42	1320	25	89	2930	13	103
20	945	23	59	850	12	28	1120	23	70	1820	12	59
21	977	24	63	820	9	20	984	20	53	1340	13	47
22	2260	34	207	790	9	19	890	17	41	1150	14	43
23	4300	39	453	790	13	28	815	15	33	1030	14	39
24	3250	35	307	920	18	45	746	14	28	892	12	29
25	2370	33	211	1290	24	84	714	15	29	791	11	23
26	1890	30	153	1010	19	52	690	11	20	775	10	21
27	1570	29	123	820	18	40	751	13	26	850	13	30
28	1510	28	114	680	15	28	1360	22	81	1420	17	65
29	1520	31	127	650	13	23	949	18	46	1990	19	102
30	1800	33	160	1320	20	71	741	17	34	1770	17	81
31	-	-	-	2290	24	148	654	13	23	-	-	-
TOTAL	47538	-	3067	48660	-	4101	40448	-	2852	31505	-	1398

TABLE 2.4-18 (Cont'd)

DATE	TIME	INSTANTANEOUS DISCHARGES (cfs)	TEMPERATURE (°C)	SUSPENDED SEDIMENT (mg/L)	SUSPENDED SEDIMENT DISCHARGE (Ton/Day)	SUSPENDED SEDIMENT FALL DIAM. % FINER THAN .004 mm	SUSPENDED SEDIMENT FALL DIAM. % FINER THAN .008 mm
OCT 19	1820	22500	15.5	344	20900	33	50
JAN 27	1900	47600	3.0	1140	14700	44	58

DATE	SUSPENDED SEDIMENT FALL DIAM. % FINER THAN .016 mm	SUSPENDED SEDIMENT SIEVE DIAM. % FINER THAN .031 mm	SUSPENDED SEDIMENT FALL DIAM % FINER THAN .062 mm	SUSPENDED SEDIMENT SIEVE DIAM. % FINER THAN .125 mm	SUSPENDED SEDIMENT SIEVE DIAM. % FINER THAN .250 mm	SUSPENDED SEDIMENT SIEVE DIAM. % FINER THAN .500 mm
OCT 19	67	80	90	97	99	100
OCT 27	71	80	84	88	96	99

TABLE 2.4-19

DURATION TABLE FOR SUSPENDED SEDIMENT CONCENTRATION OF THE SCHUYLKILL RIVER AT MANAYUNK, PA[1]

PERIOD	Mean daily concentration, in milligrams per liter, that was equaled or exceeded for indicated percentage of time													
	1	2	5	10	20	30	40	50	60	70	80	90	95	90
1976	350	165	88	40	26	21	17	15	12	11	9	6	3	1
1960-76	440	270	125	57	28	20	17	14	13	11	9	7	5	4

(1) Ref 2.4-1

TABLE 2.4-20

PERMEABILITY DATA

HOLE	TYPE OF TEST	DEPTH INTERVAL TESTED (ft.)	ZONE TESTED	PERMEABILITY (ft/yr)
PT-1	Well Permeability	4.38 - 7.55	Soil	0.6
PT-2	Well Permeameter	7.75 - 12.17	Soil	3.8
PT-3	Well Permeameter	16.67 - 22.67	Soil	3.1
PT-4	Well Permeameter	12.00 - 16.16	Soil	9.3
PT-5	Well Permeameter	21.52 - 26.94	Rock	0.06
PT-6	Well Permeameter	19.37 - 23.25	Rock	0.4
PT-7	Well Permeameter	6.37 - 12.67	Soil	0.98
T-1	Well Permeameter	14.70 - 16.45	Contact	3.6
T-2	Well Permeameter	19.10 - 21.10	Contact	17.0
T-3	Well Permeameter	20.97 - 21.77	Contact	21.5
P-1	Packer	10 - 20	Rock	38.5
	Packer	20 - 30	Rock	41.9
	Packer	30 - 40	Rock	176.8
	Packer	40 - 50	Rock	266.1
	Packer	50 - 60	Rock	18.7
	Packer	50 - 60	Rock	7.8
	Packer	60 - 70	Rock	71.2
	Packer	70 - 80	Rock	1.2
	Packer	80 - 90	Rock	287.4
	Packer	90 - 100	Rock	0.1
	Packer	100 - 110	Rock	28.3
	Packer	110 - 120	Rock	5.9
P-2	Packer	14 - 22	Rock	0.8
	Packer	22 - 32	Rock	41.7
	Packer	32 - 42	Rock	86.4
	Packer	42 - 52	Rock	119.7
	Packer	52 - 62	Rock	50.6
P-3	Packer	15 - 25	Rock	1081.2
	Packer	25 - 35	Rock	476.3
	Packer	35 - 45	Rock	459.7
	Packer	45 - 55	Rock	371.7
	Packer	55 - 65	Rock	191.0
P-4	Packer	25 - 35	Rock	329.0
	Packer	35 - 45	Rock	58.2
	Packer	45 - 55	Rock	525.7
	Packer	55 - 65	Rock	127.5
	Packer	65 - 75	Rock	361.8
P-5	Packer	21 - 31	Rock	1247.8
	Packer	41 - 51	Rock	66.6
	Packer	51 - 61	Rock	314.2
	Packer	61 - 71	Rock	200.0

CHEMICAL ANALYSES OF GROUNDWATER IN THE BRUNSWICK LITHOFACIES IN MONTGOMERY COUNTY, PENNSYLVANIA

(Results in parts per million except as indicated)

WELL NUMBER	DATE OF COLLECTION	DEPTH OF WELL (ft.)	SILICA (SiO_2)	TOTAL IRON (Fe)	TOTAL MANGANESE (Mn)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)
52	9-25-25	350	18	.06	--	47	17	9.4	2.1	194	23	13	--
62(1)	9-28-25	388	32	.05	--	36	15	11	1.8	173	15	8	--
76	2-21-52	387	21	.01	--	24	20	6	1.0	150	22	5	--
111	5-10-62	219	30	.37	.00	57	18	13	0.7	171	69	16	0.1
146	4- 7-53	205	13	.26	--	57	28	13	1.0	242	58	18	0.0
148	2- 7-62	373	17	.07	.00	45	5.4	12	1.0	134	26	10	0.1
190	2- 8-62	202	22	.04	.00	55	23	14	1.0	256	19	17	0.1
540	4- 9-62	600	20	.44	.02	116	51	22	0.8	163	370	11	0.1
541	3- 2-61	300	22	.05	.00	39	8.3	10	1.0	120	24	7.4	0.1
551	3- 1-61	450	19	.26	.01	47	9.0	14	1.0	179	12	9.3	0.0
557	4- 9-62	210	24	.00	.17	49	12	12	0.8	128	69	5.8	0.1
603	3- 2-61	916	28	3.9	.04	180	32	27	1.0	180	420	18	0.2
616	4-21-49	100	20	.17	--	52	13	11	1.4	198	23	7.0	0.0
631	2-28-61	500	16	.38	.03	30	8.2	45	0.5	173	48	3.5	0.0
642	3- 1-61	312	28	.02	.03	90	36	19	1.8	162	248	6.0	0.2
662	2-27-61	300	17	.21	.06	71	30	30	1.5	217	84	68	0.1
678	3- 1-61	300	24	.06	.04	39	14	8.3	1.0	178	17	4.2	0.0
680	3- 1-61	500	28	.70	.38	59	17	15	1.0	252	37	4.2	0.1
689	3- 1-61	300	32	.02	.05	126	28	19	2.5	158	300	16	0.6
708	2- 5-62	123	23	.14	.00	70	21	12	1.5	236	32	20	0.1
709	2- 8-62	80	23	.05	.00	44	34	12	1.0	298	9.7	5.1	0.1
710	2- 8-62	100	22	.20	.00	55	20	14	2.2	202	40	18	0.2
711	2- 8-62	81	33	.07	.00	36	17	11	3.0	152	29	13	0.2
712	2- 5-62	157	21	1.6	.00	54	36	17	1.5	268	83	6.4	0.1
718	4- 9-62	133	19	3.0	.12	53	15	15	1.5	211	27	13	0.0
736	9-30-25	111	23	4.9	--	45	11	12	3.0	183	13	12	--
738	9-30-25	110	25	0.15	--	48	24	12	1.2	234	6.4	19	--

(1) Composite sample from 3 wells (62, 63, 64).

TABLE 2.4-21 (cont'd).

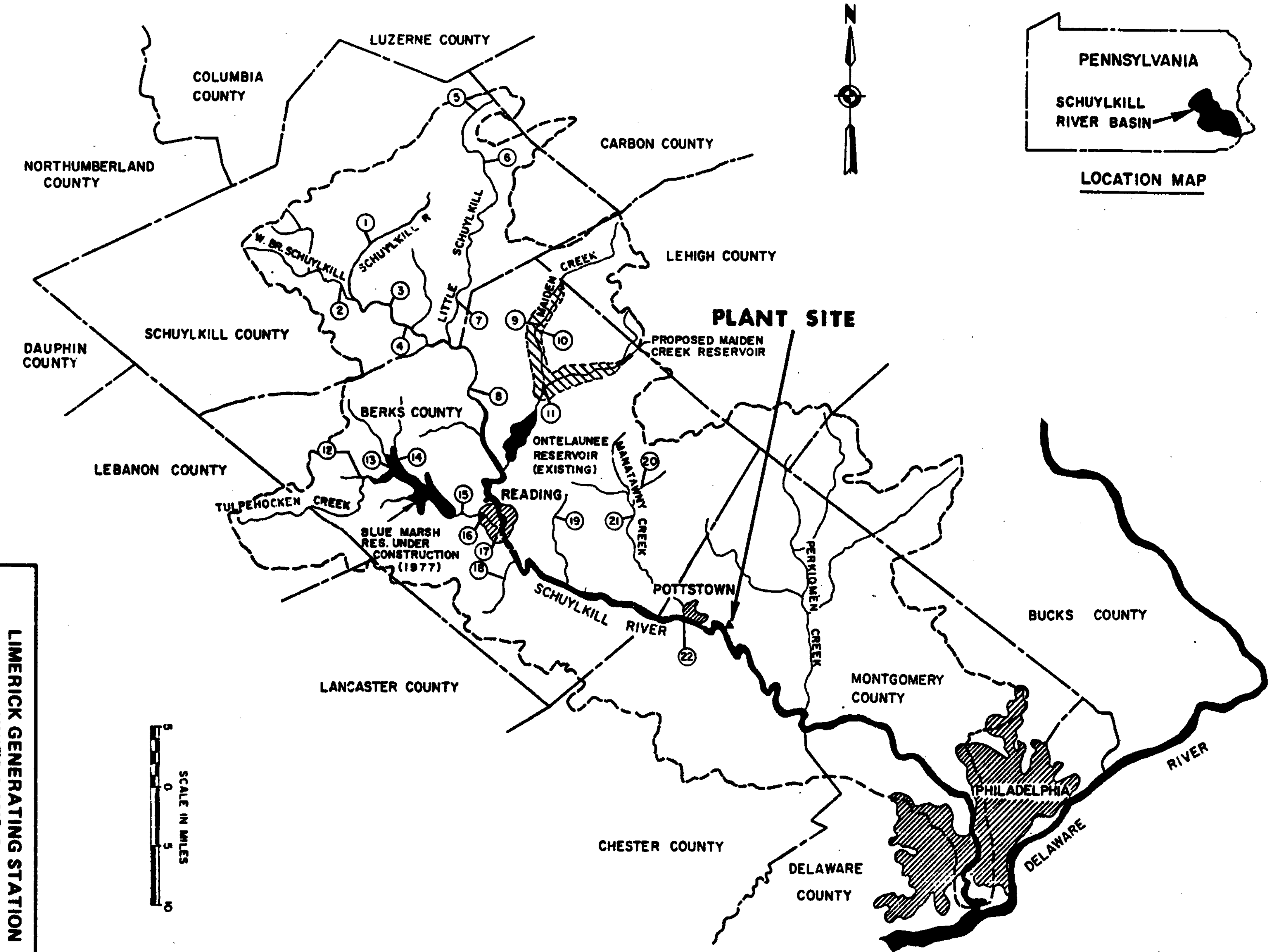
WELL NUMBER	NITRATE (NO_3)	DISSOLVED SOLIDS (Residue at 180°C)	HARDNESS AS $CaCO_3$		SPECIFIC CONDUCTANCE (micromhos/Cm at 25°C)	pH
			CALCIUM MAGNESIUM	NON-CARBONATE		
52	7.5	232	187	28	--	--
62(1)	2.5	201	185	10	--	--
76	0.4	--	142	19	321	6.4
111	4.9	317	216	76	457	6.6
146	9.9	327	257	59	555	7.3
148	13.0	200	135	25	313	7.5
190	7.7	285	232	22	480	7.6
540	11	732	500	366	959	7.3
541	20	192	132	33	295	7.7
551	18	214	155	8	351	7.8
557	13	252	172	67	378	6.8
603	2.8	805	581	433	1090	7.4
616	12	242	183	21	392	7.5
631	3.7	239	109	0	378	8.0
642	2.7	534	373	240	747	7.7
662	5.6	426	301	123	695	7.9
678	8.0	204	155	9	322	7.7
680	0.2	283	217	11	447	7.5
689	0.5	620	430	300	838	7.6
708	36	344	261	68	536	7.6
709	20	302	250	6	490	8.2
710	19	307	219	54	478	7.4
711	8.8	236	160	36	359	7.7
712	3.1	360	283	63	565	7.6
718	4.0	255	194	21	429	6.9
736	0.88	209	158	8	--	--
738	14	252	218	26	--	--

Table 2.4-22

CHEMICAL ANALYSIS OF GROUND WATER FROM WELLS IN THE BRUNSWICK LITHOFACIES AT THE LIMERICK PROJECT SITE.

(Results in parts per million except as indicated)

Well #	Date Collected	Depth of Well (ft)	Calcium as $CaCO_3$	Chloride	Sulfate	Nitrate as (N)	Ammonia as (N)	Iron (Total)	Total Alkalinity	Total Hardness EDTA	Dissolved Solids	pH
1	12/10/70	307	16.0	4.5	422	0.26	1.36	.0	120	540	988	7.7
3	12/10/70	585	177.9	6.0	461	0.38	2.24	.0	148	618	1052	7.9
4	8/12/71	198	32.0	3.0	77	1.0	----	.04	116	134	202	8.0



NOTES:

1. COMPILED FROM MAPS OF THE COMMONWEALTH OF PENNSYLVANIA, DEPARTMENT OF ENVIRONMENTAL RESOURCES (FORMERLY FORESTS AND WATERS).
2. (1) INDICATES STREAM GAGING STATION; SEE TABLE 2.4-2.

LIMERICK GENERATING STATION
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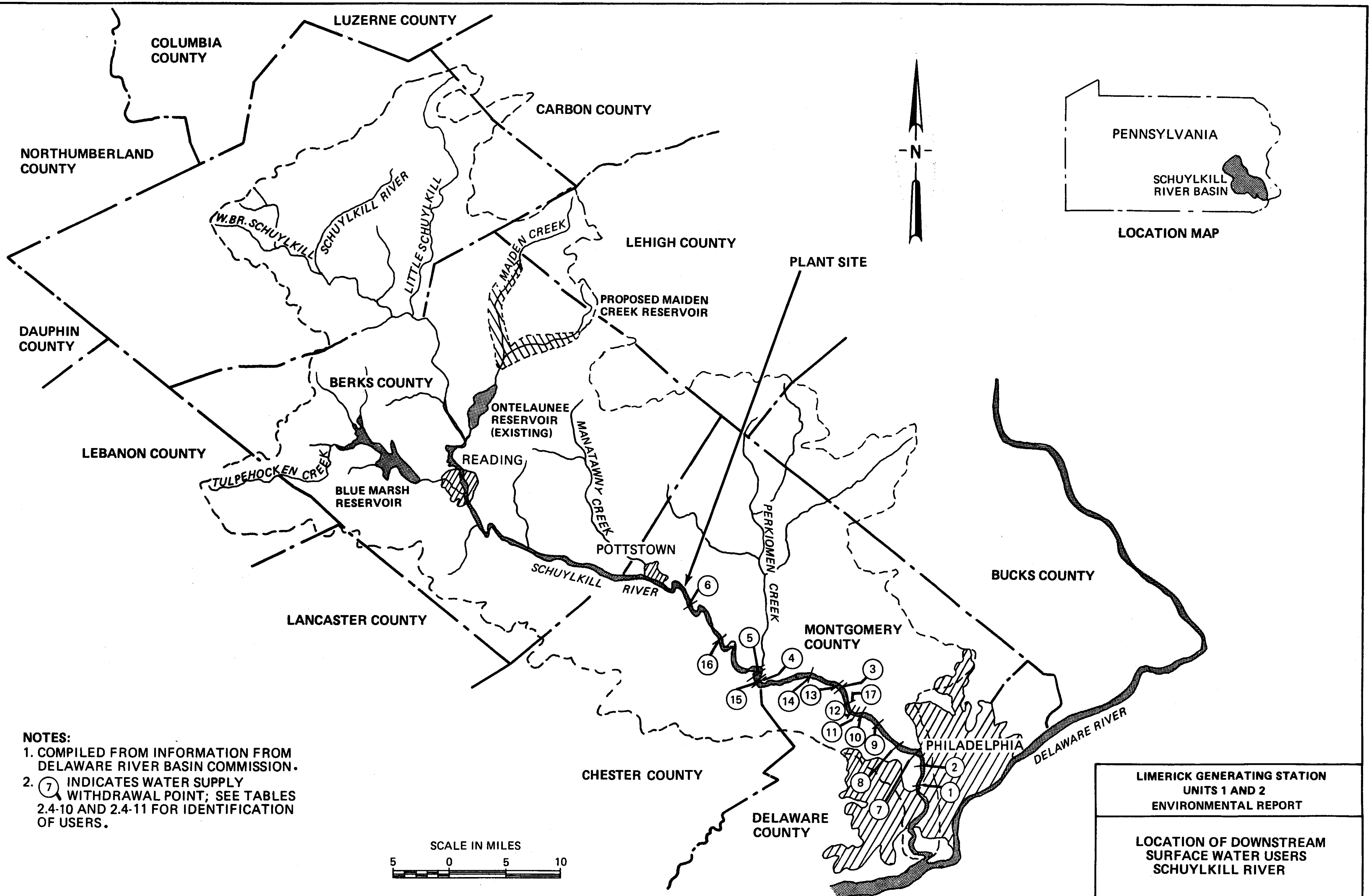
SCHUYLKILL RIVER BASIN

FIGURE 2.4-1



NOTES:
1. COMPILED FROM INFORMATION FROM DELAWARE RIVER BASIN COMMISSION.
2. (7) INDICATES WATER SUPPLY WITHDRAWAL POINT; SEE TABLES 2.4-10 AND 2.4-11 FOR IDENTIFICATION OF USERS.

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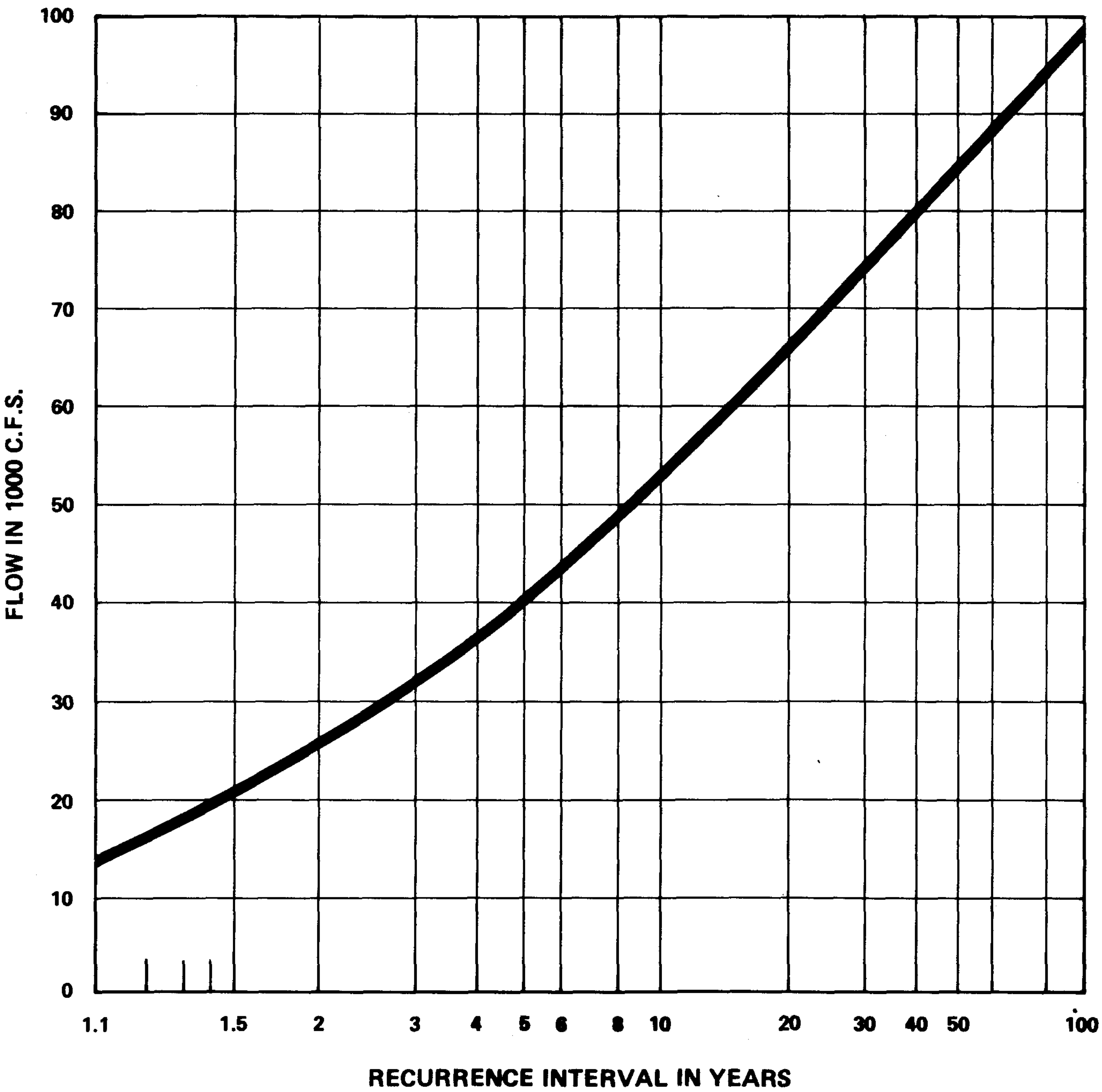
LOCATION OF DOWNSTREAM SURFACE WATER USERS SCHUYLKILL RIVER

FIGURE 2.4-2

REV. 4, 07/82



NOTES:
BASED ON REGIONAL FLOOD – FREQUENCY ANALYSIS PRESENTED IN USGS WATER SUPPLY PAPER 1672. DRAINAGE AREA EQUALS 1147 SQUARE MILES.

LIMERICK GENERATING STATION
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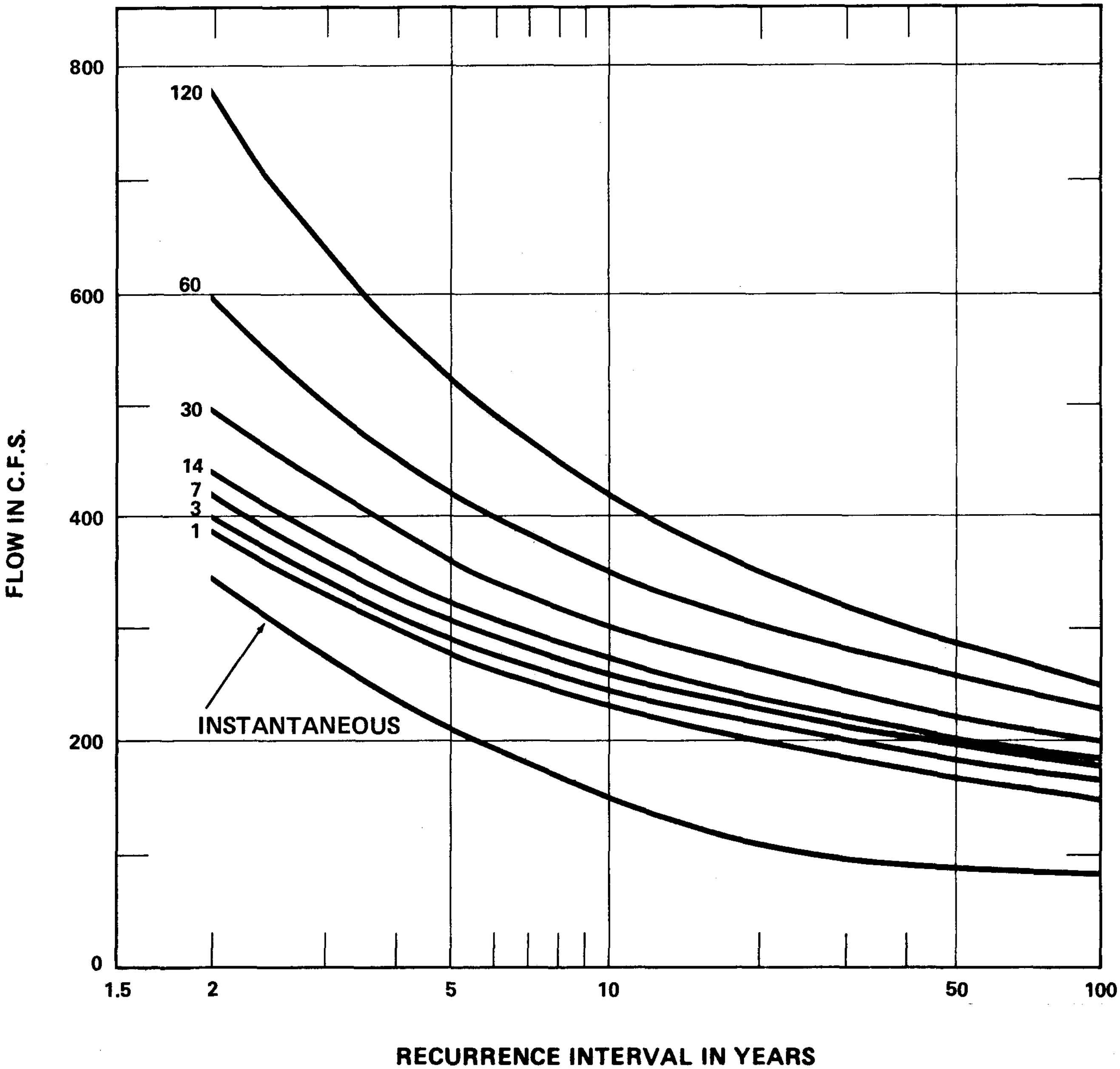
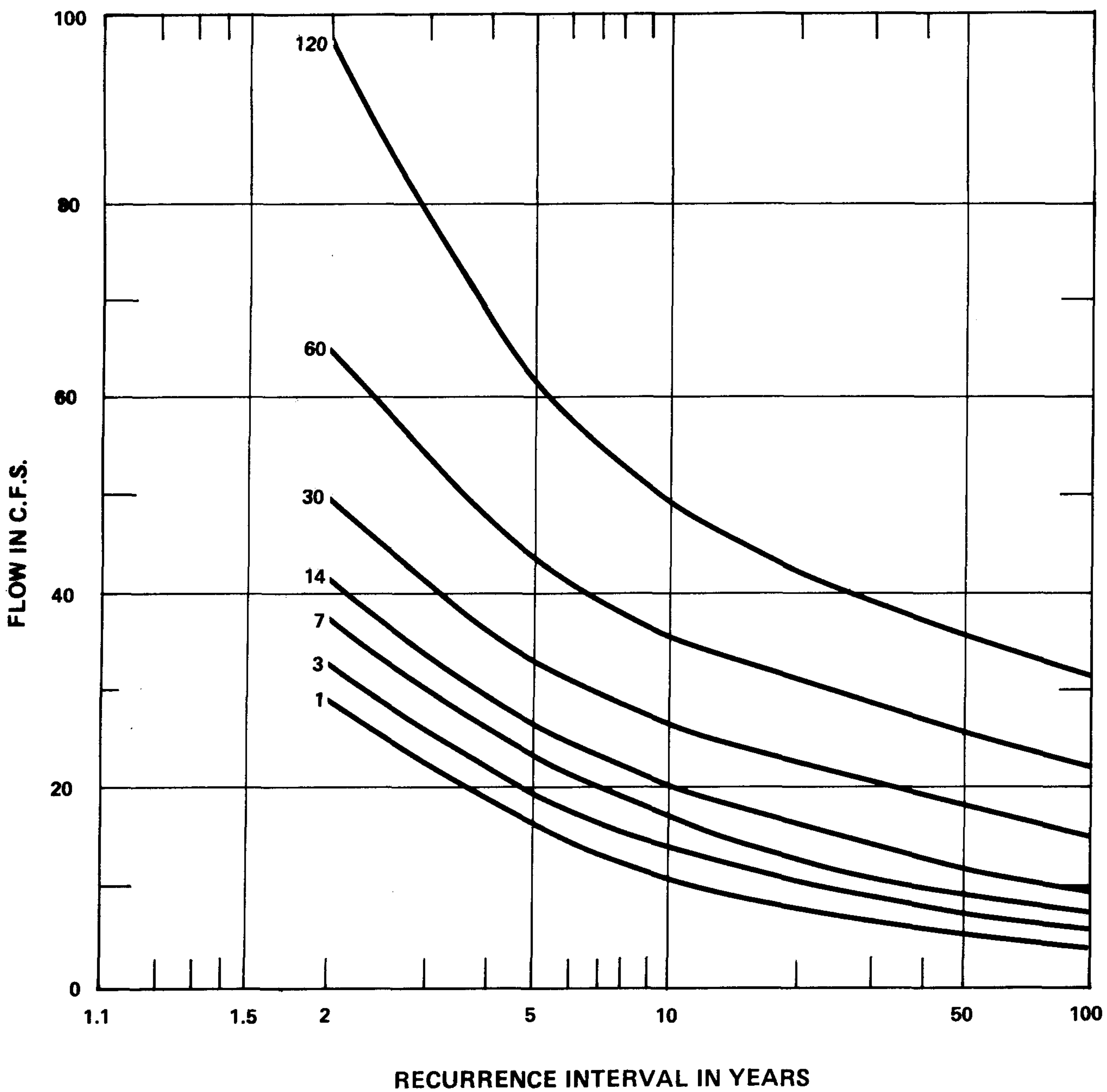
FLOOD FREQUENCY CURVE
SCHUYLKILL RIVER AT
POTTSTOWN, PA.

FIGURE 2.4-3



1. CURVES INDICATE THE AVERAGE FLOW FOR THE INDICATED NUMBER OF SUCCESSIVE DAYS.
2. DEVIATION OF THE INSTANTANEOUS CURVE RESULT FROM DIURNAL FLUCTUATION.
3. CURVES COMPUTED FROM RECORDS FOR 1929 - 80.

LIMERICK GENERATING STATION UNITS 1 AND 2 ENVIRONMENTAL REPORT
LOW FLOW FREQUENCY CURVE SCHUYLKILL RIVER AT POTTSTOWN, PA.
FIGURE 2.4-4 REV. 3, 3/82



1. CURVES INDICATE THE AVERAGE FLOW FOR THE INDICATED NUMBER OF SUCCESSIVE DAYS.
2. CURVES COMPUTED FROM RECORDS FOR 1916 - 80

LIMERICK GENERATING STATION
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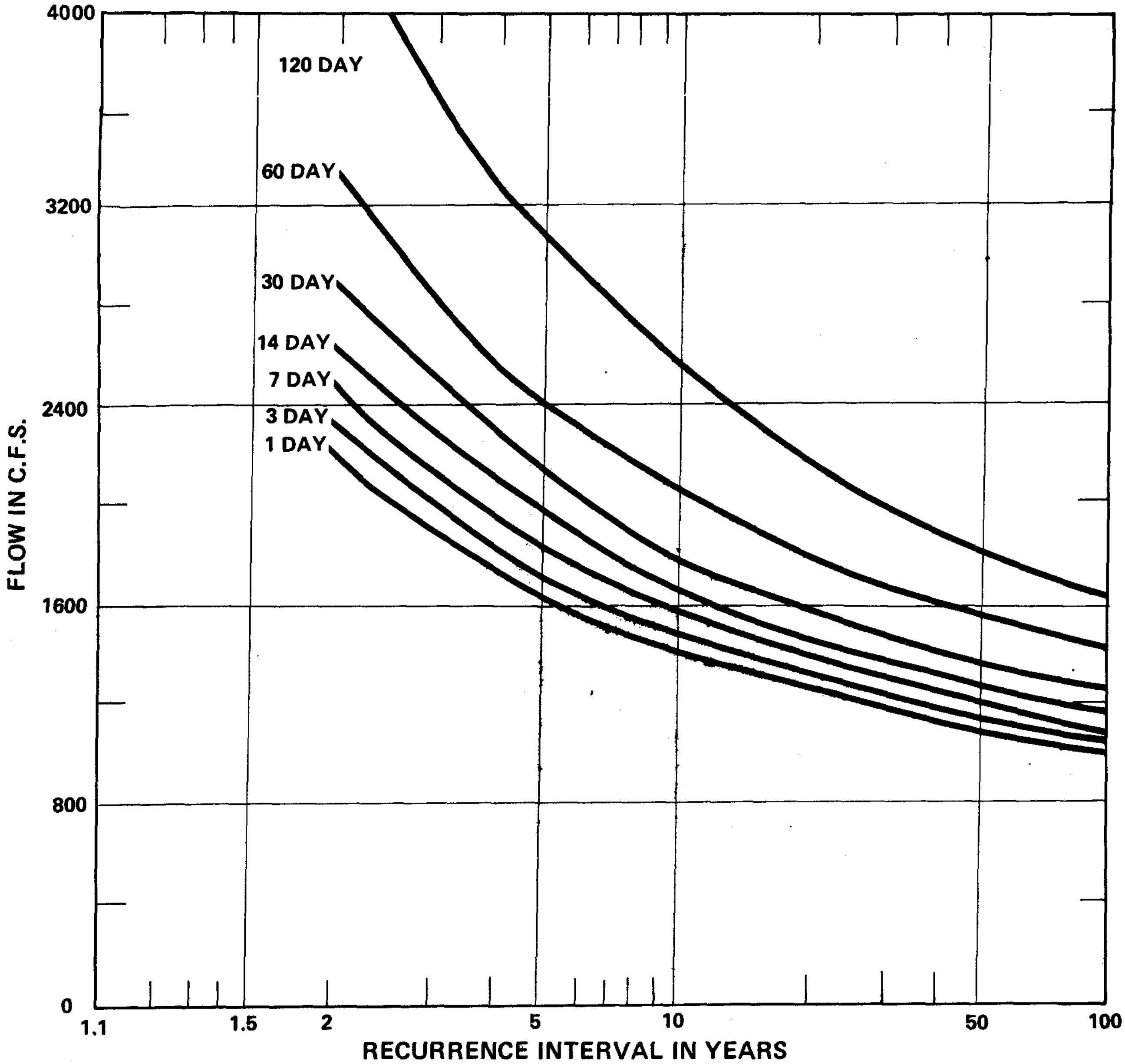
LOW FLOW FREQUENCY CURVES OF PERKIOMEN CREEK AT GRATERFORD, PA.

FIGURE 2.4-4a REV. 3, 3/82



1. CURVES INDICATE THE AVERAGE FLOW FOR THE INDICATED NUMBER OF SUCCESSIVE DAYS.
2. CURVES COMPUTED FROM RECORDS FOR 1914–80.

LIMERICK GENERATING STATION
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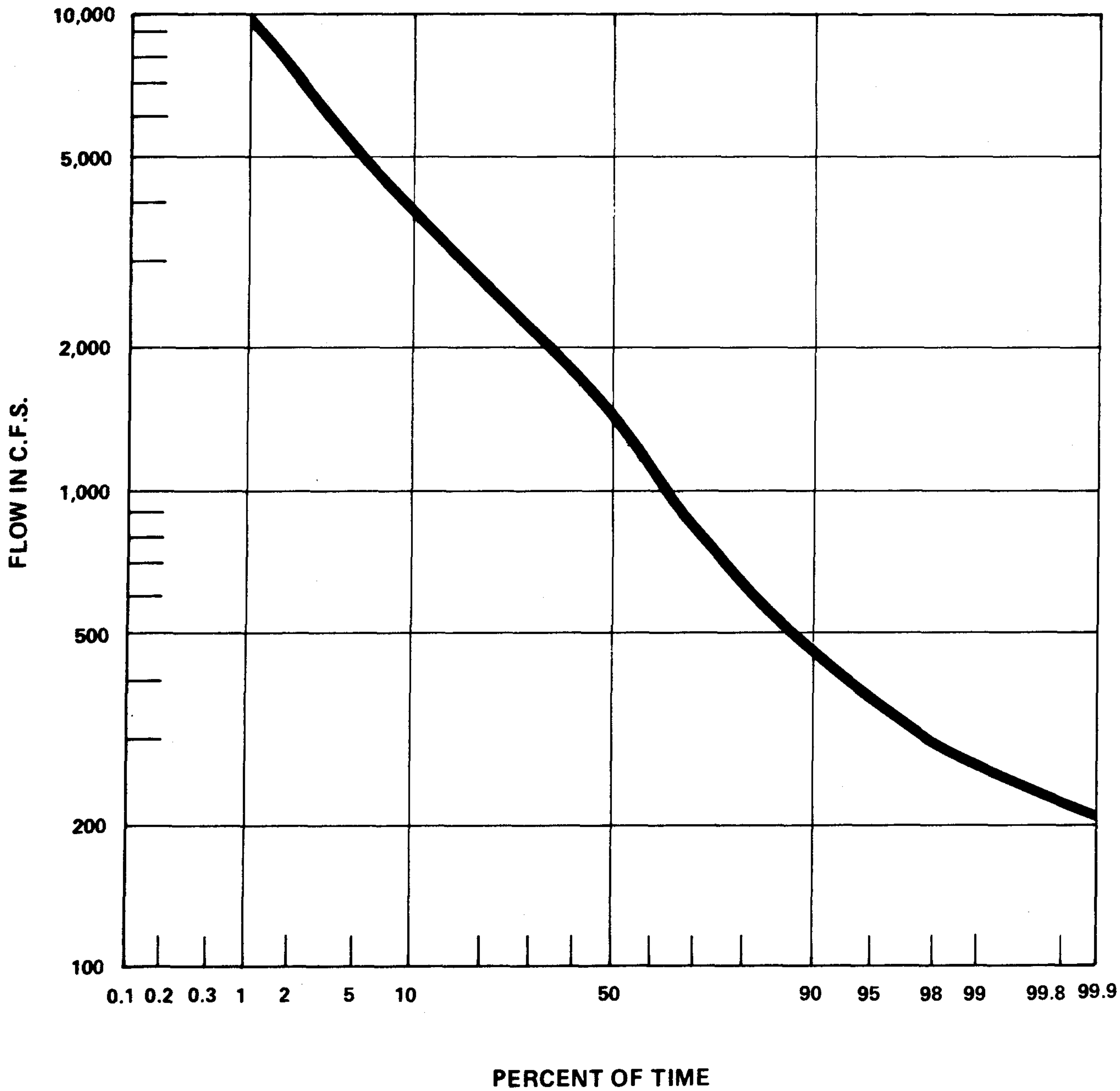
LOW FLOW FREQUENCY CURVE
DELAWARE RIVER AT
TRENTON, NEW JERSEY

FIGURE 2.4-4b

REV. 3, 3/82



NOTES:

1. THE CURVE SHOWS THE PERCENT OF TIME THE INDICATED FLOW WAS EQUALED OR EXCEEDED.
2. DATA FROM PA. DEPT. OF FORESTS AND WATERS BULL. NO. 1, PERIOD OF RECORD, 1928 - 80

LIMERICK GENERATING STATION
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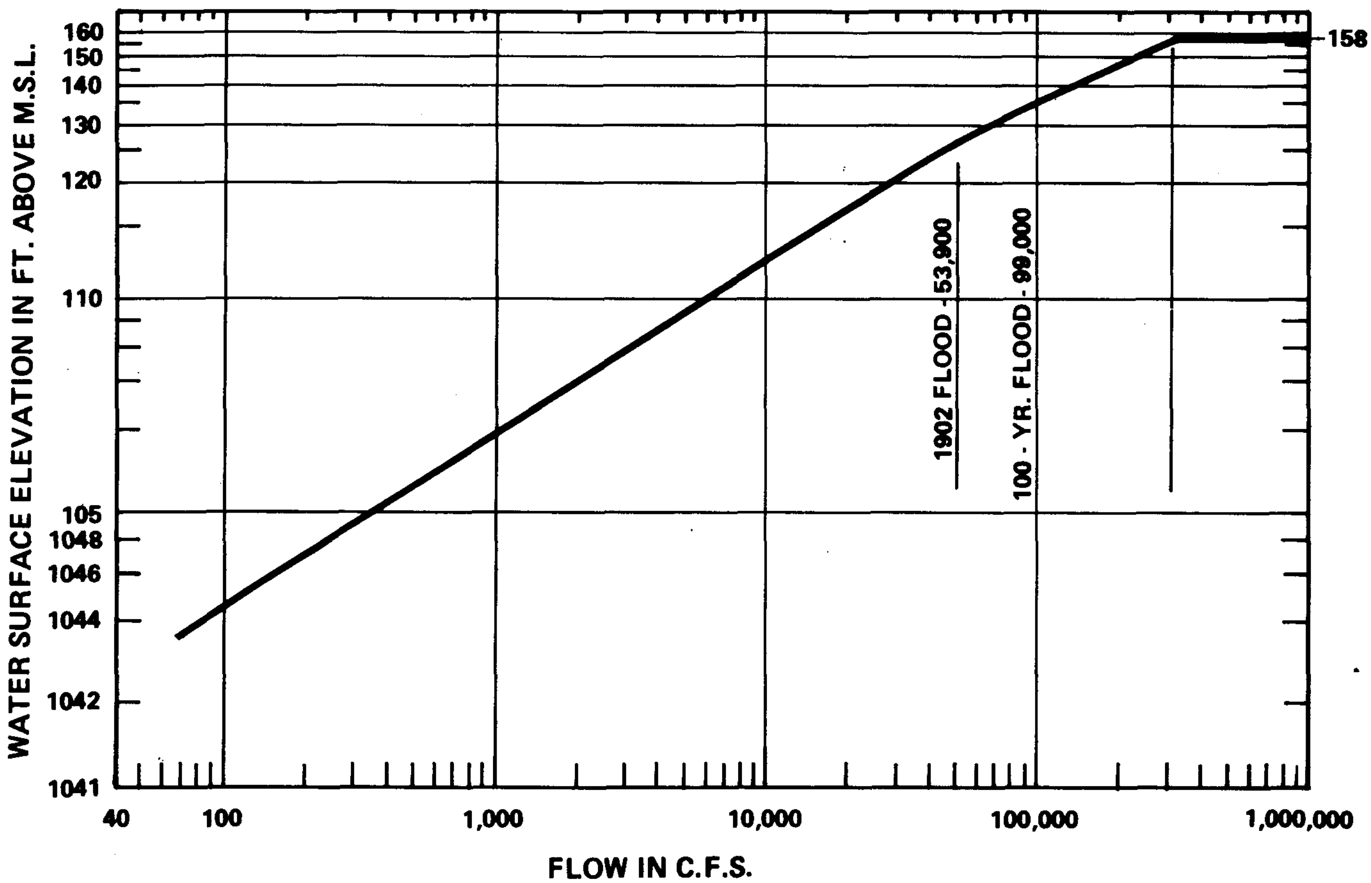
FLOW DURATION CURVE
SCHUYLKILL RIVER AT
POTTSTOWN, PENNSYLVANIA

FIGURE 2.4-5 REV. 3, 3/82



NOTES:
SECTION IS APPROXIMATELY 5.5
MILES DOWNSTREAM OF HANOVER
STREET BRIDGE IN POTTSTOWN.

LIMERICK GENERATING STATION
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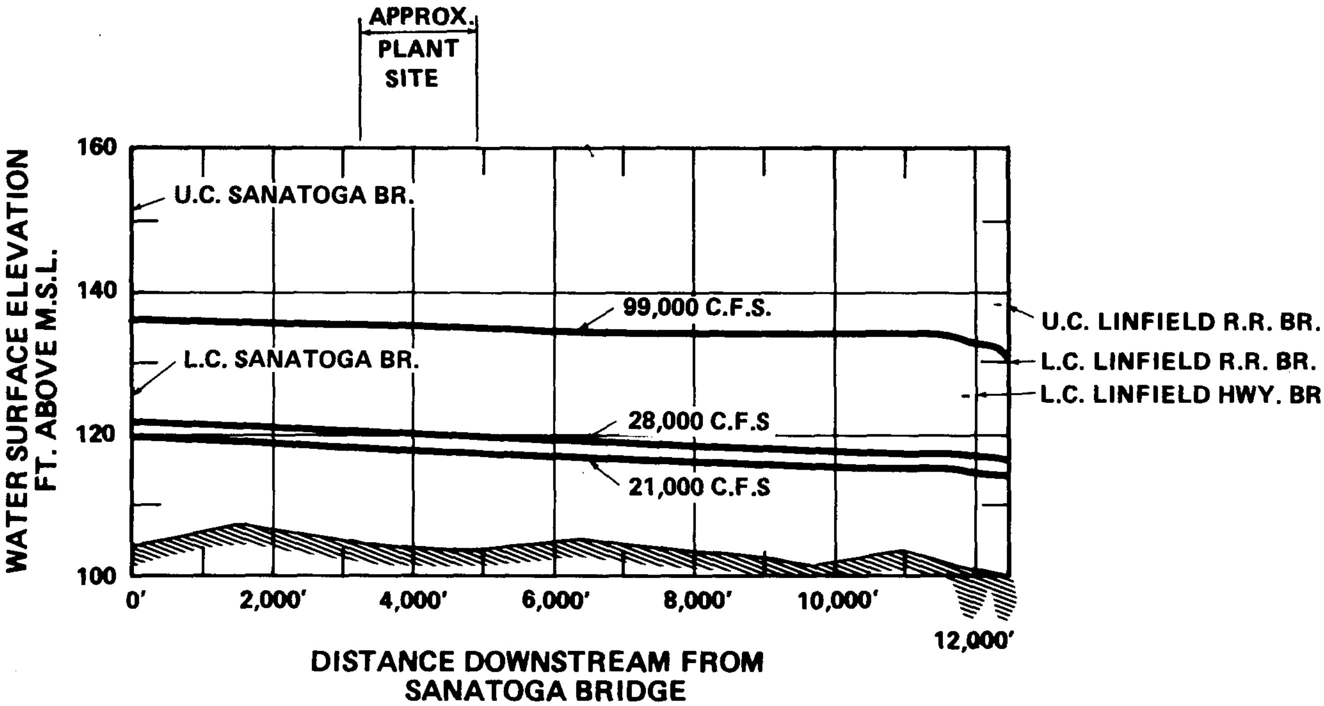
RATING CURVE SCHUYLKILL
RIVER AT LIMERICK SITE

FIGURE 2.4-6



NOTES:

1. BOTTOM SHOWN IS ASSUMED ELEV. OF EQUIVALENT RECTANGULAR MAIN CHANNEL SECTION.

LEGEND:

U.C. DENOTES UPPER CHORD.
L.C. DENOTES LOWER CHORD.
"UPPER AND LOWER CHORDS" REFER RESPECTIVELY TO THE TOP AND BOTTOM OF THE FLOW OBSTRUCTION PRESENTED BY THE BRIDGE SUPER-STRUCTURE.

LIMERICK GENERATING STATION
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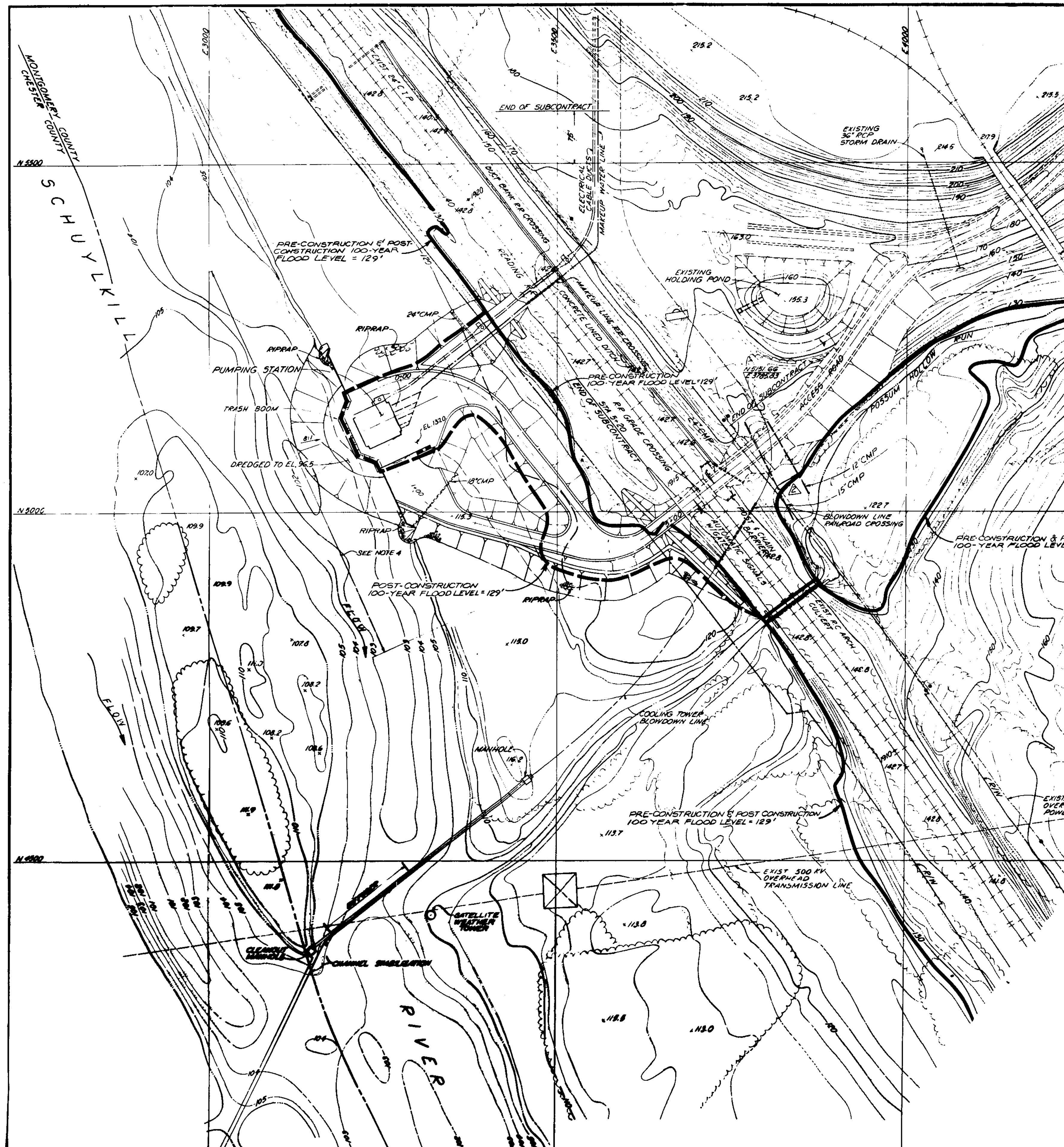
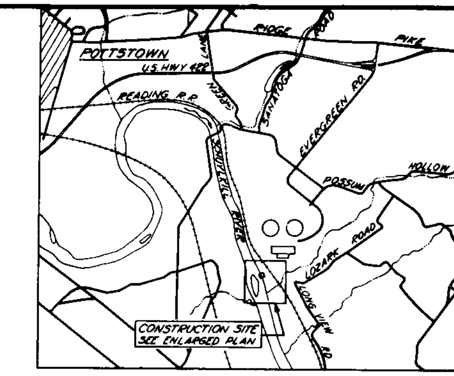
COMPUTED WATER SURFACE PROFILE OF THE SCHUYLKILL RIVER AT LIMERICK SITE

FIGURE 2.4-7





KEY PLAN
SCALE 1:24,000

GENERAL NOTES:

1. GRID IS BASED ON PLANT COORDINATES. FOR CONVERSION TO PENNSYLVANIA COORDINATE SYSTEM:
   N PLANT COORD. + 325,870.00 = N PENN. STATE COORD.
   E PLANT COORD. + 2,599,786.50 = E PENN. STATE COORD.
2. TOPOGRAPHY BY AERO SERVICE CORPORATION, PHILADELPHIA, PENNSYLVANIA.
3. CONTOUR INTERVAL IS 2 FEET. DATUM MEAN SEA LEVEL.
4. RIVER BANK TOPOGRAPHY BY FIELD SURVEY - AUGUST 1975.

LEGEND:

100-YEAR FLOOD LEVEL BEFORE PROJECT CONSTRUCTION (solid line)

100-YEAR FLOOD LEVEL AFTER PROJECT CONSTRUCTION (dashed line)

0 200 400
SCALE IN FEET

LIMERICK GENERATING STATION
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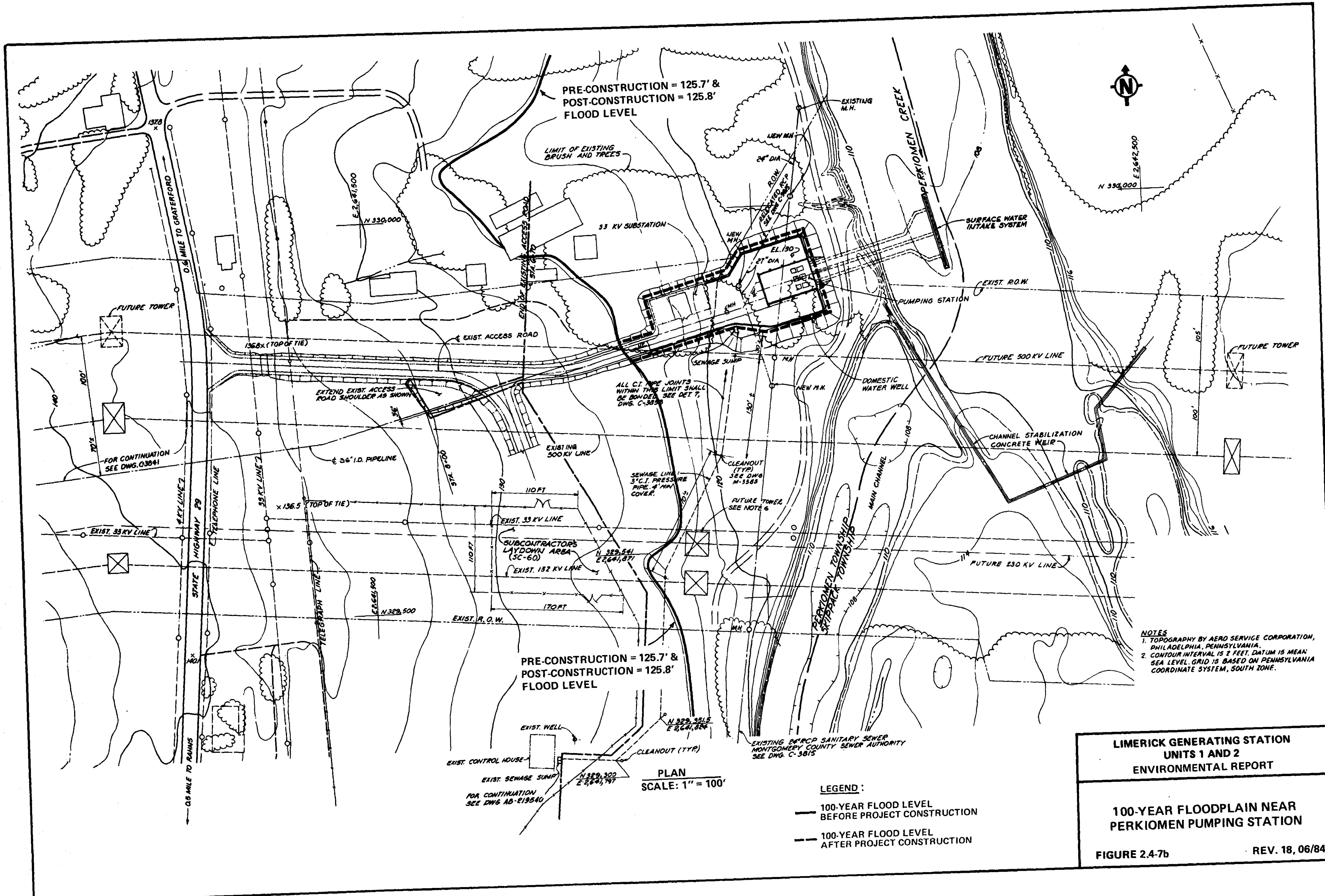
ENVIRONMENTAL REPORT

100-YEAR FLOOD PLAIN NEAR SCHUYLKILL PUMPING STATION

FIGURE 2.4-7a REV. 3, 3/82



LIMERICK GENERATING STATION
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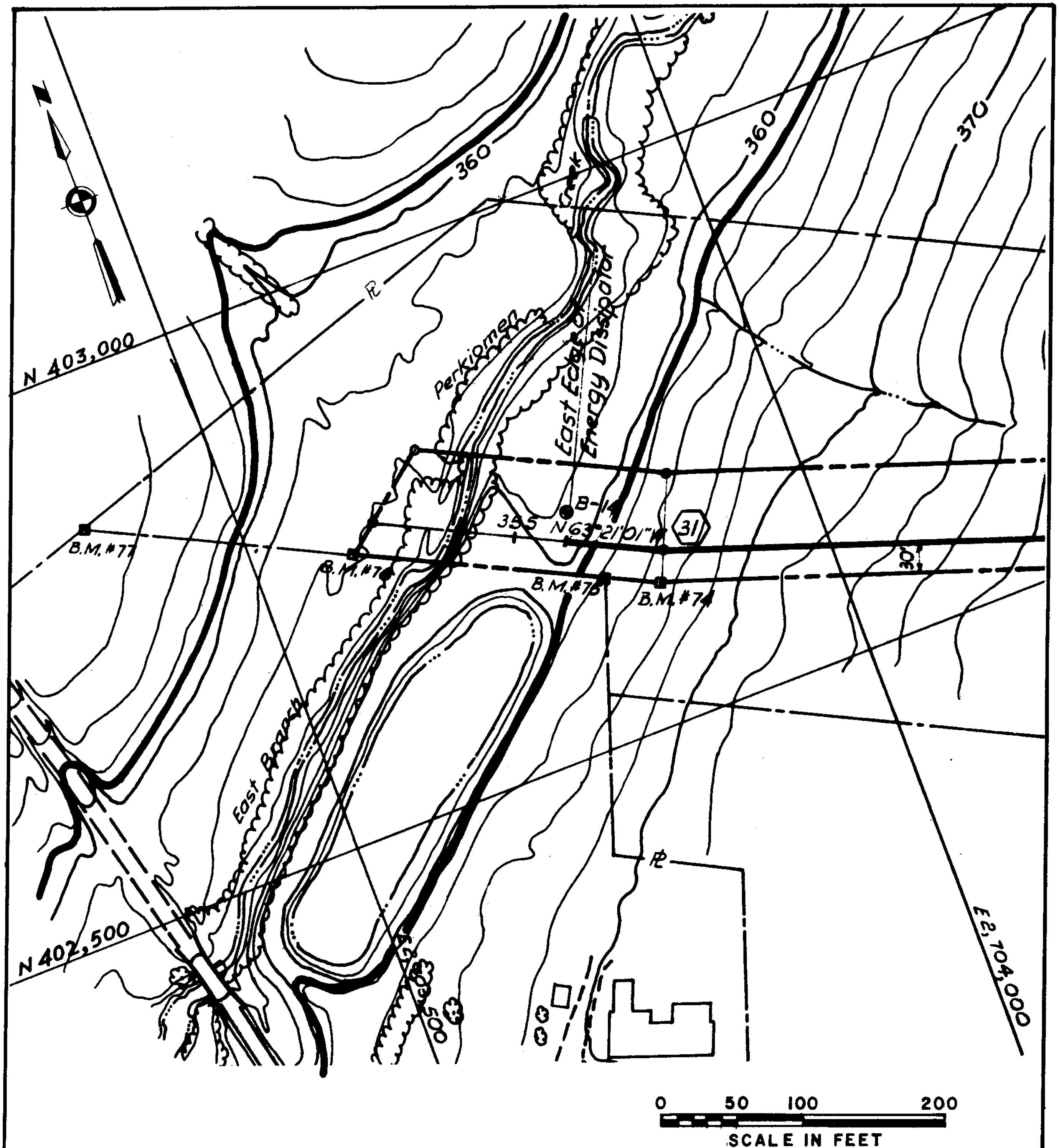
100-YEAR FLOODPLAIN NEAR PERKIOMEN PUMPING STATION

FIGURE 2.4-7b REV. 18, 06/84



EXPLANATION

100-Year flood level before and after project construction

LIMERICK GENERATING STATION
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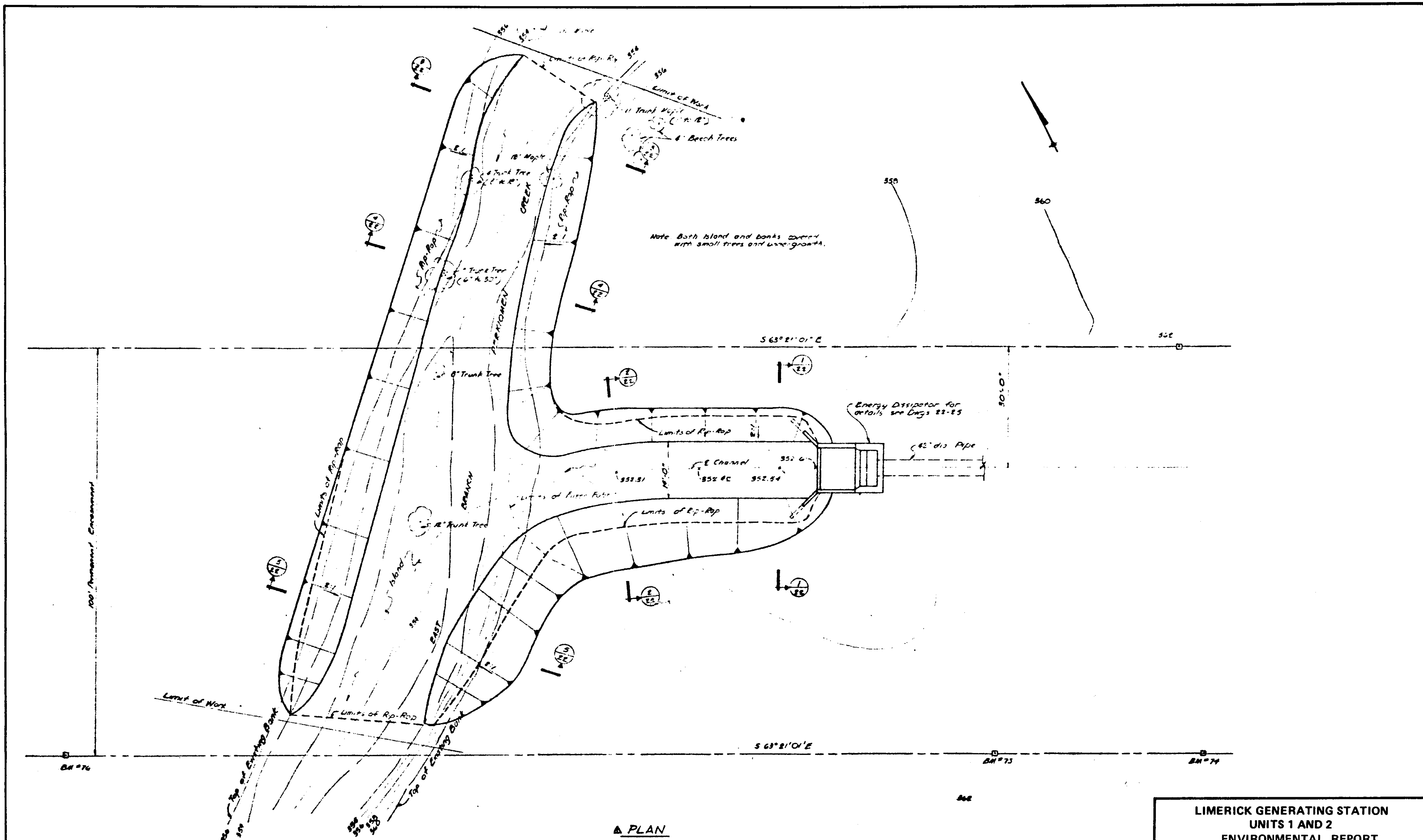
100-YEAR FLOOD PLAIN NEAR DISCHARGE LOCATION OF PERKIOMEN WATER TRANSMISSION MAIN-EAST BRANCH OF PERKIOMEN CREEK

FIGURE 2.4-7c

REV. 3, 3/82



LIMERICK GENERATING STATION
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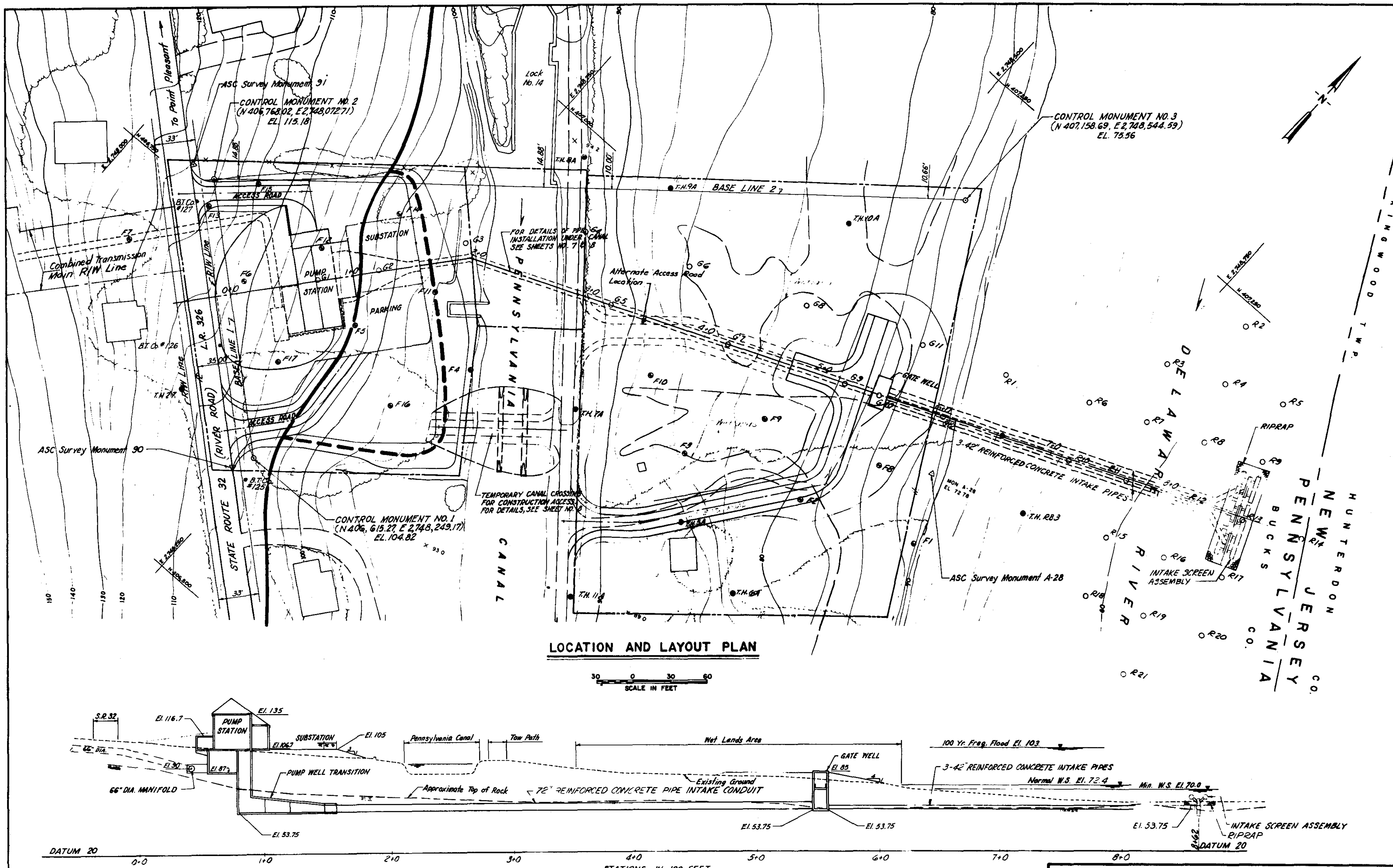
ENERGY DISSIPATOR CHANNEL
PERKIOMEN WATER TRANSMISSION MAIN
EAST BRANCH OF PERKIOMEN CREEK

FIGURE 2.4-7d

REV. 15,08/83



EXPLANATION

——— 100 Year flood level before project construction

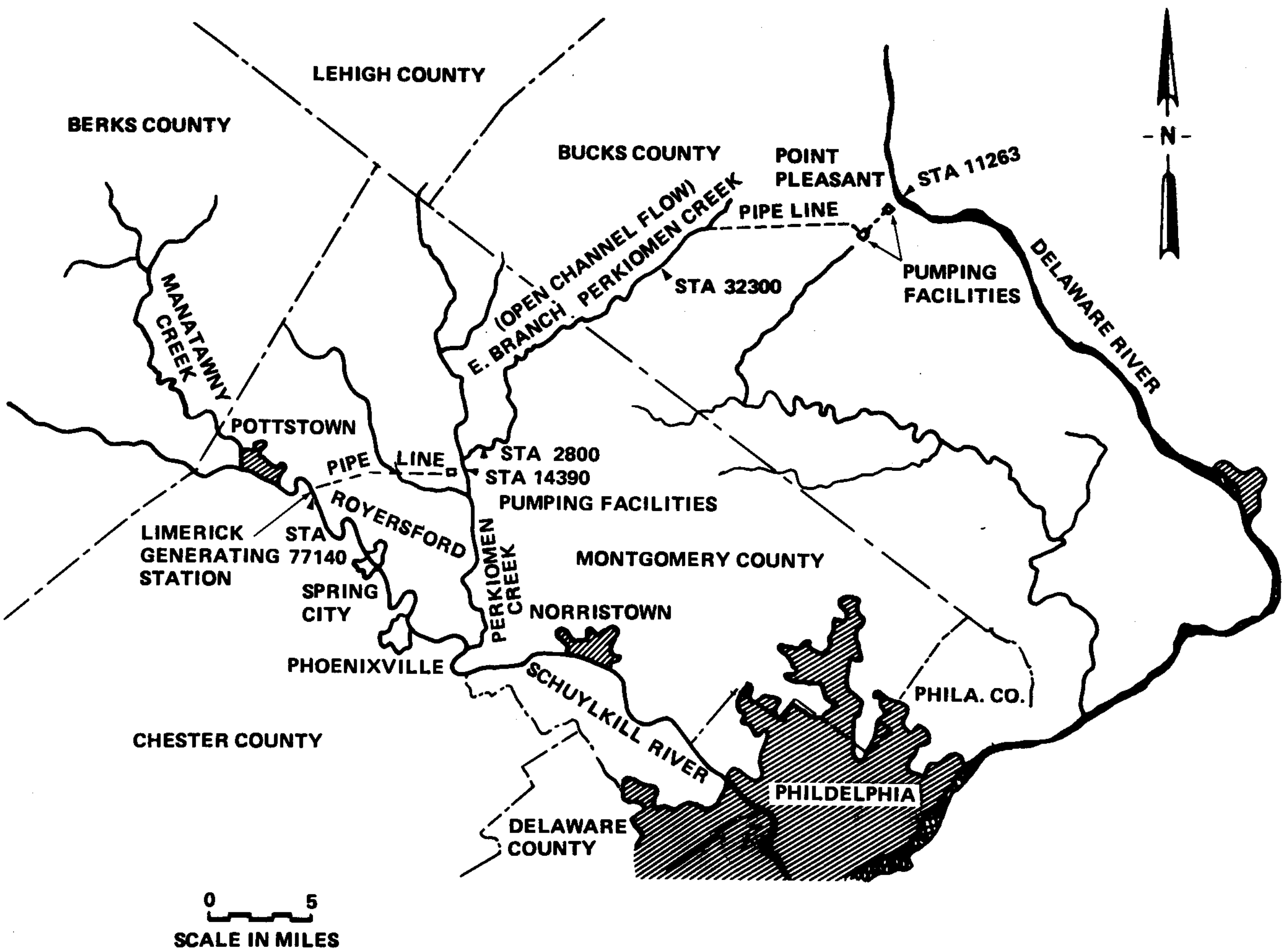
– – – 100 Year flood level after project construction

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

100 YEAR FLOOD PLAIN NEAR POINT PLEASANT PUMPING STATION - DELAWARE RIVER

FIGURE 2.4-7e

REV. 3, 3/82



LIMERICK GENERATING STATION
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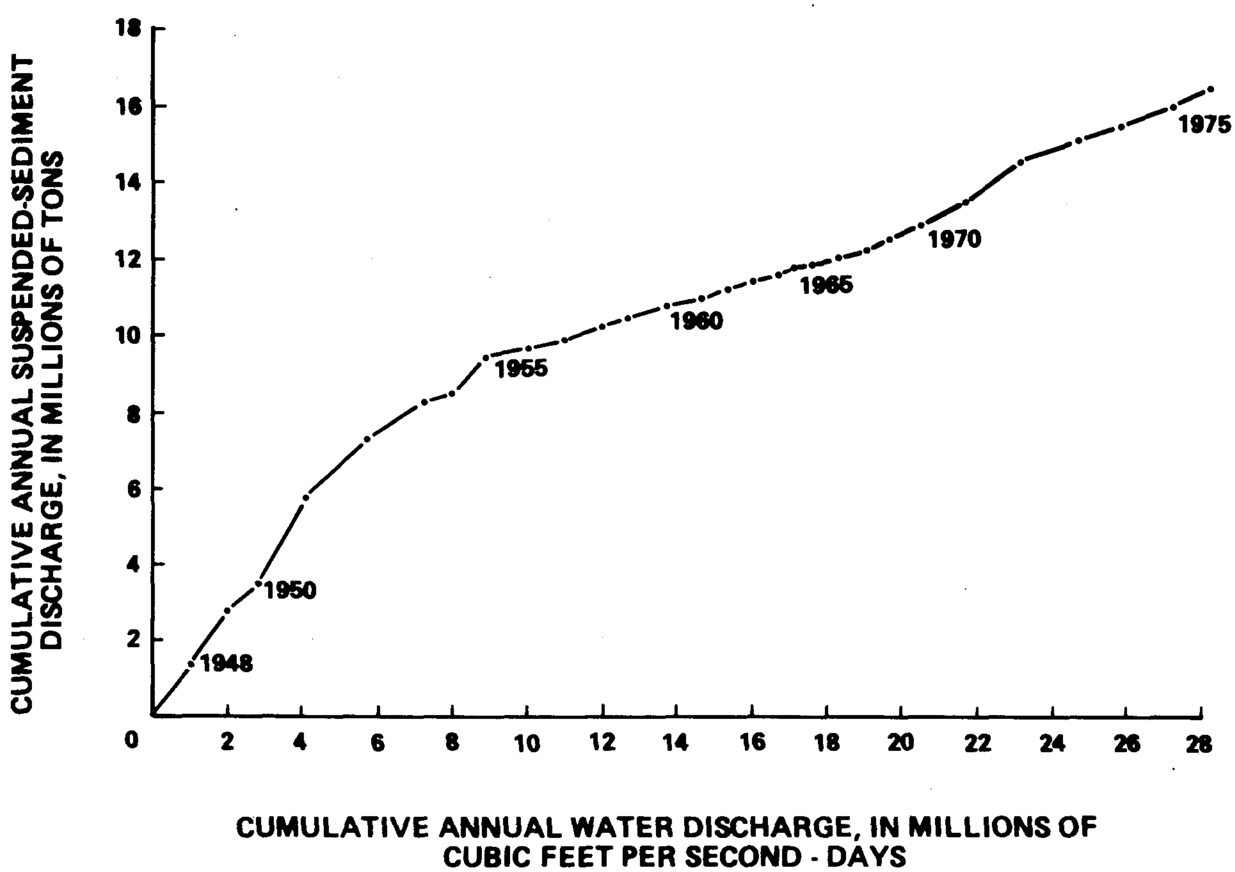
CONSUMPTIVE MAKE UP
WATER SUPPLY

FIGURE 2.4-8



LIMERICK GENERATING STATION
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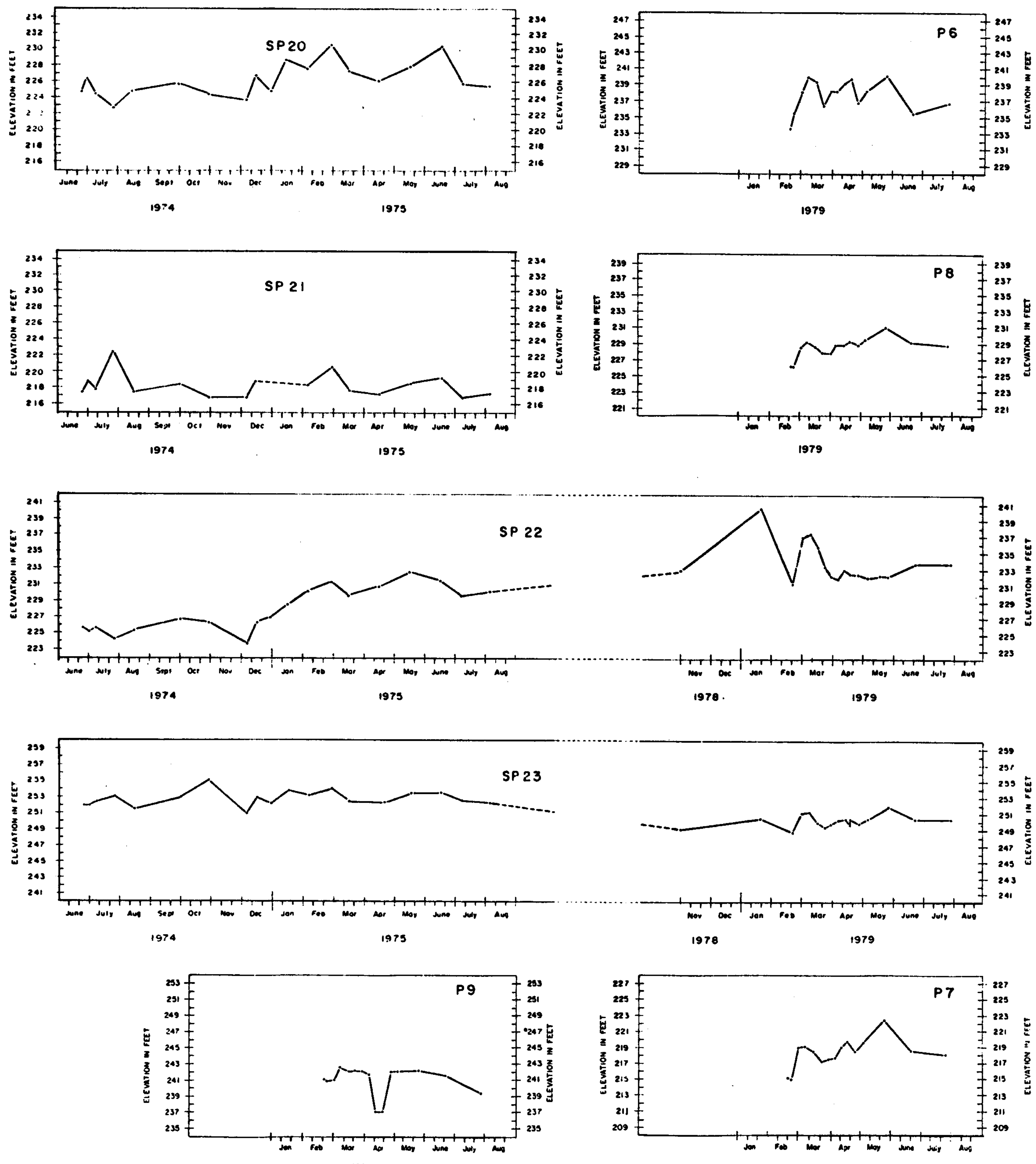
ANNUAL SUSPENDED-SEDAMENT DISCHARGE VERSUS ANNUAL WATER DISCHARGE, SCHUYLKILL RIVER AT MANAYUNK, PHILADELPHIA, PA.

FIGURE 2.4-9



NOTES:

1. FOR LOCATIONS OF OBSERVATION WELLS, SEE FIG 2.4-11.
2. OBSERVATION WELLS SP 20 AND SP21 DESTROYED DURING CONSTRUCTION; SP21 REPLACED BY P8.

LIMERICK GENERATING STATION
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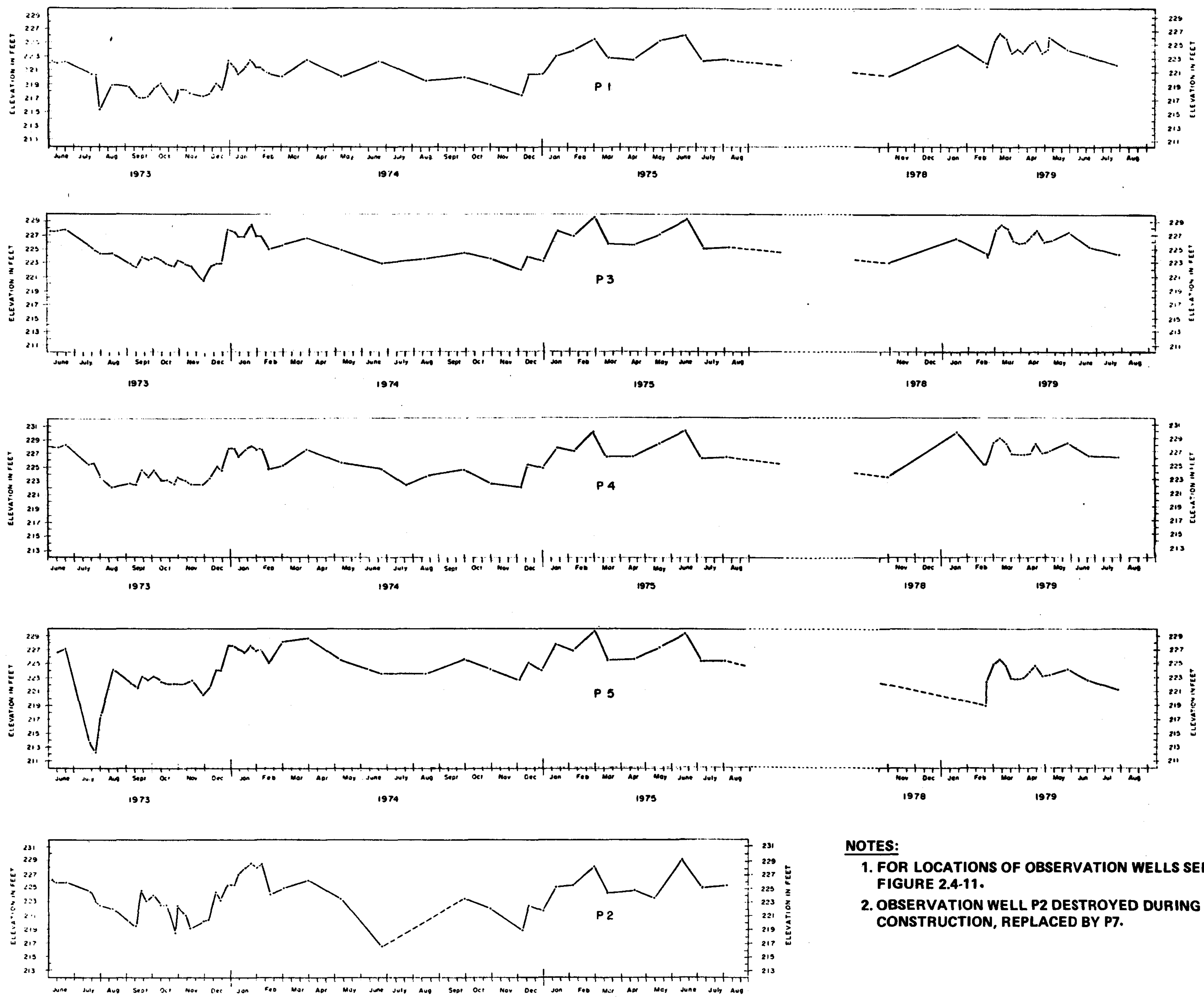
HYDROGRAPHS OF OBSERVATION WELLS SPRAY POND AREA

FIGURE 2.4-10A

SHEET 1 OF 2



NOTES:

1. FOR LOCATIONS OF OBSERVATION WELLS SEE FIGURE 2.4-11.
2. OBSERVATION WELL P2 DESTROYED DURING CONSTRUCTION, REPLACED BY P7.

LIMERICK GENERATING STATION
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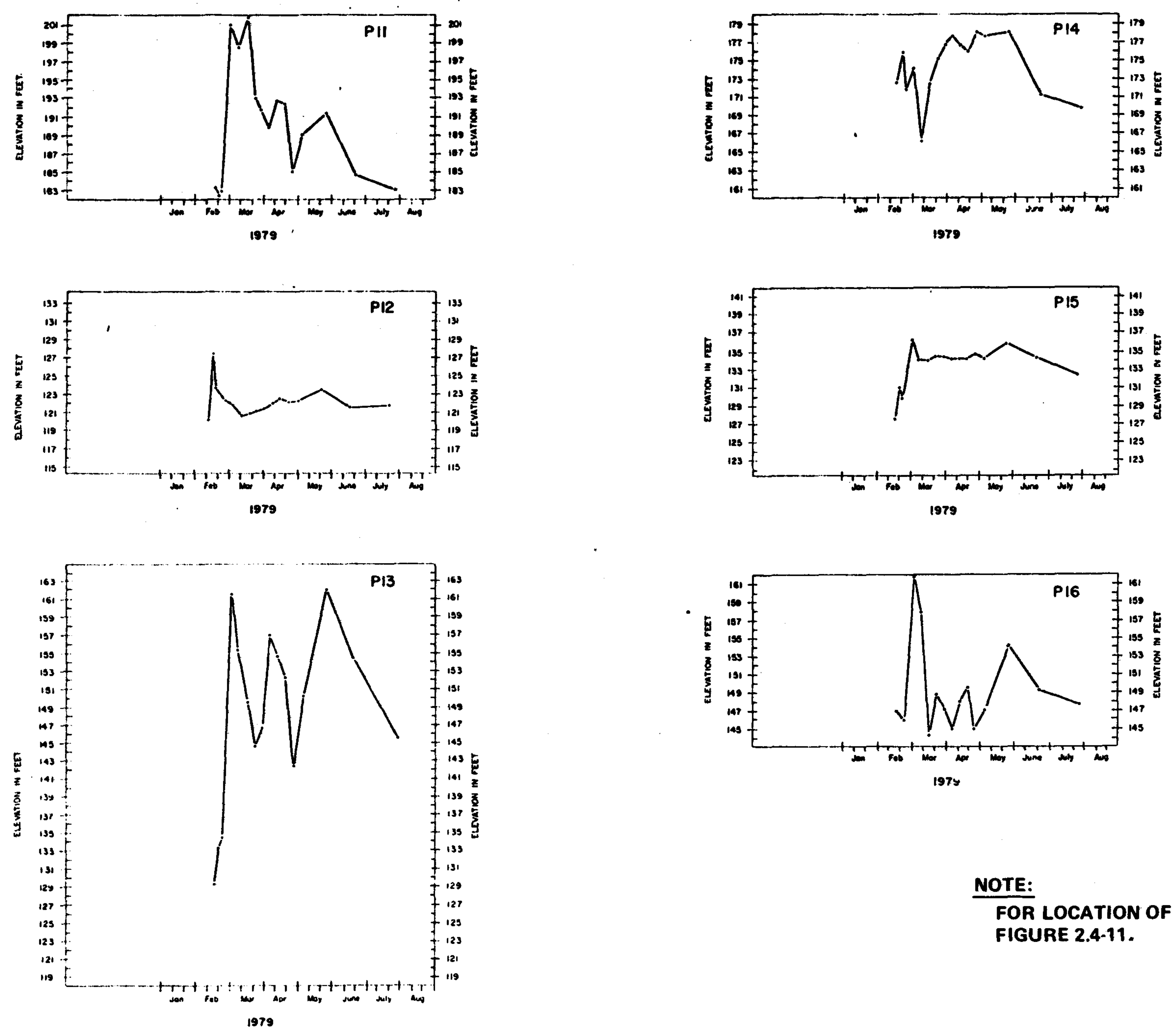
HYDROGRAPHS OF OBSERVATION WELLS SPRAY POND AREA

FIGURE 2.4-10A SHEET 2 OF 2



NOTE:
FOR LOCATION OF OBSERVATION WELLS, SEE FIGURE 2.4-11.

LIMERICK GENERATING STATION
UNITS 1 AND 2
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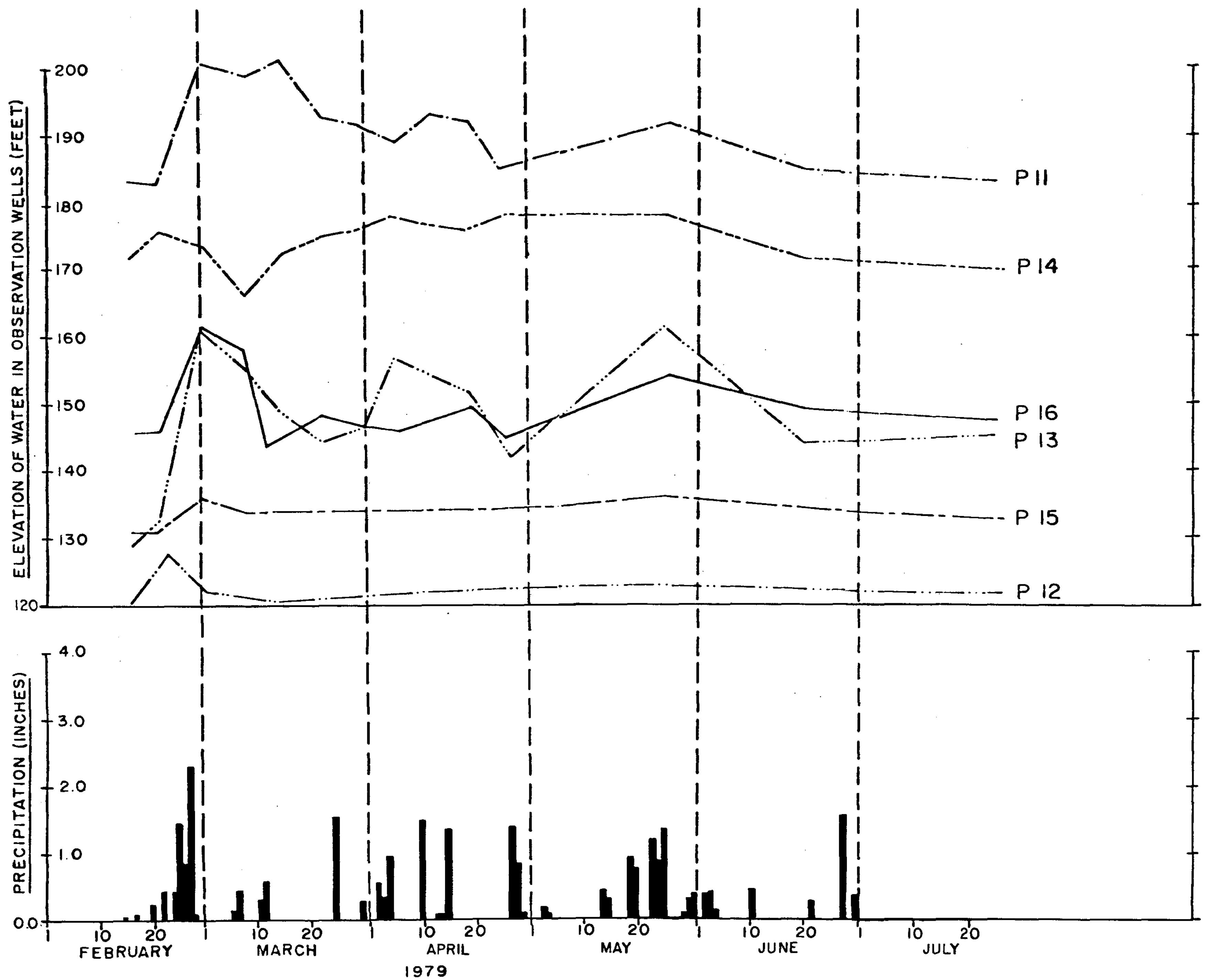
HYDROGRAPHS OF OBSERVATION WELLS POWER BLOCK AREA

FIGURE 2.4-10B



NOTES:

1. For locations of observation wells, see Figure 2.4-11.
2. Precipitation data from onsite metrological station.

LIMERICK GENERATING STATION
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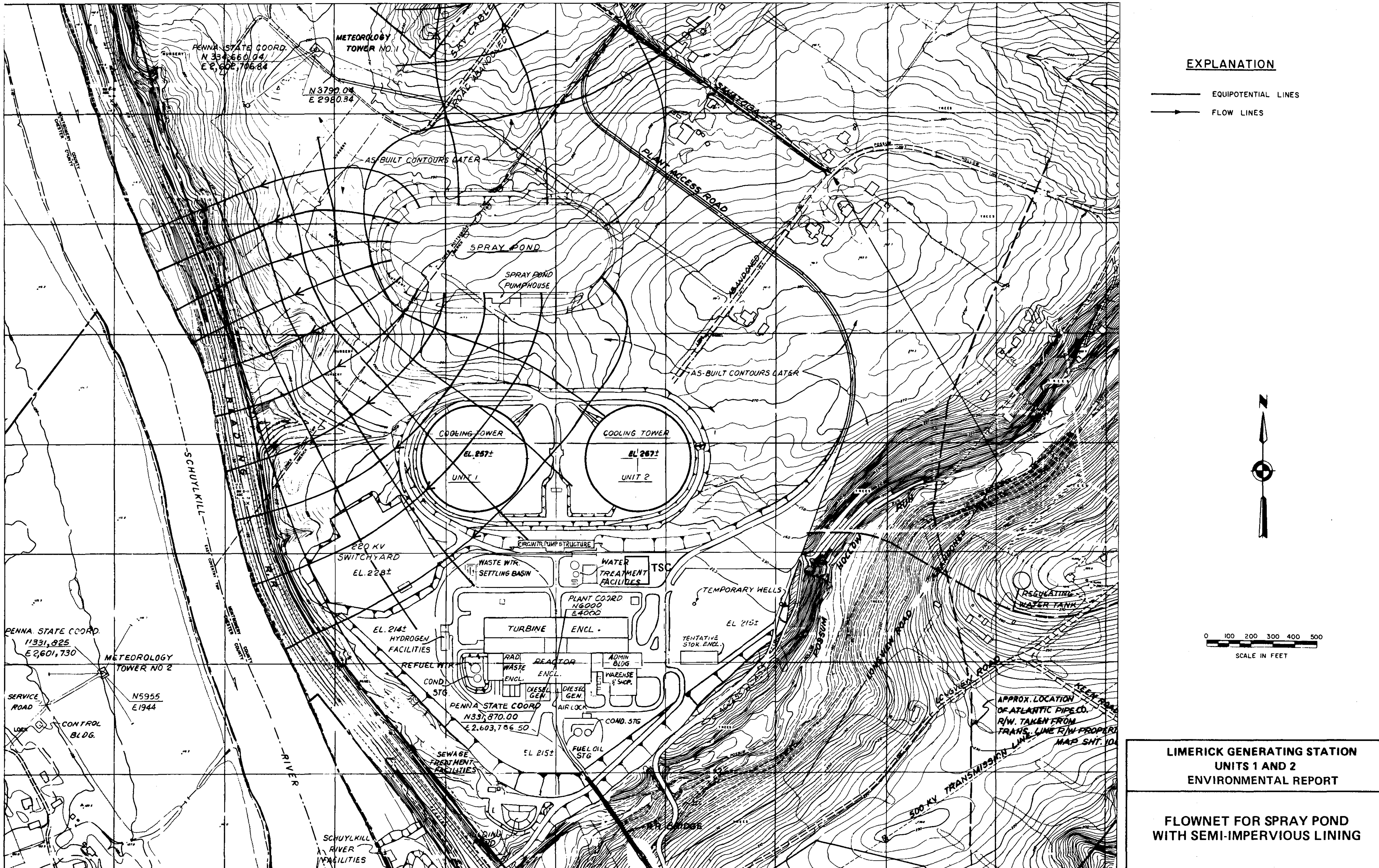
GROUND WATER ELEVATIONS-POWER BLOCK AREA OBSERVATION WELLS AND DAILY PRECIPITATION

FIGURE 2.4-10C



LIMERICK GENERATING STATION
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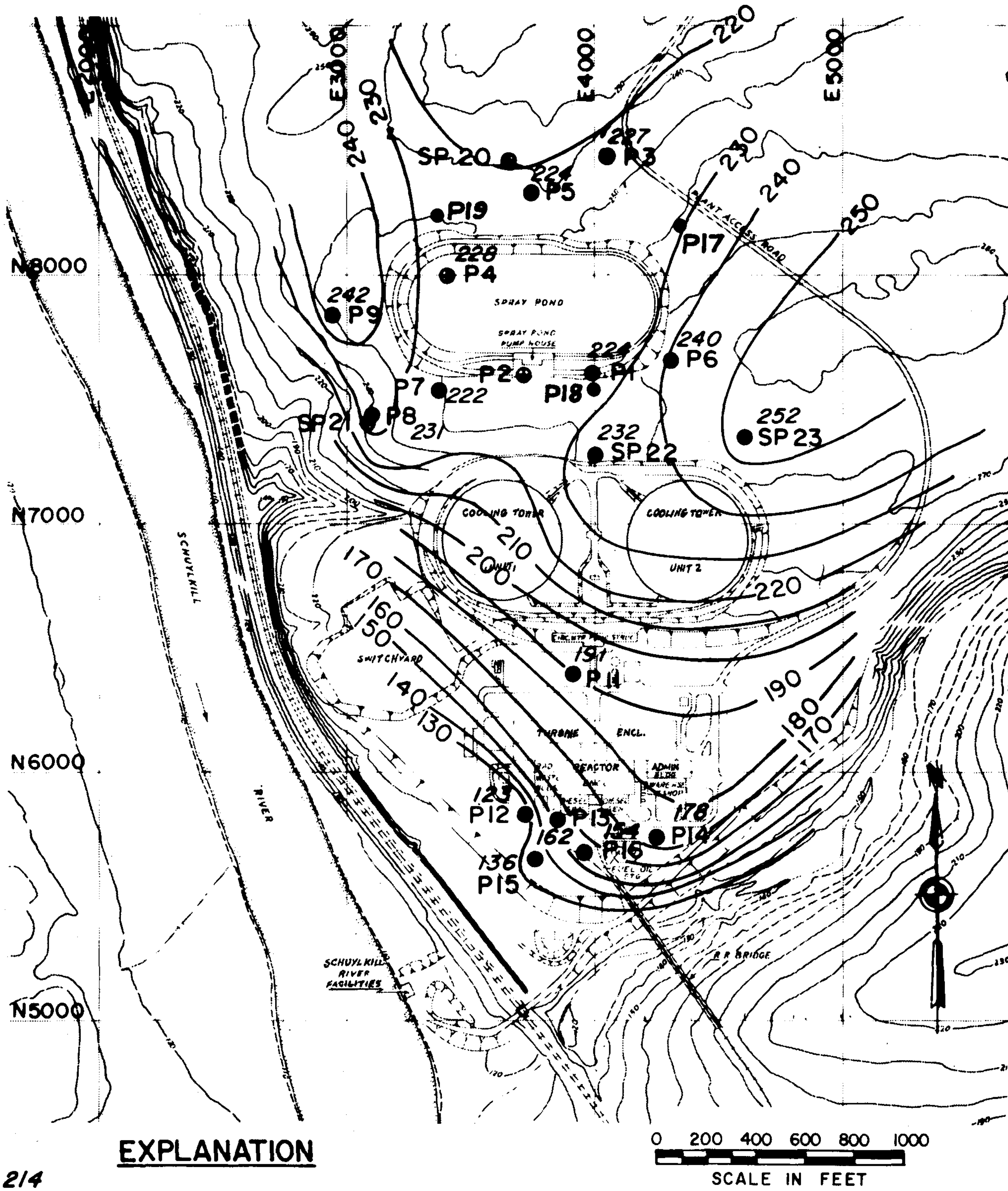
FLOWNET FOR SPRAY POND WITH SEMI-IMPERVIOUS LINING

FIGURE 2.4-12 REV. 16, 12/83



EXPLANATION

214 ● P6 — Observation well with elevation of water level in feet.

(● indicates permanent and ⊕ indicates temporary wells)

250 — Potentiometric contours in feet.

Note:
Wells SP 21, SP 20, P1, P2, and P4 destroyed during construction.

LIMERICK GENERATING STATION
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OBSERVATION WELLS AND POTENTIOMETRIC CONTOURS OF WATER TABLE, MAY 25, 1979

FIGURE 2.4-11 REV. 4, 07/82

2.5 GEOLOGY

The geology of the site and the immediate environs were discussed in Section 2.4 of the Environmental Report-Construction Permit Stage and in Section 2.4 of the Final Environmental Statement. Geology is also discussed in Section 2.5 of the FSAR. In accordance with 10 CFR 51 and Regulatory Guide 4.2, no further discussion of geology is necessary.

2.6 REGIONAL HISTORIC, ARCHEOLOGICAL, AND NATURAL FEATURES

The regional historic, archeological and natural features were discussed in Sections 2.1.2, 2.1.3, 2.3, and Supplement 1, Question 3 of the Environmental Report - Construction Permit Stage and Section 2.3 of the Final Environmental Statement.

In accordance with 10CFR51 and Regulatory Guide 4.2, no further discussion is necessary.

2.7 NOISE

This section presents the results of a sound survey that was conducted during June 1973 in the area surrounding the station site. The survey was made as part of the environmental consideration for the design and construction of the Limerick Generating Station. Other noise surveys of onsite construction noise are discussed in Section 4.5. Predicted noise levels during station operation are discussed in Section 5.6.

To obtain a variety of ambient conditions with minimum interference from construction, the measurements were made on Tuesday, June 12, 1973 when schools in the area were still in session; in the early morning of Wednesday, June 13, between the hours of 2:00 and 4:00 a.m., during daytime on Wednesday, June 13, the first day the schools were out; and on Saturday morning, June 16, representing a weekend, when all construction at the plant ceased. Tuesday was fair and hot with a slight breeze, high humidity, and 90-100°F temperature. A heavy thunderstorm occurred from 9:00 p.m. to 1:30 a.m., Wednesday. After the rain and before dawn, the temperature was cool, around 60°F with no wind. During the day on Wednesday, the weather was fair and warm with occasional showers, 70-80°F temperature with little wind. Saturday morning was overcast and cool, 60-70°F with little wind. During the weekdays, construction was limited to some earthmoving equipment working at a slack pace.

The general terrain of the area consists of rolling hills with open fields interspersed with densely wooded sections. The immediate vicinity of the site is especially largely forested. U.S. Highway 422 runs east-west about one mile north of the site, and at about the same distance to the southwest is State Highway 724. To the north is the town of Sanatoga and to the south are Linfield and Parkerford, all within two miles. Concentrated residences are located in Pottstown about two miles to the northwest.

Besides the many industrial and commercial operations in Pottstown, there is also a large Firestone plant to the northwest of LGS, Continental Distilling Corporation to the south of LGS, and some light industrial operations on the west bank of the river. Reading Railroad tracks run on the east bank and alongside the west fenceline of the plant, while ConRail tracks run on the opposite bank.

Figure 2.7-1 shows the general features of the area and the numbered points where noise measurements were made. These points were chosen to give a reasonable spread of measuring locations. They also represented various existing environments such as residential, commercial, industrial, and traffic.

Measuring instruments used were a Bruel and Kjaer (B&K) Type 2209 Impulse Precision Sound Level Meter with one-inch microphone, a B&K Type 1613 Filter Set, and a B&K Type 4220 Pistonphone for calibration. A tripod and a windscreen were used with the meter throughout the measurements. The sound level meter was calibrated with the pistonphone before and after each complete survey, and it was checked for battery and internal calibration before and after measurements at each point. The instrument was found to be in calibration at all times, and no adjustment was necessary to any of the readings taken.

Except where specifically noted, only the level of the general noise prevailing at each location was measured. Bursts of noise from automobiles driving by, jet planes flying overhead, or dogs barking in the neighborhood were not considered as prevailing ambient noise and were not recorded. Sources constituting the ambient or background noise included wind, rustling leaves, birds, insects, traffic, distant industrial plants, and dripping and flowing water, especially after the Tuesday night thunderstorm.

The results of the survey are summarized in Table 2.7-1. Except on three occasions, the ambient noise level at all locations around the Limerick Generating Station was between 39 and 50 dBA. The three exceptions were: Point 3 outside the subcontractor gate where the operation of some earthmoving tractors raised the ambient noise level to 60 dBA; Point 2 on the east end of a trussed bridge on the Schuylkill River, where a passing train produced a noise level of 67 dBA (after the train passed, the level dropped to 50 dBA); and Point 11 at the Firestone plant where the noise from the plant measured 54 dBA.

At points 1, 3, and 5, the noise level dropped appreciably between Tuesday afternoon and when readings were taken on Wednesday or Saturday morning. The noise at these points was attributable to the Firestone plant, the construction inside the LGS site, and Continental Distilling Corporation, respectively. The drop was due to reduced activity at night and on weekends for these facilities. Point 2, which was located between LGS and the Firestone plant, would have shown the same pattern except for the predawn noise level which, instead of going down, actually increased. This was due to increased water flow in the adjacent river after the heavy rainfall.

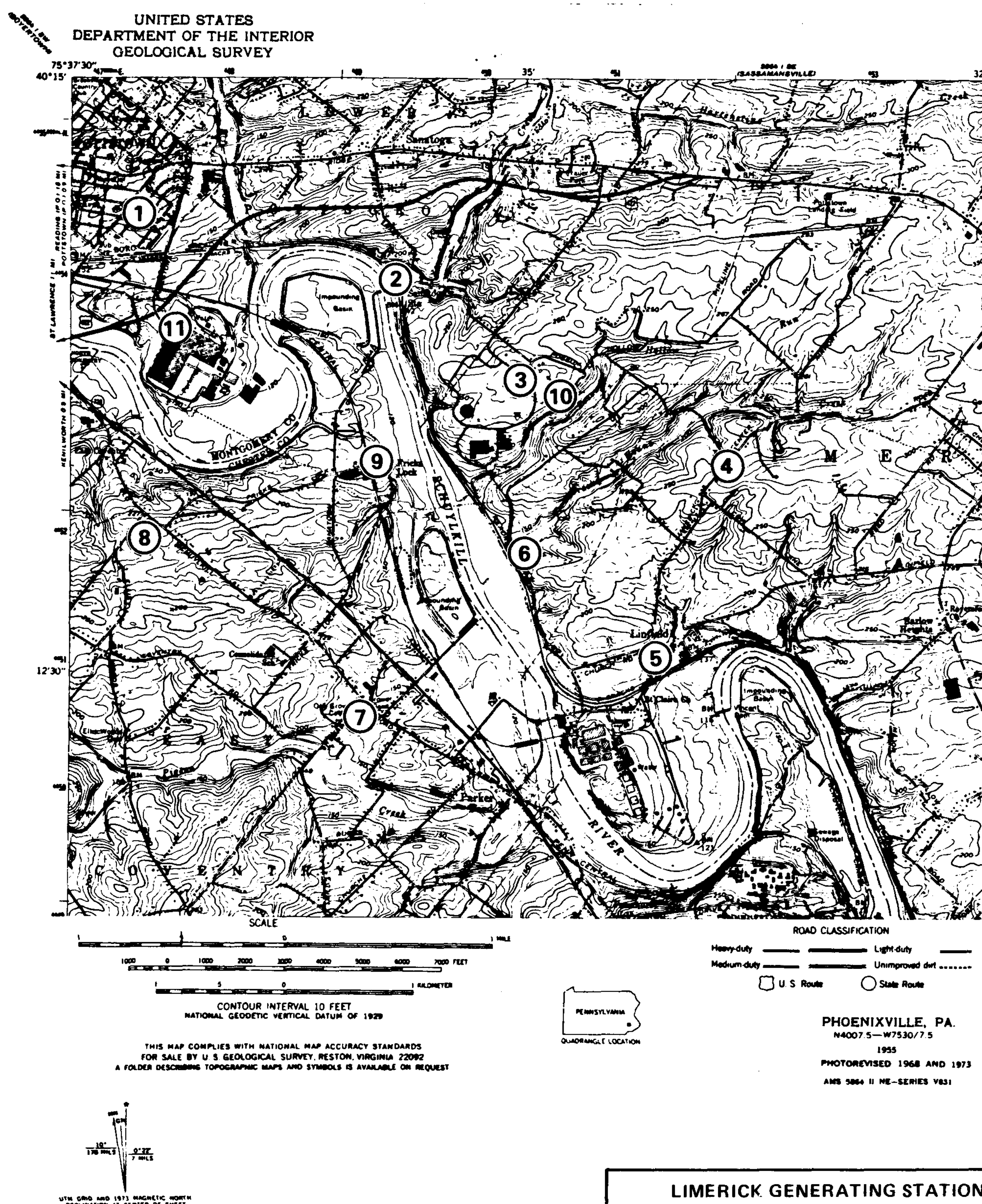
Expected levels of audible noise produced by transmission lines are addressed in Section 3.9. To the best of applicant's knowledge, there are no applicable federal or state noise standards for transmission lines.

TABLE 2.7-1

AMBIENT NOISE LEVELS FROM 1973 SURVEY[1]

MEASURING POINTS(See Figure 2.7-1 for locations)	DATE 1973	TIME	A-WT	OCTAVE BAND CENTERS, kiloHz 1/32	1/16	1/8	1/4	1/2	1	2	4	8
1-Quiet residential area,	6-12	1445	48	61	61	58	52	45	42	38	34	26
in front of 1435-1443	6-13	0205	39	54	55	50	43	37	31	26	18	9
Sunset Drive, Pottstown.	6-16	0700	43	55	55	52	43	37	34	32	31	20
2-East of Sanatoga Bridge	6-12	1510	48	60	58	57	51	44	40	38	33	24
(On 6-13 train was pass-	6-13	0230	67	78	77	72	70	66	61	60	55	46
ing 20-25mph about 20ft	6-13	0230	50	58	55	55	51	46	44	42	36	28
above & 60ft from mic.).	6-16	0715	43	55	54	53	46	37	31	30	30	18
3-On Possum Hollow Rd out	6-12	1530	60	61	67	66	57	53	54	52	50	35
side subcontractor gate,	6-13	0245	44	62	55	53	42	33	29	21	36	20
bulldozer working 6-12.	6-16	0725	44	55	55	54	44	38	32	28	28	12
4-Corner, relatively busy	6-12	1610	43	47	50	49	36	33	32	32	35	27
intersection at Sanatoga	6-13	0305	43	56	58	57	43	31	28	22	21	11
& Limerick Center Roads.	6-16	0735	42	50	54	56	36	31	26	28	34	18
5-In church parking lot,	6-12	1635	46	52	53	51	49	41	38	34	28	23
Linfield commercial area	6-13	0323	39	48	44	43	43	38	33	25	20	10
Church & Reformed Roads.	6-16	0748	40	52	51	51	48	36	30	33	30	19
6-On 5ft embankment, near	6-12	1655	41	50	52	49	41	40	33	26	22	11
RR tracks, on road(Pave-	6-13	0335	43	50	54	50	39	37	28	25	42	26
ment ended 100ft North).	6-16	0845	42	53	57	54	47	41	26	30	26	20
7-In Oak Grove Cemetery	6-12	1755	44	56	55	46	40	38	36	33	29	20
on Old Schuylkill Road,	6-13	1308	48	58	55	57	49	41	38	35	32	24
1000ft from Highway 724.	6-16	0830	43	54	57	50	39	37	37	36	31	13
8-In another cemetery on	6-12	1725	46	55	55	53	43	39	39	37	34	23
Old Schuylkill Road near	6-13	1235	49	56	56	56	53	45	42	41	35	30
Ellis Woods Road.	6-16	0815	44	57	59	55	44	37	38	35	37	22
9-In tall-grass field 200	6-12	1820	40	53	52	51	44	37	31	33	28	16
ft from Big Eastern Ware	6-13	0354	39	53	57	50	43	35	32	26	17	9
house on Fricks Lock Rd,	6-13	1246	44	55	57	53	43	39	34	33	29	18
residences along road.	6-16	0802	43	51	50	48	40	36	26	35	35	18
10-Backyard of PECo owned	6-13	1457	44	55	55	53	43	43	41	39	38	29
house, NE corner of LGS.	6-16	0900	41	55	57	52	36	28	23	24	24	18
11-Firestone parking lot.	6-13	0408	54	70	72	66	57	48	46	44	37	28

[1] Values are sound pressure levels in dB re 0.0002 microbar.



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MEASURING POINTS FOR
1973 AMBIENT NOISE SURVEY

FIGURE 2.7-1

CHAPTER 3

THE STATION

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3 THE STATION

3.1 EXTERNAL APPEARANCE

The external appearance of the station was described in the Environmental Report-Construction Permit Stage, Section 3.1 and in the Final Environmental Statement, Section 3.1. The construction of the station has been consistent with the plans described in these reports.

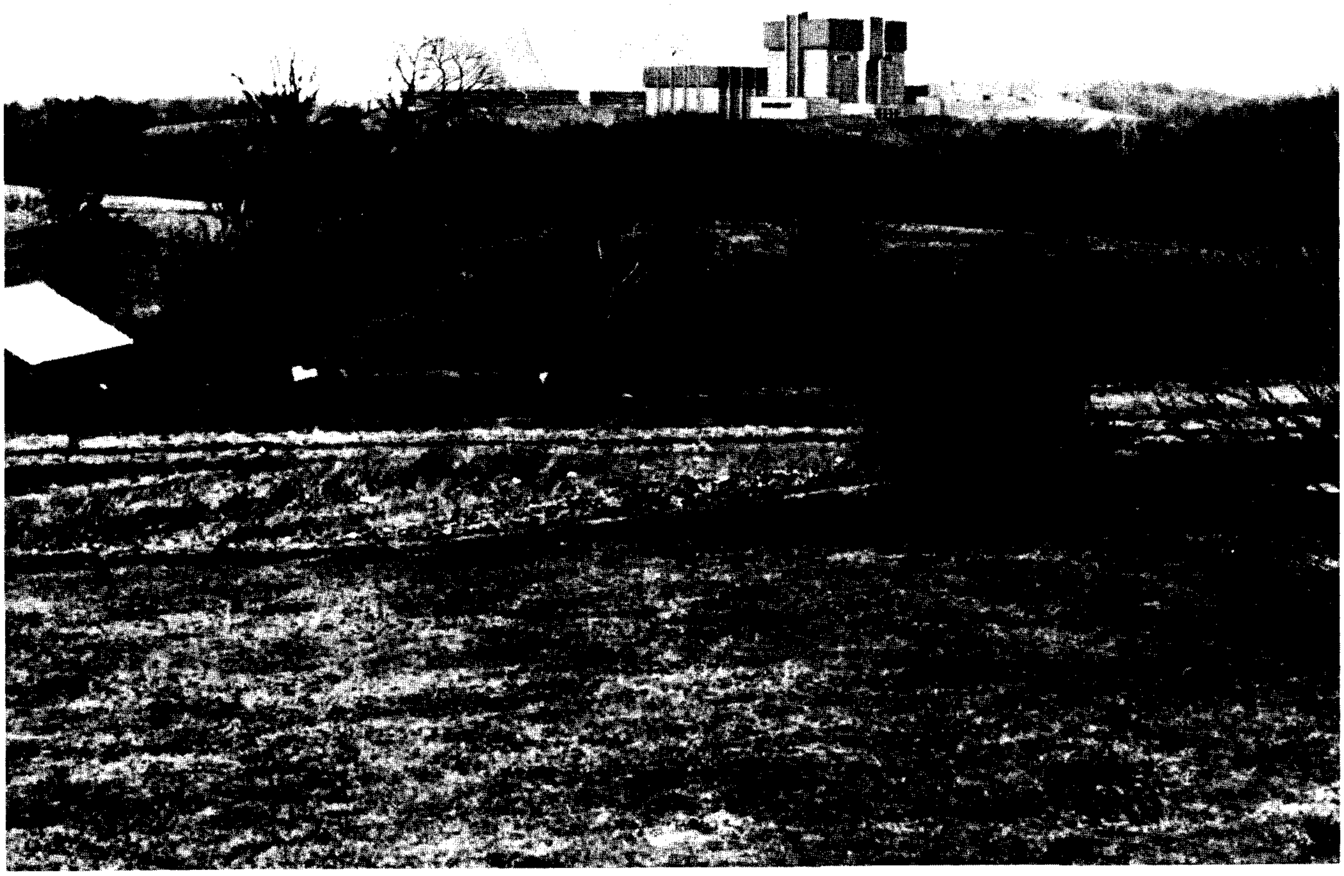
The preserved woodland, with the rolling topography of the adjacent area, partially screens the station when viewed from a distance. The tan color of the exterior precast walls was selected to harmonize with the surrounding rural environment. An architect's concept of the station as seen from offsite is shown in Figure 3.1-1. A final photograph is not available at this time because the cooling towers are not fully erected.

The turbine, reactor, radwaste, auxiliary boiler, control and diesel-generator enclosures comprise the power block, which is located at el 217 feet above mean sea level about 800 feet east of the Schuylkill River bank. The layout of the power block groups the various sized structures in a manner which creates a visually integrated mass. The resultant configuration, in addition to the articulation of the exterior walls with vertical fins, achieves an interesting play of planes and shadows which minimizes the bulk of the structures. A combination of aggregate and smooth finish wall panels were selected to create texture and contrast for the facade.

The administration building with the attached shop and warehouse is at the southeast corner of the power block. The five-story tower portion has a precast concrete and glass facade. The curtain walls are of dark bronze aluminum and double-glazed dark bronze glass. This gives the building a distinctive character, emphasizing its intended function of housing the administrative offices.

The Technical Support Center building is a two-story steel frame structure with precast concrete exterior wall panels. It contains approximately 24,000 sq ft of floor area which includes, in addition to the Technical Support Center, a computer area, security area, and office area. The building is located south of the cooling tower for Unit 2 and east of the water treatment enclosure.

The remaining structures include the Schuylkill pump structure, circulating water pump structure, sewage treatment enclosure, Perkiomen pump structure, fuel oil transfer enclosure, and spray pond pump structure. These structures are low-profiled with precast concrete exterior sides. The consistent use of one material for the exterior sides creates a sense of continuity and harmony for the plant complex. A 500-kV substation is located about 1200 feet southeast of the power block, and a 230-kV substation is located about 300 feet northwest of the power block. Figures 3.1-2 through 3.1-4 show the spatial relationship of the above-mentioned features and the location of liquid and gaseous effluent release points, which are described further in Sections 3.3 through 3.7.



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ARCHITECT CONCEPT OF
LIMERICK GENERATING STATION

FIGURE 3.1-1

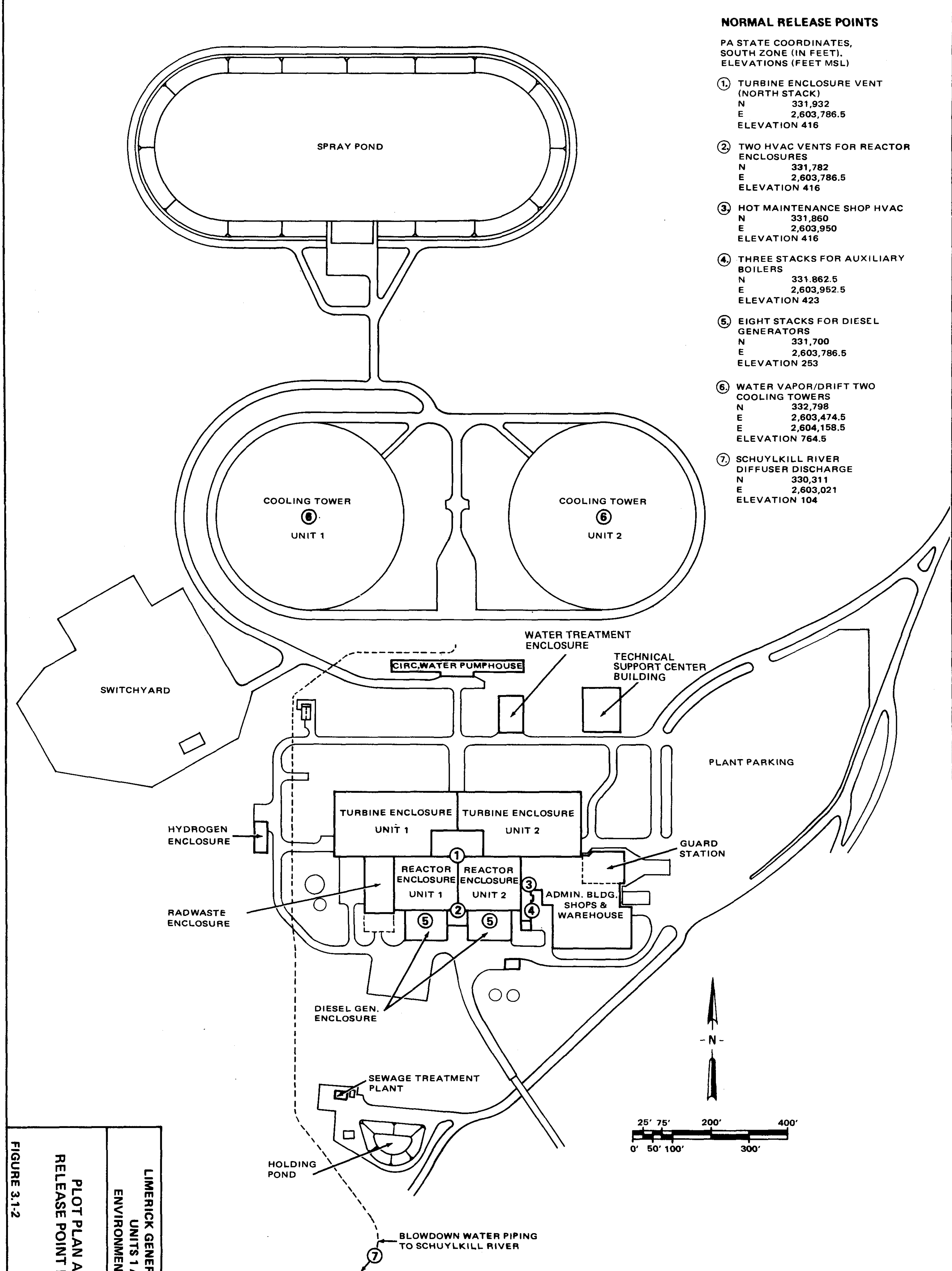

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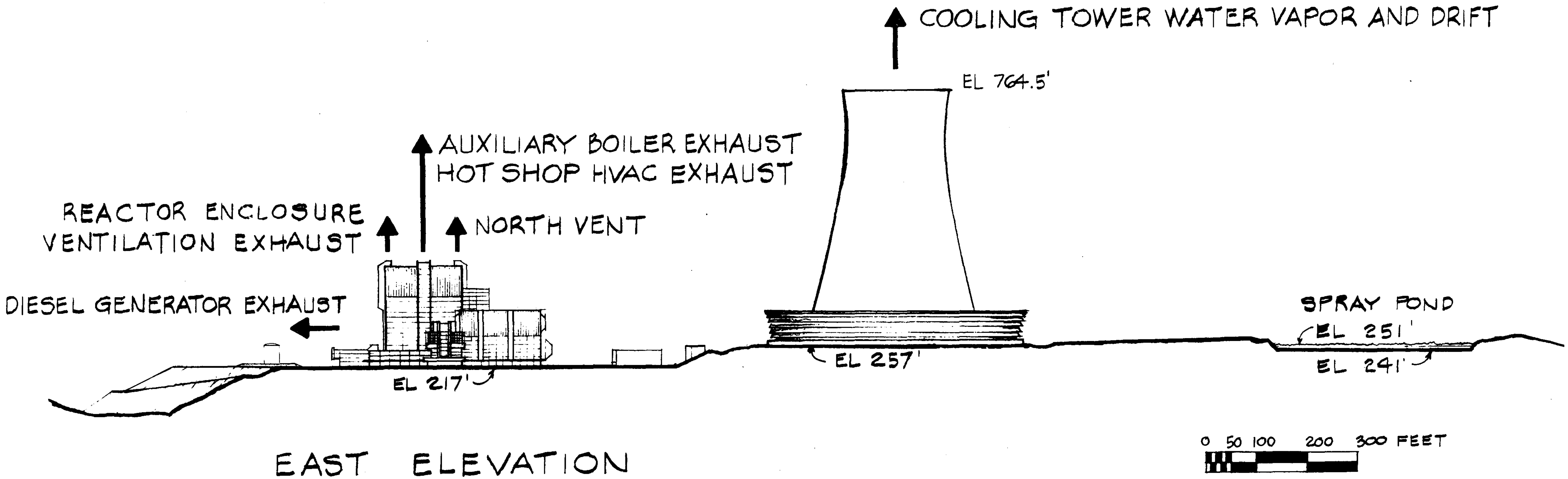
FIGURE 3.1-2
PLOT PLAN AND NORMAL RELEASE POINT FOR EFFLUENTS

REV. 4, 07/82



EAST ELEVATION

ELEVATIONS ARE GIVEN IN FEET ABOVE MEAN SEA LEVEL.

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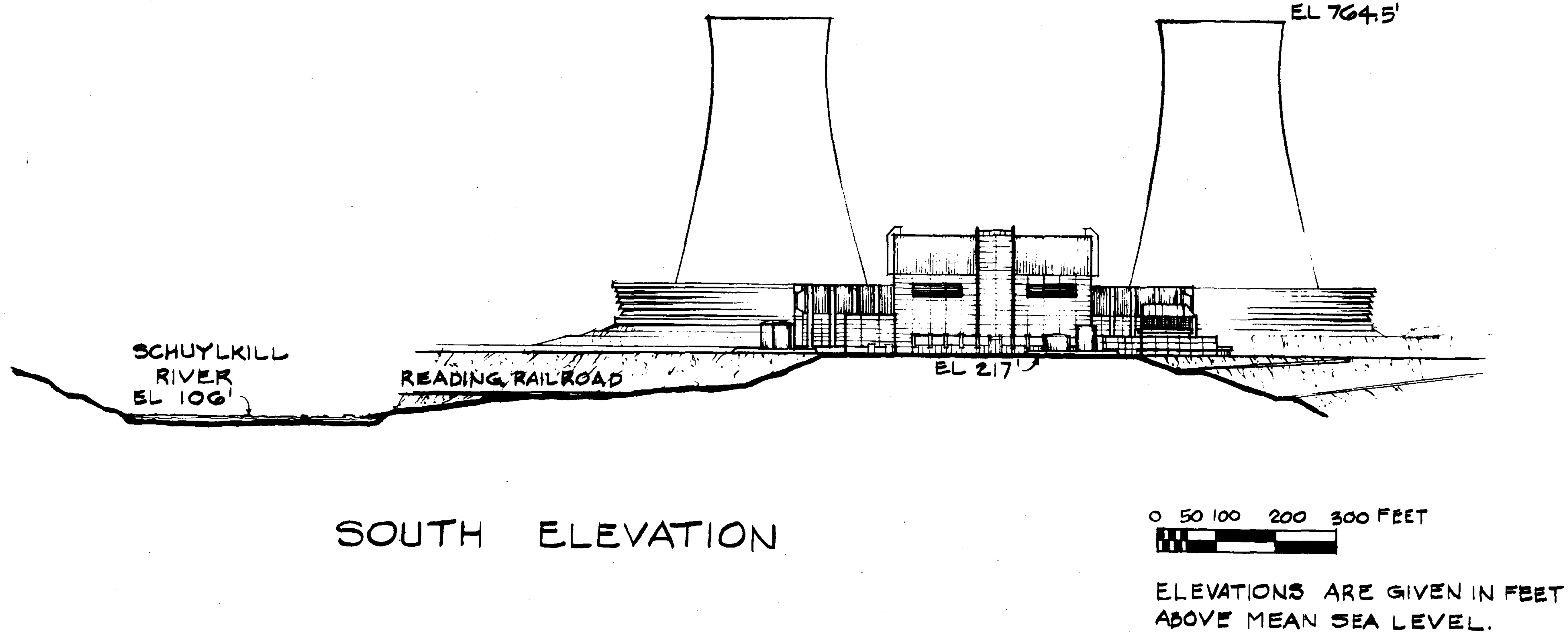
EAST ELEVATION OF STATION

FIGURE 3.1-3 REV. 19, 04/83



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SOUTH ELEVATION OF STATION

FIGURE 3.1-4

3.2 REACTOR AND STEAM-ELECTRIC SYSTEM

The Philadelphia Electric Company has employed Bechtel Power Corporation and Bechtel Construction, Inc. to serve as the architect-engineer and construction contractors of the two-unit Limerick Generating Station. Each unit employs a light water-moderated boiling-water reactor (BWR) and a turbine-generator, both supplied by the General Electric Company. Each nuclear unit is designed for an operating life of 40 years. Cooling water for the tube side of the condensers is supplied from the circulating water system that rejects heat through natural draft hyperbolic cooling towers. Figure 3.2-1 shows a simplified schematic of the reactor and steam-electric system.

Each nuclear steam supply system (NSSS) consists of a BWR/4 reactor, reactor coolant system, auxiliary systems (including systems to ensure the ability to shut down the reactor safely under adverse conditions), and appropriate instrumentation. The reactor system has a core-rated power level of 3293 megawatts thermal (MWt). Each reactor is expected to be capable of a stretch output of 3435 MWt. Stretch power output is the maximum capacity of the equipment (design) and is always a few percent greater than the nominal rated capacity. The analysis of the possible offsite radiological consequences of postulated design basis accidents, to demonstrate acceptability of the station site in accordance with 10 CFR 100, has been performed assuming a core power level of 3440 MWt.

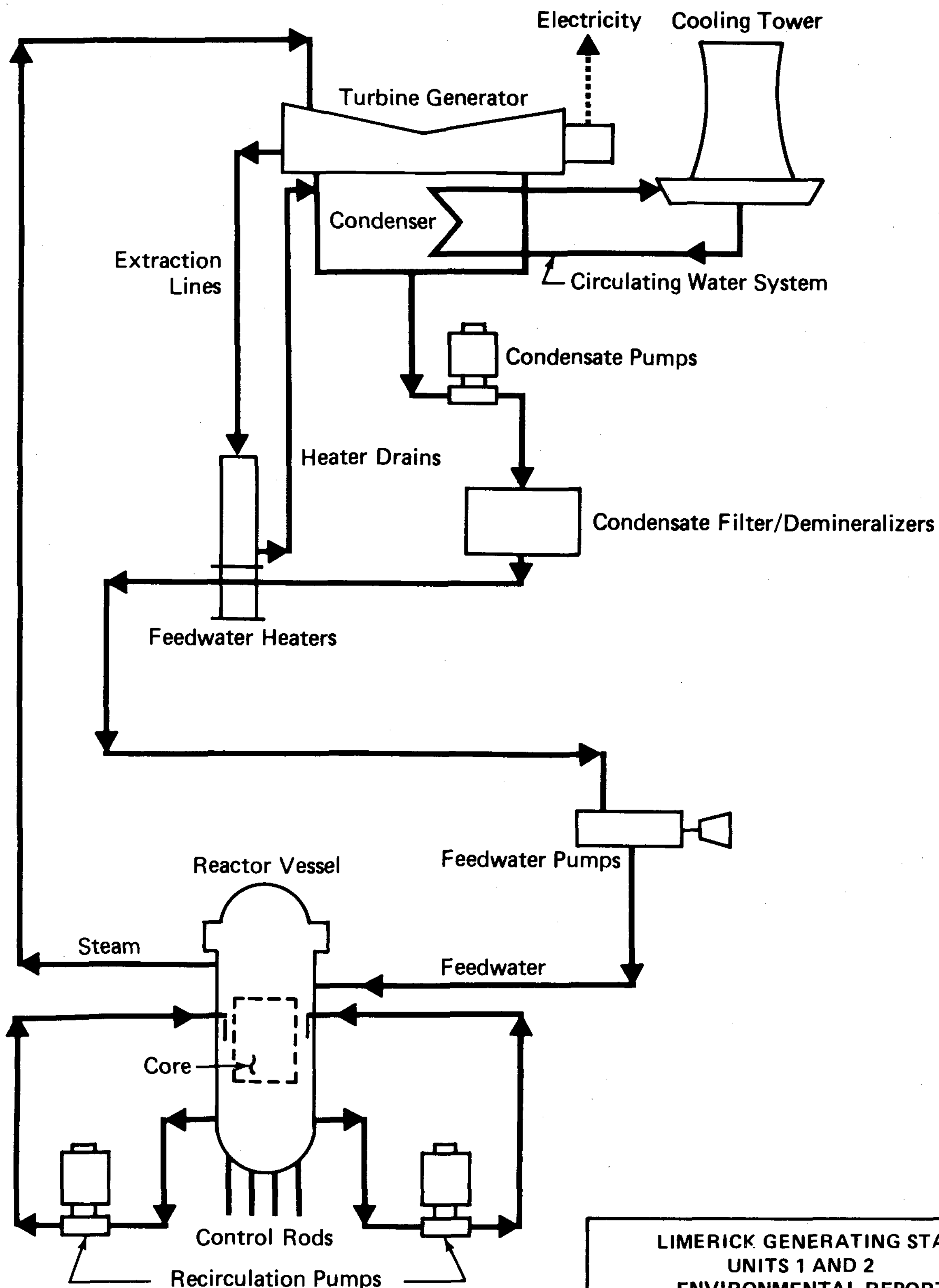
Reactivity and thermal power are controlled during normal operation by the control rod drive system and the recirculating water flow control system. The primary reactor control elements are the control rods. The control rods are used primarily for power distribution shaping and for shim control of long-term reactivity changes that occur as a result of fuel irradiation. The boron in the control rod captures neutrons, thus limiting the nuclear chain reaction. Each control rod is surrounded by four fuel assemblies. There are a total of 185 control rods in the core. The recirculation flow control system regulates the steam volume within the core to follow rapid load changes. The volume of steam within the core controls the amount of neutron moderation and the rate of the nuclear chain reaction. The recirculation flow control system is used to vary the reactor power level by 35% or less.

Each initial core consists of 764 fuel assemblies, with each assembly containing 62 fuel rods and two water rods in a square 8x8 array with 100 mil channels. The fuel is in the form of high-density uranium dioxide compacted and sintered into cylindrical pellets. These pellets are 0.41 inch long and 0.41 inch in diameter. The initial core contains approximately 139,000 kg of naturally and artificially enriched uranium. The average enrichment of the core is 1.906% U-235. Each initial core fuel rod consists of a 150-inch stack of fuel pellets inside a 160-inch-long Zircaloy-2 tube which is backfilled with helium and sealed at each end by welding with Zircaloy end plugs. Certain fuel rods contain pellets consisting of a blend of uranium dioxide and gadolinium, which is a burnable poison. The Zircaloy-2 clad fuel rods will confine fission fragments and their decay products, thereby keeping the concentration of radioactivity in the NSSS at low levels.

Each of the turbine-generator units consists of the turbine, generator, exciter, controls, and required subsystems. The turbine is an 1800-rpm, tandem-compound, six-flow machine, having one dual-flow high pressure element and three dual-flow low pressure elements with 38-inch last-stage blades. Exhaust steam from the high pressure element will pass through six parallel moisture separators before entering the three low pressure elements. A portion of the steam from each element is extracted for feedwater heating. The drains from each feedwater heater are cascaded successively to the next lower pressure and finally discharged into the condensers.

The generator is a direct-driven, three-phase, 60-Hz, 1800-rpm, 22,000-V, hydrogen inner-cooled, synchronous generator rated at 1265 megavoltamperes (MVA) at 0.90 power factor and 75 psig hydrogen pressure. The turbine-generator has a rated output of 1092 MWe gross at throttle conditions of 965 psia and 1191.5 Btu/lbm, and condenser backpressures of 2.81/3.56/4.67 inches of mercury absolute. The turbine-generator has a gross electrical rating of 1138 MWe with valves wide open. Inplant electrical consumption, including transformer losses and cooling tower makeup pump requirements, is estimated at 46 MWe for a net electrical plant output of 1092 MWe per unit with valves wide open.

Heat rate is the reactor core thermal heat output required to generate 1 kilowatter hour (kWh). The heat rate of Limerick Generating Station at design reactor output (3435 MWt) and net electrical power generated is 10,298 Btu/kWh. Figures 3.2-2 through 3.2-4 show the relationship of expected variations of condenser backpressure for various circulating water temperatures at design circulating water flow (450,000 gpm).



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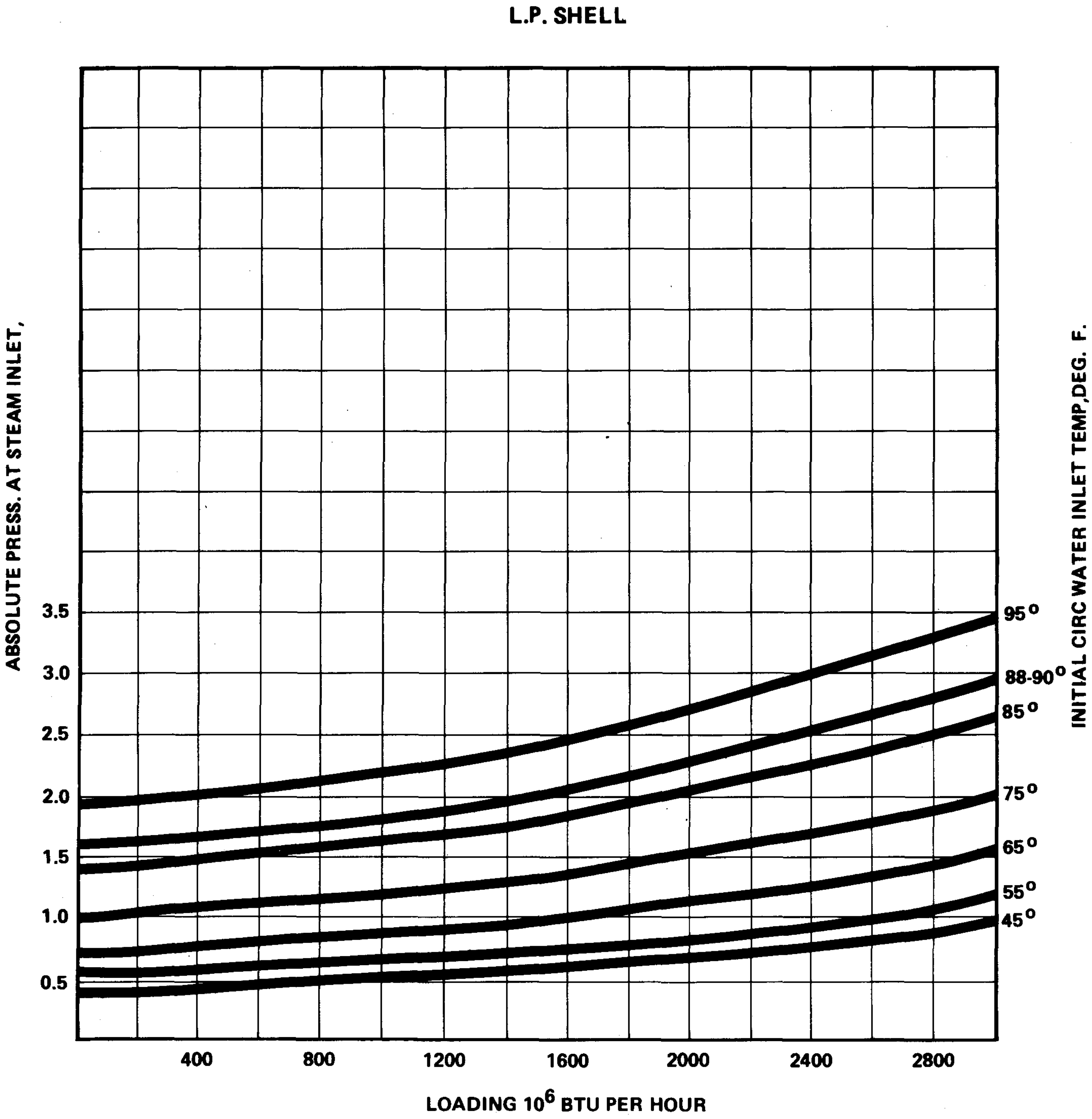
SIMPLIFIED SCHEMATIC OF (BWR) REACTOR AND STEAM-ELECTRIC SYSTEM

FIGURE 3.2-1



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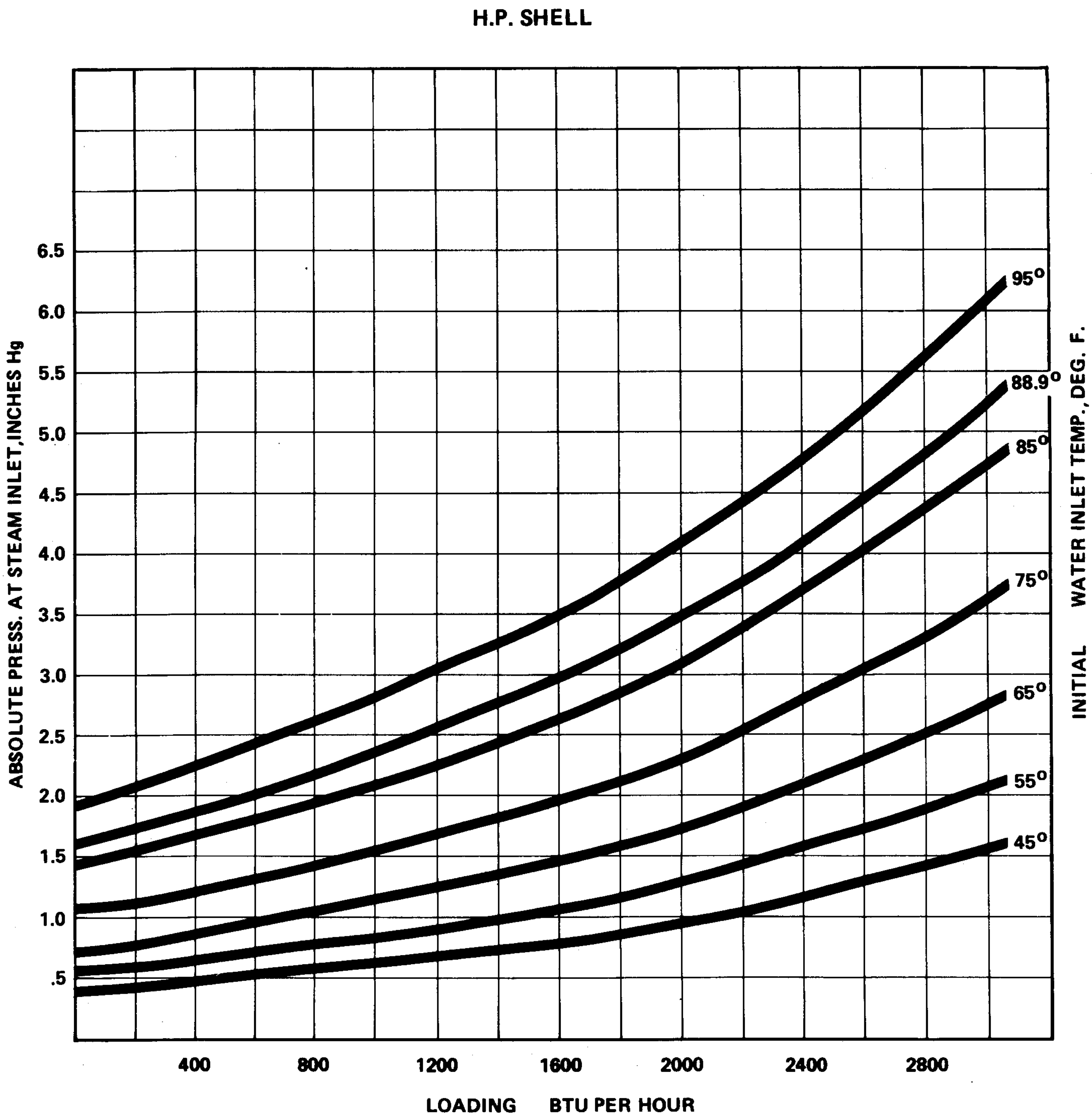
VARIATION IN CONDENSER BACKPRESSURE – L.P.

FIGURE 3.2-2



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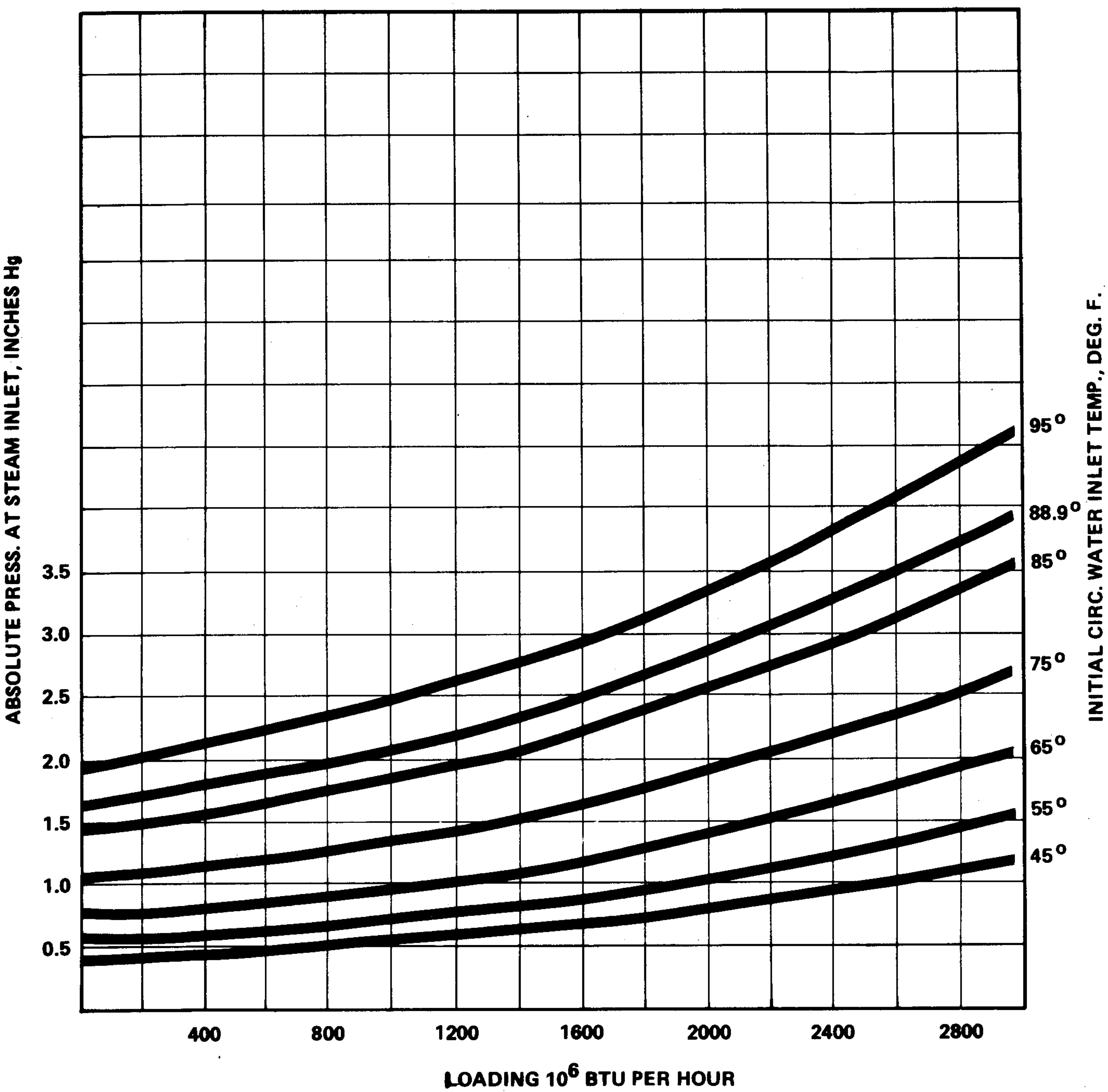
VARIATION IN CONDENSER BACKPRESSURE – H.P.

FIGURE 3.2-3

I.P. SHELL



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VARIATION IN CONDENSER BACKPRESSURE – I.P.

FIGURE 3.2-4

3.3 STATION WATER USE

The Limerick Generating Station uses recirculated cooling water systems with natural draft hyperbolic cooling towers for the rejection of heat contained in the turbine exhaust steam and auxiliary cooling systems. These cooling systems are used for normal operation and consist of the circulating water system and the service water system. The two systems consist of separate loops using separate pumping facilities, but the two flows are mixed together in the cooling tower. The circulating water system delivers the heated water from the main condenser to the cooling tower where heat removed from the turbine exhaust steam is rejected to the atmosphere. The service water system supplies the water for station auxiliary cooling needs required during normal operation, such as the various enclosure coolers, chilling equipment, lubricating oil coolers, fuel pool coolers, and other equipment.

During shutdowns, loss of offsite power, or loss of coolant accident (LOCA), the residual heat removal (RHR) service water system provides cooling water for the RHR heat exchangers to remove residual decay heat generated in the reactors. The emergency service water (ESW) system provides cooling water for various station equipment and area coolers and the diesel-generators in the event of loss of offsite power, or LOCA. The ESW and RHR service water systems are recirculated cooling water systems using vertical wet pit pumps located in the spray pond pump structure. These pumps provide the motive force to circulate cooling water between the various heat exchangers and either the cooling towers or the spray pond. Normally the heat will be rejected to atmosphere by way of the cooling towers. However, should the cooling towers be unavailable the spray pond will be used. In this event, cooling water would be withdrawn from, and returned to, the spray pond.

The cooling process in a hyperbolic cooling tower results in evaporation of a portion of the water being circulated. A carryover of water droplets into the air stream (drift) also occurs, and a small portion of the circulating water must be continuously discharged (blowdown) to prevent buildup of dissolved and suspended solids in the cooling water. The sum of these factors (evaporation, drift, and blowdown) is the amount of makeup water which must be supplied to the cooling towers. The concentration factor of the cooling tower is the makeup rate divided by the blowdown rate. The makeup rate is controlled to provide a constant concentration factor of about 3.4. The cooling tower blowdown rate for two units is expected to average 14 million gallons per day (MGD) and reach a maximum of 17 MGD.

The spray pond has a surface area of 9.9 acres. The spray pond is lined with 12 inches of soil and bentonite. If the spray pond were not lined, makeup for solar evaporation (35 inches per year) and seepage would be no more than 100,000 gpd during normal station operation. Since the pond is lined, this value is conservative. When the pond is in use, losses due to natural evaporation, plant heat load evaporation, seepage, drift loss, and fuel pool makeup are expected to total 20.56 MG over a 30-day period. Spray pond makeup water is normally supplied through a 6-inch branch line from the Schuylkill river makeup system, but water from either cooling tower basin could be added to the spray pond through normally closed 36-inch lines if necessary.

Rainfall and runoff into the spray pond is normally excess water that overflows a weir at El. 251 feet MSL. The spray pond overflow averages about 50,000 gpd based on a yearly rainfall cycle. Spray pond overflow from the once-a-year, 24-hour rainfall event is about 1 MGD. The spray pond overflow is routed through an 8-inch pipe to the cooling tower blowdown line and eventually discharges to the Schuylkill River through the same diffuser that is used for cooling tower blowdown. The spray pond also has an emergency spillway (formed at El. 252 feet MSL by a dip in the paved perimeter road on the north edge of the spray pond) that would spill only during intense precipitation exceeding the once-in-100-years storm. The maximum expected outflow during the probable maximum precipitation is less than 200 cfs. This spillway drains across existing terrain northward to Sanatoga Creek.

The Delaware River Basin Commission (DRBC) has exclusive jurisdiction over the necessity for and approval of compensating water storage capacity for the Limerick Generating Station. An application for such capacity has been submitted at the request of the DRBC and is now under consideration by the DRBC. With regard to the water supply aspects of the facility, the station will be operated under the terms and conditions imposed by the DRBC whether or not compensating water storage capacity is required.

Monthly average water use during two-unit, full-power operation is given in Table 3.3-1. Annual consumptive water usage rates distribution by source are 50% Schuylkill, 4% Perkiomen, and 46% Delaware. In addition to cooling tower blowdown, nonconsumptive water use includes water treated for process water makeup and subsequent waste discharge which is expected to average 100,000 gpd and reach a maximum of 300,000 gpd. A water-use schematic is shown in Figure 3.3-1 which includes the various station water systems that are described further in Sections 3.4 through 3.7.

3.4 HEAT DISSIPATION SYSTEM

Limerick Generating Station utilizes recirculated cooling water systems incorporating two natural draft hyperbolic cooling towers, one for each unit, to dissipate waste process heat. The cooling systems used for normal operation consist of the circulating water system and the service water system. Both systems consist of separate loops using separate pumps, but the circulating water and the service water are mixed together in passing through the cooling tower. To provide clean heat transfer surfaces for efficient power generation, the circulating and service water are maintained at a nearly neutral pH by adding sulfuric acid for scaling control. Periodic chlorination is used for biological fouling control. Water quality aspects of the heat dissipation system are described further in Section 3.6.

The environmental effect of the heat dissipation facilities is described in Section 5.1. Alternative heat dissipation systems are discussed in Section 10.1. The environmental effect of the use of chemicals and biocides to control the cooling water quality is described in Section 5.3. Quantities of water withdrawn and returned, and consumptive use are discussed in Section 3.3.

3.4.1 CIRCULATING WATER SYSTEM

The circulating water system for each unit provides the main condenser with a continuous supply of cooling water for removing the heat rejected by the turbine or turbine bypass system. In starting through the circulating water system, cool water leaves the 7-million gallon cooling tower basin at two separate outlets, where the sulfuric acid and the chlorine solutions are injected as required. The water then passes through 1/2-inch stainless steel stationary screens that prevent debris from entering and clogging the system. The water flows from the two outlets by gravity through two 96-inch pipes, one about 700 feet long, and the other about 800 feet long (see Figure 3.4-1). The two lines eventually divide to form four parallel flow paths through the main condenser.

During full power operation, the circulating water temperature will be increased by about 35°F in passing through the main condenser. The triple-shell series-flow main condenser consists of a low pressure shell, an intermediate pressure shell, and a high pressure shell, with tubes that are 1.125 inches in outside diameter by 36, 42, and 48 feet long, respectively. The main condenser contains about 74,000 Admiralty Brass (18 BWG) tubes, and about 1000 type 304 stainless steel (20 BWG) tubes, for a total effective surface area of 920,000 square feet per generating unit. Condenser tube leakage results in degradation of the condensate by infiltration of circulating water at higher pressure. In the event of significant tube leakage, the flow path containing the leaking tube is taken out of service until the leaking tubes are repaired or plugged. Design of the condenser permits turbine operation with one-fourth, one-half, or three-fourths of the tube surface out of service.

The four parallel flow paths leaving the main condenser combine into dual, 96-inch lines about 300 feet long, that are pressure equalized by a normally open, 78-inch cross-connect valve near the suction side of the circulating water pumps. There are four 25% capacity, mixed-flow dry pit circulating water pumps rated at a differential head of 110 feet, with a total flow of 452,000 gpm per generating unit. The circulating water pumps return the circulating water to the cooling tower via two 96-inch lines about 200 feet long, and then up two concrete risers to the top of the fill ring at an approximate elevation of 330 feet MSL. The circulating water then falls in droplets through the cooling tower fill into the basin, giving up the same amount of heat that was added in the condensers. Two normally closed, 78-inch circulating water bypass lines terminating in the basin can be used to bypass the fill during cold weather startup. All 96-inch and 78-inch diameter lines are coal tar epoxy-lined carbon steel pipes.

The four flow paths through the condenser are arranged so that when one-half of the circulating water is being chlorinated at one of the two cooling tower outlets, only half of the main condenser is chlorinated at a time. Immediately downstream of the main condenser, chlorinated and unchlorinated circulating water paths join, with the result that the chlorine has become uniformly diluted in the full circulating flow by the time it returns to the cooling tower. The general arrangement of the circulating water system is shown in Figure 3.4-1. Approximate travel times through the circulating water system at full flow are: 1 minute from the cooling tower outlets to the main condenser inlet, 1/2 minute through the main condenser, 1-1/2 minutes from the main condenser outlet to the cooling tower basin, and 15 minutes through the basin to the outlets.

3.4.2 SERVICE WATER SYSTEM

The service water system supplies cooling water for auxiliary heat exchange apparatus used during normal operation, such as the air conditioning chillers, lube oil coolers, turbine enclosure closed-loop cooling water heat exchangers, reactor enclosure closed-loop cooling water heat exchangers, fuel pool heat exchangers, and other equipment. The service water is protected from contamination in some cases either by the interposition of a secondary loop with an intermediate fluid where possible radioactive contamination exists, or by system design pressures that favor infiltration of service water in the event of a leak in a service water heat exchanger.

The service water for each unit will be delivered from one outlet of the cooling tower basin, through a 36-inch carbon steel pipe, to three 50% capacity centrifugal dry pit service water pumps, rated at 18,000 gpm each. These pumps, located within the circulating water pump structure, convey the service water to a supply header for distribution to the various heat exchangers. The average service water temperature rise in the heat exchangers is less than the circulating water temperature rise in the main condenser at full power operation. The service water from the heat exchangers is collected in a return header and piped via a 36-inch carbon steel pipe to the top of the cooling tower fill ring. The service water then becomes thoroughly mixed with the circulating water in falling through the cooling tower fill and into the basin. A normally closed, 20-inch service water bypass line terminating in the basin can be used to bypass the fill during cold weather startup, when the circulating water system is not operating. The service water system contributes less than 5% of the total heat dissipation to the atmosphere at full power; the circulating water system is the main source of the heat to be rejected.

3.4.3 NATURAL DRAFT EVAPORATIVE COOLING TOWERS

Each generating unit is served by one cross-flow natural draft evaporative cooling tower that cools circulating and service water by dissipating heat to the atmosphere at approximately 8 billion Btu per hour during full power operation. The cooling towers are also used, if in service, during shutdowns to cool normal service water, RHRSW, and ESW. The heat dissipation rate during shutdown is less than 10% of the heat dissipation rate during full power operation. Each cooling tower has been designed to meet the following conditions: 7.9 billion Btu/hr heat rejection, 75°F wet-bulb temperature, 66% relative humidity, 13.9°F wet-bulb approach, 33.5°F temperature range, and 476,600 gpm water flow.

Figure 3.4-2 shows the major features of one of the two identical cooling towers. The warm water falls through distribution orifices in the bottom of the distribution flume on top of the fill ring, and is broken into droplets as it cascades through the fill. The water droplets are cooled by the air flowing horizontally through the fill, which is constructed of PVC (ASTM C221-67, Type B), comprising about 5.3 million square feet of wetted surface area per tower. The natural draft, caused by pressure and density differences between entering and exiting air, passes about 50 million cfm of air through each tower during full power operation. Cooling tower air flow data are given in Table 3.4-1. The cooling is achieved in part by sensible heat transfer, but mostly by evaporating a portion of the water. Evaporation rates by month are given in Table 3.3-1. A small portion of the water droplets (drift) is carried through the drift eliminators with the water vapor. Although the drift rate is guaranteed for a maximum of 0.2% of the recirculating water flow, about 0.03% (200 thousand gpd per tower) is actually expected. The rest of the water is collected in the full diameter basin for recycling and blowdown.

Blowdown is taken continuously from the cooling tower basin, which is the coolest water in the recirculating system. The blowdown temperature varies seasonally because of ambient atmospheric conditions, and is shown in Table 3.4-2. Performance curves for the cooling tower are shown in Figure 3.4-3. The maximum cooling tower blowdown temperature will be 94°F. Blowdown will flow from the cooling tower basin over a 20-foot-long weir crest at elevation 262.4 feet MSL. The blowdown rate equals the rate of pumping makeup water minus the rate of evaporation and drift, as shown in Table 3.3-1. Evaporation curves for the cooling tower are shown in Figure 3.4-4. A small heat load (usually less than 1% of the total two-unit full-power heat rejection) is rejected to the Schuylkill River because the blowdown temperature is warmer than the river temperature. The environmental effects of heat dissipation are discussed in Section 5.1.

3.4.4 EMERGENCY SPRAY POND

The spray pond is an emergency cooling system that is used during plant shutdown if the cooling towers are not available for heat dissipation. Although the spray pond is not intended for use during normal operation or normal shutdown, it is used during loss of offsite power or loss-of-coolant accident (LOCA). Environmental impacts due to infrequent testing, and emergency operation of the spray pond are insignificant.

The spray pond system is common to both Units 1 and 2, and is shown in Figure 3.4-5. The system consists of the spray pond pump structure, spray pond spray nozzles, and associated piping and valves. The spray pond pump structure, located at the south edge of the spray pond, contains four RHRSW wet-pit turbine pumps rated at 9000 gpm each, and four ESW wet-pit turbine pumps rated at 6500 gpm each. Each pump is installed in its own bay. A removable screen is placed at the entrance of each of the bays. The spray pond has a capacity of 29.6 million gallons, a surface area of 9.9 acres, and a depth of 10 feet, with a normal water surface elevation of 251 feet MSL. The spray system consists of two spray networks for each of the two safeguard divisions. For winter startup, spray network bypass lines are provided so that when low ambient temperatures exist, the total flow can be routed directly to the pond without passing through the spray network.

The spray pond performance (for a once-in-40-year DBA) has been analyzed to ensure that the design spray pond volume is adequate for 30 days of cooling, and that the cooling water temperature does not exceed the design limit during design meteorological conditions. The transient analyses for performance evaluation assumed that the spray pond is subjected to the heat load from a LOCA on one unit, and emergency shutdown and cooldown of the other unit, and the simultaneous loss of offsite power. The loss of offsite power requires the use of the standby diesel generators that also reject heat to the spray pond. The heat rejection rate to the spray pond is given in Table 3.4-3 for decay heat, station auxiliary heat, and sensible heat. Resulting spray pond water temperatures are presented in Figure 3.4-6. The initial spray pond temperature, 88°F, corresponds to extreme monthly average atmospheric conditions that maximize initial temperature. The maximum cooling water temperature is 94.3°F, which is within the design limit of 95°F.

Evaporation due to the plant heat load was determined from the total heat dissipated by the spray pond in 30 days due to decay heat, sensible heat, and auxiliary system heat loads. The maximum water requirement is determined by assuming the heat to be dissipated only by evaporation. The total decay heat generation in 30 days is 47.8 billion Btu for both units. The auxiliary system total heat generation for the first 30 days, including the standby diesel generators and fuel pool cooling, is 45.5 billion Btu. The total sensible heat load of the reactor pressure vessel, its internals, and the suppression pool is 0.8 billion Btu, referenced to a final temperature of 100°F. The resultant evaporation calculated, assuming all heat dissipation is evaporative, is about 11 million gallons in 30 days. Heat dissipation and evaporation from the spray pond are much less than normal heat dissipation and evaporation from the two cooling towers.

Drift loss due to entrainment of spray droplets during periods of moderate and high winds has been estimated to be 1.6 million gallons in 30 days. Drift loss has been minimized by placement of the nozzles a minimum of 100 feet away from the perimeter of the pond. Drift loss from spray pond heat dissipation is less than normal drift loss from the two cooling towers. Spray pond drift is not expected to accumulate outside the site boundary.

Drought does not impair the cooling capability of the spray pond system because the design spray pond volume is adequate, with reserve capacity, for 30 days of cooling without makeup.

3.4.5 SCHUYLKILL RIVER INTAKE AND DISCHARGE FACILITIES

The Schuylkill River intake and discharge facilities are located at the Limerick Generating Station site, and consist of a makeup water pumping station and a discharge diffuser. These structures, as shown in Figures 3.4-7 through 3.4-10, are being constructed under Corps of Engineers Permit No. NAPOP-N-00-888 and Pennsylvania Department of Environmental Resources Water Obstruction Permit No. 19616.

The Schuylkill River pump structure is a full-capacity intake rated at a total flow of 34,000 gpm, with a maximum physical capability of 42,000 gpm. There are three wet-pit vertical turbine pumps (each protected by a traveling screen) rated at 11,300 gpm per pump, with runout to 13,000 gpm. A fourth vertical traveling screen protects two wet-pit vertical turbine pumps, each rated at 5650 gpm, with runout to 7000 gpm. Trash racks (with 3-1/2-inch clear openings between bars) are provided in front of the intake to protect the screens, and in both the upstream and downstream ends of the intake to allow free passage of fish swimming near the screen face. The debris gathered from the screens and trash racks is disposed of offsite. A floating trash boom in front of the trash racks diverts most surface debris and drift organisms before they reach the trash racks.

The vertical traveling screens are placed so that the offshore face of the screens is flush with the walls of the structure, and in line with the normal river bank. The 5-foot wide screen trays are fabricated with No. 14 (W+M) gauge (0.080 inch) stainless steel mesh with 1/4-inch clear openings. At design low water level (elevation 104 feet MSL) and maximum pump bay flow (14,000 gpm), the average approach velocity to the screens is less than 0.61 fps. At average river level (elevation 106-108 feet MSL), and rated pump bay flow (11,300 gpm), the average approach velocity to the screens is less than 0.5 fps. Upon being actuated either by an automatic timer at regular intervals (15 minutes once every 4 hours), or by sensing of a pressure differential (6 inches of water) across the screens, the screens are backwashed by 85 psi spray water while the screens are traveling at 10 fpm. During winter freezing conditions, the traveling screens are deiced, as necessary, with a separate spray system by spraying up to 120 gpm of warmed river water from a 100-kW electric water heater.

To ensure water during periods of extremely low river flows, a depression will be dredged in the river bed leading to the intake, and the river channel downstream from the intake is stabilized by construction of a concrete weir (minimum crest elevation of 110 feet MSL) that extends across the river at the elevation of the existing bottom. Nonconsumptive water use is returned to the Schuylkill River through the discharge diffuser, which is encased in the concrete channel stabilization structure on the east side of the river, about 700 feet downstream of the intake. The discharge diffuser consists of a 28-inch carbon steel pipe with a total of 283 nozzles (1.25 inch diameter) installed on 6-inch centers. The diffuser is supplied by a 36-inch carbon steel cooling tower blowdown pipe. Normal discharge through the diffuser is expected to be 14.2 MGD. Normal maximum discharge through the diffuser is expected to be 17 MGD (26 cfs), with a corresponding discharge velocity of 9 fps. The nozzle discharge velocity is 11 fps, although 52 MGD (80 cfs) can be discharged through the diffuser, with a corresponding nozzle discharge velocity of 33 fps.

3.4.6 PERKIOMEN MAKEUP WATER SYSTEM

The Perkiomen makeup water system is utilized when consumptive water is not available from the Schuylkill River. Water is conveyed from the Perkiomen pump structure, which is unattended and remotely controlled, through a 36-inch pipeline that extends about 8 miles to the Limerick site. A 1.5 million gallon water storage surge tank is connected to the pipeline to provide smooth operation during changing flow rates. The pipeline is installed along an existing electric transmission right-of-way, as shown in Figure 3.4-11.

The Perkiomen pump structure is located on the west bank of Perkiomen Creek, about 0.6 miles south of Graterford. The pump structure, as shown in Figures 3.4-12 through 3.4-15, is equipped with three wet-pit vertical turbine pumps rated at 14,600 gpm per pump. The pump structure is about 90 feet inshore from the normal river bank, and connected to the intake screens by buried pipes, as shown in Figure 3.4-12.

The intake consists of a series of submerged stationary wedge-wire screens, placed at midstream in Perkiomen Creek. The screens are cylindrical, approximately 6 feet long and 2 feet in diameter, with a slot size of 2 mm. The average through-slot velocity is less than 0.4 fps; maximum through-slot velocity is less than 0.5 fps. The screens are placed end-to-end in a series, with the long axis parallel to the creek flow. The top of the screens is approximately 7 inches below the minimum water surface elevation (el 111 feet MSL). The intake screens are supported by a concrete header buried approximately 2 feet below the existing creek bottom. Three buried 36-inch diameter concrete pipes connect the header with the pump structure.

On high differential pressure, the screens are cleaned by an airburst cleaning system to complement the screening system's ability to minimize impingement and entrainment of aquatic organisms. The channel downstream from the intake is stabilized by a concrete channel stabilization structure (minimum crest elevation of 111 feet MSL), as shown in Figure 3.4-14. This channel stabilization structure will also maintain the water surface elevation at the intake location to a minimum of 111 feet MSL.

Deposition of sediment around the screens to a depth sufficient to cause plant shutdown is highly improbable since the screens are located in mid-stream at the point of greatest depth and their centerline will be over 1.5 feet above the existing creek bed. There will be no excavated area required to facilitate water withdrawal.

TABLE 3.3-1

AVERAGE WATER USE DURING TWO-UNIT, FULL-POWER OPERATION
(IN MILLIONS OF GALLONS PER DAY)[1]

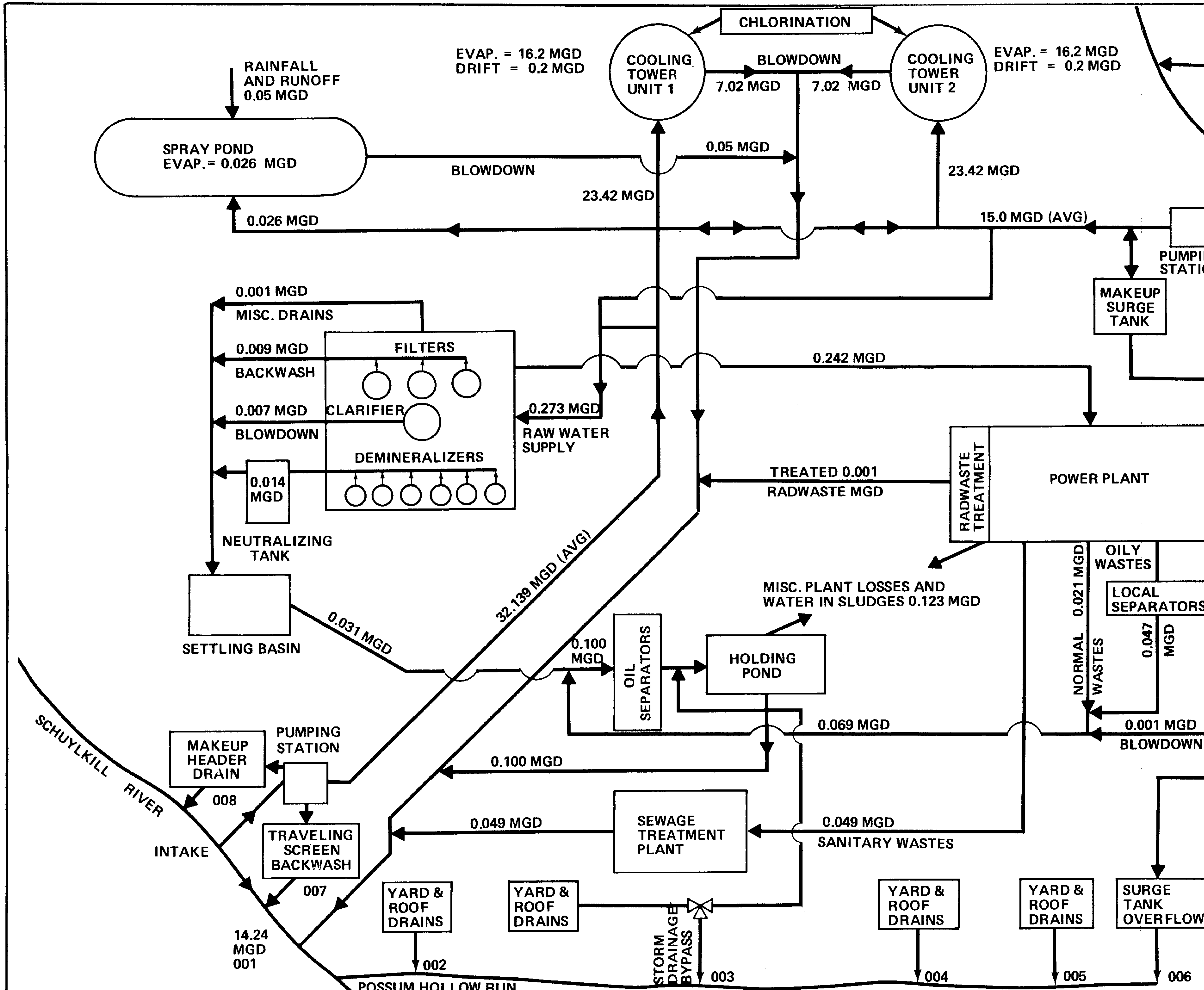
	MAKEUP PUMPED FROM:		CONSUMPTIVE LOSS		NON-CONSUMPTIVE USE	
	Schuylkill	Delaware/	Cooling Towers[3]			Total Discharge
Month	River[2]	Perkiomen	Evaporation	Drift	Misc	To Schuylkill
Jan	40.8	0	28.0	0.4	0.1	12.3
Feb	40.8	0	28.0	0.4	0.1	12.3
Mar	43.6	0	30.0	0.4	0.1	13.1
Apr	46.8	0	32.2	0.4	0.1	14.1
May	49.7	0	34.2	0.4	0.1	15.0
Jun	15.8	36.5	36.0	0.4	0.1	15.8
Jul	16.0	37.1	36.6	0.4	0.1	16.0
Aug	15.9	36.9	36.4	0.4	0.1	15.9
Sep	15.4	35.7	35.2	0.4	0.1	15.4
Oct	14.5	33.7	33.2	0.4	0.1	14.5
Nov	44.5	0	30.6	0.4	0.1	13.4
Dec	41.6	0	28.6	0.4	0.1	12.5
Annual	32.1	15.0	32.4	0.4	0.1	14.2

(1) Maximum water uses during two-unit, full-power operation are:
- Schuylkill River makeup physical capability = 60 MGD
- Delaware/Perkiomen makeup physical capability = 42 MGD
- Maximum miscellaneous consumptive losses = 1 MGD
- Maximum evaporation from two cooling towers = 38 MGD
- Maximum drift from two cooling towers = 3 MGD
- Maximum blowdown from two cooling towers = 17 MGD
- Maximum discharge capability to Schuylkill River = 52 MGD

Note that maximum water uses do not all occur concurrently.

(2) Based on controlling makeup to maintain 3.4 cycles of concentration in the cooling towers (excluding drift), and to meet DRBC consumptive use constraints during monthly average Schuylkill River flows and temperatures. Actual consumptive water withdrawals will be made in accordance with DRBC constraints governing at the time.

(3) Cooling tower evaporation rates are based on monthly average meteorology. During a shutdown, using either the cooling towers or the spray pond, evaporation and drift losses will be less than 6 and 1 MGD per unit shutdown, respectively.



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SCHEMATIC OF WATER USE DURING PLANT OPERATION

FIGURE 3.3-1

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LGS EROLS

TABLE 3.4-1

COOLING TOWER AIR FLOW DATA[1]

Entering Air Condition (Ambient) Wet Bulb °F	Entering Air Condition (Ambient) R.H. %	Moisture Content Entering Air (lb. H_2O/min.)	Discharge Air Temperature (°F)	Moisture Content Discharge Air (lb. H_2O/min.)	Discharge Air Velocity (fpm)	Discharge Air Volume (cfm)	Air Rate (lb. dry air/min.)
30	40	7229	80.3	90765	1546	56650000	4016130
30	60	9851	79.6	90714	1579	57860000	4104690
30	66	10320	79.4	90399	1588	58190000	4127800
30	80	12113	79.1	90639	1605	58810000	4176900
30	100	13997	78.6	90342	1627	59619000	4241400
50	40	15768	92.7	114399	1347	49358000	3354800
50	60	20747	91.5	115342	1406	51521000	3516520
50	66	22059	91.2	115277	1420	52034000	3557920
50	80	24770	90.6	115836	1451	53170000	3642630
50	100	28460	89.8	116085	1488	54526000	3744670
60	40	22706	99.2	127458	1245	45621000	3027500
60	60	29084	97.6	128940	1320	48370000	3231580
60	66	30847	97.2	129625	1339	49066000	3281640
60	80	34175	96.5	130272	1377	50458000	3383680
60	100	38565	95.6	131473	1423	52144000	3505940
75	40	36132	109.3	148115	1098	40235000	2562550
75	60	45724	107.1	152413	1198	43899000	2822460
75	66	48180	106.6	153484	1221	44742000	2885030
75	80	53331	105.7	155775	1271	46574000	3013060
75	100	59469	104.7	158162	1328	48663000	3163230

(1) The Marley Company

TABLE 3.4-2

COOLING TOWER BLOWDOWN TEMPERATURES DURING FULL-POWER OPERATION (IN DEGREES FAHRENHEIT) [1]

MONTH	50 PERCENT EXCEEDENCE	10 PERCENT EXCEEDENCE	5 PERCENT EXCEEDENCE	1 PERCENT EXCEEDENCE
Jan	61	69	72	77
Feb	61	69	72	77
Mar	65	73	76	80
Apr	70	80	82	87
May	76	84	86	90
Jun	82	88	89	91
Jul	84	89	91	94
Aug	84	89	91	94
Sep	79	86	87	90
Oct	73	81	83	85
Nov	66	77	80	83
Dec	62	70	72	79
Annual	72	86	88	91

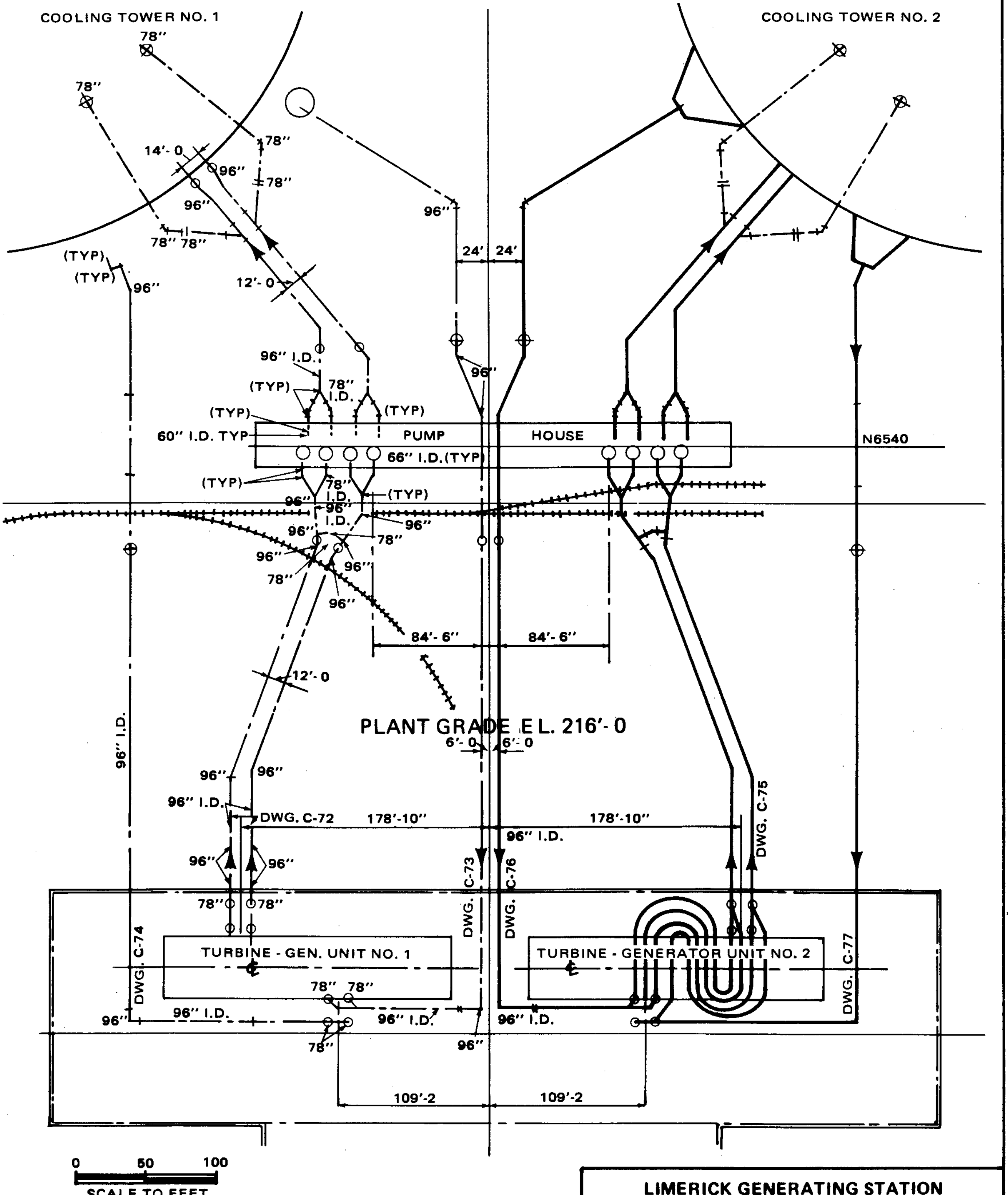
[1] Maximum Cooling Tower Blowdown Temperature is 94°F.
Minimum Cooling Tower Blowdown Temperature is 32°F.

TABLE 3.4-3

HEAT REJECTION RATE TO THE SPRAY POND

TIME AFTER LOCA (minutes)	DECAY HEAT RATE TWO UNITS (Btu/hr)	AUXILIARY HEAT RATE TWO UNITS (Btu/hr)	SENSIBLE HEAT RATE LOCA UNIT (Btu/hr)[1]	SENSIBLE HEAT RATE SHUTDOWN U (Btu/hr)	TOTAL HEAT RATE TWO UNITS (Btu/hr)
$1.00x10^{+1}$	$6.50x10^{+8}$	$7.08x10^{+7}$	$-2.60x10^{+8}$	$-3.25x10^{+8}$	$1.36x10^{+8}$
$1.20x10^{+1}$	$6.24x10^{+8}$	$7.08x10^{+7}$	$-2.46x10^{+8}$	$-3.12x10^{+8}$	$1.36x10^{+8}$
$1.52x10^{+1}$	$5.82x10^{+8}$	$7.08x10^{+7}$	$-2.24x10^{+8}$	$-2.91x10^{+8}$	$1.37x10^{+8}$
$2.92x10^{+1}$	$4.71x10^{+8}$	$7.08x10^{+7}$	$-1.63x10^{+8}$	$-2.36x10^{+8}$	$1.44x10^{+8}$
$3.92x10^{+1}$	$4.41x10^{+8}$	$7.08x10^{+7}$	$-1.44x10^{+8}$	$1.05x10^{+8}$	$4.74x10^{+8}$
$5.12x10^{+1}$	$4.07x10^{+8}$	$7.08x10^{+7}$	$-1.22x10^{+8}$	$1.05x10^{+8}$	$4.61x10^{+8}$
$6.32x10^{+1}$	$3.73x10^{+8}$	$7.08x10^{+7}$	$-1.02x10^{+8}$	$1.05x10^{+8}$	$4.47x10^{+8}$
$7.12x10^{+1}$	$3.51x10^{+8}$	$7.08x10^{+7}$	$-8.88x10^{+7}$	$1.05x10^{+8}$	$4.38x10^{+8}$
$8.72x10^{+1}$	$3.35x10^{+8}$	$7.08x10^{+7}$	$-7.77x10^{+7}$	$1.05x10^{+8}$	$4.33x10^{+8}$
$1.03x10^{+2}$	$3.20x10^{+8}$	$7.08x10^{+7}$	$-6.80x10^{+7}$	$1.05x10^{+8}$	$4.28x10^{+8}$
$1.15x10^{+2}$	$3.09x10^{+8}$	$7.08x10^{+7}$	$-6.10x10^{+7}$	$1.05x10^{+8}$	$4.24x10^{+8}$
$1.27x10^{+2}$	$2.98x10^{+8}$	$7.08x10^{+7}$	$-5.42x10^{+7}$	$1.05x10^{+8}$	$4.20x10^{+8}$
$1.71x10^{+2}$	$2.74x10^{+8}$	$7.08x10^{+7}$	$-3.84x10^{+7}$	$1.05x10^{+8}$	$4.12x10^{+8}$
$2.31x10^{+2}$	$2.55x10^{+8}$	$7.08x10^{+7}$	$-2.54x10^{+7}$	$9.97x10^{+7}$	$4.00x10^{+8}$
$2.91x10^{+2}$	$2.36x10^{+8}$	$7.08x10^{+7}$	$-1.37x10^{+7}$	$1.93x10^{+7}$	$3.12x10^{+8}$
$3.51x10^{+2}$	$2.24x10^{+8}$	$7.08x10^{+7}$	$-6.95x10^{+6}$	$4.95x10^{+6}$	$2.93x10^{+8}$
$6.11x10^{+2}$	$1.85x10^{+8}$	$7.08x10^{+7}$	$1.04x10^{+7}$	$1.53x10^{+6}$	$2.67x10^{+8}$
$1.09x10^{+3}$	$1.57x10^{+8}$	$7.08x10^{+7}$	$1.23x10^{+7}$	$7.30x10^{+5}$	$2.41x10^{+8}$
$2.29x10^{+3}$	$1.26x10^{+8}$	$6.28x10^{+7}$	$7.02x10^{+6}$	$6.38x10^{+5}$	$1.96x10^{+8}$
$3.73x10^{+3}$	$1.06x10^{+8}$	$6.28x10^{+7}$	$4.21x10^{+6}$	$4.52x10^{+5}$	$1.73x10^{+8}$
$5.17x10^{+3}$	$9.25x10^{+7}$	$6.28x10^{+7}$	$2.94x10^{+6}$	$3.57x10^{+5}$	$1.59x10^{+8}$
$6.61x10^{+3}$	$8.42x10^{+7}$	$6.28x10^{+7}$	$1.88x10^{+6}$	$2.54x10^{+5}$	$1.49x10^{+8}$
$7.81x10^{+3}$	$7.89x10^{+7}$	$6.28x10^{+7}$	$1.60x10^{+6}$	$2.32x10^{+5}$	$1.44x10^{+8}$
$8.77x10^{+3}$	$7.47x10^{+7}$	$6.28x10^{+7}$	$1.53x10^{+6}$	$2.14x10^{+5}$	$1.39x10^{+8}$
$9.73x10^{+3}$	$7.05x10^{+7}$	$6.28x10^{+7}$	$1.49x10^{+6}$	$1.99x10^{+5}$	$1.35x10^{+8}$
$1.66x10^{+4}$	$6.27x10^{+7}$	$6.28x10^{+7}$	$3.42x10^{+5}$	$1.58x10^{+4}$	$1.26x10^{+8}$
$2.23x10^{+4}$	$5.72x10^{+7}$	$6.28x10^{+7}$	$3.36x10^{+5}$	$1.35x10^{+5}$	$1.20x10^{+8}$
$2.67x10^{+4}$	$5.31x10^{+7}$	$6.28x10^{+7}$	$3.34x10^{+5}$	$2.85x10^{+5}$	$1.17x10^{+8}$
$3.24x10^{+4}$	$4.76x10^{+7}$	$6.28x10^{+7}$	$3.32x10^{+8}$	$3.08x10^{+5}$	$1.11x10^{+8}$
$4.18x10^{+4}$	$3.86x10^{+7}$	$6.28x10^{+7}$	$3.28x10^{+5}$	$2.01x10^{+5}$	$1.02x10^{+8}$
$4.32x10^{+4}$	$3.73x10^{+7}$	$6.28x10^{+7}$	$3.24x10^{+5}$	$2.66x10^{+5}$	$1.01x10^{+8}$

(1) Negative heat rates indicate heat being stored.



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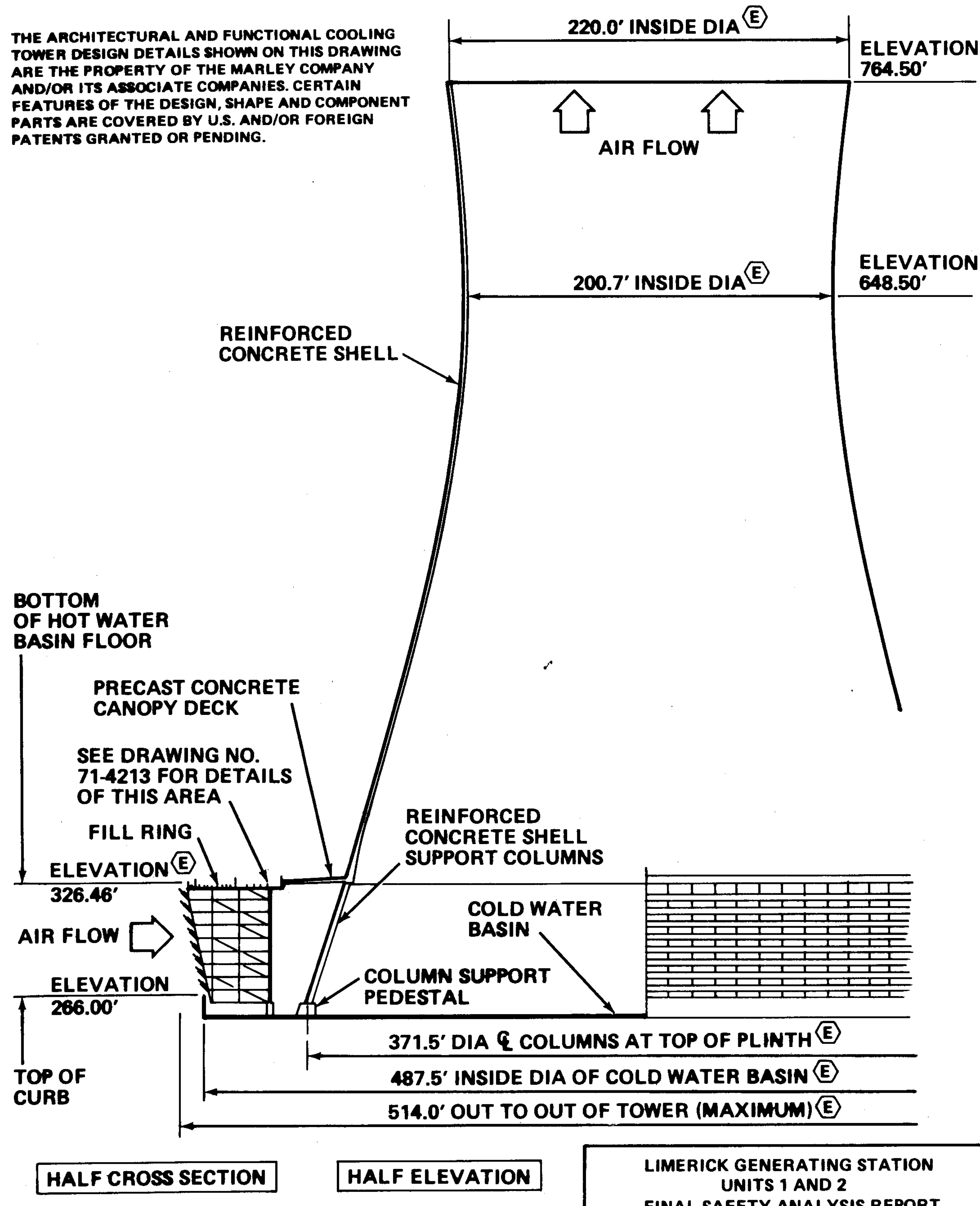
CIRCULATING WATER PIPING-
GENERAL ARRANGEMENT

FIGURE 3.4-1



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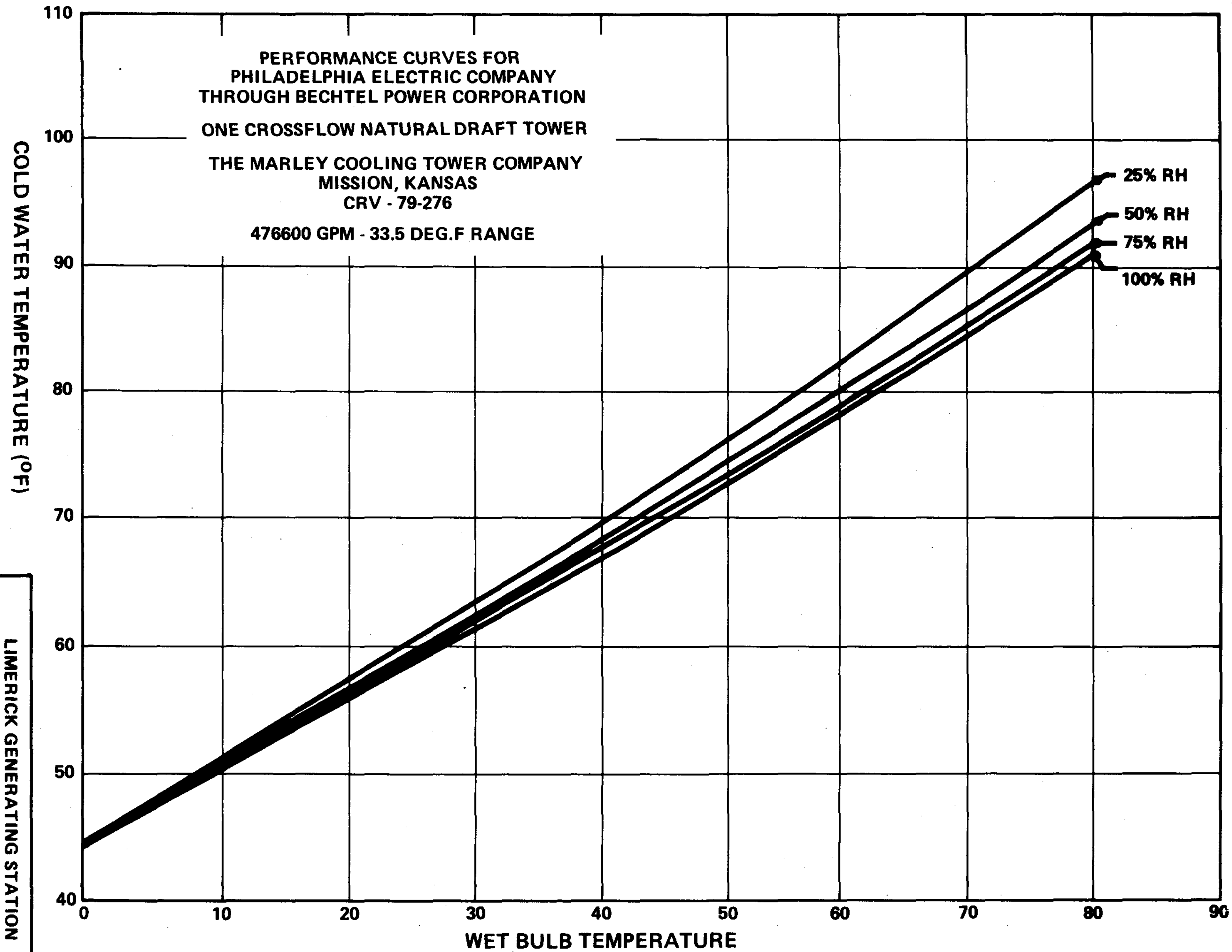
NATURAL DRAFT COOLING TOWER—
GENERAL ARRANGEMENT

FIGURE 3.4-2



LIMERICK GENERATING STATION
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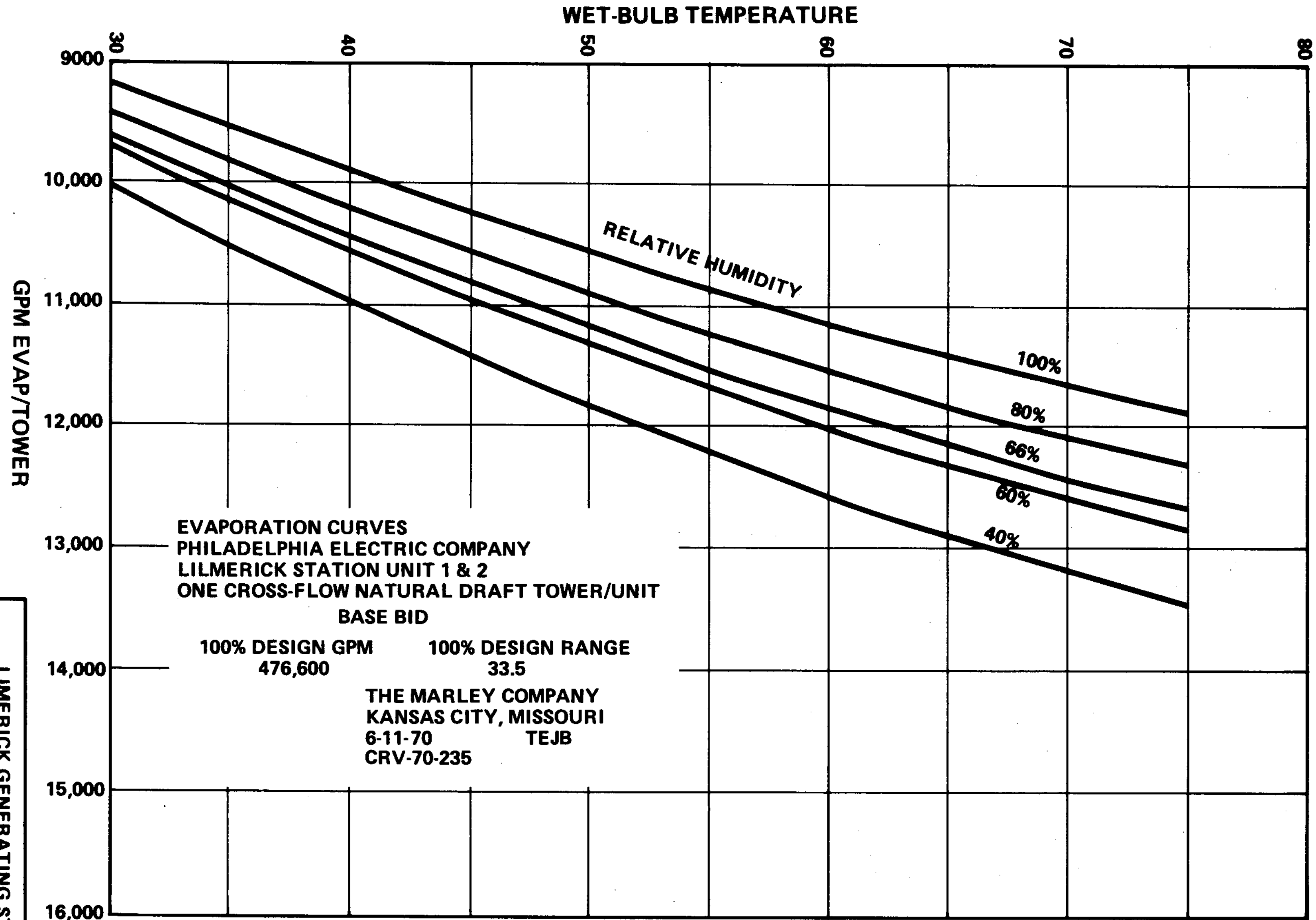
NATURAL DRAFT COOLING TOWER - PERFORMANCE CURVES

FIGURE 3.4-3



LIMERICK GENERATING STATION
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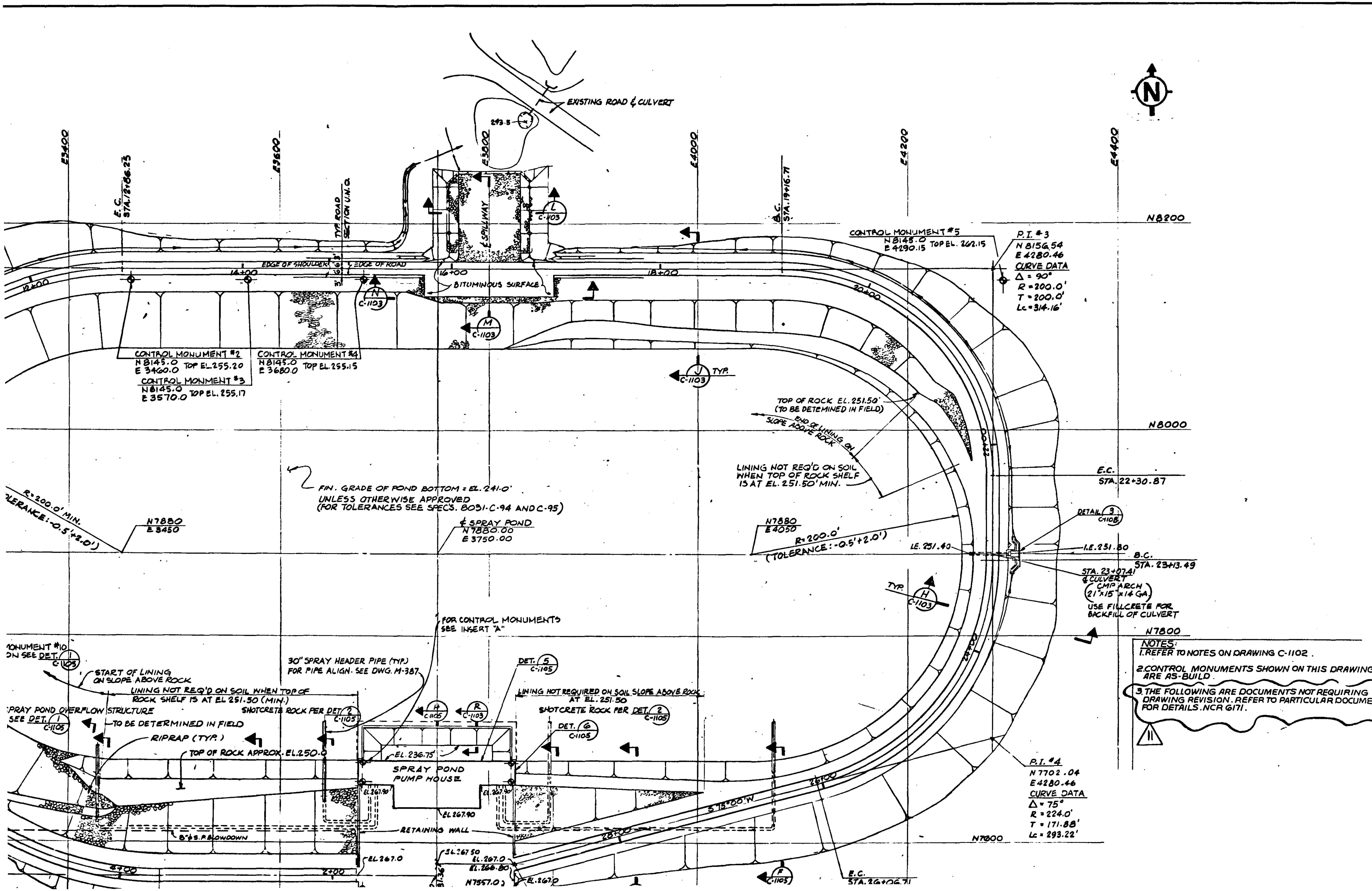
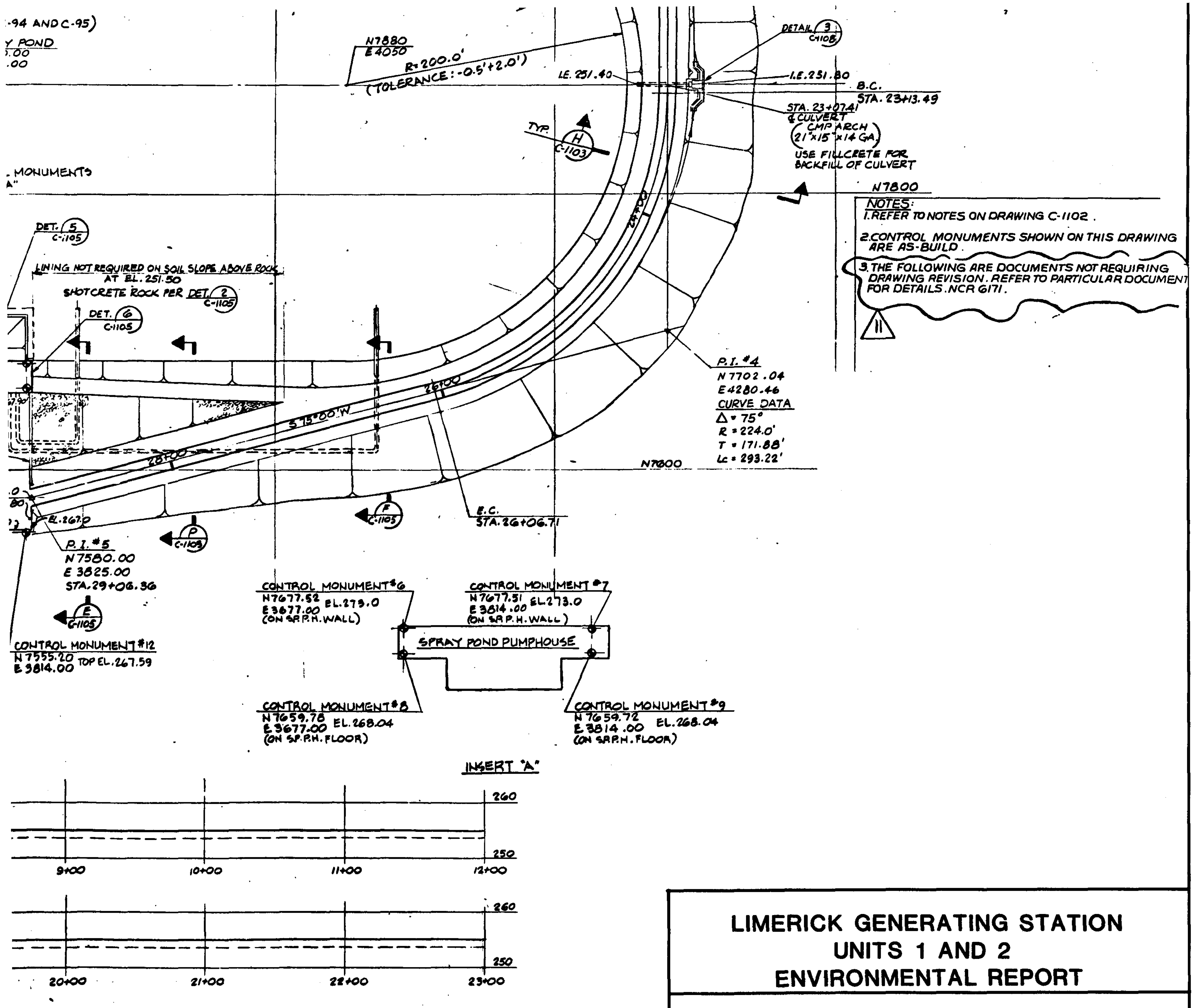
NATURAL DRAFT COOLING TOWER - EVAPORATION CURVES

FIGURE 3.4-4


EXISTING ROAD & CULVERT
293.5
E3400
E3600
E3800
E4000
E4200
E4400
E.C. STA. 12+56.25
TYP. ROAD SECTION U.N.O.
B.C. STA. 19+16.71
℄ SPILLWAY
L C-1103
N8200
CONTROL MONUMENT #5
N 8145.0
E 4290.15 TOP EL. 262.15
P.I. #3
N 8156.54
E 4280.46
CURVE DATA
Δ = 90°
R = 200.0'
T = 200.0'
Lc = 314.16'
EDGE OF SHOULDER
℄ EDGE OF ROAD
12+00
14+00
16+00
18+00
20+00
BITUMINOUS SURFACE
N C-1103
M C-1103
CONTROL MONUMENT #2
N 8145.0
E 3460.0 TOP EL. 255.20
CONTROL MONUMENT #4
N 8145.0
E 3680.0 TOP EL. 255.15
CONTROL MONMENT #3
N 8145.0
E 3570.0 TOP EL. 255.17
J C-1103 TYP.
TOP OF ROCK EL. 251.50'
(TO BE DETEMINED IN FIELD)
END OF LINING ON SLOPE ABOVE ROCK
N8000
22+00
LINING NOT REQ'D ON SOIL WHEN TOP OF ROCK SHELF IS AT EL. 251.50' MIN.
E.C. STA. 22+30.87
FIN. GRADE OF POND BOTTOM = EL. 241.0'
UNLESS OTHERWISE APPROVED
(FOR TOLERANCES SEE SPECS. 8031-C-94 AND C-95)
R = 200.0' MIN.
TOLERANCE: -0.5'+2.0')
N7880
E 3450
℄ SPRAY POND
N 7880.00
E 3750.00
N7880
E 4050
R = 200.0'
(TOLERANCE: -0.5'+2.0')
DETAIL 3 C-1105
I.E. 251.40
I.E. 251.80
B.C. STA. 23+13.49
STA. 23+07.41
℄ CULVERT
(CMP ARCH 21"x15" x14 GA)
USE FILLCRETE FOR BACKFILL OF CULVERT
TYP. H C-1103
N7800
FOR CONTROL MONUMENTS SEE INSERT "A"
MONUMENT #10
ON SEE DET. 1 C-1105
30" SPRAY HEADER PIPE (TYP.)
FOR PIPE ALIGN. SEE DWG. M-387
DET. 5 C-1105
START OF LINING ON SLOPE ABOVE ROCK
LINING NOT REQ'D ON SOIL WHEN TOP OF ROCK SHELF IS AT EL 251.50 (MIN.)
LINING NOT REQUIRED ON SOIL SLOPE ABOVE ROCK AT EL. 251.50
SHOTCRETE ROCK PER DET. 2 C-1105
SPRAY POND OVERFLOW STRUCTURE
SEE DET. 1 C-1105
TO BE DETERMINED IN FIELD
H C-1105
R C-1103
DET. 6 C-1105
RIPRAP (TYP.)
EL. 236.75'
TOP OF ROCK APPROX. EL. 250.0
SPRAY POND PUMP HOUSE
EL. 267.90
EL 267.90
RETAINING WALL
8" ø S.P. BLOWDOWN
S 75°00' W
24+00
26+00
28+00
EL. 267.0
EL. 267.50
EL. 266.80
N7557.0
EL. 267.0
4+00
2+00
F C-1105
N7600
E.C. STA. 26+06.71
P.I. #4
N 7702.04
E 4280.46
CURVE DATA
Δ = 75°
R = 224.0'
T = 171.88'
Lc = 293.22'
NOTES:
1. REFER TO NOTES ON DRAWING C-1102.
2. CONTROL MONUMENTS SHOWN ON THIS DRAWING ARE AS-BUILD.
3. THE FOLLOWING ARE DOCUMENTS NOT REQUIRING DRAWING REVISION. REFER TO PARTICULAR DOCUMENT FOR DETAILS. NCR 6171.
11



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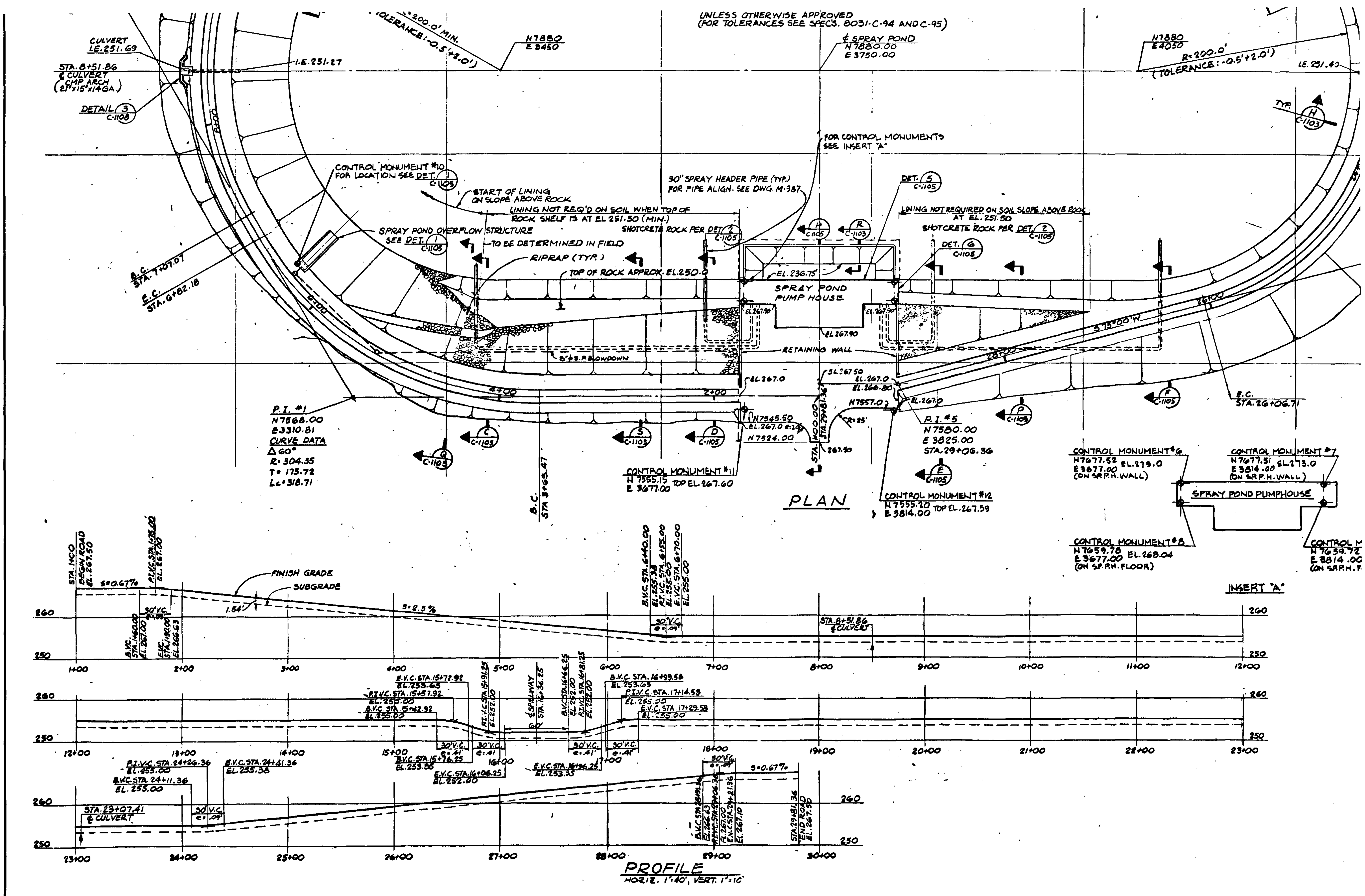
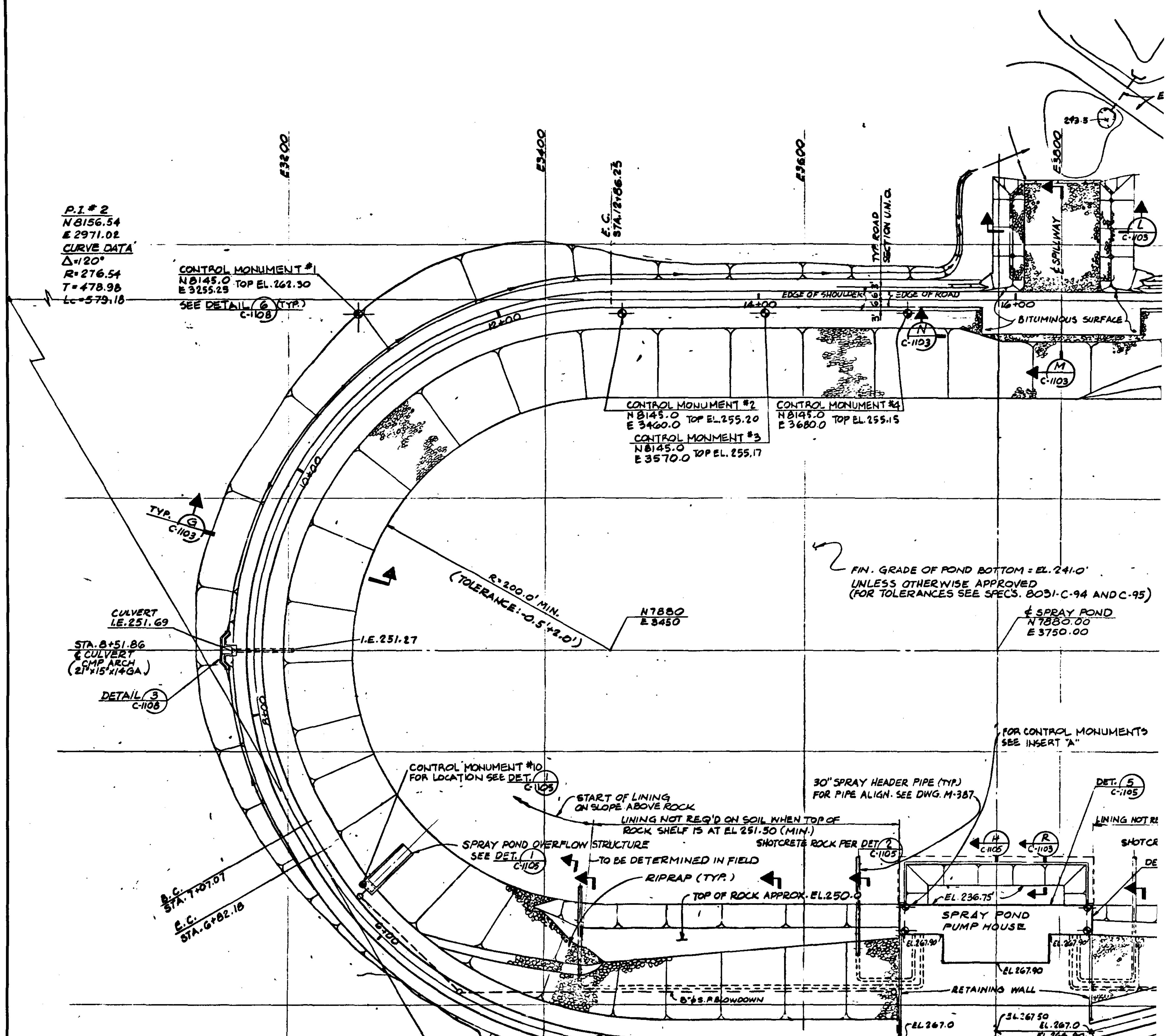
SPRAY POND PLAN AND SECTIONS

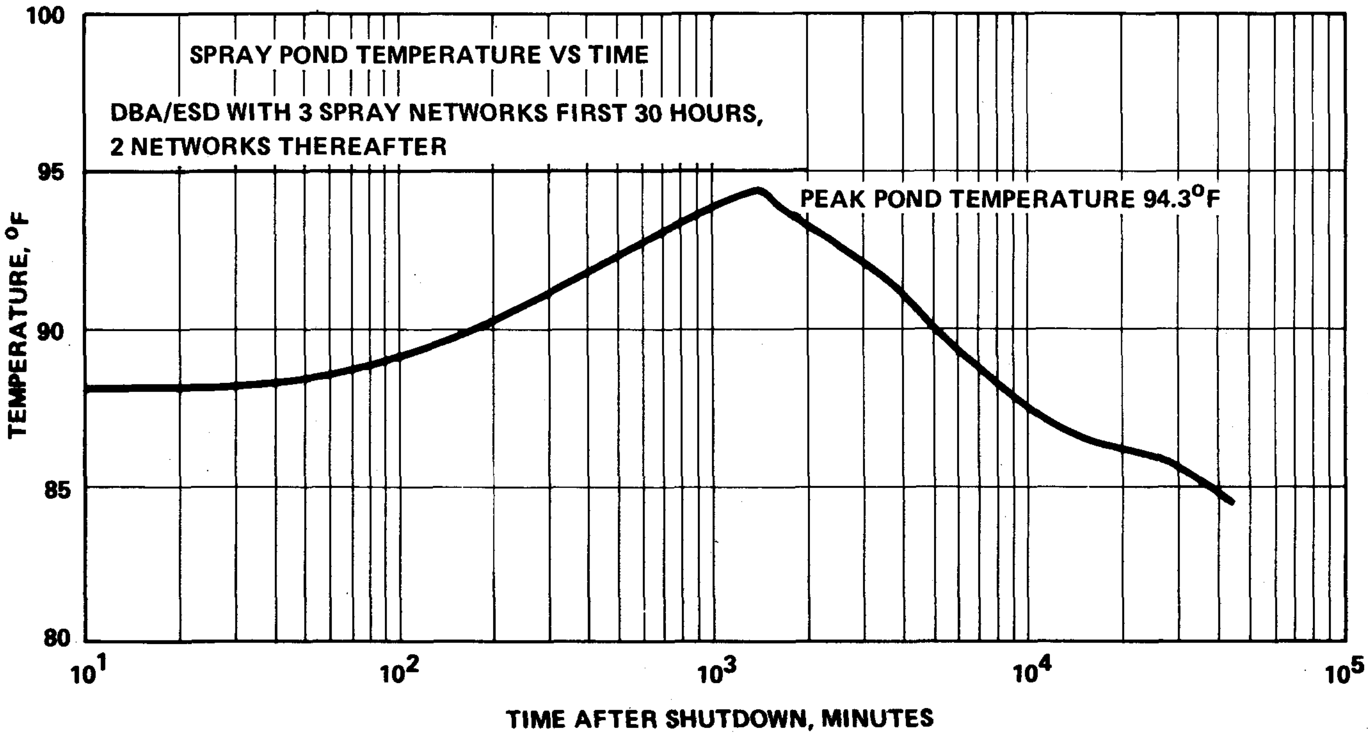
FIGURE 3.4-5

REV. 12, 04/83


UNLESS OTHERWISE APPROVED
(FOR TOLERANCES SEE SPECS. 8031-C-94 AND C-95)
CULVERT
I.E. 251.69
STA. 8+51.86
℄ CULVERT
CMP ARCH
(21"x15"x14GA.)
DETAIL 3 C-1108
I.E. 251.27
N7880
E3450
℄ SPRAY POND
N7880.00
E3750.00
N7880
E4050
R=200.0'
(TOLERANCE: -0.5'+2.0')
I.E. 251.40
FOR CONTROL MONUMENTS SEE INSERT "A"
CONTROL MONUMENT #10
FOR LOCATION SEE DET. 1 C-1105
START OF LINING ON SLOPE ABOVE ROCK
LINING NOT REQ'D ON SOIL WHEN TOP OF ROCK SHELF IS AT EL 251.50 (MIN.)
30" SPRAY HEADER PIPE (TYP.)
FOR PIPE ALIGN. SEE DWG. M-387
SHOTCRETE ROCK PER DET. 2 C-1105
DET. 5 C-1105
LINING NOT REQUIRED ON SOIL SLOPE ABOVE ROCK AT EL. 251.50
SHOTCRETE ROCK PER DET. 2 C-1105
DET. 6 C-1105
SPRAY POND OVERFLOW STRUCTURE
SEE DET. 1 C-1105
TO BE DETERMINED IN FIELD
RIPRAP (TYP.)
TOP OF ROCK APPROX. EL. 250.0
EL. 236.75'
SPRAY POND PUMP HOUSE
B.C. STA. 7+07.07
E.C. STA. 6+82.18
EL. 267.90
RETAINING WALL
8"φ S.P. BLOWDOWN
S 75°00' W
E.C. STA. 26+06.71
EL. 267.0
EL. 267.50
EL. 266.80
N7557.0
N7545.50
N7524.00
P.I. #1
N7568.00
E3310.81
CURVE DATA
Δ 60°
R= 304.35
T= 175.72
Lc= 318.71
B.C. STA 3+63.47
CONTROL MONUMENT #11
N 7555.15
E 3677.00 TOP EL. 267.60
PLAN
P.I. #5
N7580.00
E 3825.00
STA. 29+06.36
CONTROL MONUMENT #12
N 7555.20
E 3814.00 TOP EL. 267.59
CONTROL MONUMENT #6
N7677.52 EL. 273.0
E 3677.00
(ON SP.P.H. WALL)
CONTROL MONUMENT #7
N7677.51 EL. 273.0
E 3814.00
(ON SP.P.H. WALL)
SPRAY POND PUMPHOUSE
CONTROL MONUMENT #8
N7659.78 EL. 268.04
E 3677.00
(ON SP.P.H. FLOOR)
CONTROL M
N7659.72
E 3814.00
(ON SP.P.H. F
INSERT "A"
STA. 1+00 BEGIN ROAD EL. 267.50
FINISH GRADE
SUBGRADE
S=0.67%
S=2.3%
30' V.C.
STA. 8+51.86 ℄ CULVERT
60' ℄ SPILLWAY
STA. 23+07.41 ℄ CULVERT
STA. 29+81.36 END ROAD EL. 267.50
PROFILE
HORIZ. 1"=40', VERT. 1"=10'



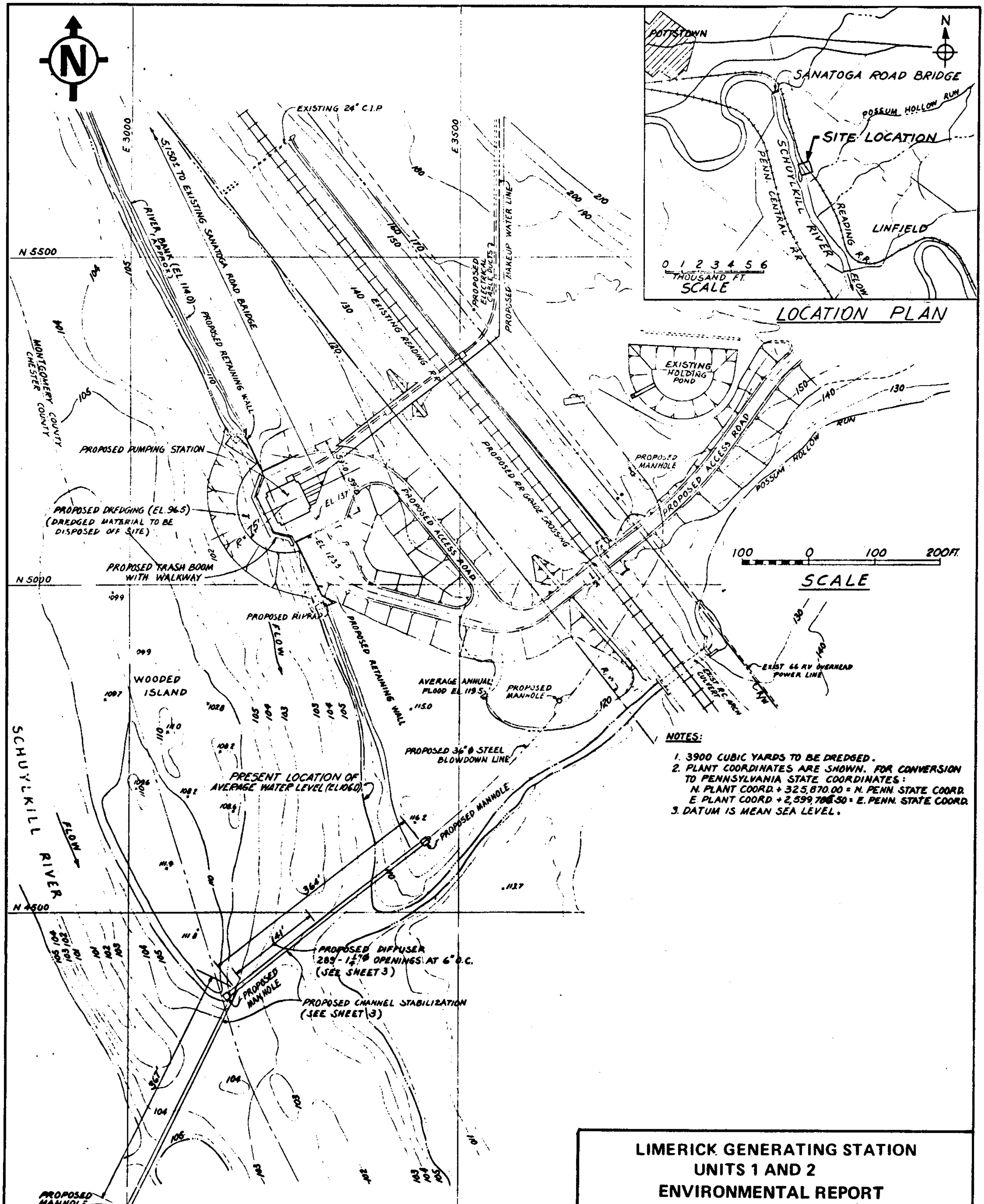
P.I. # 2
N 8156.54
E 2971.02
CURVE DATA
Δ=120°
R=276.54
T=478.98
Lc=579.18
E3200
E3400
E3600
E3800
E.C. STA. 18+86.23
TYP. ROAD SECTION U.N.O.
CONTROL MONUMENT #1
N 8145.0 TOP EL. 262.30
E 3255.25
SEE DETAIL 6 (TYP.) C-1108
EDGE OF SHOULDER
EDGE OF ROAD
16+00
14+00
12+00
10+00
BITUMINOUS SURFACE
SPILLWAY
C-1103
CONTROL MONUMENT #2
N 8145.0 TOP EL. 255.20
E 3460.0
CONTROL MONUMENT #4
N 8145.0 TOP EL. 255.15
E 3680.0
CONTROL MONUMENT #3
N 8145.0 TOP EL. 255.17
E 3570.0
TYP. G C-1103
R=200.0' MIN.
(TOLERANCE: -0.5' +2.0')
N7880
E3450
FIN. GRADE OF POND BOTTOM = EL. 241.0'
UNLESS OTHERWISE APPROVED
(FOR TOLERANCES SEE SPECS. 8031-C-94 AND C-95)
℄ SPRAY POND
N 7880.00
E 3750.00
CULVERT
I.E. 251.69
STA. 8+51.86
℄ CULVERT
CMP ARCH
(21'x15' x14GA.)
DETAIL 3 C-1108
I.E. 251.27
8+00
FOR CONTROL MONUMENTS SEE INSERT "A"
CONTROL MONUMENT #10
FOR LOCATION SEE DET. 1 C-1105
START OF LINING ON SLOPE ABOVE ROCK
LINING NOT REQ'D ON SOIL WHEN TOP OF ROCK SHELF IS AT EL 251.50 (MIN.)
30" SPRAY HEADER PIPE (TYP.)
FOR PIPE ALIGN. SEE DWG. M-387
DET. 5 C-1105
SPRAY POND OVERFLOW STRUCTURE
SEE DET. 1 C-1105
TO BE DETERMINED IN FIELD
SHOTCRETE ROCK PER DET. 2 C-1105
H C-1105
R C-1103
RIPRAP (TYP.)
TOP OF ROCK APPROX. EL. 250.0
B.C. STA. 7+07.07
E.C. STA. 6+82.18
6+00
EL. 236.75'
SPRAY POND PUMP HOUSE
EL. 267.90
8" ø S.P. BLOWDOWN
RETAINING WALL
EL. 267.0
EL. 267.50
EL. 266.80
4+00
2+00



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

SPRAY POND –
TEMPERATURE TRANSIENT

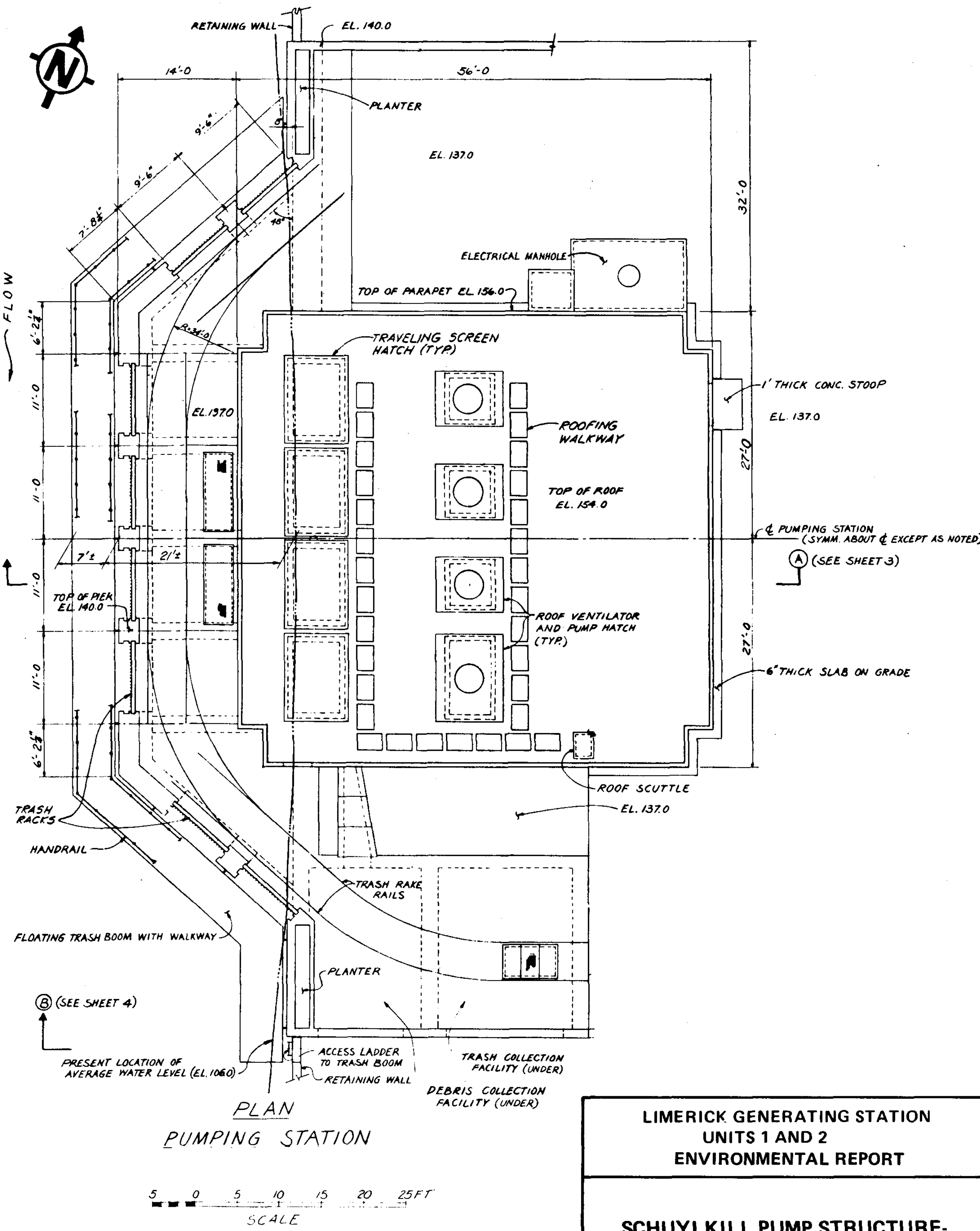
FIGURE 3.4-6



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

PROPOSED INTAKE AND DISCHARGE STRUCTURES IN THE SCHUYLKILL RIVER

FIGURE 3.4-7



LIMERICK GENERATING STATION
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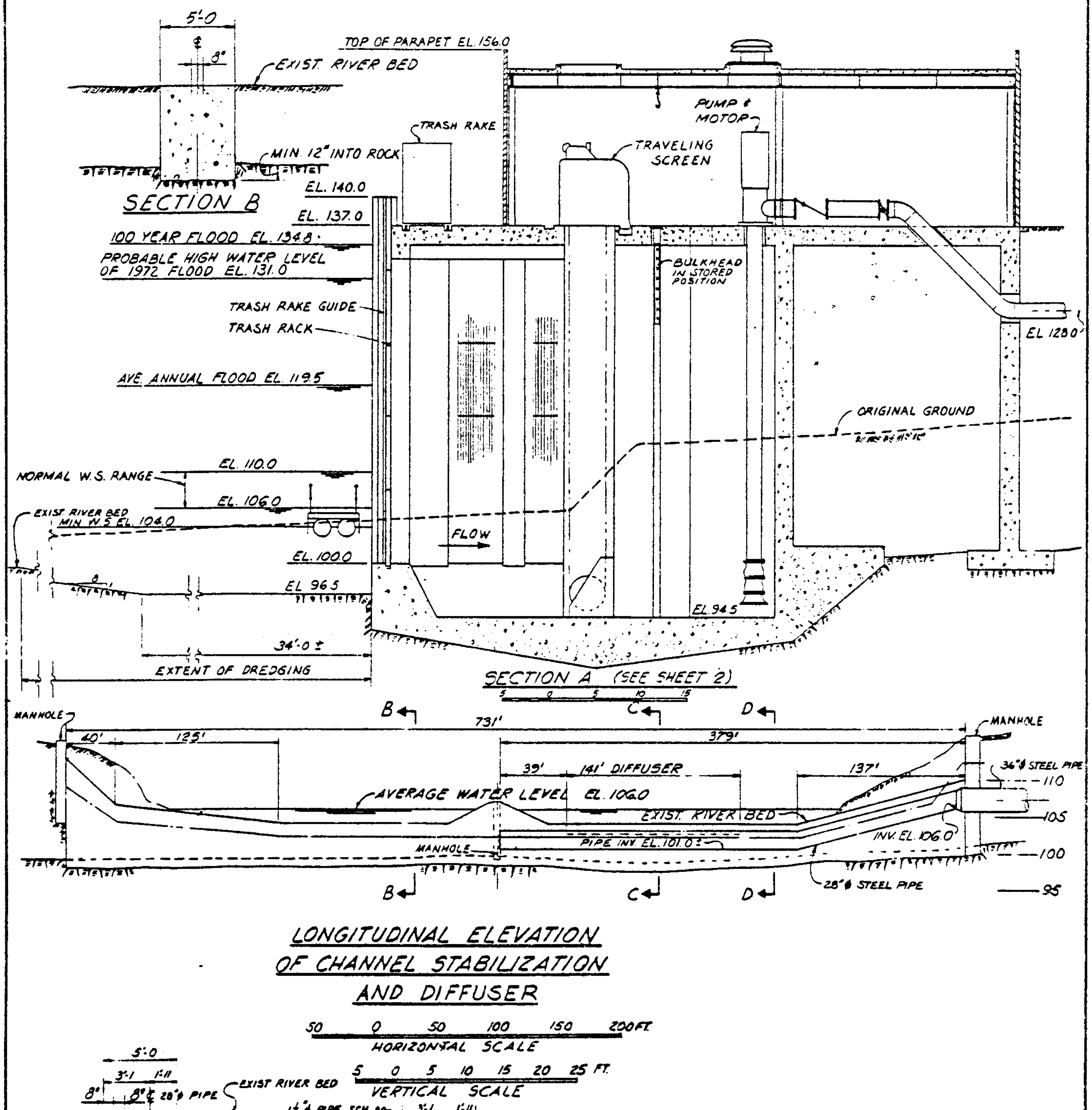
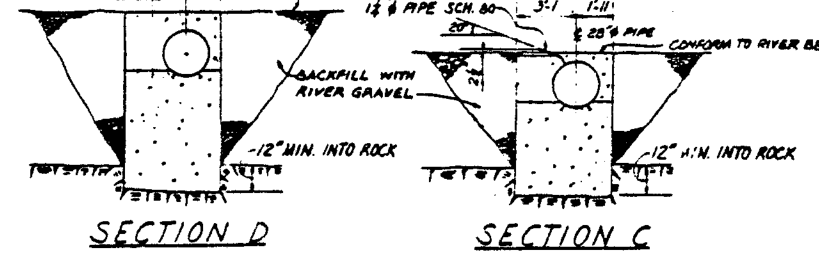
ENVIRONMENTAL REPORT

SCHUYLKILL PUMP STRUCTURE-PLAN

FIGURE 3.4-8





LIMERICK GENERATING STATION
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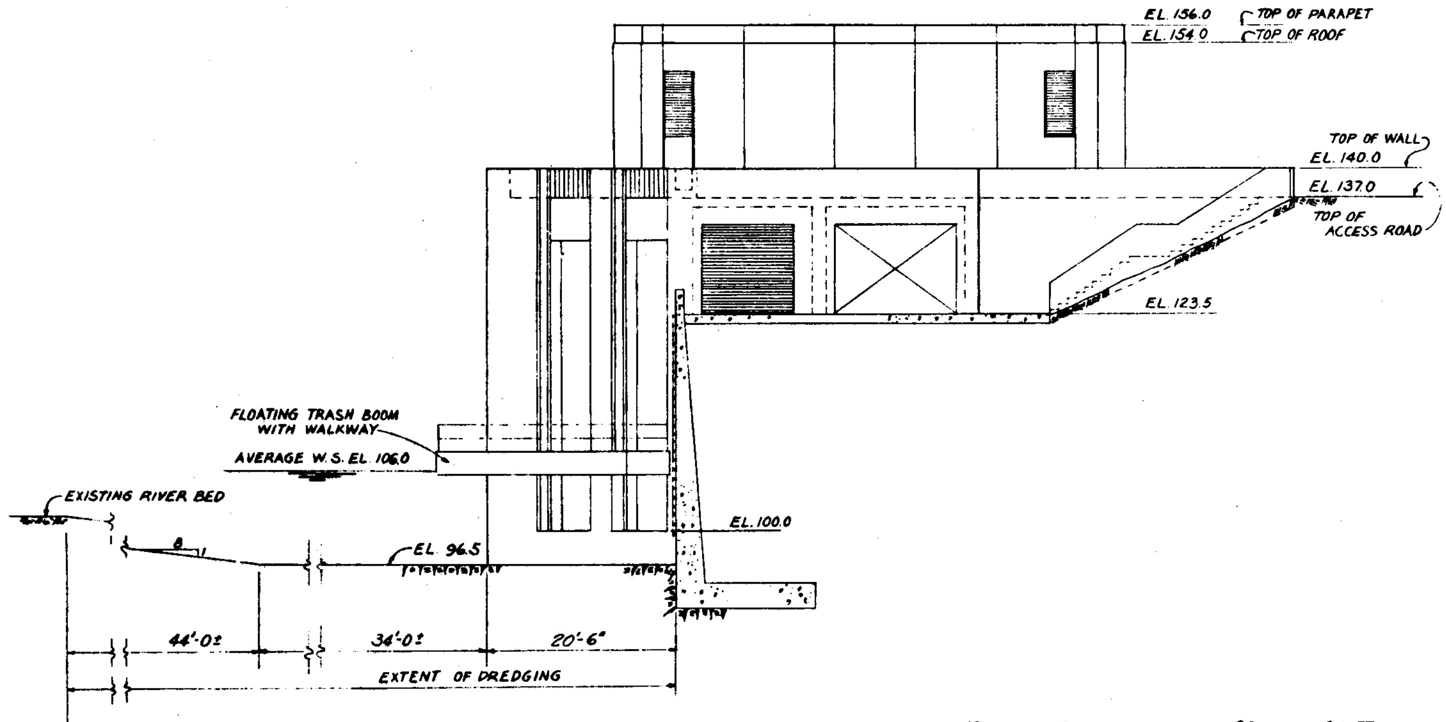
SCHUYLKILL PUMP STRUCTURE AND DIFFUSER SECTIONS

FIGURE 3.4-9 REV. 7, 10/82



ELEVATION B
(SEE SHEET 2)

LIMERICK GENERATING STATION
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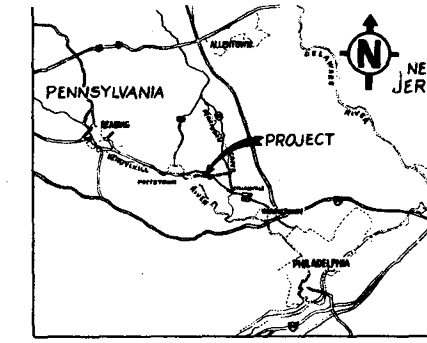
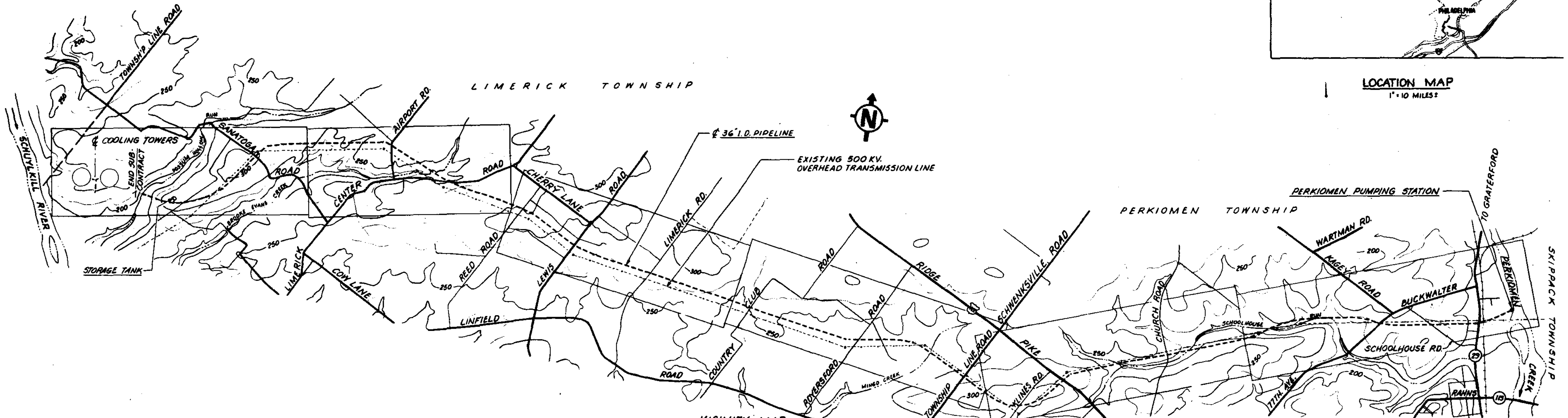
SCHUYLKILL PUMP STRUCTURE-
ELEVATION

FIGURE 3.4-10

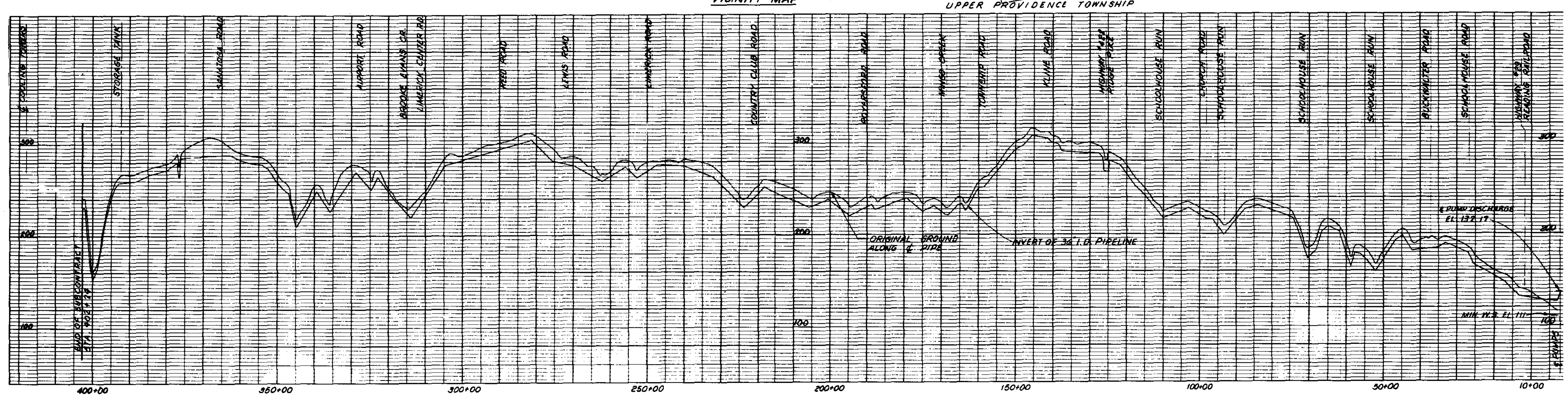


LOCATION MAP

1" = 10 MILES ±



VICINITY MAP



PROFILE

HORIZONTAL: 1000 0 1000 2000 3000 FT.

VERTICAL: 40 0 40 80 120 FT.

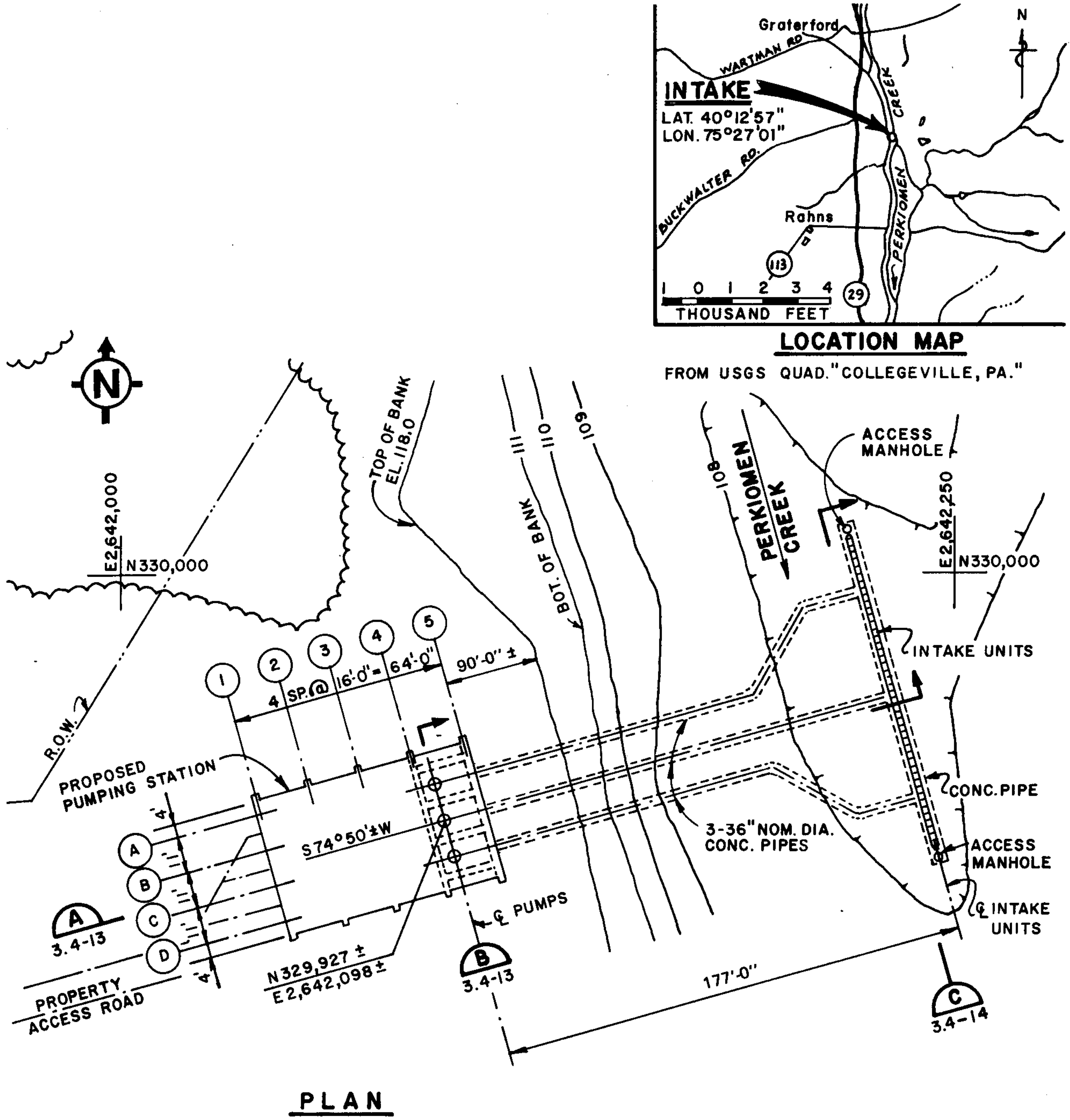
NOTES

1. VICINITY MAP ENLARGED FROM THE FOLLOWING USGS PENNSYLVANIA 7.5 MINUTE SERIES TOPOGRAPHIC MAPS:
   COLLEGEVILLE QUADRANGLE, DATED 1966.
   PHOENIXVILLE QUADRANGLE, DATED 1955, PHOTOREVISED 1968.

LIMERICK GENERATING STATION UNITS 1 AND 2 ENVIRONMENTAL REPORT

PERKIOMEN MAKEUP WATER SYSTEM GENERAL PLAN & PROFILE

FIGURE 3.4-11



NOTES

1. COORDINATES ARE IN THE PENNSYLVANIA COORDINATE SYSTEM, SOUTH ZONE.
2. DATUM IS MEAN SEA LEVEL.

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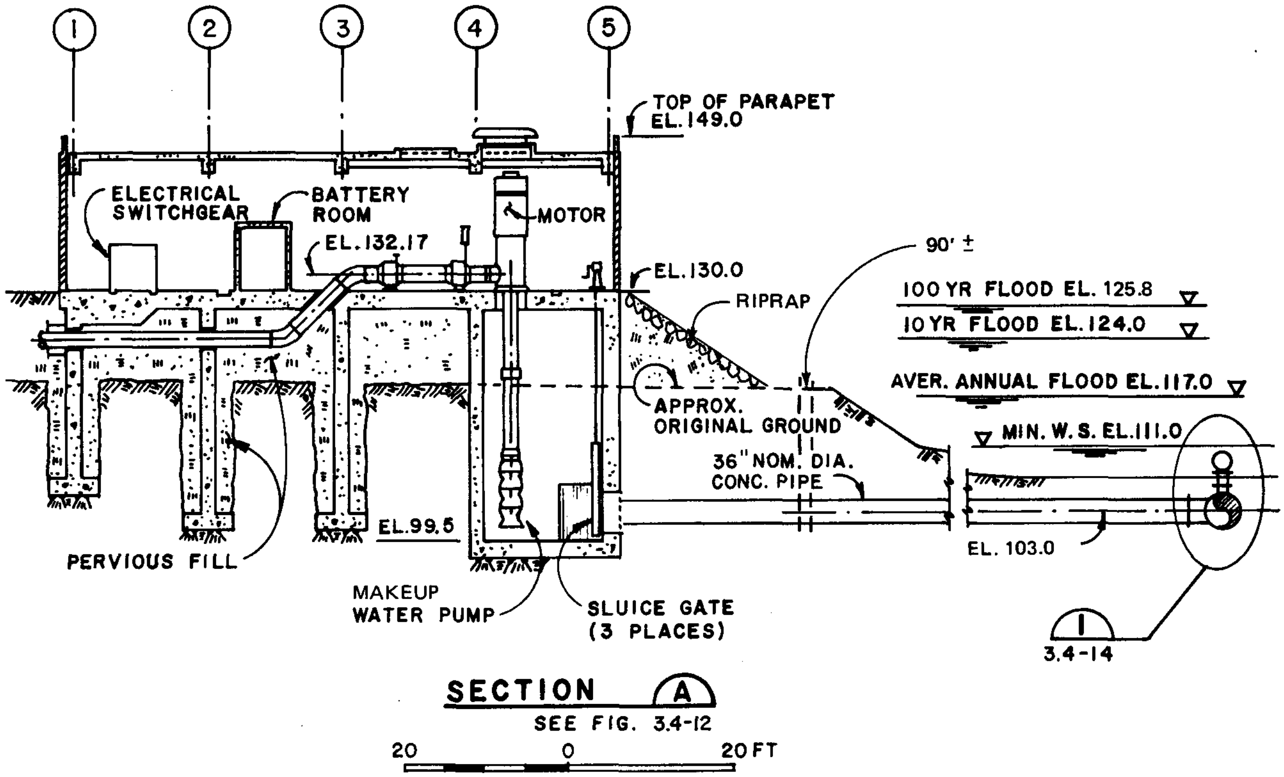
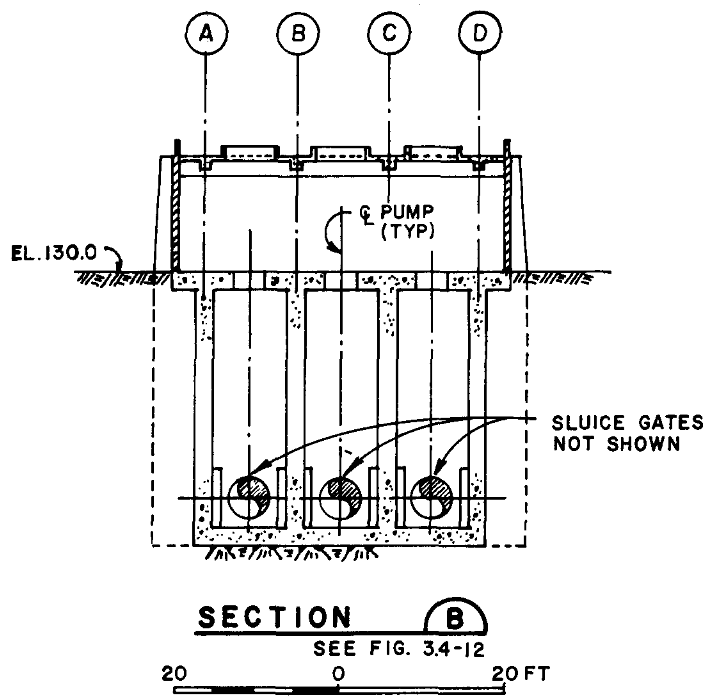
PERKIOMEN CREEK INTAKE STRUCTURE - LOCATION AND GENERAL LAYOUT

FIGURE 3.4-12 REV. 18, 06/84





LIMERICK GENERATING STATION
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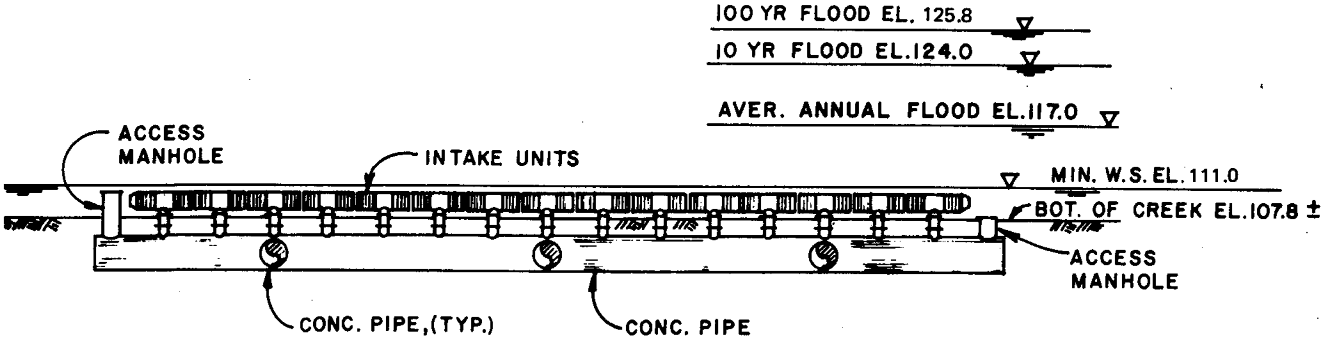
ENVIRONMENTAL REPORT

PERKIOMEN CREEK INTAKE STRUCTURE - SECTIONS

FIGURE 3.4-13

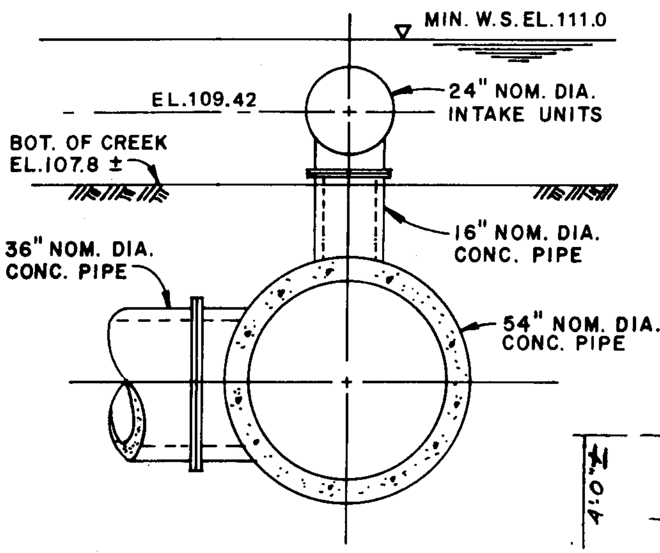
REV. 18, 06/84



SECTION C

SEE FIG. 3.4-12

20 0 20 FT



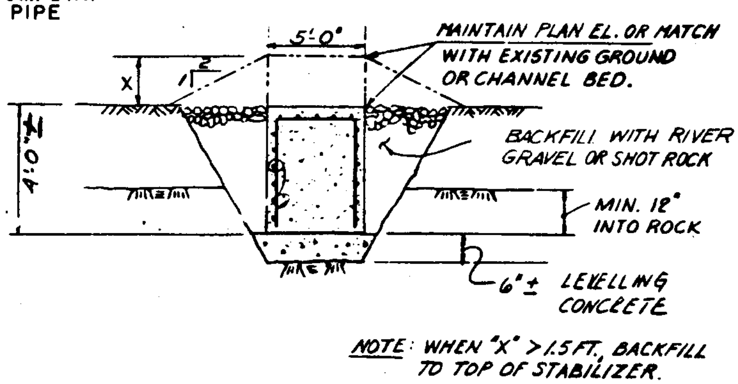
DETAIL 1

SEE FIG. 3.4-13

4 0 4 FT

NOTE

NOZZLES FOR AIR BURST BACKWASH SYSTEM ARE PROVIDED AT SREENS.



PRECAST CONCRETE CHANNEL STABILIZER

N.T.S.

LIMERICK GENERATING STATION
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PERKIOMEN CREEK INTAKE STRUCTURE - DETAILS

FIGURE 3.4-14 **REV. 18, 06/84**

3.5 RADWASTE SYSTEMS AND SOURCE TERM

Limerick Generating Station (Units 1 and 2) radwaste systems are designed to limit the radioactive releases from the station to the environment to levels that are as low as reasonably achievable (ALARA), consistent with 10 CFR Part 50, Appendix I. Radwaste is generated in liquid, gaseous, and solid form.

The bulk of the liquid radwaste is treated for recycling within the station. To maintain the balance of the station water inventory, excess liquid and the laundry drain waste are normally discharged after processing and monitoring.

Gaseous effluents originating from the gaseous radwaste systems and the heating, ventilating, and air conditioning (HVAC) systems are released through monitored vent stacks.

Solid wastes are shipped offsite to a licensed burial ground in accordance with 10 CFR Part 71, and 49 CFR Parts 170 through 178.

The processing components for the liquid and solid radwaste systems, and radwaste enclosure HVAC system, are common for both units, while the gaseous radwaste system, reactor, and turbine enclosure HVAC systems are separate for each unit.

3.5.1 SOURCE TERMS

The source terms, methods, and parameters of NUREG 0016 (Ref 3.5-1) are used in the evaluation of radioactive releases for compliance with Appendix I to 10 CFR Part 50, except where system differences necessitated changes, as noted below. Table 3.5-1 lists the information, or location of the information requested in Appendix F to Regulatory Guide 4.2, Rev 2. The concentrations of fission, activation (including tritium), and corrosion products in the coolant, given in Table 3.5-2, were calculated using the methodology of the ANSI 18.1 working group draft standard N237, as given in NUREG 0016.

Tritium formed in the reactor is generally present as tritiated oxide and, to a lesser degree, as tritiated gas. Tritium concentration in the steam generated in the reactor will be the same as in the reactor water at any given time. This tritium concentration is also present in condensate and feedwater. Since radioactive effluents generally originate from the reactor and turbine cycle equipment, radioactive effluents also have this tritium concentration. The condensate storage tanks receive treated water from the liquid radwaste system, and water from the condensate system. Thus, all station process water has a common tritium concentration.

Offgases released from the station contain tritium, as tritiated gas resulting from reactor water radiolysis, as well as tritiated water vapor. In addition, tritium is present in water vapor from the turbine gland seal steam packing exhauster, evaporation from the spent fuel pool and, in a lesser amount, in ventilation air due to process steam leaks or evaporation from sumps, tanks, and spills on floors. The remainder of the tritium leaves the station in liquid effluents, or with solid wastes.

Recombination of radiolysis gases in the air ejector offgas system forms water, which is condensed and returned to the main condenser. This reduces the amount of tritium leaving in gaseous effluents, resulting in a slightly higher tritium concentration in the station process water. Reducing the amount of liquid effluent discharged also results in a higher process coolant equilibrium tritium concentration.

Tritium from the primary coolant will eventually be released to the environs as water vapor and gas to the atmosphere, as liquid effluent to the station discharge, or as solid waste. Reduction due to radioactive decay is negligible, because of the 12-year half-life of tritium.

The releases of radioactive gases and vapors from the refueling floor during refueling and normal operation are estimates, and are included in the total station gaseous releases. The bases for these estimates are the measured plant releases of operating stations given in NUREG 0016. Each spent fuel pool water volume is 350,000 gallons. Makeup for the spent fuel pool is from the demineralized water system. During refueling operations, the reactor well and dryer/separator storage pool are flooded with 534,000 gallons of condensate quality water from the refueling water storage tank. This water is mixed with approximately 60,000 gallons of reactor coolant, and the 350,000 gallons of fuel pool water. Both the RWCU system and the FPCC system are operated to reduce the radioactivity concentrations to acceptable levels before fuel movements begin. During refueling, makeup water is supplied from the refueling water storage tank or the demineralized water system. Following refueling, the reactor well and dryer/separator pool water is processed through a condensate demineralizer, and returned to the refueling water storage tank.

Concentration of radioactivity in the pool water varies, depending upon the duration of operation of the RWCU system, shutdown spiking, the amount of mixing of reactor well and dryer/separator pool water with spent fuel pool water, the failed fuel leak rate, the operation of the FPCC system, the time taken for the refueling operations, and the pool temperature. Due to the uncertainties in many of these parameters, a mathematical analysis of the releases from the pools may not yield realistic values of the releases. Thus the actual measurements from similar stations, as given in NUREG 0016, are used to estimate releases.

Similarly, since in-station leakage, iodine partition factors, and leakage source terms are uncertain and likely to vary, the releases from ventilation systems are estimated, based upon the actual station measurements summarized in NUREG 0016.

3.5.2 LIQUID RADWASTE SYSTEMS

The liquid waste management system is designed to process and dispose of, or recycle, the radioactive or potentially radioactive liquid wastes generated in the operation of the plant. The liquid waste management system consists of equipment drain (low conductivity), floor drain (high conductivity), chemical, and laundry subsystems. These subsystems are shown in Figure 3.5-1.

The liquid wastes are collected in sumps, located in the structures containing radioactive equipment, and pumped to collection tanks located in the radwaste enclosure. The incoming wastes are classified, collected, and treated as floor drain, equipment drain, chemical, and laundry wastes. Cross-connections between the subsystems provide additional flexibility for processing the wastes by alternative methods.

3.5.2.1 Equipment Drain Subsystem

Wastes from piping and equipment drains are collected in the equipment drain collection tank. Equipment drain collection tank contents are processed on a batch basis through a precoat filter and mixed bed demineralizer, and then collected in one of two sample tanks.

From an equipment drain sample tank, wastes are normally returned to a condensate storage tank for plant reuse. A recycle routing allows high conductivity wastes, or water of excessively high radioactivity concentration, to be either recycled to the equipment drain collection tank for additional processing through the filter and demineralizer, or recycled to the floor drain collection tank for additional processing.

3.5.2.2 Floor Drain Subsystem

Wastes originating from the drywell, reactor, turbine, and radwaste enclosure floor drains are collected in the floor drain collection tank. In addition, small infrequent quantities of liquid waste from condensate and refueling water storage tank dike sumps are also collected and treated with these wastes.

The wastes collected in the floor drain collection tank are processed on a batch basis through a precoat filter and mixed bed demineralizer, bypassing floor drain sample tank No. 1, and discharged to floor drain sample tank No. 2 for final sampling and analysis. Provision is available to discharge directly to sample tank No. 1, for use when warranted. The bases for selecting this treatment path are water quality, equipment availability, and economic considerations. If the quality of the filtered waste in sample tank No. 1 is unsuitable for plant reuse, then the flexibility exists to reprocess the batch through the floor drain system or to recycle it to the equipment drain collection tank.

Treated floor drain wastes may be discharged from the plant after dilution with cooling tower blowdown. However, if the treated wastes meet the specifications of water quality used in the plant, and if the water inventory of the plant permits their recycle, they are returned to the condensate storage tank for reuse.

3.5.2.3 Chemical Waste Subsystem

Chemical wastes collected in the chemical waste tank consist of laboratory wastes, decontamination solutions, sample rack drains, and other corrosive wastes. After accumulation in the chemical waste tank, these wastes are chemically neutralized, if required, and transferred to the floor drain collection tank for batch processing through the floor drain subsystem. The chemical waste subsystem is designed to permit addition of an evaporation system as an alternate means of waste processing. Installation of this equipment will not be completed for initial plant operation. Complete installation may occur after the plant begins operation if it is determined that this method of waste processing is desired and appropriate.

3.5.2.4 Laundry Drain System

Laundry wastes consist of detergent-containing water from the laundries and personnel decontamination facilities throughout the plant. These wastes are routed to two laundry drain tanks interconnected by an overflow line. From the tanks, the wastes are processed through the laundry drain filter, and collected in the sample tank for sampling and analysis.

Effluent from the sample tank is normally discharged through the monitored discharge pipe, into the cooling tower blowdown pipe. High conductivity filtrate can be recycled back to the laundry drain tanks, or to the floor drain system.

3.5.2.5 Radioactive Liquid Releases

During processing of liquid radwastes, radioactivity is removed so that the bulk of the liquid is restored to clean water, which is either recycled in the plant or discharged to the environment. The radioactivity removed from the liquids is concentrated in filters and ion exchange resins. These concentrated wastes are sent to the solid waste management system for eventual shipment to a licensed burial facility. Normally, most of the liquid passing through the liquid waste management system is recycled in the plant. However, the treatment in this system is such that these liquids can be discharged from the plant after monitoring, if required, by plant water balance considerations. Liquid radwaste will be discharged from the system consistent with the discharge criteria of 10 CFR Part 20, and 10 CFR Part 50, Appendix I. Normally, the liquid passing through the laundry drain processing subsystem is discharged directly; however, it may be processed through the floor drain system if necessary.

The resulting doses from radioactive effluents are within the guideline values of Appendix I to 10 CFR Part 50. The expected yearly activity releases for each waste stream, and the total, are given in Table 3.5-3.

Design and administrative controls are incorporated into the liquid waste management system to prevent inadvertent releases to the environment. Controls include administrative procedures, operator training, redundant discharge valves, and discharge radiation monitors that alarm and initiate automatic discharge valve closure. Prior to any discharge, activity concentrations are measured in samples taken from the various sample tanks. A single line is provided for radioactive plant discharges to minimize the potential for inadvertent releases.

The processed liquid radwaste that is not recycled in the plant is discharged into the cooling tower blowdown pipe on a batch basis, at up to 280 gpm from the liquid radwaste equipment and floor drain processing system and 10 gpm from the liquid radwaste laundry drain processing system. A total cooling tower blowdown flow of 10,000 gpm for both units dilutes the above discharges by a factor of at least 35 for the liquid radwaste equipment and floor drain subsystems, and 1000 for the laundry waste subsystem. This dilution occurs within the site boundary, and is used in determining specific activity concentrations for the releases.

3.5.3 GASEOUS RADWASTE SYSTEMS

The gaseous radwaste systems are designed to process and control the release of radioactivity to the environment. The doses resulting from the releases of gaseous radwaste systems conform to the guidelines of 10 CFR Part 50, Appendix I.

The systems are designed to limit the dose to offsite persons from the routine station releases to less than the limits specified in 10 CFR Part 20, and to operate within the release rate limits established in the operating license.

For evaluation of the systems, an annual average radioactive noble gas source term (based upon a 30-minute decay) of 60,000 microcuries/sec per reactor unit is used.

HVAC is provided through the station areas to:

a. Maintain a controlled environment in all station areas, to maintain the integrity and operability of equipment and components, and for the safety and comfort of personnel in occupied areas

b. Adequately meet the airborne radioactive material requirements of 10 CFR Part 20, 10 CFR Part 100, and 10 CFR Part 50, Appendix I, where applicable, to ensure the safety of operating personnel in the various station areas, and to ensure that the radioactive gaseous emissions from the station to the environment are kept as low as reasonably achievable (ALARA) and below permissible discharge limits, and

c. Direct airflow from areas of lesser radioactive contamination to areas of higher contamination to ensure the control of airborne radioactive contaminants.

The containment and the reactor, turbine, and radwaste enclosures are the potential sources of airborne radioactivity that are treated by the station enclosure HVAC systems.

The gaseous radwaste systems are divided into the following:

a. The offgas system

b. The primary containment and secondary containment HVAC systems

c. The turbine enclosure HVAC system

d. The radwaste enclosure HVAC system

e. The reactor enclosure recirculation system, and

f. The standby gas treatment system.

The radioactive source terms used to calculate the releases from each enclosure are given in Table 3.5-2. Dose rates, and the radiological impact of gaseous releases, are described in Section 5.2.

3.5.3.1 The Offgas System

The offgas system process flow diagram is presented in Figure 3.5-2. The offgas system piping and instrumentation diagrams are presented in FSAR Figures 11.3-2 through 11.3-3 (Ref 3.5-2).

Gaseous activation products such as N-16, O-19, and N-13, as well as fission products such as xenon, krypton, and iodine are expected in the reactor coolant. In addition to these radionuclides, the condenser noncondensible gases contain air from condenser leakage, and hydrogen and oxygen from radiolytic decomposition of water. These gases in the three condenser shells are removed by two-stage steam jet air ejectors. The air ejectors add steam to the noncondensible gases to dilute hydrogen to a nonexplosive level. The steam/gas mixture is pre-heated and passed through a catalytic recombiner assembly, which converts hydrogen and oxygen into water. The steam is then condensed, and the remaining air and noble gas mixture enters a delay pipe that connects the recombiner assembly to a charcoal adsorption train. At the design flow rate of 30 scfm, this pipe provides approximately 6.3 minutes of decay of the radioactive products in the offgas steam, prior to entering the charcoal adsorption system. The gas is then cooled to approximately 40°F to remove moisture.

Prior to entering the main charcoal vessels, the process stream passes through a guard bed. The principal function of this guard bed is to absorb impurities in the process gas that might adversely affect the performance of the charcoal adsorbent material.

After passing through the guard bed, the gas enters the main adsorption beds. These beds, operating in controlled temperature vaults, selectively adsorb and delay the xenon and krypton from the bulk carrier gas. This delay on the charcoal permits the xenon and krypton to decay in the charcoal bed. The process stream then passes through a HEPA afterfilter, where radioactive particulate matter and possible charcoal fines are retained. This process stream is continuously monitored, and an alarm will annunciate any abnormal releases from this system.

The offgas process stream is then directed to the turbine enclosure vent stack, where it is diluted with a minimum of 183,000 scfm of air prior to being released from the top of the north end of the reactor enclosure. Table 3.5-4 gives the estimated annual release rate from the offgas system.

Tables 3.5-1 and 3.5-5 present the assumptions and parameters used for the evaluation of gaseous releases. The dynamic adsorption coefficients for xenon and krypton that were selected for the charcoal adsorbent, were derived by adjusting the values presented in NUREG 0016 to reflect the temperature and humidity conditions of the process stream for the Limerick Generating Station system.

With an air inleakage of 75 scfm, the offgas system results in a delay of 36 hours for krypton, and 35 days for xenon. The amount of condenser inleakage actually expected is significantly less than 75 scfm.

Leakage of radioactive gases from the offgas system is minimized by the use of welded construction wherever practicable, and by using valves with bellows stem seals or double packings. The offgas system operates at a maximum pressure of 7 psig during startup, and less than 2 psig during normal station operations, so that the differential pressure to the atmosphere is small.

During station startups, and restart from extended outages, air is removed from the condenser by a mechanical vacuum pump. The mechanical vacuum pump exhaust is passed through the turbine enclosure equipment compartment exhaust air filter and discharged to the turbine enclosure vent stack. Some radionuclides from prior operation, and from daughter product formation are expected to be released via this pathway. It is estimated that there will be an average of 96 hours of mechanical vacuum pump operation each year.

3.5.3.2 Primary Containment and Secondary Containment Heating, Ventilating, and Air Conditioning (HVAC) Systems

The secondary containment is divided into three separate ventilation zones. Zones I and II comprise the respective Units 1 and 2 reactor enclosures below floor el 352 feet. Zone III includes both Units 1 and 2 reactor enclosures above floor el 352 feet, including the refueling floors.

The primary containment and secondary containment HVAC systems that are important for the treatment of potentially radioactive air are the following: Zone I and Zone II equipment compartment exhaust systems (ECES), the standby gas treatment system (SGTS), and the reactor enclosure recirculation system (RERS).

During periods of reactor shutdown, when access to the primary containment by plant personnel is required, the primary containment is purged by a high-volume flow of air supplied from the reactor enclosure HVAC system. Air purged from the primary containment is processed through the SGTS prior to release to the environment.

During power operation of the reactor, the oxygen content of the primary containment is maintained at a concentration no greater than 4% by volume. This low-oxygen atmosphere is achieved by displacing air in the primary containment with nitrogen gas. The nitrogen is supplied from a liquid nitrogen storage facility that is common to both reactor units. Gases released from the primary containment during nitrogen inerting and deinerting are processed through the SGTS filters prior to release to the environment. Once the specified oxygen concentration in the primary containment has been achieved during inerting, the nitrogen flow is terminated.

During periods of reactor operation, the high-volume purge is not used, and primary containment ventilation is provided by the drywell air cooling system. This system includes eight unit coolers in the drywell, each of which consists of two redundant fans and two redundant cooling coils. Primary containment pressure, temperature, oxygen concentration, and hydrogen concentration are continuously monitored from the control room. Pressure in the primary containment is controlled during reactor operation by use of the low-volume purge. In this purge mode, N_2 is supplied by the nitrogen make-up system through 1-inch lines, and is exhausted from the primary containment through 2-inch lines connecting to the high-volume purge exhaust lines. Low-volume purge air is processed through the equipment compartment exhaust system prior to release to the environment. The containment isolation valves on the high-volume and low-volume purge lines are closed upon receipt of a containment isolation signal.

Each of the ventilation zones is provided with independent HVAC systems designed to operate during normal station operations, and during shutdown. Zone III systems function during normal operation fuel handling, and storage operation. A recirculation filtration system and the SGTS will be used in the unlikely event of a fuel handling accident.

The supply air system delivers filtered outside air to the various spaces of Zone III. The supply system contains heating and cooling coils to maintain the supply air within the design temperature range.

The Zone III exhaust system removes air from access areas, and the refueling floor directly to the atmosphere. Radiation monitors, located in the Zone III exhaust ducts, will close the isolation valves before release limits to the atmosphere are exceeded. The exhaust air transit time between the monitors and the system isolation valves is greater than the combined time of monitor response and valve closure.

If high radiation is detected in the Zone III exhaust system, the Zone III isolation signal will:

a. Close the isolation valves located in the Zone III ductwork systems and stop all fans serving Zone III

b. Start the recirculation filtration system's lead fan, and

c. Start the SGTS to maintain 0.25 inch water gage negative pressure in Zone III.

Pressure differential controllers are provided to maintain a predetermined average pressure differential between Zones I, II, and III and the atmosphere. These controllers will modulate the appropriate systems' exhaust flow rate to maintain the predetermined pressure differential profile. In addition, differential pressure switches are provided to stop all Zone III ventilation, and isolate systems on abnormally high or low pressure differential.

When purging or ventilating the primary containment, the supply air damper is opened to allow supply air from the Zone I supply system into the drywell or suppression chamber.

The Zone I exhaust system exhausts air from the access areas directly to the atmosphere. The Zone I ECES contains two 100% capacity fans and two filter trains, each sized for 100% of the system airflow. The system exhausts air from potentially contaminated compartments. Before system air is exhausted to the atmosphere, it is passed through prefilters, upstream HEPA filters, charcoal filters, and downstream HEPA filters.

A reactor enclosure isolation signal generated from low reactor water level, drywell high pressure, high radiation detected in the Zone III exhaust system, abnormal differential pressure, or manual isolation signal will:

a. Close the affected zone(s) isolation valves located in the reactor enclosure H/V ductwork systems at penetrations of the secondary containment, and shut down appropriate operating H/V systems

b. Open dampers in the recirculation system ductwork to tie Zone I, II, or III into the recirculation system if these zones are to be recirculated

c. Start the recirculation filtration system, and

d. Start the SGTS.

Either Zone I or Zone III may be included in the recirculated volume. When a secondary containment isolation signal is received, and either Zone I or III is to be included, automatic valves open to tie the Zone I or III ductwork into the recirculation system. If necessary, both Zones I and III may be recirculated simultaneously.

The return air from the various spaces is mixed in the recirculation system return and supply plenums, and a portion of the mixture is exhausted from the supply plenum through the SGTS. The Zone II recirculation system operates in a similar manner.

Table 3.5-1 presents the assumptions and parameters used for the evaluation of gaseous releases. All radioactive releases from the primary containment and reactor enclosure are assumed to pass through a charcoal and HEPA filter train before release to the atmosphere. Table 3.5-5 indicates the estimated annual activity releases from the reactor enclosure.

3.5.3.3 Turbine Enclosure HVAC System

The turbine enclosure HVAC system operates continuously during both normal station operation and station shutdown periods. This system has been designed so that the flow of air is from areas of low potential radioactive contamination to areas of high potential radioactive contamination. The turbine enclosure HVAC systems have been designed, and are automatically controlled, to exhaust more air than is supplied by supply fans, and to inhibit exfiltration of potentially radioactive air from the turbine enclosure.

The supply system delivers filtered and tempered air to satisfy the temperature requirements within the areas it serves.

The return (exhaust) fan returns air to the supply system, or directly discharges to the turbine enclosure vent from the clean areas, as required by the temperature requirements of the supply system, and the pressurization requirements for the potentially contaminated areas.

The filtered exhaust system contains two 100% capacity fans, and two filter housings of 50% capacity each. Each filter housing contains prefilters, HEPA filters, and charcoal filters. Air from potentially contaminated areas in the turbine enclosure is routed through the filtered exhaust system before it is discharged to the atmosphere via the reactor enclosure exhaust stack (north vent stack).

All exhaust air from the turbine enclosure is monitored by radiation monitoring devices installed in the reactor enclosure exhaust stack (north vent stack). If high radiation levels are detected, an alarm is annunciated in the control room. All radioactive releases from the turbine enclosure are assumed to pass through the charcoal and HEPA filter train before release to the atmosphere.

Table 3.5-6 indicates the estimated annual activity releases from the turbine enclosure.

3.5.3.4 Radwaste Enclosure HVAC Systems

The radwaste enclosure HVAC systems are designed to operate during normal operations, and accomplish the following objectives:

a. Provide a supply of filtered and tempered outside air to all areas of the enclosure

b. Maintain airflow from areas of lesser to areas of greater potential contamination

c. Maintain the enclosure spaces at the required minimum and maximum temperatures

d. Maintain the enclosure at a slightly negative pressure to minimize exfiltration to the outside atmosphere

e. Filter through charcoal and particulate filters all air exhausted from the tank vent system, and

f. Discharge air from the equipment compartment exhaust, fume hood exhaust, service area, and control area through particulate filters to the turbine enclosure exhaust vent.

The supply system delivers filtered and tempered air that is distributed throughout the enclosure in quantities sufficient to maintain required temperatures, and maintain airflow toward areas of higher potential contamination. The equipment compartment exhaust system consists of two 100% capacity fans, and two 100% capacity filter housings. The service and control area exhaust system consists of two 100% capacity fans, and two 100% capacity filter housings. The fume hood exhaust system consists of two 100% capacity fans, and two 100% capacity filter housings. Each filter housing has a bank of prefilters, and a bank of HEPA filters. This exhaust system is balanced to maintain the flow of air within the enclosure.

The tank exhaust system provides a means of filtering and venting air from tanks and equipment housed in the radwaste enclosure. A single fan and filter train are employed for this purpose, as necessary, to ensure proper charcoal adsorber operation. There are HEPA filters, and charcoal adsorbers in this system. Since the flow of air from tanks and equipment varies, space air is admitted as required to maintain system volume.

Both exhaust systems use the same duct to transport the filtered air to the turbine enclosure exhaust vent.

Each exhaust system, and the respective supply system, are interlocked so that failure of the exhaust system will shut down the supply system. This condition is alarmed directly in the radwaste control room.

3.5.3.5 Standby Gas Treatment System (SGTS)

The principal objectives of the SGTS are to minimize exfiltration from the reactor enclosure, and provide filtration of the primary and secondary containment atmosphere.

The SGTS, as shown in FSAR Figure 9.4-2, is common to both Units 1 and 2. The SGTS consists of the following components important for the treatment of radioactive gases:

a. Two 100% exhaust fans, and

b. Two 100% filter trains. Each train consists of an electric heater to maintain 70% relative humidity (RH) in the air, two banks of 99.97% efficiency di-octyl phthalate (DOP) HEPA filters, and an 8-inch deep carbon adsorber bed with a 99.9% efficiency for removing elemental iodine, and a 99.5% efficiency for removing methyl iodide at 70% RH.

Each filter train is sized to purge the primary containment, or to serve the common Zone III of both units and Zone I or II simultaneously, and each exhaust fan is capable of exhausting the rated flow through one filter train.

The SGTS is designed to accomplish the following specific functions:

a. Exhaust sufficient filtered air from the reactor enclosure to maintain a negative pressure of about 0.25 inch water gauge in the affected volumes during secondary containment isolation, and filter the exhausted air to remove radioactive particulates and radioactive iodine to limit the offsite dose consequences to less than the guideline values of 10 CFR Part 100

b. Filter and exhaust the discharge stream from the main steam isolation valve leakage control system

c. Filter and exhaust air from the primary containment for purging and ventilating prior to personnel entry, and

d. Filter and exhaust gas mixtures from the primary containment pressure relief line.

The SGTS is actuated either automatically or manually. The automatic actuation is originated by any of the reactor enclosure isolation signals. The manual actuation is initiated from the control room.

The air processed by the SGTS filter train is continuously monitored by redundant radiation detectors downstream of the filter trains. High radiation levels in the discharge stream will annunciate an alarm in the control room.

3.5.4 SOLID RADWASTE SYSTEM

The Applicant is committed to providing a solid waste management system that complies with the intent of Branch Technical Position ETSB 11-3 (Ref 3.5-3).

The solid radwaste system collects, monitors, processes, packages, and provides temporary storage facilities for solid wastes, for offsite shipment and permanent disposal. For the purpose of this section, the term "solid waste" is used for spent bead and powdered resin, and dry solid waste produced from plant operation. A flow diagram of the solid radwaste system is shown in Figure 3.5-3.

The activities of the wastes entering the solid radwaste system are dependent upon the liquid activities in the various liquid systems, such as the condensate, RWCU, fuel pool cleanup, equipment drain, and floor drain systems, whose activities are in turn a function of the reactor coolant activity.

The quantities of solid wastes generated will be dependent upon the plant operating factor, extent of equipment leakage, plant maintenance and housekeeping, and decontamination requirements. Input to the solid radwaste system is predominantly powdered resins from filter demineralizers and bead resins from deep bed demineralizers. Powdered and bead resins are dewatered by centrifuge and then packaged in high integrity containers (HICs) for offsite disposal.

3.5.4.1 Wet Solid Waste Processing

Wet solid wastes consist primarily of spent demineralizer resins and powdered filter resins backwashed from RWCU, condensate filter/demineralizer, floor drain, equipment drain, and fuel pool cleanup systems. Only reactor water cleanup material is expected to be of high specific activity (HSA). The remainder of the solid wastes are low specific activity (LSA), as defined in 10 CFR Part 71.

Spent condensate filter demineralizer material (powdered resins) is backwashed to the respective condensate backwash receiving tank, and from there is pumped to one of two (per unit) phase separators. When the material has settled, the clear water is decanted to the equipment drain tank for further processing and reuse. When a predetermined sludge level is reached in a phase separator, the other phase separator is used, while the material in the first is allowed to decay. After decay, the waste from the phase separator is pumped in slurry form to the centrifuge for dewatering. Each condensate phase separator is sized for a normal 14-day collection, and 14-day decay time.

Backwash from the RWCU system is handled in a manner similar to the condensate filter demineralizer system, except that there is only one RWCU phase separator per unit. Each RWCU phase separator is sized for a normal 60-day collection (from both units), and 60-day decay time.

Material from the equipment and floor drain filters, and fuel pool cleanup filter demineralizer, is backwashed to the waste sludge tank, and then pumped to the centrifuges for dewatering. Equipment and floor drain demineralizer spent resins are backwashed to their respective intermediate spent resin tanks prior to being pumped to the waste sludge tank. The waste sludge tank, equipment drain spent resin tank, and floor drain spent tank are sized for normal 20-day, 62-day, and 23-day collection times, respectively.

Slurries from the phase separator, or the waste sludge tank are pumped to one of two horizontal centrifuges. The approximately 5% by weight fluid is dewatered to approximately 40 to 60% by weight solid content. The dewatered material drops from the centrifuge to its respective HIC. Centrifuge effluent water is returned to a condensate phase separator for further processing. The dewatering operation is normally terminated by low tank level or high HIC level signals, and an automatic flushing of piping up to the centrifuges takes place. The centrifuges are flushed afterwards. Flush water is returned to a condensate phase separator.

The centrifuge discharges through a fill head assembly that fits into the container opening. The fill assemblies are flushed with spray nozzles after being emptied. Flush water is returned by gravity drain to a condensate phase separator. The fill assemblies are controlled locally, and container filling operations in the process cells are viewed through shielded glass windows. Ventilation connections to the radwaste enclosure ventilation system are provided from the centrifuges and the fill assemblies to minimize the spread of any airborne contamination.

After filling, the HICs are capped by a capping machine controlled from outside the filling cell, and viewed through a shielded glass window. The capping machine installs caps on the HIC openings in an automatic operation.

3.5.4.2 Concentrated Liquid Waste Processing

Installation of the radwaste evaporators will not be completed for plant operation (Section 3.5.2.3). Because the solid waste management system does not include an installed solidification subsystem, any future concentrates produced would be solidified prior to offsite shipment by an acceptable mobile solidification system connected to the external processing station.

3.5.4.3 Dry Solid Waste Inputs

Dry wastes consist of air filters, miscellaneous paper, rags, etc, from contaminated areas; contaminated clothing, tools, and equipment parts that cannot be effectively decontaminated; and solid laboratory wastes. The activity of much of this waste is low enough to permit handling by contact. These wastes are collected in containers located in appropriate areas throughout the plant, as dictated by the volume of wastes generated during operation and maintenance. The filled containers are sealed and moved to a controlled-access enclosed area for temporary storage. Compressible wastes are compacted into 55-gallon steel drums by a hydraulic press. Ventilation is provided to control contaminated particles while this packaging equipment is being operated. Noncompressible wastes are packaged manually in similar 55-gallon steel drums, or in other suitable containers. Because of its low activity, this waste can be stored until enough is accumulated to permit economical transportation to an offsite facility for final disposal.

3.5.4.4 Irradiated Reactor Internals

Irradiated reactor internals being replaced are removed from the RPV underwater, and stored for radioactive decay in the spent fuel storage pool. An estimated average of seven of the control rod blades are removed from each reactor annually, and are stored on hangers on the fuel pool walls, or in racks interspersed with the spent fuel racks. Offsite shipping is done in spent fuel shipping casks.

Approximately 30% of the power range monitor detectors are replaced in each reactor annually. Spent incore detectors and dry tubes are transferred by the refueling platform auxiliary hoist underwater to the spent fuel pool. A pneumatically operated cutting tool supplied from the nuclear steam supply system (NSSS) allows remote cutting of the incore detectors and dry tubes on the work table in the fuel pool. The cut incore monitors and dry tubes, and other small-sized reactor internals, are shipped offsite in suitable containers and/or shielded casks that can be loaded underwater.

A trolley-mounted disposal cask with an internal cable drum is supplied with the NSSS for source and intermediate range neutron monitor detector cables, and the traversing incore probe wires.

3.5.4.5 Solid Radwaste System Components

System components of the solid waste management system include tanks, piping, pumps, centrifuges, fill head assemblies, capping machines, decontamination equipment, hydraulic press, and handling equipment.

System collection and phase separator tanks are sized for normal plant waste volumes, with sufficient excess capacity to accommodate equipment downtime and expected maximum volumes that may occur during refueling, abnormal leak rates, or decontamination. Tank supplies and discharges are cross-connected as appropriate for greater operational flexibility. Air spargers or recirculation lines are provided in the tanks to create a homogenous slurry for pumping. Tanks are provided with overflow lines to route any inadvertent overflow to liquid radwaste collection sumps. Tanks are vented to their enclosures' respective ventilation system, where any airborne particulate matter is removed by filtration.

System piping material is carbon steel, except for piping associated with the external processing station, which is stainless steel. Line sizing is based upon maintaining adequate flow velocities to maintain slurries in suspension. The piping is located to avoid low points and other features that could create local "hot spots." The lines are flushed with condensate after a pumping or draining operation.

Pumps are vertical, inline, centrifugal types. Pump seals are routed to drains so that leakage is contained.

Two centrifuges are provided to dewater filter sludges and spent ion exchange resins. The water removed is returned to a condensate phase separator by gravity, and the dewatered sludges are directed to the HICs. The centrifuges are fabricated of stainless steel and are continuous feed, horizontal, solid bowl, sanitary types.

Discharge chutes from the centrifuges are equipped with fill head assemblies to interface with the HIC openings.

The caping machines automatically cap the HICs. Operation is controlled locally at the process cell, and viewed through the shielded glass window to verify proper closure.

The solid waste management system does not include a permanently installed solification capability. An external processing station has been provided to accommodate the use of a mobile solidification system if the need should arise.

Containers are washed down with spray nozzles and air blast dried within the decontamination cell to minimize spread of contamination. A swipe sample mechanism, and a contact radiation monitor are provided to verify decontamination, and determine radiation level for shipping considerations.

A hydraulic press is provided so that compressible wastes such as paper, rags, and clothing can be reduced in volume. The press is designed to compress these wastes in a 55-gallon steel drum by a vertical moving piston, at about 50 psig.

A ventilation system is provided as an integral part of the hydraulic press to control airborne particulate matter during the compressing operation by pulling air across the top of the drum to minimize the spread of contamination. The air exhausts through an HEPA filter into the radwaste enclosure ventilation system.

HIC handling is accomplished by an overhead crane and transfer carts. The overhead crane moves containers to and from storage cells, and to trucks for shipping offsite. Operations are viewed through a shielded glass window, as well as on closed-circuit television monitors. Two area television cameras and one crane-mounted camera are provided.

HICs are moved in and out of process cells on railed, electric motor-driven transfer carts. In the event of motor failure, the carts can be manually placed in position for container removal and access for repair by means of a push rod. Cart operations are viewed and controlled from behind the shielded glass window of the process cell.

3.5.4.6 Packaging and Storage

LSA and HSA dewatered wastes are packaged in large polyethylene HICs. Compressible dry waste is packaged in 55-gallon steel drums. Noncompressible dry wastes are packaged in 55-gallon steel drums, or other suitable containers. All containers comply with 10 CFR Part 71, and applicable portions of 49 CFR.

Storage is provided in storage bays for the HICs. Each HIC is located in its own shielded cubicle with a removable plug on top. The storage compartments and process cell areas, where the HICs are handled, are equipped with floor drains for washdown of any spillage that may occur.

Compressible and other dry wastes are expected to be of low activity, and the 55-gallon drums and other containers will be stored in appropriately controlled unshielded areas prior to shipment.

The expected volumes and activities of solid wastes shipped offsite are given in Table 3.5-4.

3.5.5 PROCESS AND EFFLUENT MONITORING

Radioactive gaseous effluents will normally be released to the environment from three locations: the south stack, the north stack, and the hot shop exhaust. Radioactive liquid effluents will normally be released to the environment through the cooling tower blowdown diffuser in the Schuylkill River.

3.5.5.1 North Stack Ventilation Exhaust Radiation Monitors

The north stack ventilation exhaust radiation monitors are comprised of two subsystems:

a. Normal plant operation monitoring subsystem

b. Post-accident monitoring subsystem

The objectives of the normal plant operation subsystem are to indicate whether the limits of actual release of radioactive material to the environs are reached or exceeded, and to measure the quantity of release of radioactive material during normal plant operation, in compliance with 10 CFR 50 and Regulatory Guide 1.21.

The stack radiation monitoring system, including the isokinetic sampling system and the post-accident monitoring subsystem, is designed to carry out the following functions:

a. To provide continuous isokinetic and representative samples of the stack flow in compliance with the requirements of General Design Criterion 64 of 10 CFR 50, Appendix A, Regulatory Guide 1.21, and ANSI 13.1-1971.

b. To continuously record releases of radioactive particulates, iodines and noble gases to the environs so that the total quantity of radioactive material released can be evaluated.

c. To alarm, in event that specified rates of release of radioactive material are exceeded.

d. To provide continuous real-time indications of radioactive releases during the accident and post-accident modes of operation.

The north stack exhausts from the following systems:

a. Turbine enclosure No. 1 exhaust

b. Turbine enclosure No. 1 equipment compartment exhaust

c. Turbine enclosure No. 2 exhaust

d. Turbine enclosure No. 2 equipment compartment exhaust

e. Radwaste enclosure equipment compartment exhaust

f. Radwaste enclosure fume hood exhaust

g. Radwaste service and control area exhaust

h. Control structure battery compartment exhaust

i. Unit 1 steam packing condenser and effluents from the recombination system

j. Unit 2 steam packing condenser and effluents from the recombination system

k. Standby gas treatment enclosure system exhaust

l. Unit 1 battery compartment exhaust

m. Unit 2 battery compartment exhaust

n. Control structure toilet room exhaust

o. Standby gas treatment filter exhaust

p. Drywell purge system exhaust

q. Offgas treatment system exhaust.

Units 1 and 2 share the north stack and consequently the same radiation monitoring system. Under normal plant operation, the stack flow rate varies from about 183,000 cfm to about 664,000 cfm. Following an accident, flow may be reduced as low as 1250 cfm. Under this condition, the flow rate will be below the range capability of the isokinetic sampling system, but the post-accident subsystem will continue to provide representative data. The north stack is provided with three equally-spaced honeycomb grids that serve the purpose of stabilizing, equalizing, and collimating the stack flow in order that the exhaust velocity can be measured accurately and representative air sampling can be achieved. A flow velocity sensing array is provided, consisting of 128 uniformly-spaced total pressure sensors and 32 uniformly-spaced static pressure sensors for providing an instantaneous traverse across the stack. Two independent sampling arrays, each consisting of a set of 64 uniformly-spaced isokinetic nozzles are provided for extracting representative samples at the stack cross section.

One array provides a sample for the radiation monitoring subsystem designed for normal plant operation. The stack velocity and sampling rate are integrated and recorded continuously. The sample is split into parallel paths. Each half is passed through a particulate filter provided with a radiation detector indicating the corresponding integrated measurement of the particulate effluent, an iodine filter provided with an in-place detector, and then to a noble gas monitoring chamber. The parallel paths rejoin downstream of the noble gas monitoring chamber. Thus, each of the two monitoring racks provide the following outputs:

- Sampling rates, integrated.
- Particulate radioactivity, integrated
- Iodine radioactivity, integrated
- Noble gas radioactive concentration

From these data, the total radioactive effluent may readily be evaluated. Readouts from the detectors are fed into microprocessors, which in turn provide outputs to readout modules in the auxiliary equipment room and to recorders in the control room. The microprocessors are provided with memory-retention capability to preclude the loss of data in event of a power failure.

Each monitor has one downscale and two upscale alarms which annunciate in the control room. The upscale alarms indicate high and high-high radiation, and the downscale alarm indicates instrument malfunction.

For the normal plant operation mode, the characteristics of the isokinetic sampling system and radiation monitoring subsystem provide plant operations personnel with complete and accurate data of radioactive materials released to the environs from the north stack. The system thus enables personnel to control activity release rates. Sufficient redundancy is provided to allow maintenance and checking of one channel without losing monitoring capability.

The post-accident monitoring subsystem is independent of the normal plant operation monitoring subsystem and operates continuously. Two samples are available. One sample, drawn from the second 64-nozzle array described above, is passed through a particulate filter, iodine filter, and noble gas monitoring chamber. This provides redundancy to the normal plant operation monitoring subsystem. A second, much smaller sample is drawn from a separate comb-type probe located downstream of the isokinetic nozzle arrays. This sample is passed through shielded particulate and iodine filters and two extended range noble gas monitoring chambers. Detector outputs are fed into microprocessors that evaluate the total radioactive effluents. Outputs of the microprocessors are transmitted to readout modules in the auxiliary equipment room and recorders in the control room. The microprocessors have memory retention in event of loss of power. Digitized outputs are provided from both subsystems. These outputs are designed to be fed into a radiation monitoring computer which can provide ongoing print-outs of RG 1.21 reports.

3.5.5.2 South Stack Ventilation Exhaust Radiation Monitor

The objectives and functions of the south stack monitoring system are the same as those of the north stack normal plant operation monitoring subsystem. A system for post-accident monitoring is not provided because any HVAC exhaust to this stack containing accident effluent is automatically isolated.

The south stack exhausts ventilation air from the following systems:

<u>Unit 1 Stack</u>

a. Reactor enclosure No. 1 exhaust

b. Reactor enclosure No. 1 equipment compartment exhaust

c. Refueling floor Unit 1 side exhaust

<u>Unit 2 Stack</u>

a. Reactor enclosure No. 2 exhaust

b. Reactor enclosure No. 2 equipment compartment exhaust

c. Refueling floor Unit 2 side exhaust

The south stack encloses two independent exhaust ducts servicing reactor enclosure Unit 1 and Unit 2, respectively. Each of these two ducts is monitored by means of two redundant subsystems. Consequently, four independent sets of data are obtained of stack flow rates and corresponding sampling rates.

Flow rates in each of the two ducts vary from about 54,000 cfm to about 234,000 cfm. The stack flow is collimated to provide a uniform velocity distribution over the entire cross section to assure representative sampling. Exhaust velocity is measured by a manifold containing 64 uniformly spaced total pressure sensors and 16 static pressure sensors in order to provide an instantaneous ongoing velocity traverse. Sampling is done by an array of 32 uniformly spaced isokinetic nozzles.

Radiation detection is done by means of a particulate filter, iodine filter and noble gas chamber in series. Each of these items is provided with a dedicated detector. The shielded gas chamber has a beta scintillation detector consisting of a beta-sensitive crystal optically connected to a photomultiplier tube. The output from the preamplifier is fed to a microprocessor, which in turn outputs to the readout module in the auxiliary equipment room and to the recorder in the control room. Digitized outputs are also available.

The readout module is provided with one downscale and two upscale alarms that are annunciated in the control room. The downscale alarm indicates instrument malfunction and the upscale alarms indicate high and high-high radiation.

Output records are in the form of strip chart print-outs of flow rates, sampling rates, and count rates of particulates, iodines, and noble gases.

3.5.5.3 Hot Shop Ventilation Exhaust Radiation Monitor

Equipment serviced in the hot shop is expected to be contaminated with residual particulate radioactivity. A small quantity of radioactive iodine might also be present. No radioactive gases are anticipated.

Continuous isokinetic sampling of the hot shop exhaust duct is provided. This sample is passed through a fixed particulate/iodine filter. The integrated radioactivity is continuously detected and recorded locally. Local annunciation is provided in the event of increases of this radioactivity beyond the preset limits. The particulate and iodine filters will be analyzed periodically in the counting room.

3.5.5.4 Liquid Radwaste Discharge Radiation Monitor

The liquid radwaste effluent discharges into the cooling tower blowdown line. The liquid radwaste discharge radiation monitors detect activity in the discharge line to prevent concentration in the discharge line from exceeding the 10 CFR Part 20, Appendix B, limits.

Monitoring is performed in an offline sample rack, which affords improved sensitivity, and precludes the necessity of shutting down the radwaste discharge line in order to purge accumulated radioactive sludge from the monitoring system.

The monitoring channel consists of a gamma scintillation detector/preamplifier, a ratemeter in the auxiliary equipment area, and a recorder in the radwaste control room. A low-alarm trip, indicative of instrument failure or loss of power, will initiate discharge valve closure. The high-alarm trip will alarm in the control room, and the high-high alarm will initiate discharge valve closure.

3.5.5.5 Plant Service Water Radiation Monitor

Plant service water effluent is discharged to the cooling tower after usage in the plant. The effluent is monitored by the plant service water radiation monitor. No activity is expected to be present in this line. For radioactivity to be present, leakage would have to occur simultaneously in equipment cooled by the reactor enclosure cooling water system, and in the reactor enclosure cooling water heat exchanger. Thus, this monitor provides a backup for the reactor enclosure cooling water monitor.

Offline monitoring was selected to facilitate decontamination without shutdown. The channel consists of a detector, preamplifier, a ratemeter in the auxiliary equipment room, and a recorder in the control room. The ratemeter provides a low- and high-alarm in the control room. Annunciation due to low sample flow rate is also provided. The alarm setpoint is based upon detecting leakage into the service water, with the setpoint set sufficiently above background to preclude spurious alarms.

3.5.5.6 RHR Service Water

This system is comprised of four monitors for sampling the service water from the four RHR heat exchangers and two backup monitors, and for sampling the effluent from each unit to the spray pond. Detection of leakage of radioactive fission products into the service water will result in the tripping of RHR service water pumps, and the valve from the RHR heat exchanger to the spray pond. The system also monitors the emergency service water (ESW).

Each monitor provides three alarm conditions: low radiation, high radiation, and low pump flow. These alarms trip annunciators in the control room, and the high-alarm trips the service water flow and RHR pumps.

These monitors are qualified for IEEE class 1E.

3.5.6 REFERENCES

3.5-1 NUREG 0016 "A Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors," April 1976.

3.5-2 Branch Technical Position ETSB 11-3 "Design Guidance for Solid Radioactive Waste Management Systems Installed in Light Water Cooled Nuclear Power Reactor Plants."

3.5-3 Limerick Generating Station. Final Safety Analysis Report (FSAR), Philadelphia Electric Company.

TABLE 3.5-1

ASSUMPTIONS AND PARAMETERS USED FOR EVALUATION OF RADIOACTIVE RELEASES

PARAMETER	VALUE
I. General	
1. Maximum core thermal power	3458 MWt
2. The methods and parameters of NUREG 0016 Rev. 0 are used to calculate the source terms in the primary coolant:	
a. Plant capacity factor	0.8
b. Isotopic release rates of noble gases to the reactor coolant at 30-minute decay (μCi/sec)	60,000
c. Concentration of fission, corrosion, and activation products in the reactor coolant	Table 3.5-2
3. The quantity of tritium released in liquid and gaseous effluents (Ci/yr, 2 units)	Liquid - 11 Gaseous - 144
II. Nuclear Steam Supply System	
1. Total steam flow rate for valve wide open condition	$1.48x10^{+7}$ lb/hr
2. Mass of reactor coolant and steam in the reactor vessel at full power	$5.5x10^{+5}$ lb $2.1x10^{+4}$ lb
III. Reactor Water Cleanup System	
1. Average flow rate for 2 vessels	$1.33x10^{+5}$ lb/hr
2. Demineralizer type	Powdex
3. Number of demineralizers	2
4. Backwash frequency	3.4 days (6.8-day run for each demineralizer)
5. Backwash volume	
IV. Condensate Demineralizers	

TABLE 3.5-1 (Cont'd) (Page 2 of 4)

PARAMETER	VALUE
1. Average flow rate for 7 vessels (valve wide open condition)	$1.5x10^{+7}$ lb/hr
2. Demineralizer type	Powdex
3. Number of demineralizers and size	7 plus 1 standby 1300 ft^2
4. Backwash frequency	1.43 days (10-day run for each demineralizer)
5. Ultrasonic resin cleaning	Not used
6. Backwash volume	9000 gal/backwash
V. Liquid Waste Processing Systems	
1. For each liquid waste subsystem, provide in tabular form the following information:	
a. Sources, flow rates (gpd), and expected activities (fraction of primary coolant activity, PCA) all inputs to each system	Table 3.5-7
b. Holdup times associated with collection, processing, and discharge of all liquid streams	Table 3.5-8
c. Capacities of all tanks (gal) and processing equipment (gpd) considered in calculating holdup times	Table 3.5-9
d. Decontamination factors for each processing step	Table 3.5-10
e. Stream fraction discharged	
Equipment drain subsystem	0.01
Floor drain subsystem	0.1
Chemical waste subsystem	0.1
Laundry drain subsystem	1.00
f. For waste demineralizer regeneration, time between regenerations, regenerant volumes and activities,	Spent resins from the radwaste demineralizer are sluiced to

TABLE 3.5-1 (Cont'd) (Page 3 of 4)

PARAMETER		VALUE
	treatment of regenerants, and fractions of regenerant discharged (include parameters used in making these determinations)	the solid radwaste system
g.	Liquid source term by radionuclide in Ci/yr for normal operation, including anticipated operational occurrences	Table 3.5-3
2.	Piping and instrumentation diagrams (P&IDs) and process flow diagrams for the liquid radwaste systems along with all other systems influencing the source term calculations	Figure 3.5-1 See FSAR Chapter 11 for P&IDs
VI.	Main Condenser and Turbine Gland Seal Air Removal Systems	
1.	Holdup time for offgas prior to offgas treatment system (hr)	0.105
2.	Description of offgas treatment system	Section 3.5.3
3.	Offgas treatment system	
	1) Mass of charcoal (lb)	321,790
	2) Operating/dew point (°F)	60-65/40
	3) Dynamic adsorption coeff. Xe, Kr (cm^3/g)	733, 31.8
4.	Gland seal steam flow (lb/hr) and source	15,000 (normal) steam from condensate
5.	Radioactive iodine reduction systems for the gland seal system	N/A - Clean steam from condensate is used
6.	P&IDs and process flow drawings for offgas system	FSAR Figures 11.3-3 through 11.4-2
VII.	Ventilation and Exhaust Systems	
1.	Provisions incorporated to reduce radioactivity releases through the ventilation or exhaust systems	Reactor, turbine, and radwaste enclosure ventilation systems contain

TABLE 3.5-1 (Cont'd)

PARAMETER	VALUE
	charcoal and HEPA filtration systems on exhaust that are considered to be radioactive
2. Decontamination factors assumed and the bases (include charcoal absorbers, HEPA filters, mechanical devices)	
Iodine release fraction	0.1
Particulate release fraction	0.01
3. Release rates for radioiodines, noble gases, and radioactive particulates (Ci/yr)	Table 3.5-6
4. Release point to the environment:	3 roof vents
Height above plant grade	200 feet
Effluent temperature rise	20 to 50°F above ambient
Exit velocity	Approx. 10 m/sec
5. Containment purge and venting frequency (per year)	5
VIII. Solid Waste Processing Systems	
1. Solid waste processing system inputs:	
a. Source, volume (ft^3/yr per reactor)	Table 3.5-11
b. Activity (Ci/yr per reactor) of principal radionuclides	Table 3.5-12
2. Onsite storage provisions (location and capacity) and expected onsite storage times for all solid wastes prior to shipment	Section 3.5.4
3. P&IDs and process flow diagrams for the solid radwaste system	Figure 3.5-3 See FSAR Chapter 11 for P&IDs (Ref 3.5-2)

TABLE 3.5-2

EXPECTED RADIONUCLIDE ACTIVITY CONCENTRATIONS IN REACTOR COOLANT AND MAIN STEAM USED FOR EVALUATION OF RADIOACTIVITY RELEASES(1)

ISOTOPE	REACTOR WATER (microCi/g)	REACTOR STEAM (microCi/g)
Noble Gases		
Kr-83m	-	$1.1x10^{-3}$
Kr-85m	-	$1.9x10^{-3}$
Kr-85	-	$6.0x10^{-6}$
Kr-87	-	$6.6x10^{-3}$
Kr-88	-	$6.6x10^{-3}$
Kr-89	-	$4.1x10^{-2}$
Kr-90	-	$9.0x10^{-2}$
Kr-91	-	$1.1x10^{-1}$
Kr-92	-	$1.1x10^{-1}$
Kr-93	-	$2.9x10^{-2}$
Kr-94	-	$7.2x10^{-3}$
Kr-95	-	$6.6x10^{-4}$
Kr-97	-	$4.4x10^{-6}$
Xe-131m	-	$4.7x10^{-6}$
Xe-133m	-	$9.0x10^{-5}$
Xe-133	-	$2.6x10^{-3}$
Xe-135m	-	$8.4x10^{-3}$
Xe-135	-	$7.2x10^{-3}$
Xe-137	-	$4.7x10^{-2}$
Xe-138	-	$2.8x10^{-2}$
Xe-139	-	$9.0x10^{-2}$
Xe-140	-	$9.6x10^{-2}$
Xe-141	-	$7.8x10^{-2}$
Xe-142	-	$2.3x10^{-2}$
Xe-143	-	$3.8x10^{-3}$
Xe-144	-	$1.8x10^{-4}$
Halogens		
Br-83	$2.38x10^{-3}$	$4.76x10^{-5}$
Br-84	$3.63x10^{-3}$	$7.26x10^{-5}$
Br-85	$2.11x10^{-3}$	$4.22x10^{-5}$
I-131	$4.93x10^{-3}$	$9.86x10^{-5}$
I-132	$2.37x10^{-2}$	$4.74x10^{-4}$
I-133	$1.87x10^{-2}$	$3.74x10^{-4}$
I-134	$5.19x10^{-2}$	$1.04x10^{-3}$

TABLE 3.5-2 (Cont'd)

ISOTOPE	REACTOR WATER (microCi/g)	REACTOR STEAM (microCi/g)
I-135	$1.73x10^{-2}$	$3.46x10^{-4}$
Fission Products		
Rb-89	$3.56x10^{-3}$	$3.56x10^{-6}$
Sr-89	$9.92x10^{-5}$	$9.92x10^{-8}$
Sr-90	$5.96x10^{-6}$	$5.96x10^{-9}$
Sr-91	$3.70x10^{-3}$	$3.70x10^{-6}$
Sr-92	$9.42x10^{-3}$	$9.42x10^{-6}$
Y-91	$3.97x10^{-5}$	$3.97x10^{-6}$
Y-92	$5.17x10^{-3}$	$5.17x10^{-6}$
Y-93	$3.71x10^{-3}$	$3.71x10^{-6}$
Zr-95	$6.94x10^{-6}$	$6.94x10^{-9}$
Zr-97	$4.75x10^{-6}$	$4.75x10^{-9}$
Nb-95	$6.94x10^{-6}$	$6.94x10^{-9}$
Nb-98	$3.06x10^{-3}$	$3.06x10^{-6}$
Mo-99	$1.96x10^{-3}$	$1.96x10^{-6}$
Tc-99m	$1.80x10^{-2}$	$1.80x10^{-5}$
Tc-101	$6.49x10^{-2}$	$6.49x10^{-5}$
Tc-104	$5.81x10^{-2}$	$5.81x10^{-5}$
Ru-103	$1.98x10^{-5}$	$1.98x10^{-8}$
Ru-105	$1.75x10^{-3}$	$1.75x10^{-6}$
Ru-106	$2.98x10^{-6}$	$2.98x10^{-9}$
Ag-110m	$9.92x10^{-7}$	$9.92x10^{-10}$
Te-129m	$3.97x10^{-5}$	$3.97x10^{-8}$
Te-131m	$9.67x10^{-5}$	$9.67x10^{-8}$
Te-132	$9.82x10^{-6}$	$9.82x10^{-9}$
Cs-134	$2.98x10^{-5}$	$2.98x10^{-8}$
Cs-136	$1.98x10^{-5}$	$1.98x10^{-8}$
Cs-137	$6.95x10^{-5}$	$6.95x10^{-8}$
Cs-138	$7.27x10^{-3}$	$7.27x10^{-6}$
Ba-139	$7.94x10^{-3}$	$7.94x10^{-6}$
Ba-140	$3.96x10^{-4}$	$3.96x10^{-7}$
Ba-141	$7.27x10^{-3}$	$7.27x10^{-6}$
Ba-142	$4.30x10^{-3}$	$4.30x10^{-6}$
La-142	$4.01x10^{-3}$	$4.01x10^{-6}$
Ce-141	$2.97x10^{-5}$	$2.97x10^{-8}$
Ce-143	$2.91x10^{-5}$	$2.91x10^{-8}$
Ce-144	$2.98x10^{-6}$	$2.98x10^{-9}$
Pr-143	$3.96x10^{-5}$	$3.96x10^{-8}$
Nd-147	$2.97x10^{-6}$	$2.97x10^{-9}$

TABLE 3.5-2 (Cont'd)

ISOTOPE	REACTOR WATER (microCi/g)	REACTOR STEAM (microCi/g)
W-187	$2.88x10^{-4}$	$2.88x10^{-7}$
Np-239	$6.85x10^{-3}$	$6.85x10^{-6}$
Coolant Activation Products		
N-13	$5x10^{-2}$	$7x10^{-3}$
N-16	$6x10^{+1}$	$5x10^{+1}$
N-17	$9x10^{-3}$	$2x10^{-2}$
O-19	$7x10^{-1}$	$2x10^{-1}$
F-18	$4x10^{-3}$	$4x10^{-3}$
Non-coolant Activation Products		
Na-24	$8.51x10^{-3}$	$8.51x10^{-6}$
P-32	$1.98x10^{-4}$	$1.98x10^{-7}$
Cr-51	$4.96x10^{-3}$	$4.96x10^{-6}$
Mn-54	$5.95x10^{-5}$	$5.95x10^{-8}$
Mn-56	$4.19x10^{-2}$	$4.19x10^{-5}$
Fe-55	$9.93x10^{-4}$	$9.93x10^{-7}$
Fe-59	$2.98x10^{-5}$	$2.98x10^{-8}$
Co-58	$1.98x10^{-4}$	$1.98x10^{-7}$
Co-60	$3.97x10^{-4}$	$3.97x10^{-7}$
Ni-63	$9.93x10^{-7}$	$9.93x10^{-10}$
Ni-65	$2.51x10^{-4}$	$2.51x10^{-7}$
Cu-64	$2.82x10^{-2}$	$2.82x10^{-5}$
Zn-65	$1.98x10^{-4}$	$1.98x10^{-7}$
Zn-69	$1.88x10^{-3}$	$1.88x10^{-6}$
Tritium		
H-3	$1x10^{-2}$	$1x10^{-2}$

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(1) The values in this table are calculated based on GALE code in NUREG-16 (April 1976)

TABLE 3.5-3

EXPECTED YEARLY ACTIVITY RELEASED FROM LIQUID WASTE MANAGEMENT SYSTEMS[1]
(curies/year; totals are for 2 units)

ISOTOPE	FLOOR DRAIN SUBSYSTEM	EQUIPMENT DRAIN SUBSYSTEM	CHEMICAL DRAIN SUBSYSTEM	LWS SUBTOTAL	ADJUSTED TOTAL[2]	LAUNDRY DRAIN SUBSYSTEM	TOTAL
Br-83	2.47×10^{-5}	3.28×10^{-5}	1.11×10^{-7}	5.75×10^{-5}	6.19×10^{-4}	-	6.19×10^{-4}
Br-84	-	1.19×10^{-6}	-	1.19×10^{-6}	1.28×10^{-5}	-	1.28×10^{-5}
Br-85	-	-	-	-	-	-	-
I-131	9.40×10^{-4}	4.58×10^{-4}	1.32×10^{-5}	1.41×10^{-3}	1.52×10^{-2}	1.20×10^{-3}	1.64×10^{-2}
I-132	2.23×10^{-4}	2.96×10^{-4}	1.01×10^{-6}	5.19×10^{-4}	5.59×10^{-3}	-	5.59×10^{-3}
I-133	1.98×10^{-3}	1.35×10^{-3}	1.37×10^{-5}	3.34×10^{-3}	3.60×10^{-2}	-	3.60×10^{-2}
I-134	6.95×10^{-5}	8.57×10^{-5}	2.42×10^{-7}	1.55×10^{-4}	1.67×10^{-3}	-	1.67×10^{-3}
I-135	7.05×10^{-4}	7.40×10^{-4}	3.56×10^{-6}	1.45×10^{-3}	1.56×10^{-2}	-	1.56×10^{-2}
Rb-89	7.90×10^{-6}	1.31×10^{-6}	-	9.21×10^{-6}	9.92×10^{-5}	-	9.92×10^{-5}
Cs-134	1.53×10^{-4}	1.43×10^{-4}	2.46×10^{-5}	1.67×10^{-3}	1.80×10^{-2}	2.60×10^{-2}	4.40×10^{-2}
Cs-136	9.70×10^{-4}	9.31×10^{-5}	1.44×10^{-5}	1.06×10^{-3}	1.14×10^{-2}	-	1.14×10^{-2}
Cs-137	3.57×10^{-3}	3.33×10^{-4}	5.76×10^{-5}	3.90×10^{-3}	4.20×10^{-2}	4.80×10^{-2}	9.00×10^{-2}
Cs-138	5.57×10^{-4}	1.25×10^{-4}	1.54×10^{-6}	6.82×10^{-4}	7.35×10^{-3}	-	7.35×10^{-3}
Na-24	7.40×10^{-4}	5.59×10^{-4}	4.49×10^{-6}	1.30×10^{-3}	1.40×10^{-2}	-	1.40×10^{-2}
P-32	3.89×10^{-5}	1.87×10^{-5}	5.80×10^{-7}	5.76×10^{-5}	6.20×10^{-4}	-	6.20×10^{-4}
Cr-51	9.97×10^{-4}	4.72×10^{-4}	1.54×10^{-5}	1.47×10^{-3}	1.58×10^{-2}	-	1.58×10^{-2}
Mn-54	1.22×10^{-5}	5.69×10^{-6}	1.56×10^{-7}	1.79×10^{-5}	1.93×10^{-4}	2.00×10^{-3}	2.19×10^{-3}
Mn-56	4.81×10^{-4}	6.39×10^{-4}	2.19×10^{-6}	1.12×10^{-3}	1.21×10^{-2}	-	1.21×10^{-2}
Fe-55	2.04×10^{-4}	8.87×10^{-4}	3.08×10^{-6}	1.09×10^{-3}	1.17×10^{-2}	-	1.17×10^{-2}
Fe-59	6.03×10^{-6}	2.84×10^{-6}	9.50×10^{-8}	8.87×10^{-6}	9.55×10^{-5}	-	9.55×10^{-5}
Co-58	4.04×10^{-5}	1.89×10^{-5}	6.40×10^{-8}	5.93×10^{-5}	6.39×10^{-4}	8.00×10^{-3}	8.64×10^{-3}
Co-60	8.16×10^{-5}	3.81×10^{-5}	1.31×10^{-6}	1.20×10^{-4}	1.29×10^{-3}	1.80×10^{-2}	1.93×10^{-2}
Ni-63	2.04×10^{-7}	9.53×10^{-8}	-	2.99×10^{-7}	3.22×10^{-6}	-	3.22×10^{-6}
Ni-65	2.86×10^{-6}	3.80×10^{-6}	1.30×10^{-8}	6.66×10^{-6}	7.17×10^{-5}	-	7.17×10^{-5}
Cu-64	2.16×10^{-3}	1.81×10^{-3}	1.46×10^{-5}	3.97×10^{-3}	4.28×10^{-2}	-	4.28×10^{-2}
Zn-65	4.05×10^{-5}	1.89×10^{-5}	6.52×10^{-7}	5.94×10^{-5}	6.40×10^{-4}	-	6.40×10^{-4}
Zn-69	1.27×10^{-5}	3.96×10^{-6}	-	1.67×10^{-5}	1.80×10^{-4}	-	1.80×10^{-4}
Sr-89	2.03×10^{-5}	9.53×10^{-6}	3.20×10^{-7}	2.98×10^{-5}	3.21×10^{-4}	-	3.21×10^{-4}
Sr-90	1.22×10^{-6}	5.69×10^{-7}	1.97×10^{-8}	1.79×10^{-6}	1.93×10^{-5}	-	1.93×10^{-5}
Sr-91	2.23×10^{-4}	2.00×10^{-4}	1.19×10^{-6}	4.23×10^{-4}	4.56×10^{-3}	-	4.56×10^{-3}
Sr-92	1.05×10^{-4}	1.38×10^{-4}	4.79×10^{-7}	2.43×10^{-4}	2.62×10^{-3}	-	2.62×10^{-3}
Y-91	1.17×10^{-5}	4.77×10^{-6}	2.04×10^{-7}	1.65×10^{-5}	1.78×10^{-4}	-	1.78×10^{-4}
Y-92	2.56×10^{-4}	3.09×10^{-4}	1.27×10^{-6}	5.65×10^{-4}	6.09×10^{-3}	-	6.09×10^{-3}
Y-93	2.37×10^{-4}	2.08×10^{-4}	1.29×10^{-6}	4.45×10^{-4}	4.79×10^{-3}	-	4.79×10^{-3}
Zr-95	1.41×10^{-6}	6.65×10^{-7}	2.24×10^{-8}	2.08×10^{-6}	2.24×10^{-5}	2.80×10^{-3}	2.83×10^{-3}
Zr-97	4.51×10^{-7}	3.26×10^{-7}	-	7.77×10^{-7}	8.37×10^{-6}	-	8.37×10^{-6}
Nb-95	1.43×10^{-6}	6.65×10^{-7}	2.30×10^{-8}	2.10×10^{-6}	2.26×10^{-5}	4.00×10^{-3}	4.02×10^{-3}
Nb-98	5.59×10^{-6}	4.77×10^{-6}	1.35×10^{-8}	1.04×10^{-5}	1.12×10^{-4}	-	1.12×10^{-4}
Mo-99	3.25×10^{-4}	1.72×10^{-4}	3.61×10^{-6}	4.97×10^{-4}	5.35×10^{-3}	-	5.35×10^{-3}
Tc-99m	8.97×10^{-4}	8.04×10^{-4}	6.13×10^{-6}	1.70×10^{-3}	1.83×10^{-2}	-	1.83×10^{-2}
Tc-101	3.50×10^{-7}	2.38×10^{-7}	-	5.43×10^{-7}	5.85×10^{-6}	-	5.85×10^{-6}
Tc-104	1.31×10^{-6}	1.18×10^{-6}	-	2.49×10^{-6}	2.68×10^{-5}	-	2.68×10^{-5}

TABLE 3.5-3 (Cont'd)

ISOTOPE	FLOOR DRAIN SUBSYSTEM	EQUIPMENT DRAIN SUBSYSTEM	CHEMICAL DRAIN SUBSYSTEM	LWS SUBTOTAL	ADJUSTED TOTAL(2)	LAUNDRY DRAIN SUBSYSTEM	TOTAL
Ru-103	4.01×10^{-6}	1.88×10^{-6}	6.27×10^{-8}	5.89×10^{-6}	6.34×10^{-5}	2.80×10^{-4}	3.43×10^{-4}
Ru-105	4.34×10^{-5}	5.24×10^{-5}	2.09×10^{-7}	9.58×10^{-5}	1.03×10^{-3}	-	1.03×10^{-3}
Ru-106	6.11×10^{-7}	2.85×10^{-7}	-	8.96×10^{-7}	9.65×10^{-6}	4.80×10^{-3}	4.81×10^{-3}
Ag-110m	2.04×10^{-7}	9.53×10^{-8}	-	2.99×10^{-7}	3.22×10^{-6}	8.80×10^{-4}	8.83×10^{-4}
Te-129m	8.02×10^{-6}	3.78×10^{-6}	1.25×10^{-7}	1.18×10^{-5}	1.27×10^{-4}	-	1.27×10^{-4}
Te-131m	1.25×10^{-5}	7.66×10^{-6}	1.02×10^{-7}	2.02×10^{-5}	2.18×10^{-4}	-	2.18×10^{-4}
Te-132	1.68×10^{-6}	8.73×10^{-7}	1.96×10^{-8}	2.55×10^{-6}	2.75×10^{-5}	-	2.75×10^{-5}
Ba-139	3.07×10^{-5}	4.02×10^{-5}	1.25×10^{-7}	7.09×10^{-5}	7.64×10^{-4}	-	7.64×10^{-4}
Ba-140	7.76×10^{-5}	3.73×10^{-5}	1.14×10^{-6}	1.15×10^{-4}	1.24×10^{-3}	-	1.24×10^{-3}
Ba-141	1.64×10^{-7}	1.47×10^{-7}	-	3.11×10^{-7}	3.35×10^{-6}	-	3.35×10^{-6}
Ba-142	3.13×10^{-9}	2.08×10^{-9}	-	5.21×10^{-9}	5.61×10^{-8}	-	5.61×10^{-8}
La-142	2.20×10^{-5}	2.90×10^{-5}	9.28×10^{-8}	5.10×10^{-5}	5.49×10^{-4}	-	5.49×10^{-4}
Ce-141	6.49×10^{-6}	3.01×10^{-6}	1.02×10^{-7}	9.51×10^{-6}	1.02×10^{-4}	-	1.02×10^{-4}
Ce-143	3.92×10^{-6}	2.34×10^{-6}	3.33×10^{-8}	6.26×10^{-6}	6.74×10^{-5}	-	6.74×10^{-5}
Ce-144	6.11×10^{-7}	2.85×10^{-7}	-	9.06×10^{-7}	9.76×10^{-6}	-	9.76×10^{-6}
Pr-143	7.97×10^{-6}	3.77×10^{-6}	1.21×10^{-7}	1.18×10^{-5}	1.27×10^{-4}	-	1.27×10^{-4}
Nd-147	5.78×10^{-7}	2.78×10^{-7}	-	8.56×10^{-7}	9.22×10^{-6}	-	9.22×10^{-6}
W-187	3.35×10^{-5}	2.17×10^{-5}	2.47×10^{-7}	5.52×10^{-5}	5.95×10^{-4}	-	5.95×10^{-4}
Np-239	1.09×10^{-3}	5.91×10^{-4}	1.15×10^{-5}	1.68×10^{-3}	1.81×10^{-2}	-	1.81×10^{-2}
OTHERS(3)	2.24×10^{-4}	1.76×10^{-4}	2.12×10^{-6}	4.02×10^{-4}	4.32×10^{-3}	1.00×10^{-2}	1.43×10^{-2}
TOTAL	1.94×10^{-2}	1.12×10^{-2}	2.02×10^{-4}	3.08×10^{-2}	3.31×10^{-1}	1.26×10^{-1}	4.57×10^{-1}
H-3							$1.1 \times 10^{+1}$

(1) Estimated releases are based on NUREG-0016, Rev 0, GALE Code evaluation

(2) Increased the calculated LWS release by 0.15 Ci/yr per reactor using the same isotopic distribution as the calculated LWS releases to account for anticipated operational occurrences that result in unplanned releases.

(3) Activity of daughter products resulting from radioactive decay of the influent isotopes during the accumulation period.

TABLE 3.5-4 (Page 1 of 4)

EXPECTED AND MAXIMUM SHIPPING CASK INVENTORIES(Ci)[1]

Isotope	EXPECTED[2] LSA	EXPECTED[2] HSA	MAXIMUM[2] LSA	MAXIMUM[2] HSA
Br-83	-	-	-	-
Br-84	-	-	-	-
Br-85	-	-	-	-
I-131	1.30	4.47×10^{-4}	1.19×10^{1}	4.11×10^{-3}
I-132	3.74×10^{-5}	-	6.46×10^{-1}	-
I-133	5.03×10^{-6}	-	8.27×10^{-5}	-
I-134	-	-	-	-
I-135	-	-	-	-
Rb-89	-	-	-	-
Cs-134	4.01×10^{-2}	4.88	7.54×10^{-1}	9.18×10^{1}
Cs-136	1.91×10^{-3}	3.86×10^{-4}	3.69×10^{-2}	7.52×10^{-3}
Cs-137	9.65×10^{-2}	1.32×10^{1}	1.18	1.61×10^{2}
Cs-138	-	-	-	-
Na-24	1.59×10^{-8}	-	3.68×10^{-9}	-
P-32	2.84×10^{-2}	8.58×10^{-3}	2.86×10^{-3}	8.67×10^{-4}
Cr-51	2.01	1.16×10^{1}	2.02×10^{-1}	1.17
Mn-54	7.76×10^{-2}	7.72	5.23×10^{-2}	5.19
Mn-56	-	-	-	-
Fe-55	1.29	1.69×10^{2}	-	-
Fe-59	1.94×10^{-2}	3.64×10^{-1}	5.16×10^{-2}	9.76×10^{-1}
Co-58	1.73×10^{-1}	6.67	4.36	1.69×10^{2}
Co-60	5.73×10^{-1}	7.20×10^{1}	7.23×10^{-1}	9.07×10^{1}

TABLE 3.5-4 (Cont'd) (Page 2 of 4)

Isotope	EXPECTED(2) LSA	EXPECTED(2) HSA	MAXIMUM(2) LSA	MAXIMUM(2) HSA
Ni-63	1.46×10^{-3}	1.92×10^{-1}	-	-
Ni-65	-	-	-	-
Cu-64	-	-	-	-
Zn-65	2.50×10^{-1}	2.30×10^{1}	2.52×10^{-3}	2.32×10^{-1}
Zn-69	-	-	-	-
Zn-69m	-	-	-	-
Sr-89	7.12×10^{-2}	1.69	7.74	1.84×10^{2}
Sr-90	8.76×10^{-3}	1.14	1.18	1.53×10^{2}
Sr-91	-	-	-	-
Sr-92	-	-	-	-
Y-91	5.10×10^{-2}	1.52	1.24	3.85×10^{1}
Y-92	-	-	-	-
Y-93	-	-	-	-
Zr-95	5.74×10^{-3}	1.95×10^{-1}	1.16×10^{-1}	3.92
Zr-97	-	-	-	-
Nb-95	8.29×10^{-3}	3.80×10^{-1}	1.70×10^{-1}	7.71
Nb-98	-	-	-	-
Mo-99	3.81×10^{-3}	-	1.47×10^{-1}	-
Tc-99m	3.64×10^{-3}	-	1.41×10^{-1}	-
Tc-101	-	-	-	-
Tc-104	-	-	-	-
Ru-103	1.16×10^{-2}	1.69×10^{-1}	3.88×10^{-2}	5.66×10^{-1}
Ru-105	-	-	-	-

TABLE 3.5-4 (Cont'd) (Page 3 of 4)

Isotope	EXPECTED(2) LSA	EXPECTED(2) HSA	MAXIMUM(2) LSA	MAXIMUM(2) HSA
Ru-106	3.97×10^{-3}	4.11×10^{-1}	1.21×10^{-2}	1.25
Ag-110m	1.26×10^{-3}	1.17×10^{-1}	7.61×10^{-2}	7.08
Te-129m	2.00×10^{-2}	1.98×10^{-1}	7.01×10^{-2}	6.98×10^{-1}
Te-131m	1.33×10^{-6}	-	-	-
Te-132	3.64×10^{-5}	-	6.28×10^{-1}	-
Ba-139	-	-	-	-
Ba-140	4.56×10^{-2}	6.70×10^{-3}	3.60	5.31×10^{-1}
Ba-141	-	-	-	-
Ba-142	-	-	-	-
La-142	-	-	-	-
Ce-141	1.58×10^{-2}	1.46×10^{-1}	1.73×10^{-1}	1.65
Ce-143	9.06×10^{-8}	-	3.79×10^{-6}	-
Ce-144	3.86×10^{-3}	3.72×10^{-1}	1.58×10^{-1}	1.53×10^{1}
Pr-143	5.50×10^{-3}	1.23×10^{-3}	1.90×10^{-2}	4.22×10^{-3}
Nd-147	2.48×10^{-4}	1.15×10^{-5}	4.05×10^{-2}	1.89×10^{-3}
W-187	3.91×10^{-7}	-	4.02×10^{-6}	-
Np-239	6.48×10^{-3}	-	7.82×10^{-1}	-
Other(3)	1.90×10^{-1}	1.48×10^{1}	6.68	3.23×10^{2}
Total	6.27	3.30×10^{2}	4.28×10^{1}	1.26×10^{3}

TABLE 3.5-4 (Cont'd) (Page 4 of 4)

(1) Container inventories are based on the specific activity levels of the source waste as processed by the radwaste centrifuge and assume a filled container storage period prior to shipment of 15 days for LSA waste and 90 days for HSA waste.

(2) LSA activity inventories are based on a prorated mixture of condensate sludge and waste sludge. HSA inventories are based on RWCU sludge. Container inventories assume 90% fill.

(3) "Other" isotopes consist of daughter products resulting from radioactive decay of the influent isotopes during accumulation and storage periods.

TABLE 3.5-5

ASSUMPTIONS AND PARAMETERS USED FOR EVALUATION OF GASEOUS RELEASES

Power	3458 MWt
Capacity Factor	80%
Total Steam Flow	14.863×10^6 lb/hr
Mass of Water in Reactor	3.8×10^5 lb
Cleanup Demineralizer Flow	1.33×10^5 lb/hr
Fraction of Feedwater Through Condenser Demineralizer	1.00
Gland Seal System uses Clean System with no Radioactive Releases	
Reactor Encl Iodine Release Fraction	.3 (2" Carbon Filter)
Particulate Release Fraction	.01 (HEPA Filter)
Turbine Encl Iodine Release Fraction	.01 (8" Deep Bed Charcoal Filter)
Particulate Release Fraction	.01
Radwaste Encl Iodine Release Fraction	1.0
Particulate Release Fraction	.01
Mech Vac Pump Iodine Release Fraction	.01
Particulate Release Fraction	.01

Charcoal Delay System designed with vendor coefficients for 35-day Xenon holdup at 75 scfm. (This corresponds to 58.6 days Xe at 30 scfm condenser inleakage using the NUREG-16, Rev. 0 coefficients).

TABLE 3.5-6

EXPECTED ANNUAL ACTIVITY RELEASED FROM GASEOUS WASTE MANAGEMENT SYSTEMS(1)
(CURIES/YEAR; 2 UNITS)

NUCLIDE	REACTOR ENCL	TURBINE ENCL	RADWASTE ENCL	GLAND SEAL	AIR EJECTOR	MECH VAC PUMP	TOTAL
Ar-41	5.0 x 10^{+1}	*	*	*	*	*	5.0 x 10^{+1}
Kr-83m	*(2)	*	*	*	*	*	*
Kr-85m	12.0	13.6 x 10^{+1}			12.0		16.0 x 10^{+1}
Kr-85	*	*	*		5.6 x 10^{+2}	*	5.6 x 10^{+2}
Kr-87	12.0	2.6 x 10^{+2}	*	*	*	*	2.8 x 10^{+2}
Kr-88	12.0	4.6 x 10^{+2}	*	*	*	*	4.8 x 10^{+2}
Kr-89	*	*	*	*	*	*	*
Xe-131m	*	*	*	*	14.0	*	14.0
Xe-133m	*	*	*	*	*	*	*
Xe-133	2.60 x 10^{+2}	5.0 x 10^{+2}	2.0 x 10^{+1}	*	11.2 x 10^{+1}	4.6 x 10^{+3}	5.4 x 10^{+3}
Xe-135m	18.40 x 10^{+1}	13.0 x 10^{+2}	*	*	*	*	14.8 x 10^{+2}
Xe-135	13.60 x 10^{+1}	12.6 x 10^{+2}	9.0 x 10^{+1}	*	*	7.0 x 10^{+2}	2.2 x 10^{+3}
Xe-137	*	*	*	*	*	*	*
Xe-138	2.8 x 10^{+1}	2.80 x 10^{+3}	*	*	*	*	2.8 x 10^{+3}
TOTAL NOBLE GASES							13.4 x 10^{+3}
I-131	2.0 x 10^{-1}	3.8 x 10^{-3}	1.0 x 10^{-1}	**(3)	**	6.0 x 10^{-2}	3.6 x 10^{-1}
I-133	8.0 x 10^{-1}	15.2 x 10^{-3}	3.6 x 10^{-1}	**	**	**	1.2
TOTAL HALOGENS(4)							12.2 x 10^{-1}
Tritium Gaseous Release							14.4 x 10^{+1}
Carbon-14	*	*	*	*	19.0	*	19.0
Cr-51	12.0 x 10^{-6}	2.6 x 10^{-4}	18.0 x 10^{-5}	0.0	0.0	0.0	4.6 x 10^{-4}
Mn-54	12.0 x 10^{-5}	12.0 x 10^{-6}	6.0 x 10^{-4}	0.0	0.0	0.0	7.4 x 10^{-4}
Co-58	2.4 x 10^{-5}	12.0 x 10^{-6}	9.0 x 10^{-5}	0.0	0.0	0.0	12.6 x 10^{-5}
Fe-59	16.0 x 10^{-6}	10.0 x 10^{-6}	3.0 x 10^{-4}	0.0	0.0	0.0	3.2 x 10^{-4}
Co-60	4.0 x 10^{-4}	4.0 x 10^{-5}	18.0 x 10^{-4}	0.0	0.0	0.0	2.2 x 10^{-3}
Zn-65	8.0 x 10^{-5}	4.0 x 10^{-6}	3.0 x 10^{-5}	0.0	0.0	0.0	11.4 x 10^{-5}
Sr-89	3.6 x 10^{-6}	12.0 x 10^{-5}	9.0 x 10^{-6}	0.0	0.0	0.0	13.2 x 10^{-5}
Sr-90	2.0 x 10^{-7}	4.0 x 10^{-7}	6.0 x 10^{-6}	0.0	0.0	0.0	6.6 x 10^{-6}
Zr-95	16.0 x 10^{-6}	2.0 x 10^{-6}	10.0 x 10^{-7}	0.0	0.0	0.0	19.0 x 10^{-6}
Sb-124	8.0 x 10^{-6}	6.0 x 10^{-6}	10.0 x 10^{-7}	0.0	0.0	0.0	15.0 x 10^{-6}
Cs-134	16.0 x 10^{-5}	6.0 x 10^{-6}	9.0 x 10^{-5}	0.0	0.0	6.0 x 10^{-6}	2.6 x 10^{-4}
Cs-136	12.0 x 10^{-6}	10.0 x 10^{-7}	9.0 x 10^{-6}	0.0	0.0	4.0 x 10^{-6}	2.6 x 10^{-5}
Cs-137	2.2 x 10^{-4}	12.0 x 10^{-6}	18.0 x 10^{-5}	0.0	0.0	2.0 x 10^{-5}	4.4 x 10^{-4}
Ba-140	16.0 x 10^{-6}	2.2 x 10^{-4}	2.0 x 10^{-6}	0.0	0.0	2.2 x 10^{-5}	2.6 x 10^{-4}
Ce-141	4.0 x 10^{-6}	12.0 x 10^{-6}	5.2 x 10^{-5}	0.0	0.0	0.0	6.8 x 10^{-5}
TOTAL AIRBORNE PARTICULATE RELEASE							5.2 x 10^{-3}

TABLE 3.5-6 (cont'd)

(1) Estimated releases based on NUREG 16 Rev. 0, GALE Code evaluation
(2) Less than 1.0 Ci/yr. (*)
(3) Less than 1.0×10^{-4} Ci/yr. (**)
(4) Includes both gaseous and particulate releases.

TABLE 3.5-7

AVERAGE DAILY INPUTS AND ACTIVITIES TO THE LIQUID WASTE MANAGEMENT SYSTEM FROM TWO UNITS

SOURCE	AVERAGE DAILY INPUT FROM TWO UNITS IN NORMAL OPERATION[1] (gal)	PRIMARY COOLANT ACTIVITY FRACTION (PCA)
Floor Drains		
Drywell	1400	1.0
Reactor Enclosure	4000	0.01
Turbine Enclosure - condensate pump area	1000	0.01
- backwash area	3000	0.01
Radwaste Enclosure	1000	0.01
TOTAL	10400	0.143
Equipment Drains		
Drywell	6800	1.0
Reactor Enclosure	7440	0.01
Turbine Enclosure - condensate pump area	2000	0.01
- backwash area	3920	0.01
Radwaste Enclosure	1060	0.01
TOTAL	21220	0.327
Decant Water		
RWCU phase separator	600	0.002
Condensate phase separator	11600	0.0002
Centrifuge effluent	5360	0.002
TOTAL	17560	0.0008
Chemical Wastes		
Lab drains	1000	0.02
Chemical lab drains	200	0.02
TOTAL	1200	0.02
Laundry Drains	900	-

(1) These values are taken directly from NUREG-16 (April 1976).

TABLE 3.5-8

EXPECTED HOLDUP TIMES FOR COLLECTION, PROCESSING, AND DISCHARGE USED FOR EVALUATION OF RADIOACTIVITY RELEASES

PROCESS SUBDIVISION	HOLDUP TIME (days)
Floor drain Subsystem	
Collection	1.616
Processing	0.042
Sampling	0.042
Total	1.700
Equipment Drain Subsystem	
Collection	0.519
Processing	0.050
Sampling	0.042
Total	0.611
Chemical Drain Subsystem[1]	
Collection	5.000
Processing	0.063
Sampling	0.042
Total	5.105
Laundry Drain Subsystem	
Collection	1.000
Processing	0.025
Sampling	0.042
Total	1.067

[1] Holdup times shown for the chemical drains subsystem are based on processing via the floor drain subsystem (Section 3.5.2.3).

TABLE 3.5-9

LIQUID WASTE MANAGEMENT SYSTEM COMPONENT PARAMETERS

A. TANKS

	QUANTITY	DESIGN PRESSURE/TEMP. (psig/°F)	TYPE	MATERIAL	CAPACITY, EACH (gal)	DIAM/HEIGHT
Equipment drain collection tank	1	Atmos/212	Vert cyl	CS	25,000	20 ft/11 ft
Equipment drain sample tanks	2	Atmos/212	Vert cyl	Alum.	25,000	16 ft/17 ft
Equip. drain surge tank	1	Atmos/212	Vert cyl	CS	75,000	32 ft/13 ft
Floor drain collection tank	1	Atmos/212	Vert cyl	CS	21,000	15 ft/16 ft
Floor drain sample tank #1	1	Atmos/212	Vert cyl	CS	21,000	15 ft/16 ft
Floor drain sample tank #2	1	Atmos/212	Vert cyl	Alum.	21,000	15 ft/16 ft
Floor drain surge tank	1	Atmos/212	Vert cyl	CS	75,000	32 ft/13 ft
Chemical waste tank	1	Atmos/212	Vert cyl	SS	7500	10 ft/13 ft
Evaporator feed tank(1)	1	Atmos/212	Vert cyl	CS	7500	11 ft/10.5 ft
Evaporator distillate sample tank(1)	1	Atmos/212	Vert cyl	Alum.	7500	11 ft/10 ft
Laundry drain tanks	2	Atmos/212	Vert cyl	CS	1000	5.5 ft/6 ft
Laundry drain sample tank	1	Atmos/212	Vert cyl	CS	2000	7 ft/7 ft
Backwash air accumulator	1	125/110	Vert cyl	CS	90 ft^3	4 ft/6.75 ft
Precoat tank	1	Atm/Ambient	Cyl	CS	800	6 ft/4 ft
Resin funnel	2	Atm/Ambient	Con cyl	CS	3 ft^3	1.5 ft/3.5 ft

TABLE 3.5-9 (Cont'd)

B. PUMPS

	QUANTITY	TYPE	RATED FLOW (gpm)	RATED HEAD, TDH (ft)	RATED POWER (hp)	DESIGN PRESSURE/TEMP. (psig/°F)
Equipment drain collection tank pump	1	Vert inline centrifugal	280	250	40	150/140
Equipment drain sample tanks pumps	2	Vert inline centrifugal	280	180	25	150/140
Equipment drain surge tank pump	1	Vert inline centrifugal	280	220	30	150/140
Floor drain collection tank pump	1	Vert inline centrifugal	280	250	40	150/140
Floor drain sample tank #1 pump	1	Vert inline centrifugal	280	110	15	150/140
Floor drain sample tank #2 pump	1	Vert inline centrifugal	280	180	25	150/140
Floor drain surge tank pump	1	Vert inline centrifugal	280	220	30	150/140
Chemical waste tank pump	1	Vert inline centrifugal	200	70	7.5	150/140
Evaporator feed tank pump(1)	2	Vert inline centrifugal	20	25	1	150/140
Evaporator distillate sample tank pump(1)	1	Vert inline centrifugal	50	130	7.5	150/140
Laundry drain tanks pumps	2	Vert inline centrifugal	25	105	5	150/140
Laundry drain sample tank pump	2	Vert inline centrifugal	10	65	2	150/140
Equipment drain filter holding pump	1	Horiz centrif	27	60	3	245/155
Floor drain filter holding pump	1	Horiz centrif	27	60	3	245/155
Precoat pump	1	Horiz centrif	688	75	20	150/155

TABLE 3.5-9 (Cont'd) (Page 3 of 3)

C. PROCESSING EQUIPMENT

	QUANTITY	TYPE DIAM/HEIGHT	MATERIAL TYPE/NUMBER	RATED FLOW, EACH (gpm)	EQUIPMENT PARAMETER	DESIGN PRESSURE/TEMP. (psig/°F)
Equipment and floor drain filters	2	Precoat type 3 ft/7 ft	SS wire mesh element/90	280	Filter area: 275 ft²	150/235
Equipment and floor drain demineralizers	2	Mixed bed 6 ft/6 ft	Effective resin volume of each bed = 85 ft³	280	Resin bed depth: 3 ft min 5 ft max	150/235
Radwaste evaporator-reboiler skids with control panels:[1]						
Evaporator	2	Single-effect, 2-pass, horiz tube forced circulation (HTFC) Skid dimensions: 12 ft x 12 ft x 21 ft	Shell: SS 304L or 316L seamless tubing Water & steam piping: CS	20	Vol. reduction to 10% of original volume: decontam. factor of 10^4	15/155
Reboiler	2	2-pass horiz. U-tubes 4.5 ft/11 ft	Shell: CS Tubes: SS 304L seamless	Shell: 11,100 lb/hr Tube: 12,500 lb/hr	Heat transfer area: 386 ft²	50/300 250/405
Laundry drain filter	1	Shell: Vert cyl 8.6 in./ 46 in.	Shell: SS	25	Filter area: 48 ft²	75/250
		Cartridge: "Epocel-30" 6 in./32 in.	Cartridge: Epoxy impregnated cellulose of 49 microns			

(1) Installation of these components associated with the chemical waste subsystem will not be completed for initial plant operation (see Section 3.5.2.3).

TABLE 3.5-10

DECONTAMINATION FACTORS USED FOR EVALUATION OF RADIOACTIVITY RELEASES[1]

EQUIPMENT	IODINE	CESIUM AND RUBIDIUM	OTHERS
Equipment drain filter/demin[2]	10	2	10
Equipment drain demineralizer	100	10	100
Floor drain filter/demin[2]	10	2	10
Floor drain demineralizer	100	2	100
RWCU filter demineralizer	10	2	10
Condensate filter demineralizer	10	2	10
Laundry drain cartridge filter	1	1	1

[1] The values are taken from NUREG-16, Table 1-3 (April 1976).
[2] Powered resin is used to precoat the filter/demin, DF value of powdex is used here.

TABLE 3.5-11

SOLID WASTE MANAGEMENT SYSTEM FLOWS

STREAM No.[1]	AVERAGE BATCH FREQUENCY FOR NORMAL OPERATION OF BOTH UNITS (no.batches/no.days)	MAXIMUM BATCH FREQUENCY FOR ONE UNIT[2] (1/day)	VOLUME PER BATCH (gal)	FLOWRATE (gpm)	NORMAL ACTIVITY CONCENTRATION (Ci/cc)	MAXIMUM ACTIVITY CONCENTRATION (Ci/cc)
21	2/6.8	2/1	1100	By gravity	35.8	1110
22	4/6.8	2/1	1100	By gravity	35.1	1100
23	1/60	-	5600	20	20.2	91.8
24	7/10	4/1	9000	By gravity	1.1	26.6
25	7/10	4/1	9000	450	1.0	26.4
26	1/14.3	-	13000	20	0.7	5.1
27	1/125.8	-	1500	By gravity	0.25	4.61
28A[3]	1/0.69	-	1925	By gravity	0.020	0.74
28B[3]	1/1.1	-	1925	By gravity	0.85	6.66
28C[3]	1/5	-	1965	By gravity	0.096	2.61
29	1/25.8	-	1500	By gravity	0.025	0.66
30[5]	1/2.5	-	12800	20	0.061	2.26
31A[4]	1/60	-	51 ft^3	By gravity	293	1340
31B[4]	1/14.3	-	235 ft^3	By gravity	4.97	37.4
31C[4][5]	1/2.5	-	27 ft^3	By gravity	3.92	144

(1) Refer to Figure 3.5-3 for location of stream numbers.
(2) Maximum condition is assumed to happen 30 days per year per unit for the RWCU system and condensate filter/demineralizer system.
(3) 28A is floor drain filter backwash
28B is equipment drain filter backwash
28C is fuel pool cleanup filter backwash
(4) 31A is RWCU sludge
31B is condensate sludge
31C is waste sludge
(5) Batch frequencies, volumes, and activity concentrations are based on chemical waste processing via the floor drain subsystem (see Section 3.5.2.3)

TABLE 3.5-12

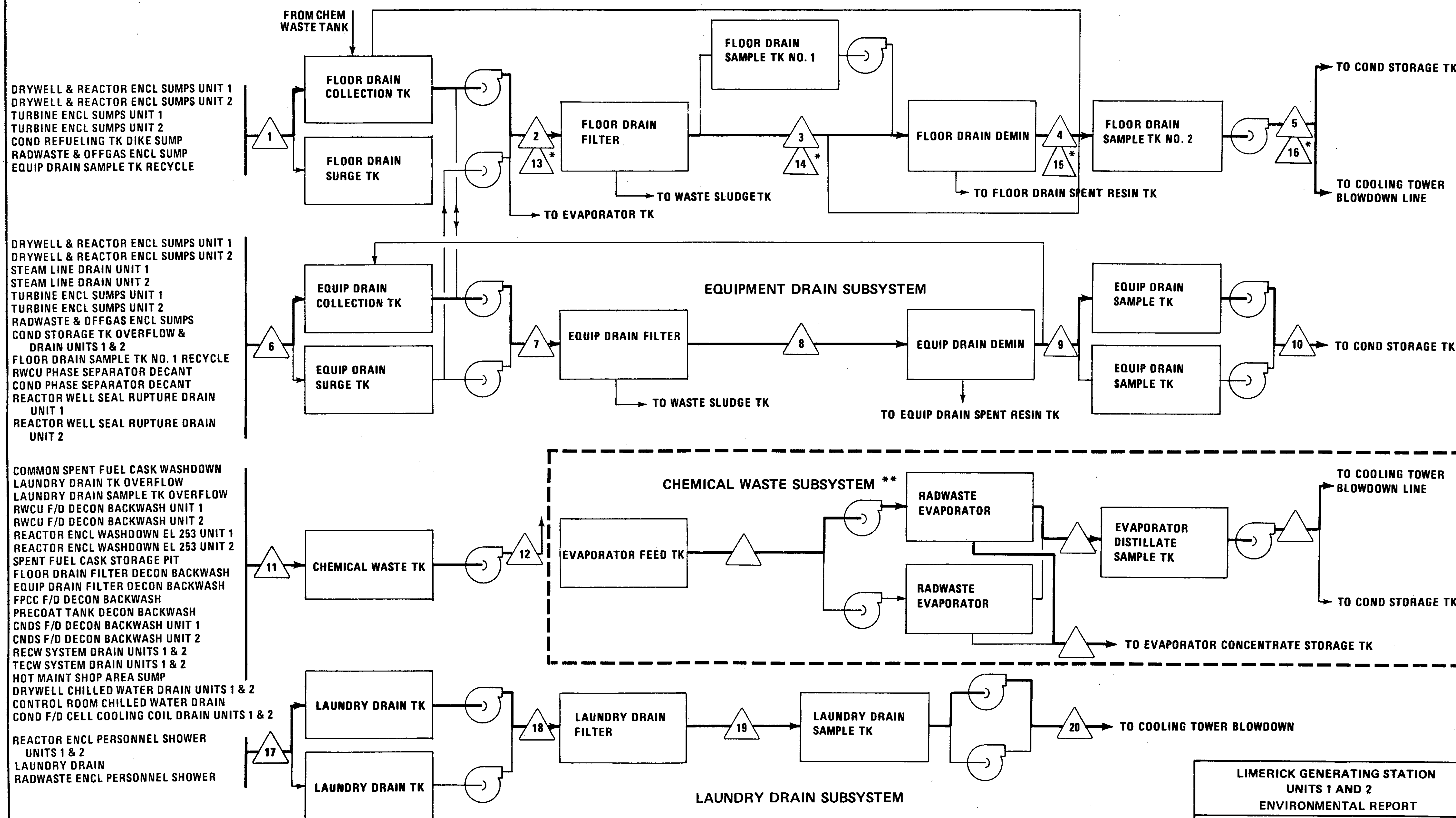
EXPECTED RADIONUCLIDE INVENTORIES OF SOLID WASTE MANAGEMENT SYSTEM COMPONENTS[1]

NUCLIDE	RWCU BACKWASH RECEIVING TNK	RWCU PHASE SEPARATOR	CONDENSATE BACKWASH RECEIVING TNK	CONDENSATE PHASE SEPARATOR	FLOOR DRAIN SPENT RESIN TNK	EQUIP. DRAIN SPENT RESIN TNK	WASTE SLUDGE TANK[2]
Br-83	2.41×10^{-1}	8.79×10^{-1}	1.47×10^{-1}	9.37×10^{-1}	1.55×10^{-4}	2.45×10^{-4}	3.33×10^{-3}
Br-84	6.84×10^{-2}	1.77×10^{-1}	3.52×10^{-2}	1.59×10^{-1}	1.16×10^{-5}	1.86×10^{-5}	4.98×10^{-4}
Br-85	4.63×10^{-4}	1.82×10^{-5}	2.94×10^{-3}	2.02×10^{-6}	5.98×10^{-8}	9.62×10^{-8}	1.84×10^{-5}
I-131	$1.87\times10^{+1}$	$1.67\times10^{+2}$	$1.56\times10^{+1}$	$1.72\times10^{+2}$	1.56×10^{-2}	1.47×10^{-1}	3.48×10^{-1}
I-132	2.27	8.26	1.39	8.80	1.39×10^{-3}	2.27×10^{-3}	3.05×10^{-2}
I-133	$1.66\times10^{+1}$	$6.60\times10^{+1}$	$1.06\times10^{+1}$	$7.34\times10^{+1}$	2.76×10^{-2}	4.87×10^{-2}	4.99×10^{-1}
I-134	1.74	5.33	9.74×10^{-1}	5.22	4.42×10^{-4}	7.11×10^{-4}	1.43×10^{-2}
I-135	5.02	$1.94\times10^{+1}$	3.16	$2.13\times10^{+1}$	7.05×10^{-3}	1.02×10^{-2}	1.20×10^{-1}
Rb-89	2.57×10^{-2}	4.19×10^{-2}	5.25×10^{-4}	1.49×10^{-3}	7.39×10^{-7}	1.94×10^{-5}	1.07×10^{-4}
Cs-134	1.48×10^{-1}	5.11	6.97×10^{-3}	1.38×10^{-1}	1.09×10^{-3}	4.21×10^{-2}	1.34×10^{-3}
Cs-136	8.37×10^{-2}	1.09	3.65×10^{-3}	4.91×10^{-2}	3.91×10^{-4}	4.59×10^{-3}	8.20×10^{-4}
Cs-137	3.47×10^{-1}	$1.22\times10^{+1}$	1.63×10^{-2}	3.26×10^{-1}	2.56×10^{-3}	1.04×10^{-1}	3.12×10^{-3}
Cs-138	1.39×10^{-1}	3.61×10^{-1}	3.58×10^{-3}	1.63×10^{-2}	6.61×10^{-6}	1.74×10^{-4}	5.64×10^{-4}
Na-24	5.58	$2.20\times10^{+1}$	1.77×10^{-1}	1.22	9.64×10^{-3}	1.52×10^{-2}	1.67×10^{-1}
P-32	8.43×10^{-1}	$1.13\times10^{+1}$	3.68×10^{-2}	5.03×10^{-1}	6.54×10^{-4}	1.05×10^{-2}	1.48×10^{-2}
Cr-51	$2.28\times10^{+1}$	$4.54\times10^{+2}$	1.03	$1.66\times10^{+1}$	1.68×10^{-2}	4.95×10^{-1}	3.85×10^{-1}
Mn-54	2.95×10^{-1}	9.81	1.38×10^{-2}	2.71×10^{-1}	2.07×10^{-4}	1.70×10^{-2}	4.79×10^{-3}
Mn-56	4.56	$1.66\times10^{+1}$	1.39×10^{-1}	8.92×10^{-1}	3.11×10^{-3}	4.89×10^{-3}	6.55×10^{-2}
Fe-55	4.96	$1.71\times10^{+2}$	2.34×10^{-1}	4.63	-	-	-
Fe-59	1.41×10^{-1}	3.45	6.49×10^{-3}	1.13×10^{-1}	1.02×10^{-4}	4.36×10^{-3}	2.35×10^{-3}
Co-58	9.58×10^{-1}	$2.64\times10^{+1}$	4.43×10^{-2}	8.13×10^{-1}	6.84×10^{-4}	3.75×10^{-2}	1.57×10^{-2}
Co-60	1.98	$6.93\times10^{+1}$	9.31×10^{-2}	1.85	1.39×10^{-3}	1.28×10^{-1}	3.21×10^{-2}
Ni-63	4.96×10^{-3}	1.75×10^{-1}	2.33×10^{-4}	4.67×10^{-3}	3.47×10^{-6}	3.27×10^{-4}	8.02×10^{-5}
Ni-65	2.72×10^{-2}	9.94×10^{-2}	8.31×10^{-4}	5.31×10^{-3}	1.85×10^{-5}	2.90×10^{-5}	3.89×10^{-4}
Cu-64	$1.61\times10^{+1}$	$6.31\times10^{+1}$	5.18×10^{-1}	3.62	-	-	-
Zn-65	9.81×10^{-1}	$3.21\times10^{+1}$	4.59×10^{-2}	8.95×10^{-1}	6.90×10^{-4}	5.48×10^{-2}	1.59×10^{-2}
Zn-69	6.99×10^{-2}	2.19×10^{-1}	1.97×10^{-3}	1.08×10^{-2}	3.03×10^{-8}	3.09×10^{-5}	5.76×10^{-4}
Sr-89	4.78×10^{-1}	$1.22\times10^{+1}$	2.20×10^{-2}	3.91×10^{-1}	3.44×10^{-4}	1.60×10^{-2}	7.90×10^{-3}
Sr-90	2.98×10^{-2}	1.05	1.40×10^{-3}	2.80×10^{-2}	2.08×10^{-5}	1.95×10^{-3}	4.82×10^{-4}
Sr-91	1.56	6.10	4.93×10^{-2}	3.37×10^{-1}	2.55×10^{-3}	3.72×10^{-3}	4.30×10^{-2}
Sr-92	9.67×10^{-1}	3.55	2.96×10^{-2}	1.90×10^{-1}	6.91×10^{-4}	1.08×10^{-3}	1.43×10^{-2}
Y-91	3.02×10^{-1}	8.21	1.41×10^{-2}	2.58×10^{-1}	2.05×10^{-4}	1.10×10^{-2}	4.81×10^{-3}
Y-92	1.79	6.94	5.63×10^{-2}	3.82×10^{-1}	2.19×10^{-3}	3.27×10^{-3}	3.89×10^{-2}
Y-93	1.67	6.53	5.28×10^{-2}	3.61×10^{-1}	2.77×10^{-3}	4.03×10^{-3}	4.68×10^{-2}
Zr-95	3.35×10^{-2}	9.07×10^{-1}	1.54×10^{-3}	2.81×10^{-2}	2.39×10^{-5}	1.26×10^{-3}	5.52×10^{-4}
Zr-97	3.54×10^{-3}	1.40×10^{-2}	1.12×10^{-4}	7.77×10^{-4}	6.06×10^{-6}	9.96×10^{-6}	1.07×10^{-4}
Nb-95	3.46×10^{-2}	1.12	1.62×10^{-3}	3.18×10^{-2}	2.42×10^{-5}	1.74×10^{-3}	5.60×10^{-4}
Nb-98	1.00×10^{-1}	3.06×10^{-1}	2.80×10^{-3}	1.49×10^{-2}	2.51×10^{-5}	4.03×10^{-5}	8.21×10^{-4}
Mo-99	4.71	$2.30\times10^{+1}$	1.68×10^{-1}	1.28	5.17×10^{-3}	1.93×10^{-2}	1.08×10^{-1}
Tc-99m	8.74	$3.83\times10^{+1}$	2.94×10^{-1}	2.12	1.06×10^{-2}	2.66×10^{-2}	2.01×10^{-1}
Tc-101	4.08×10^{-1}	6.06×10^{-1}	7.95×10^{-3}	2.06×10^{-2}	4.00×10^{-5}	6.44×10^{-5}	3.13×10^{-3}
Tc-104	5.24×10^{-1}	9.71×10^{-1}	1.14×10^{-2}	3.69×10^{-2}	5.93×10^{-5}	9.53×10^{-5}	3.81×10^{-3}

TABLE 3.5-12 (Cont'd)

NUCLIDE	RWCU BACKWASH RECEIVING TNK	RWCU PHASE SEPARATOR	CONDENSATE BACKWASH RECEIVING TNK	CONDENSATE PHASE SEPARATOR	FLOOR DRAIN SPENT RESIN TNK	EQUIP. DRAIN SPENT RESIN TNK	WASTE SLUDGE TANK(2)
Ru-103	9.33×10^{-2}	2.16	4.26×10^{-3}	7.32×10^{-2}	6.77×10^{-5}	2.62×10^{-3}	1.56×10^{-3}
Ru-105	3.34×10^{-1}	1.27	1.04×10^{-2}	6.92×10^{-2}	3.61×10^{-4}	5.39×10^{-4}	6.58×10^{-3}
Ru-106	1.48×10^{-2}	4.97×10^{-1}	6.94×10^{-4}	1.36×10^{-2}	1.04×10^{-5}	8.73×10^{-4}	2.40×10^{-4}
Ag-110m	4.91×10^{-3}	1.61×10^{-1}	2.30×10^{-4}	4.49×10^{-3}	3.45×10^{-6}	2.76×10^{-4}	7.98×10^{-5}
Te-129m	1.85×10^{-1}	4.04	8.44×10^{-3}	1.41×10^{-1}	1.35×10^{-4}	4.69×10^{-3}	3.10×10^{-3}
Te-131m	1.24×10^{-1}	5.07×10^{-1}	4.05×10^{-3}	2.82×10^{-2}	1.85×10^{-4}	3.97×10^{-4}	3.54×10^{-3}
Te-132	2.58×10^{-2}	1.34×10^{-1}	9.49×10^{-4}	7.49×10^{-3}	2.69×10^{-5}	1.14×10^{-4}	5.71×10^{-4}
Ba-139	4.46×10^{-1}	1.51	1.31×10^{-2}	7.77×10^{-2}	1.72×10^{-4}	2.76×10^{-4}	4.49×10^{-3}
Ba-140	1.65	$2.06\times10^{+1}$	7.18×10^{-2}	9.46×10^{-1}	2.94×10^{-3}	1.89×10^{-2}	2.94×10^{-2}
Ba-141	6.56×10^{-2}	1.21×10^{-1}	1.42×10^{-3}	4.62×10^{-3}	8.17×10^{-7}	1.19×10^{-5}	4.76×10^{-4}
Ba-142	1.85×10^{-2}	2.10×10^{-2}	3.16×10^{-4}	6.27×10^{-4}	1.80×10^{-7}	2.64×10^{-6}	1.56×10^{-4}
La-142	2.87×10^{-1}	9.97×10^{-1}	8.57×10^{-3}	5.18×10^{-2}	1.36×10^{-5}	1.98×10^{-4}	3.08×10^{-3}
Ce-141	1.50×10^{-1}	3.23	6.86×10^{-3}	1.14×10^{-1}	3.49×10^{-4}	3.57×10^{-3}	2.47×10^{-3}
Ce-143	4.09×10^{-2}	1.68×10^{-1}	1.33×10^{-3}	9.37×10^{-3}	2.20×10^{-5}	1.33×10^{-4}	1.13×10^{-4}
Ce-144	1.47×10^{-2}	4.89×10^{-1}	6.92×10^{-4}	1.35×10^{-2}	4.14×10^{-5}	8.44×10^{-4}	2.40×10^{-4}
Pr-143	1.76×10^{-1}	2.33	7.74×10^{-3}	1.05×10^{-1}	3.27×10^{-4}	2.15×10^{-3}	3.07×10^{-3}
Nd-147	1.20×10^{-2}	1.36×10^{-1}	5.18×10^{-4}	6.49×10^{-3}	2.01×10^{-5}	1.22×10^{-4}	2.17×10^{-4}
W-187	3.00×10^{-1}	1.20	9.62×10^{-3}	6.68×10^{-2}	1.39×10^{-4}	9.09×10^{-4}	8.86×10^{-3}
Np-239	$1.47\times10^{+1}$	$6.78\times10^{+1}$	5.14×10^{-1}	3.78	1.03×10^{-2}	5.63×10^{-2}	3.54×10^{-1}
OTHERS(3)	3.20	$3.29\times10^{+1}$	1.14×10^{-1}	1.50	1.56×10^{-2}	9.92×10^{-2}	2.98×10^{-1}
Total	$1.49\times10^{+2}$	$1.43\times10^{+3}$	$3.57\times10^{+1}$	$3.27\times10^{+2}$	1.45×10^{-1}	1.41	2.92

(1) Activity inventories are given in curies.
(2) Activity inventory is based on chemical waste processing via the floor drain subsystem (see Section 11.2.2.1.3).
(3) Activity of daughter products resulting from radioactive decay of the influent isotopes during the accumulation period.



STREAM NUMBERS REFLECT BATCH PROCESSING OF CHEMICAL WASTE VIA THE FLOOR DRAIN SUBSYSTEM

**INSTALLATION OF THIS PORTION OF THE CHEMICAL WASTE SUBSYSTEM WILL NOT BE COMPLETED FOR INITIAL PLANT OPERATION.

NOTE: INFORMATION ON STREAM NUMBERS IDENTIFIED BY △ IS GIVEN IN FSAR TABLE 11.2-2

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LIQUID WASTE MANAGEMENT SUBSYSTEM

FIGURE 3.5-1

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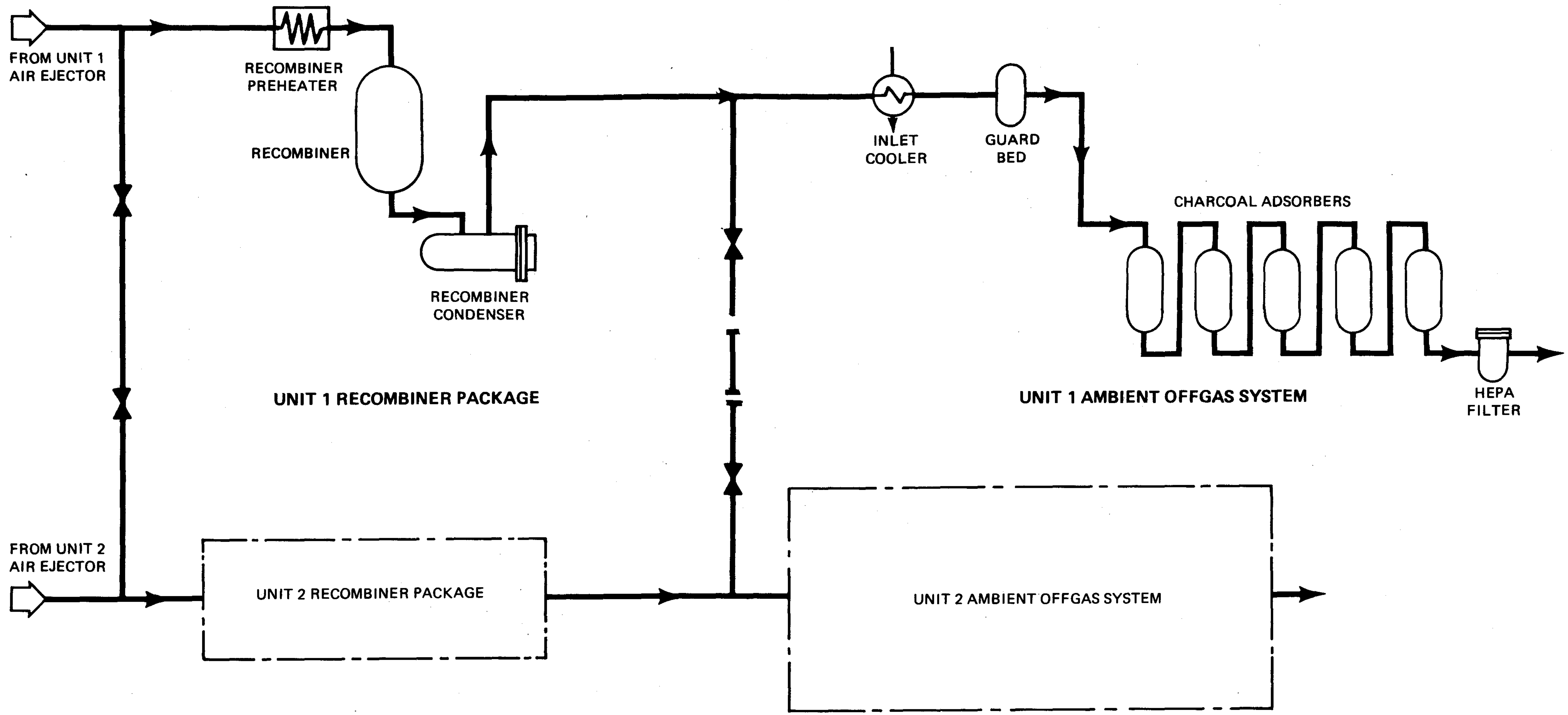

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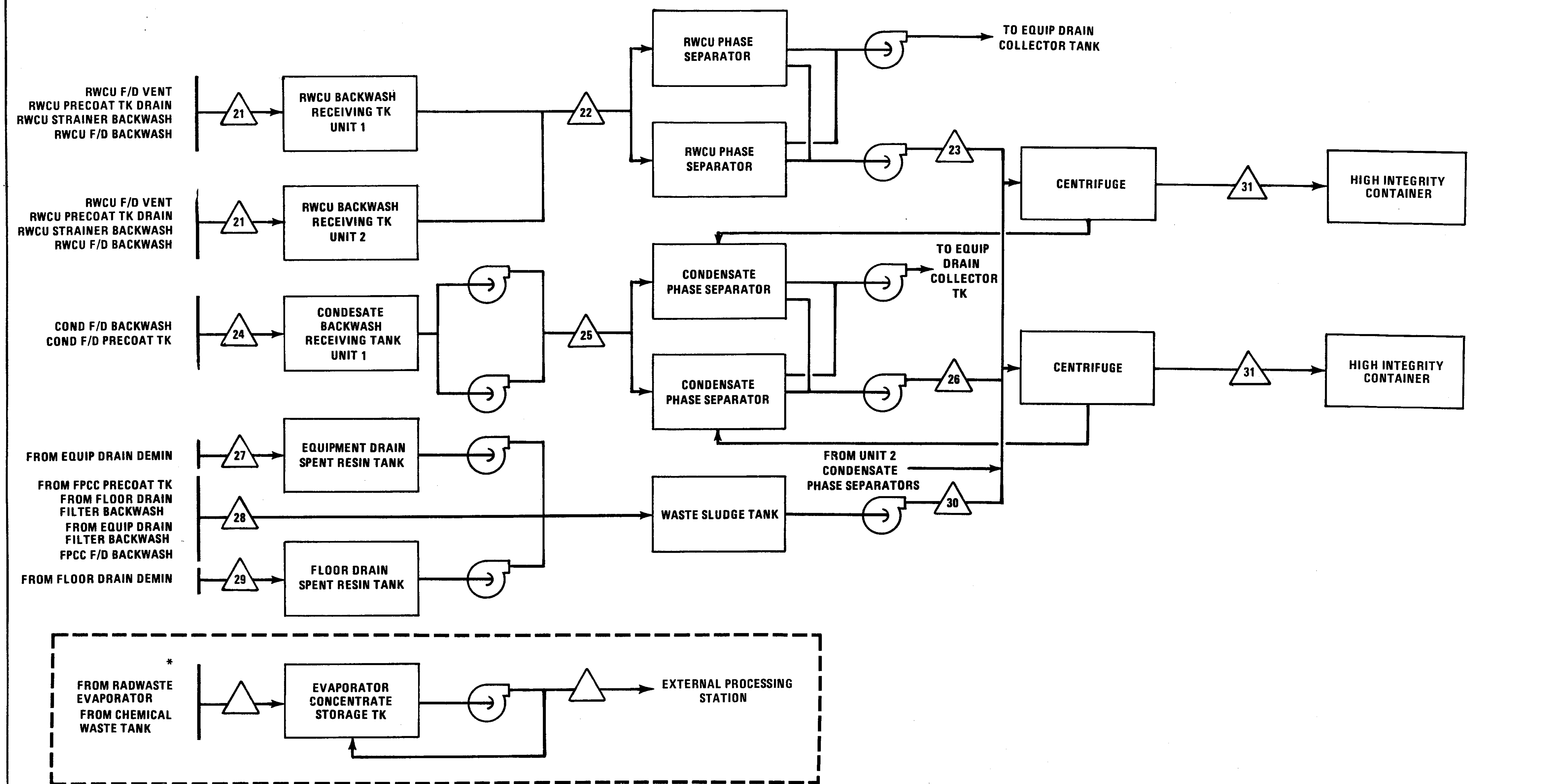
PROCESS FLOW DIAGRAM FOR OFFGAS SYSTEM

FIGURE 3.5-2



* INSTALLATION OF THIS PORTION OF THE SYSTEM WILL NOT BE COMPLETED FOR INITIAL PLANT OPERATION (SEE SECTION 11.2.2.1.3)

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FLOW DIAGRAM OF THE SOLID RADWASTE SYSTEM

FIGURE 3.5-3

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condenser, chlorinated and unchlorinated circulating water paths join, with the result that the chlorine becomes uniformly diluted in the full circulating flow by the time it returns to the cooling tower. Approximate travel times through the circulating water system at full flow are: 1 minute from the cooling tower outlets to the main condenser inlet; 1/2 minute through the main condenser; 1-1/2 minutes from the main condenser outlet to the cooling tower basin; and 15 minutes through the basin to the outlets.

Because the biological growth constitutes chlorine demand, in addition to that which is naturally in the water, the normal chlorine injection rate is expected to be 2 mg/l, although rates up to 5 mg/l are available if necessary to sustain heat transfer efficiency. Higher injection rates can be achieved by reducing circulating water flow, or by using the spare chlorinator. In accordance with good design practice (Ref 3.6-1), the chlorination equipment for the circulating water system at Limerick has a greater capacity than is normally needed. The chlorine addition to the cooling water for the two units is expected to average one ton per day.

In addition, it may occasionally be necessary to chlorinate the cooling towers. The best estimate is that chlorination of the inventory of water in a cooling tower-condenser loop system to a maximum of 10 mg/l would be necessary. Expected frequency of this application of chlorination is three to four times per year for each of the two towers; however, operating experience is necessary to establish the actual requirements. The cooling towers are not blown down during chlorination of the cooling towers as long as the free available chlorine residual exceeds 0.5 mg/l.

No corrosion inhibitors are added to the circulating or service water systems that are directly connected to the cooling tower blowdown. Some corrosion products from the Admiralty Brass condenser tubes are expected to be present in the cooling tower blowdown, but copper and zinc concentrations in the blowdown are each expected to be less than 1 mg/l.

Process controls on the circulating water and service water maintain the cooling tower blowdown within the U.S. Environmental Protection Agency (EPA) chemical effluent limitations for cooling tower blowdown in 40 CFR Part 423, dated October 8, 1974, that specify:

(a) The pH of all discharges, except once through cooling water, shall be within the range of 6.0-9.0.

The quantity of pollutants discharged in cooling tower blowdown shall not exceed the quantity determined by multiplying the flow of cooling tower blowdown sources times the concentration listed in the following table:

Effluent Characteristic	Maximum Concentration	Average Concentration
Free available chlorine	0.5 mg/l	0.2 mg/l
	Maximum for any one day	Average of daily values for 30 consecutive days shall not exceed
Material added for corrosion inhibition including but not limited to zinc, chromium, phosphorus.	No detectable amount	No detectable amount

Neither free available chlorine nor total residual chlorine may be discharged from any unit for more than two hours in any one day and not more than one unit in any plant may discharge free available or total residual chlorine at any one time unless the utility can demonstrate to the regional administrator or state, if the state has NPDES permit issuing authority, that the units in a particular location cannot operate at or below this level of chlorination.

3.6.2 SPRAY POND BLOWDOWN

The spray pond is kept full by a level control system. The level control system also maintains spray pond chemical water quality.

Chemical water quality of the spray pond is concentrated to approximately 1.4 times average Schuylkill River quality. Algae in the spray pond is controlled by slug applications of hypochlorite, as is done for the control of algae in drinking water supply reservoirs (Ref 3.6-2). The hypochlorite addition to the spray pond is expected to average 500 pounds per application. The chemicals are distributed from a boat, or from along the shore as often as deemed necessary by visual inspection (probably twice a year). Slug quantities are predetermined so that free available chlorine concentration does not exceed 0.5 mg/l. During and following chlorination, grab samples will be taken at the spray pond to monitor the chlorine concentration.

3.6.3 HOLDING POND EFFLUENT

A 400,000 gallon concrete-lined holding pond receives all waste-water from the Limerick Generating Station except cooling tower overflow, spray pond overflow, radwaste, sewage, and storm drainage. Holding pond inflows include low volume waste from nonradioactive floor, equipment, and sampling drains, as well as powerblock subdrainage sump pump flows and auxiliary boiler blowdown. The total holding pond inflow is expected to average 70,000 gpd, of which approximately one-half is water treatment facility waste-water from the settling basins, and approximately one-half is from miscellaneous sources. The total maximum holding pond inflow is expected to be 300,000 gpd. Two parallel 750 gpm gravity differential oil separators, located immediately upstream of the holding pond, treat all flows entering the holding pond, except for the floor dainage from the holding pond treatment enclosures, which is routed directly to the holding pond.

3.6.3.1 Water Treatment Facility Wastewater from the Settling Basins

A major low volume waste source draining to the holding pond is the wastewater settling basin effluent. Raw water for the makeup water system is supplied by either the Schuylkill or the Perkiomen pumping stations. The makeup water treatment facility includes a clarification and filtration system, clarified water storage tank, ion exchange demineralization system, and demineralized water storage tank. The raw water treatment facility supplies lube water for the circulating water pump seal system, domestic water system, and demineralized water system.

Alum, polyelectrolyte, sodium hydroxide, and hypochlorite are added for clarification. Sulfuric acid and sodium hydroxide are used for regeneration of cation, anion, and mixed bed demineralizer units. Concentrated chemicals are pumped from storage tanks to system regenerant tanks, feed proportioned with dilution water, and passed through exhausted ion exchange resins. The spent regenerant chemicals are collected in a chemical waste sump, and then transferred to waste neutralizing tanks. Combined waste solutions are neutralized (pH 6.0-9.0) in two 15,000-gallon outside neutralizing tanks prior to release to the water treatment facility normal waste sump. The sulfuric acid and sodium hydroxide usages are expected to average 200 pounds per day and 150 pounds per day, respectively, for the two units. The alum usage is expected to average 50 pounds per day for the two units. The polyelectrolyte usage is expected to average 3 pounds per day for the two units.

All wastewater and floor drainage from the makeup water treatment facility is collected in a normal waste sump, and then transferred by either one or two 400 gpm sump pumps to the wastewater settling basins at a daily average rate of 9000 gpd from filter backwash, 7000 gpd from clarifier blowdown, 14,000 gpd from demineralizer regeneration, and 1000 gpd from floor, equipment, and sampling drains. Maximum wastewater flow from the water treatment facility is estimated to be 90,000 gpd.

The wastewater settling basins are arranged in parallel so that one can be cleaned while the other is still in operation. Each of the two parallel basins contains approximately 15,000 gallons, and is approximately 5 feet deep by 40 feet long by 10 feet wide, with an 8.7}foot long overflow weir. After leaving the wastewater settling basins, the chemical constituents of the wastewater from the water treatment facilities are primarily the same constituents withdrawn from the river, plus sodium sulfate that results from the neutralization reaction between sodium hydroxide and sulfuric acid. Suspended solids are reduced in the wastewater settling basin to approximately 30 mg/l in the effluent, although additional sedimentation is available at the holding pond. The dissolved solids concentration of the settling basin effluent is expected to average 1300 mg/l, resulting from demineralization of makeup water and neutralized sulfuric acid and caustic soda regenerant solutions. The wastewater settling basin effluent is routed through oil separators to the holding pond.

3.6.3.2 Circulating Water Pump Structure Sump Pump Effluent

Another low volume waste source draining to the holding pond is the circulating water pump structure sump pump effluent. The circulating water pump structure sumps collect circulating water pump floor drainage, chlorine feed facility drainage, acid feed facility drainage, and drainage from emergency and residual heat removal service water valve pits. The other floor, equipment, and sampling drainage that enters the sumps is expected to average 1000 gpd. From each of the two 450-gallon sumps in the circulating water pump structure, two 100 gpm sump pumps are available to transfer the water to normal waste yard piping, which drains through oil separators to the holding pond. The average and maximum daily flows from the sump pumps in the circulating water pump structure are expected to be 1,000 gpd and 10,000 gpd, respectively.

3.6.3.3 Auxiliary Boiler Blowdown

Three auxiliary boilers supply nonradioactive steam (45,000 pounds per hour maximum per boiler) for station heating with copper-tubed unit heaters during cold weather, and for various other services related to year-around station operation.

Most of the steam flow is returned to the auxiliary boilers as condensate. Boiler makeup water is supplied from the demineralized water system. The auxiliary boiler water is treated with sodium sulfite and trisodium phosphate to control corrosion and scaling. The sodium sulfite and trisodium phosphate usages are each expected to average less than one pound per day.

The auxiliary boilers are blown down to maintain water quality that is suitable for boiler operation. The auxiliary boiler blowdown is flashed to 212°F in an atmospheric blowoff tank, and filtered to remove iron and copper in order to meet EPA point source limitations. The blowdown is then cooled to 105°F by mixing in service water. The cooled auxiliary boiler blowdown is expected to average 1000 gpd, and drains through oil separators and filters, to the holding pond. EPA point source limitations for boiler blowdown are specified in 40 CFR Part 423 as:

(b) The quantity of pollutants discharged in boiler blowdown shall not exceed the quantity determined by multiplying the flow of blowdown times the concentration listed in the following table:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l
Oil and Grease	20 mg/l	15 mg/l
Copper, Total	1.0 mg/l	1.0 mg/l
Iron, Total	1.0 mg/l	1.0 mg/l

3.6.3.4 Other Holding Pond Inflows

During station operation the holding pond also receives storm water drainage from potential spill surfaces totalling approximately 1.5 acres, although most yard areas and all roof areas drain storm water directly to Possum Hollow Run and the Schuylkill River. Based upon the annual average rainfall, the holding pond receives an average of 5000 gpd of storm water from outside potential spill areas that include pipe trenches, transformer aprons, the neutralizing tank curbed area, the settling basin surface, the holding pond surface, and two normally valved-open oil truck unloading areas, as well as the normally valved-closed condensate, refueling water, and fuel oil diked areas. The above areas drain through oil separators to the holding pond, and those normally valved-closed areas are drained by opening normally closed valves under operator supervision.

The holding pond also receives effluent from the powerblock foundation subdrainage sump pumps, which is estimated to average 10,000 gpd of ground water. Additional holding pond inflows include floor, equipment, and sampling drainage from the administration building, warehouse, shop, auxiliary boiler enclosure, lube oil storage area, fuel oil transfer enclosure, diesel-generator enclosures, and miscellaneous valve pits, all of which together are assumed to total an average of 18,000 gpd. Floor, equipment, and sampling drainages in the circulating water pump structure that do not drain to the sump pumps are the fire pump area, service water pump area, and chlorination facility area, which together are expected to contribute an average of 5000 gpd to the holding pond. Nonradioactive floor, equipment, and sampling drainage from each turbine enclosure is estimated to contribute an average of 5000 gpd to the holding pond. All these holding pond inflows are first routed through oil separators, and drainages from oil use areas are also routed through local oil interceptors.

The holding pond does not receive turbine enclosure radioactive waste drainage, or reactor enclosure drainage. The treated radioactive waste from the turbine enclosures and the reactor enclosures is routed directly to the cooling tower blowdown line through the radwaste discharge line.

3.6.3.5 Holding Pond Operation and Treatment

The holding pond volume is normally maintained at 100,000 gallons, and the 100,000 gpd effluent flows through a normally open, automatically operated valve into the cooling tower blowdown line after an average retention time of 24 hours. The holding pond effluent is continuously monitored for pH and turbidity while discharging, and the effluent is automatically stopped if excessively acid, caustic, or turbid water is detected. The holding pond is then manually operated, using the additional 300,000 gallon surge capacity, until the water is suitable for discharge.

Manual operation would include grab sampling with laboratory analysis, jar test, chemical treatment, and discharge through an 8-inch gravity line and/or the 4-inch pump discharge line with a grab sample being taken for NPDES reporting requirements. Chemical treatment of the holding pond consists of recirculating the water and feeding aluminum sulfate, polyelectrolyte, sodium hydroxide, and/or sulfuric acid, as necessary, from facilities located in the holding pond treatment enclosure. Adjustment of pH at the holding pond is not normally expected to be necessary because the major acid and caustic wastes from demineralizer regeneration are neutralized (pH 6.0-9.0) before draining to the holding pond.

Oil treatment at the holding pond is not normally expected to be necessary because all of the holding pond inflows (except floor drainage from the holding pond treatment enclosure, which goes directly to the holding pond) are routed through two 750-gpm gravity differential separators before entering the holding pond. Moreover, five 150-gpm oil interceptors are installed farther up the normal waste drainage system in yard areas near the points of oil storage and use. Additional oil treatment is available at the holding pond, if necessary, by using a portable oil skimmer, oil sorbent materials, alum, and polyelectrolytes.

Suspended solids treatment at the holding pond is not normally expected to be necessary because nearly all of the suspended solids load, which comes from the water treatment clarifier blowdown and filter backwash, is removed at the wastewater settling basins. Some suspended solids are also expected to settle out in the local oil interceptors, and in the two 750-gpm oil separators where the flow velocity is greatly reduced. Sedimentation is further provided at the holding pond, and additional suspended solids treatment is available at the holding pond, if necessary, by using alum and polyelectrolytes.

With sedimentation and gravity oil separation normally (but with chemical treatment in the holding pond if necessary), the holding pond effluent is expected to meet the EPA effluent limitations for low volume waste sources in 40 CFR Part 423 that specify:

(c) The quantity of pollutants discharged from low volume waste sources shall not exceed the quantity determined by multipying the flow of low volume waste sources times the concentration listed in the following table:

Effluent characteristic	Maximum for any one day	Average of daily values for thirty consecutive days shall not exceed
TSS	100 mg/l	30 mg/l
Oil and Grease	20 mg/l	15 mg/l

3.6.4 COMBINED DISCHARGE

Just downstream of where the holding pond effluent enters the cooling tower blowdown line, a hydraulic jump completely mixes together all of the flows (blowdown from each cooling tower, spray pond overflow, treated liquid radwaste effluent, treated sewage effluent, and holding pond effluent). After the hydraulic jump, there is an air vent riser for grab sampling access, and taps in the blowdown line from which a well mixed sample is pumped to instruments, located in the holding pond treatment enclosure, for recording pH, temperature, turbidity, and conductivity, as well as weekly automatic composite sampling. The automatic composite sampler collects approximately 100 ml/hr into a 5-gallon container for subsequent laboratory analysis.

Effluents other than cooling tower blowdown cause a nearly undetectable change in the combined discharge when mixed with the cooling tower blowdown. Therefore, the water quality of the combined discharge as shown in Tables 3.6-2 and 3.6-3 is approximately equivalent to the water quality of the cooling tower blowdown, except as noted. The Pennsylvania Department of Environmental Resources specifies effluent limitations on the combined discharge in Water Quality Management Permit Number 4671202.

3.6.5 REFERENCES

3.6-1 White, G. C., Handbook of Chlorination, Van Nostrand Reinhold Co. (1972)

3.6-2 Handbook of Taste and Odor Control Experiences in the U.S. and Canada, American Water Association (1976)

TABLE 3.6-1

CHEMICAL USAGE RESULTING IN DISCHARGE DURING TWO UNIT OPERATION

CHEMICAL USAGE[1] tons/yr	MAX.[2]	AVG.	PURPOSE OF USAGE
Sulfuric acid	4000	2000	Cooling water scaling control Makeup demineralizer regeneration Holding pond pH adjustment
Sodium hydroxide	60	30	Makeup demineralizer regeneration Clarified water neutralization Holding pond pH adjustment
Aluminum sulfate	20	10	Clarified water coagulation Holding pond coagulation
Polyelectrolyte	2	1	Clarified water coagulation aid Holding pond coagulation aid
Chlorine gas	600	300	Cooling water biological control
Hypochlorite	2	1	Clarified water disinfection Domestic water disinfection Treated sewage disinfection Spray pond biological control
Sodium sulfite	2	1	Auxiliary boiler corrosion control
Trisodium phosphate	2	1	Auxiliary boiler scaling control
			Turb encl cooling water conditioning Admin HVAC cooling water conditioning Cont str chilled water conditioning
Fluoroprotein (National Aero-O-Foam)	2	1	Fire protection system tests & use
Detergents	2	1	Laundry & personnel showers

[1] Other chemicals are used but are treated by demineralization or evaporation in the radwaste
[2] The maximum is not expected to exceed twice the average.

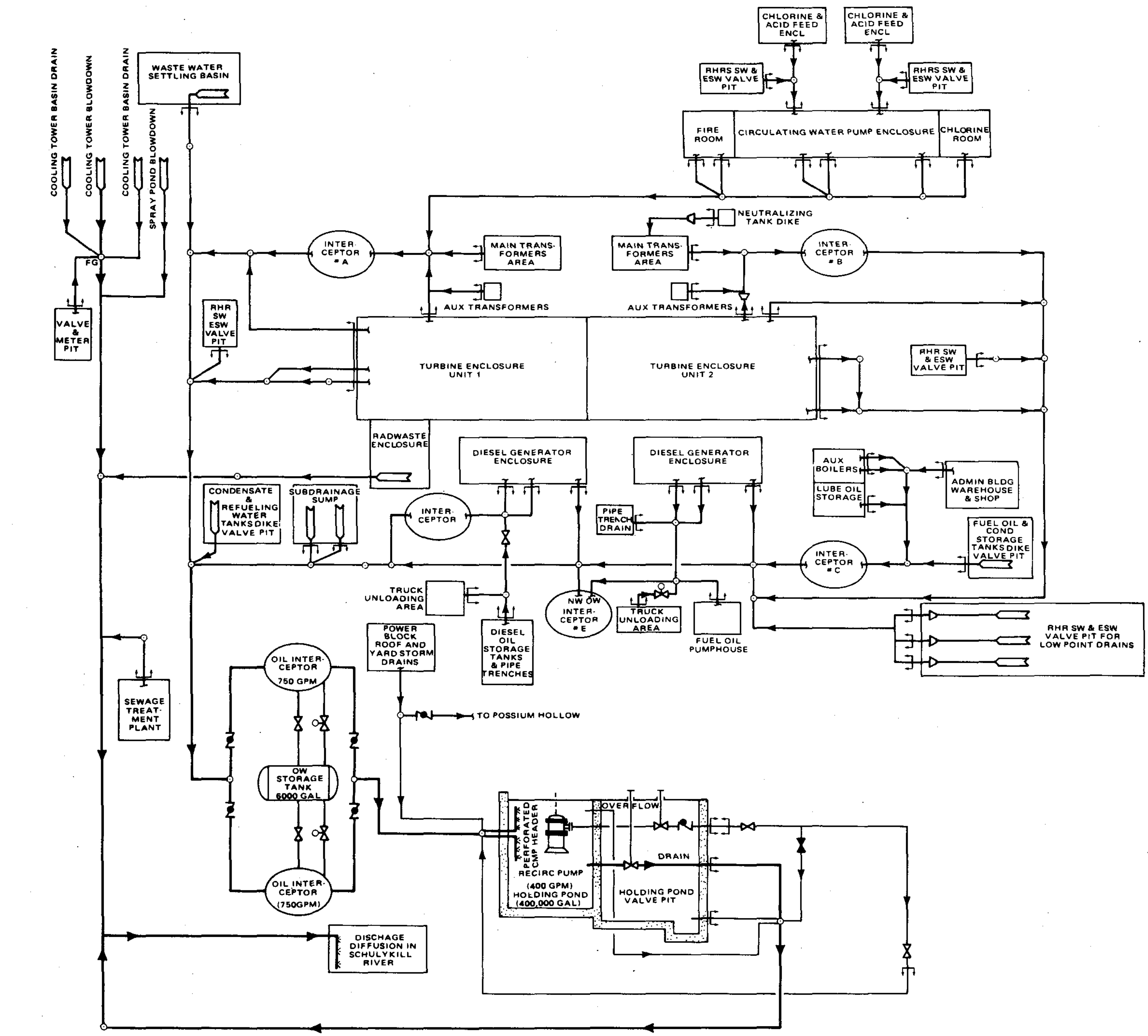

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FIGURE 3.6-1

SCHEMATIC OF STATION WASTE WATER EFFLUENT

3.7 SANITARY AND OTHER WASTE SYSTEMS

This section describes the sanitary wastewater system, storm water drainage system, gaseous emissions from oil combustion, and solid waste disposal. Sections 3.5 and 3.6 describe radioactive and chemical wastes, including chemical laboratory wastes, laundry solutions, and decontamination solutions.

3.7.1 SANITARY WASTEWATER SYSTEM

The sewage treatment plant at the Limerick Generating Station, Units 1 and 2, treats the sanitary wastewater generated during the construction and operation periods. The plant is designed to utilize the activated sludge biological treatment process, with the flexibility to operate in two modes; extended aeration and contact stabilization. The sewage treatment plant in both modes during plant construction, at the peak of which about 3000 persons were onsite and the maximum sewage flow was about 38,000 gallons per day. The plant may be operated in the extended aeration mode during station operation when about 350 persons will be onsite, and the average sewage flow will be about 10,000 gallons per day. During refueling, when about 1100 persons will be onsite, the plant may be operated in the contact stabilization mode.

The sewage treatment facilities include a comminutor with a bypass screen channel, two aeration tanks, three final clarifiers, one chlorine contact tank, two aerobic digesters, three air blowers, a froth spray pump, a hypochlorite pump, and related equipment. Figure 3.7-1 shows the mechanical and structural components of the facilities.

The sewage treatment plant was discussed in the Environmental Report-Construction Permit Stage and the Final Environmental Statement, and was constructed under the Pennsylvania Department of Environmental Resources, Bureau of Water Quality Management, Sewage Permit No. 4672437. The sewage treatment plant is operated in accordance with NPDES Permit No. PA 0024414 issued by the U.S. Environmental Protection Agency. Further detailed effluent information is provided in Section 5.4.

3.7.2 STORM WATER DRAINAGE SYSTEM

Storm runoff from roof and yard drains is conveyed to Possum Hollow Run and the Schuylkill River via an underground storm drainage system, as shown in Figure 3.7-2. The storm drainage is not treated, since wastewaters are not admitted to the storm water drainage system. Storm water falling within contained oil and chemical storage areas is released to the holding pond through a separate waste system described in Section 3.6.

Drainage ditches are provided to convey the runoff from graded areas, and interceptor ditches are provided to prevent sheet flow over fill and cut slopes. The ditches are graded at minimum practical slopes to keep runoff velocities to a minimum. Within the permanently graded areas, the slopes of the ditches are less than 0.6%, and reinforced concrete ditch checks, with riprap downstream, are provided to accommodate differences in elevations. In the areas restored to natural conditions, the slopes of the drainage and interceptor ditches are graded to less than 4%.

The drainage and interceptor ditches convey storm water to underground pipes by way of catch basins or culvert inlets. Downdrains are provided to prevent discharges from flowing on slopes. A baffled outlet is provided at each storm downdrain to dissipate the runoff's energy. Also, riprap is placed downstream from each outlet to further dissipate the flow and to prevent scouring.

The access roads, service roads, and parking areas are covered with asphalt pavement. Drainage ditches are provided along the edges of the paved areas to convey runoff, and culverts are provided for ditch crossings. In some cases, the access and service roads are graded to as much as 9%. For these cases, the tributary areas of the side drainage ditches are small, so that the amount of runoff is also small.

3.7.3 GASEOUS EMISSIONS FROM OIL COMBUSTION

Auxiliary steam (for plant heating and various services related to plant startup and operation) is supplied by three Erie City A-type auxiliary boilers, each rated at overload capacity for 45,000 lb/hr at 250 psig. The boilers are designed for firing either No. 2 (diesel) or No. 6 (residual) fuel oil, but unreclaimable lube oil may also be burned. Sulfur dioxide and nitrogen oxide emissions from the auxiliary boilers are each expected to be about 300,000 lb/year. The auxiliary boilers were placed in service in late 1977.

Onsite emergency power will be provided by eight 2850-kW diesel generators, each using approximately 200 gal/hr of No. 2 fuel at full load. After preoperational testing is completed, each unit will be tested once a month for a period of approximately one hour to demonstrate its operability. Sulfur dioxide and nitrogen oxide emissions from the diesel generators are each expected to be about 3,000 lb/year.

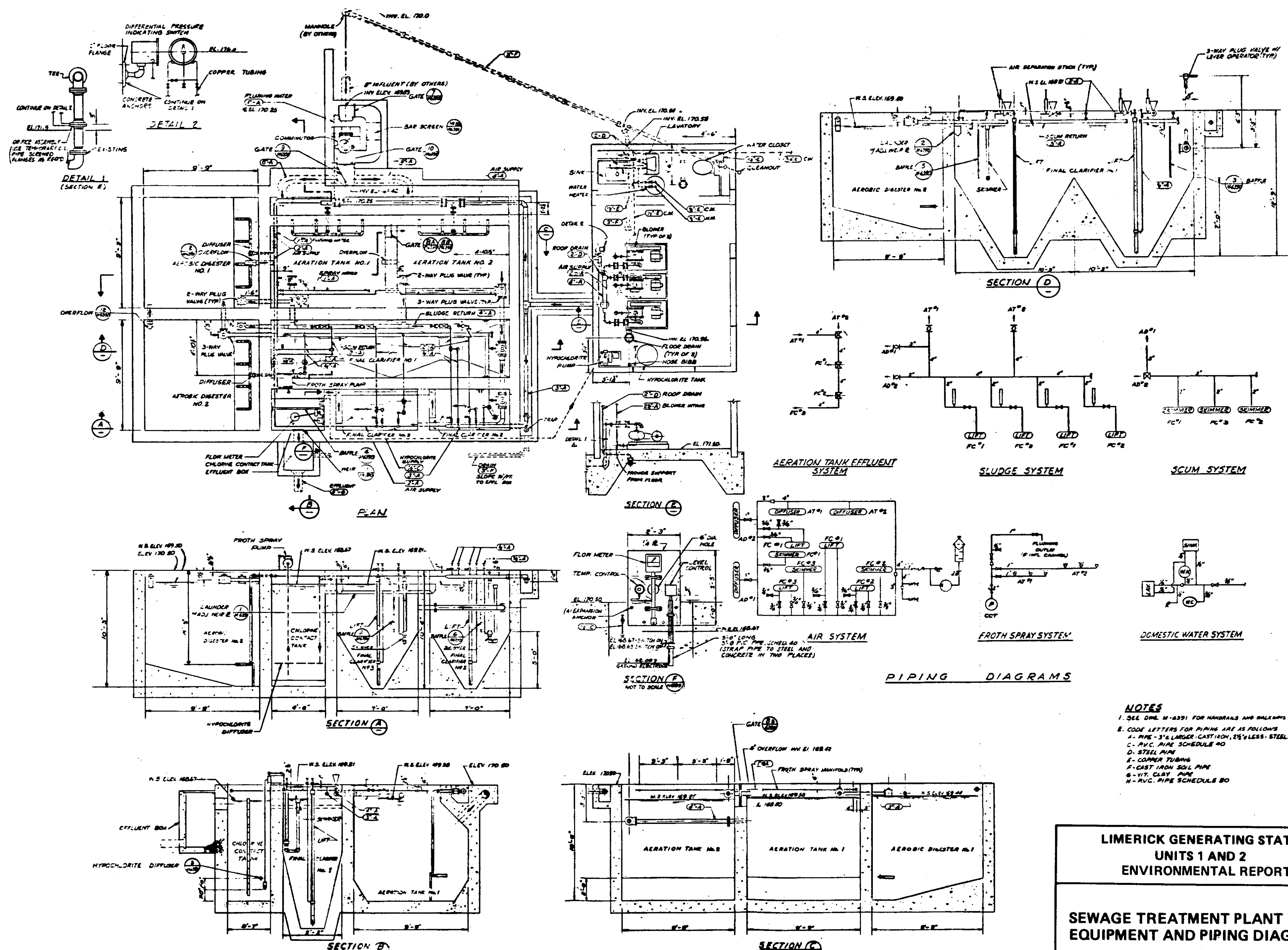
A 255-hp diesel engine-driven fire pump is also installed at the station for emergency use. Intermittent emissions from the fire pump diesel are insignificant compared to those from normal truck traffic in the area.

3.7.4 SOLID WASTE DISPOSAL

During operation, the station will produce miscellaneous solid wastes consisting of ordinary trash from office work, packing materials, garbage, and debris collected on the trash racks and traveling screens at the intake structures. These wastes will be shipped offsite to a sanitary landfill.

Station operation will also produce various sludges. Sludges consisting of aerobically digested sewage sludge, alum sludge from raw water clarification, and sludge from wastewater sedimentation will be transferred into a tank truck for disposal.

Solids are also expected to settle out in the cooling tower basins during operation. During shutdowns, if necessary, the basins will be drained and settled solids will be removed. The solids are solids settled from the river water and solids scrubbed out of the air. This material will be buried or used as fill.



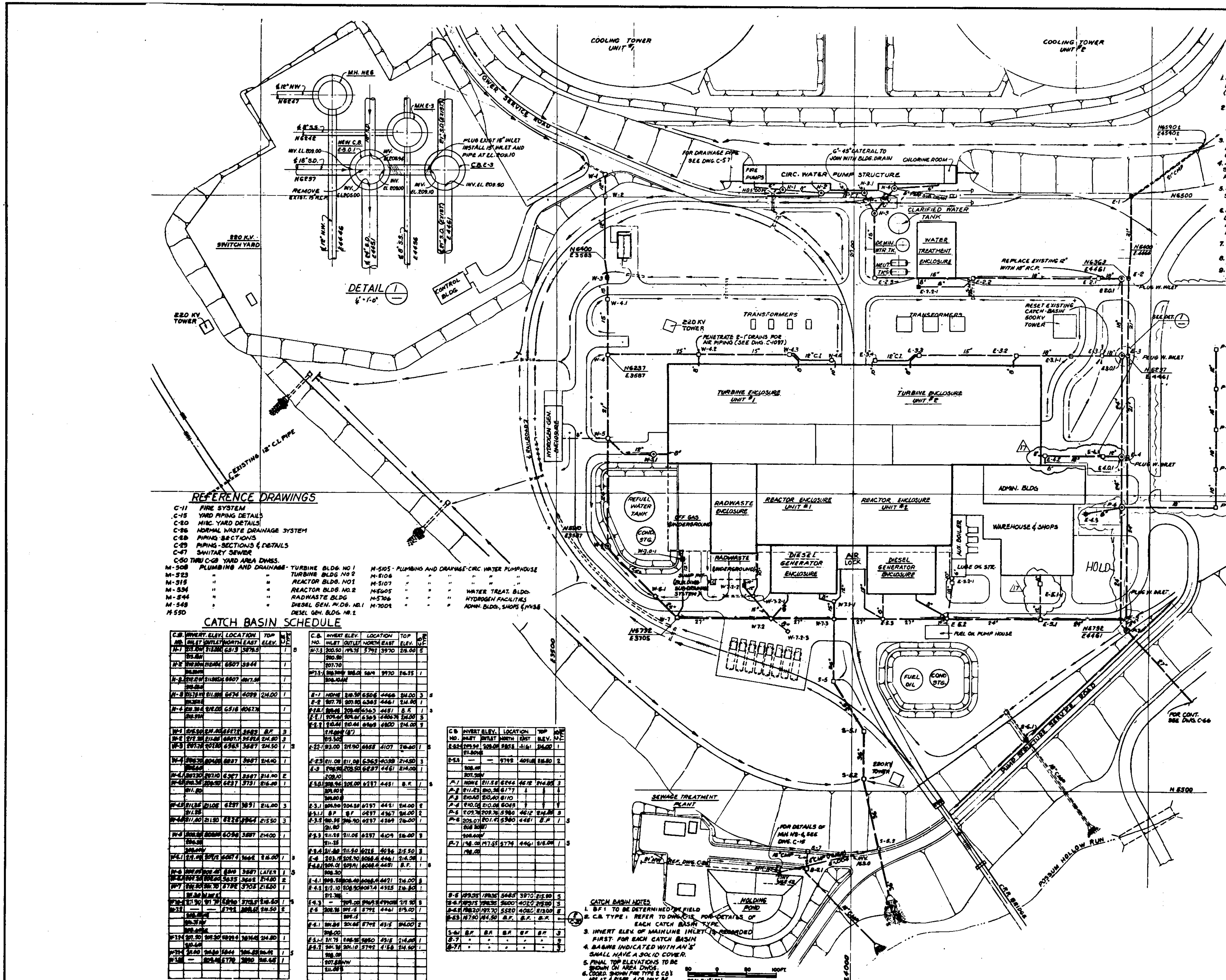
NOTES

1. SEE DWG. M-6391 FOR HANDRAILS AND WALKWAYS
2. CODE LETTERS FOR PIPING ARE AS FOLLOWS
   - A - PIPE - 3"& LARGER: CAST IRON, 2½"& LESS: STEEL
   - C - P.V.C. PIPE SCHEDULE 40
   - D - STEEL PIPE
   - E - COPPER TUBING
   - F - CAST IRON SOIL PIPE
   - G - VIT. CLAY PIPE
   - H - P.V.C. PIPE SCHEDULE 80

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

SEWAGE TREATMENT PLANT TANK, EQUIPMENT AND PIPING DIAGRAMS

FIGURE 3.7-1



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

STORM DRAINAGE SYSTEM FOR POWER BLOCK AREA

FIGURE 3.7-2

3.8 REPORTING OF RADIOACTIVE MATERIAL MOVEMENT

The transportation of fuel and waste to and from Limerick Generating Station is within the scope of Paragraph (g) of 10 CFR 51.20. The environmental impacts of radioactive material transportation are as set forth in Summary Table S-4 of 10 CFR 51, shown as Table 3.8-1 in this section.

In accordance with Regulatory Guide 4.2 and 10 CFR 51, no further discussion is necessary.

TABLE 3.8-1

ENVIRONMENTAL IMPACT OF TRANSPORTATION OF FUEL AND WASTE TO AND FROM ONE LIGHT-WATER-COOLED NUCLEAR POWER REACTOR[1]

NORMAL CONDITIONS OF TRANSPORTATION

	Environmental impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hr
Weight (governed by Federal or state restrictions)	73,000 lb per truck; 100 tons per cask per rail car.
Traffic density:	
Truck	Less than 1 per day
Rail	Less than 3 per month

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals[2] (per reactor year)	Cumulative dose to exposed population (per reactor year)[3]
Transportation workers	200	0.01 to 300 millirem	4 man-rem
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem
Along Route	600,000	0.0001 to 0.06 millirem	

ACCIDENTS IN TRANSPORT

	Environmental risk
Radiological effects	Small[4]
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

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[1] Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238. December 1972, and Supp. I. NUREG-75/038, April 1975.

TABLE 3.8-1 (Cont'd)

[2] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3] Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[4] Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numberically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

3.9 TRANSMISSION FACILITIES

3.9.1 DESCRIPTION OF TRANSMISSION FACILITIES

As described in Section 3.2 of the Environmental Report-Construction Permit Stage and 3.7 of the Final Environmental Statement, five outlets for generation will be provided as shown schematically in Figures 3.9-1 and 3.9-8. The existing Peach Bottom to Whitpain 500-kV line will be routed through the Limerick 500-kV substation where the line will be cut and reconnected to provide two generation outlets. A 500-kV Limerick to Whitpain line will be constructed entirely on existing rights-of-way (ROW). This line is referred to in Sections 3.9.1.1 and 3.9.2.1. Two 230-kV Limerick to Cromby lines will be constructed along two existing railroad ROWs. These lines are referred to in Sections 3.9.1.2 and 3.9.2.2.

In addition to these previously described transmission facilities, two new 230-kV lines are required. A new 230-kV line from Cromby to North Wales will be constructed on existing ROW. This line is discussed in greater detail in Sections 3.9.1.3 and 3.9.2.3. A new 230-kV line from Cromby to Plymouth Meeting will be constructed using a combination of existing and railroad ROW. This is discussed in greater detail in Sections 3.9.1.4 and 3.9.2.4.

Figure 3.9-2 provides a detailed illustration of the transmission facilities associated with the Limerick Generating Station.

3.9.1.1 Limerick to Whitpain 500-kV Line

The Limerick to Whitpain 500-kV line was discussed in Section 3.2 of the Environmental Report-Construction Permit Stage and Section 3.7 of the Final Environmental Statement. In accordance with NRC Regulatory Guide 4.2 and 10 CFR 51, no further discussion is necessary.

3.9.1.2 Two Limerick to Cromby 230-kV Lines

The two Limerick to Cromby lines were discussed in Section 3.2 of the Environmental Report-Construction Permit Stage and Section 3.7 of the Final Environmental Statement. In accordance with NRC Regulatory Guide 4.2 and 10 CFR 51, no further discussion is necessary.

3.9.1.3 Cromby to North Wales 230-kV Line

The proposed Cromby to North Wales 230-kV transmission line will be approximately 16 miles in length. Philadelphia Electric Company owns, or has easement for, 100% of the proposed ROW for this line. The ROW varies between 150 and 300 feet in width. At the present time, this ROW contains a 138-kV lattice tower transmission line. Most properties adjacent to the ROW are farms and much of the ROW is farmed. For this reason, tree trimming for the Cromby-North Wales line will be minimal. Less than 5% of the ROW is wooded. No changes in land usage are anticipated. The new line will cross the Schuylkill River, Perkiomen Creek, and the northeast extension of the Pennsylvania Turnpike.

The route selection for this line was based upon using an existing ROW. The existence of this ROW makes further consideration of alternative routes for this line impractical, as discussed in Section 10.9.

The new line will be supported on gray, single-circuit, triangular configuration, tubular steel structures (Figure 3.9-4) for a distance of approximately 15 miles from Cromby to West Point Pike in Upper Gwynedd Township. The conductor configuration will change from triangular to vertical where sharp turns in the ROW are encountered.

The last mile of the line requires installation of double-circuit vertical tubular structures (Figure 3.9-5). These structures will carry the new line and the existing Whitpain-North Wales line, which must be relocated, to new bus takeoff positions at North Wales Substation. The double-circuit vertical structures are needed because of the narrowness of the ROW in this area. These structures will also be painted gray.

The Cromby-North Wales line will be a high-capacity, 230-kV line with two 1590-kcmil (1.545 inches in diameter) ACSR conductors per phase. This line will have a summer normal rating of 1200 mVA and an emergency rating of 1400 mVA. The ruling span for this line will vary between 600 and 1200 feet depending upon terrain. All clearances will meet or exceed the minimum requirements of National Electric Safety Code (NESC) Section 23. The line will be designed to maintain a minimum vertical clearance to the ground of 25 feet at a maximum conductor temperature of 140°C, (284°F). This temperature is the conductor temperature used to establish clearances for ACSR conductors. The maximum electric field strengths anticipated for typical spans are indicated on the ROW cross sections (Figure 3.9-2).

The visual impact of the new line will be minimized by locating the new structures next to the existing line towers. This procedure takes full advantage of existing foliage which now shields the line towers from view and ensures that no structures will be placed where the general public has become accustomed to seeing only the conductors.

3.9.1.4 Cromby to Plymouth Meeting 230-kV Line

The proposed Cromby to Plymouth Meeting 230-kV transmission line will be approximately 13.5 miles long and will be constructed on existing Conrail and Philadelphia Electric Company ROW. The existence of the ROW makes further consideration of alternative routes for this line impractical, as discussed in Section 10.9.

The new line will exit Cromby Substation to the east, cross the Schuylkill River, and join the existing Cromby-Barbadoes ROW crossing over the Schuylkill River and Perkiomen Creek near Oaks, Pennsylvania. Additional width for swingout clearances may be required in this section. From Oaks to Plymouth Meeting Substation, the line will follow Conrail (formerly Penn Central Transportation Company) ROW.

The section of line between Cromby and Haws Avenue in Norristown, a distance of approximately 10.5 miles, will be constructed with gray tubular steel structures (Figure 3.9-4). The conductors will vary from horizontal, to vertical, to triangular configurations. The exact configuration will depend upon ROW width restrictions. The ruling span will vary between 300 and 950 feet for these structures. River crossing spans will be 1000 feet or more.

From Haws Avenue to Plymouth Meeting Substation, the proposed line will utilize either tubular steel structures or the wide flange (WF) type of steel structure (Figures 3.9-6 and 3.9-7). WF structures are normally used by the railroad to support catenaries and railroad transmission lines. The existing WF structures between Haws Avenue and the Pennsylvania Turnpike will be reinforced to provide adequate structural strength to support the additional loading. Tubular steel poles will be used from the Pennsylvania Turnpike to Plymouth Meeting.

The conductors on the WF portion of the proposed line will vary from horizontal, to vertical, to triangular configurations. The structures will be made of steel with either steel or aluminum crossarms. These structures will be similar to other railroad structures existing in this area. Between the turnpike and Plymouth Meeting Substation, the railroad ROW parallels an existing 315-foot-wide Philadelphia Electric Company ROW containing five transmission lines. The cost to build this portion of the proposed line on Applicant's ROW would be prohibitive due to the need to relocate the existing lines.

The proposed line will use two 1590-kcmil (1.545 inches in diameter) ACSR conductors per phase and will have a summer normal and emergency rating of 1200 mVA and 1400 mVA, respectively.

Design maximum loading conditions for this voltage level is 1-inch-radial ice and an 8-pound-per-square-foot wind at -17.80°C (0°F). The minimum clearances at conductor operating temperature of (140°C) 284°F will be equal to or greater than the NESC requirements.

3.9.2 ENVIRONMENTAL IMPACT

The overall impact of transmission line installations associated with Limerick Generating Station on the terrestrial ecology of the area will be minimal due to the routing of the new lines along existing ROW and through areas that are not sensitive to additional disturbance. Environmental impacts of new transmission lines are addressed in this section.

3.9.2.1 Limerick to Whitpain 500-kV Line

The Limerick to Whitpain 500-kV line is discussed in Section 3.2 of the Environmental Report-Construction Permit Stage and Section 3.7 of the Final Environmental Statement. In accordance with NRC Regulatory Guide 4.2 and 10 CFR 51, no further discussion is necessary.

3.9.2.2 Two Limerick to Cromby 230-kV Lines

The two Limerick to Cromby 230-kV lines are discussed in Section 3.2 of the Environmental Report-Construction Permit Stage and Section 3.7 of the Final Environmental Statement. In accordance with NRC Regulatory Guide 4.2 and 10 CFR 51, no further discussion is necessary.

3.9.2.3 Cromby to North Wales 230-kV Line

This new line will leave Cromby toward the east and follow the existing Cromby to North Wales 138-kV transmission ROW. This route has been cleared to the boundary lines of the ROW and no additional clearing will be necessary. Current land use inside this ROW is mostly agricultural (corn, wheat, soybeans, and pasture) with the remainder in various successional stages similar to an old-field community. The ground cover on ROW land that is not used for agricultural purposes is a mixture of composites (asters, goldenrods, and grasses) which in places is covered with a well-developed vine layer composed primarily of Japanese honeysuckle and blackberry. Some areas also exhibit a sparse tree layer (red cedar, black locust, white ash, sassafras, and other early successional tree species). This layer is not permitted to develop to maturity and must be cleared periodically.

The environmental impact of this transmission line would be primarily due to the small loss of agricultural land under the tower bases.

3.9.2.4 Cromby to Plymouth Meeting 230-kV Line

This line will follow the existing Cromby to Barbadoes 69-kV line ROW for approximately 7.6 miles before branching off and continuing along the former Penn Central ROW toward the Plymouth Meeting Substation.

The 7.6-mile private ROW portion of this line which follows the Cromby-Barbadoes ROW has already been cleared and would not require additional clearing. Current land use within this segment is limited to a few agricultural portions with the remainder left idle. At Port Indian, this route joins the former Penn Central ROW and follows it to the Plymouth Meeting Substation. The environmental impact of the transmission line along this segment of the route would be minimal due to the existing impact of the railroad, local industry, and the use of existing poles for a 1.9-mile segment of the line in the Norristown area.

3.9.2.5 Other Environmental Considerations

The following comments are general in nature and apply to all the proposed transmission routes:

a. Endangered Species - The area through which the proposed transmission lines will be routed is within the geographical range of the southern bald eagle and the bog turtle, both of which are considered as endangered species by the U.S. Department of Interior. There is no evidence, however, that local populations of bog turtle exist or that the areas investigated are used by the southern bald eagle for nesting purposes.

b. Erosion - Excavation associated with the installation of transmission towers or poles on sloped surfaces may result in local erosion. This can be minimized by routine erosion control practices. This would also apply to the construction of new access roads if they are needed. Access to the major portion of new construction would be by existing roads.

c. Wildlife Habitat - Habitat modification such as clearing of woodland may result in a change in the composition of the local wildlife community. Woodland species such as grey squirrels may be replaced by species such as the ring-necked pheasant and mourning dove, both of which prefer a more open habitat.

3.9.3 CORONA-RELATED PHENOMENA

The transmission lines associated with Limerick Generating Station will be designed to minimize corona-related phenomena as described below. These phenomena include radio influence (RI), television influence (TVI), audible noise (AN), and ozone production.

A corona occurs when the electric field gradient in the vicinity of the conductor surface is high enough to cause ionization (breakdown of the dielectric strength) of the air around it. The corona is dependent upon conductor diameter, spacing, condition, and operating voltage. There are no industry standards for an allowable corona. However, when a line is designed to minimize the corona power loss, RI, TVI, AN, and ozone will be minimized.

The design of the 230-kV lines for Limerick Generating Station specifies the installation of two 1.545 inch diameter conductors per phase. The Applicant's experience indicates that the bundle of two large conductors, necessary for line capacity, will provide a quiet and virtually corona- free line.

The 500-kV line and loop will utilize two 1.821 inch diameter conductors per phase. This conductor selection is based upon a study made by Stone & Webster Engineering Corp in 1963. The purpose of this study was to select an economical conductor for 500-kV transmission that would produce acceptable corona noise levels. A value of 39 db at 50 feet from the edge of ROW was determined by a survey of existing 230-kV lines to be an acceptable level of radio interference. Smooth surfaced, corona-free line hardware is used for 230- and 500-kV lines.

3.9.3.1 Radio Influence (RI)

Radio influence is produced by a corona. It is a function of conductor size, surface conditions, spacing, voltage, and meteorological conditions. The evaluation of RI is subjective. Its effect is dependent upon the strength of desired radio signals in the vicinity of a transmission line. In remote areas, far from radio towers, special attention must be given in transmission line design to ensure that the levels of RI do not become excessive. Current line design practices and strong radio signals in the vicinity of the proposed transmission lines are expected to minimize RI problems.

3.9.3.2 Television Influence (TVI)

Television influence is also caused by a corona. In general, if a line has good RI performance, it will also have good TVI performance. These lines are designed to have corona levels that have been proven through experience to be acceptable and lie in areas of strong television signals. Therefore, no TVI problems are anticipated along Limerick transmission line ROW.

3.9.3.3 Audible Noise (AN)

Audible noise is also a byproduct of a corona. Maximum AN will occur when water droplets form irregularities on the conductor surface. The electric field around the conductor causes the droplets to deform to a spike-line shape. The point on the water droplet is the source of AN.

Under fair weather conditions, AN is imperceptible at 230 kV and slightly perceptible at 500 kV near tower locations. In fog or light rain, and during times of minimal background noise, AN is most noticeable for both voltages. The Applicant's lines are designed to keep AN within acceptable limits as determined by experience with existing lines. The Applicant has had good results with its 500-kV design which produces 54 db at 50 feet from the conductor during a heavy rain. Heavy rain causes the loudest AN, but this noise is masked by the rain and is not audible.

3.9.3.4 Ozone

The low quantities of ozone produced by high voltage transmission lines cannot be practically measured. The Applicant does not expect the ozone level in the ROW to exceed the national primary ambient air quality standard for oxidants of 0.08 ppm [Section 109(b)(1) of the Act, 43 U.S.C. 1857c-4(b)(1)] as a result of the construction or operation of these lines.

3.9.4 SUBSTATIONS

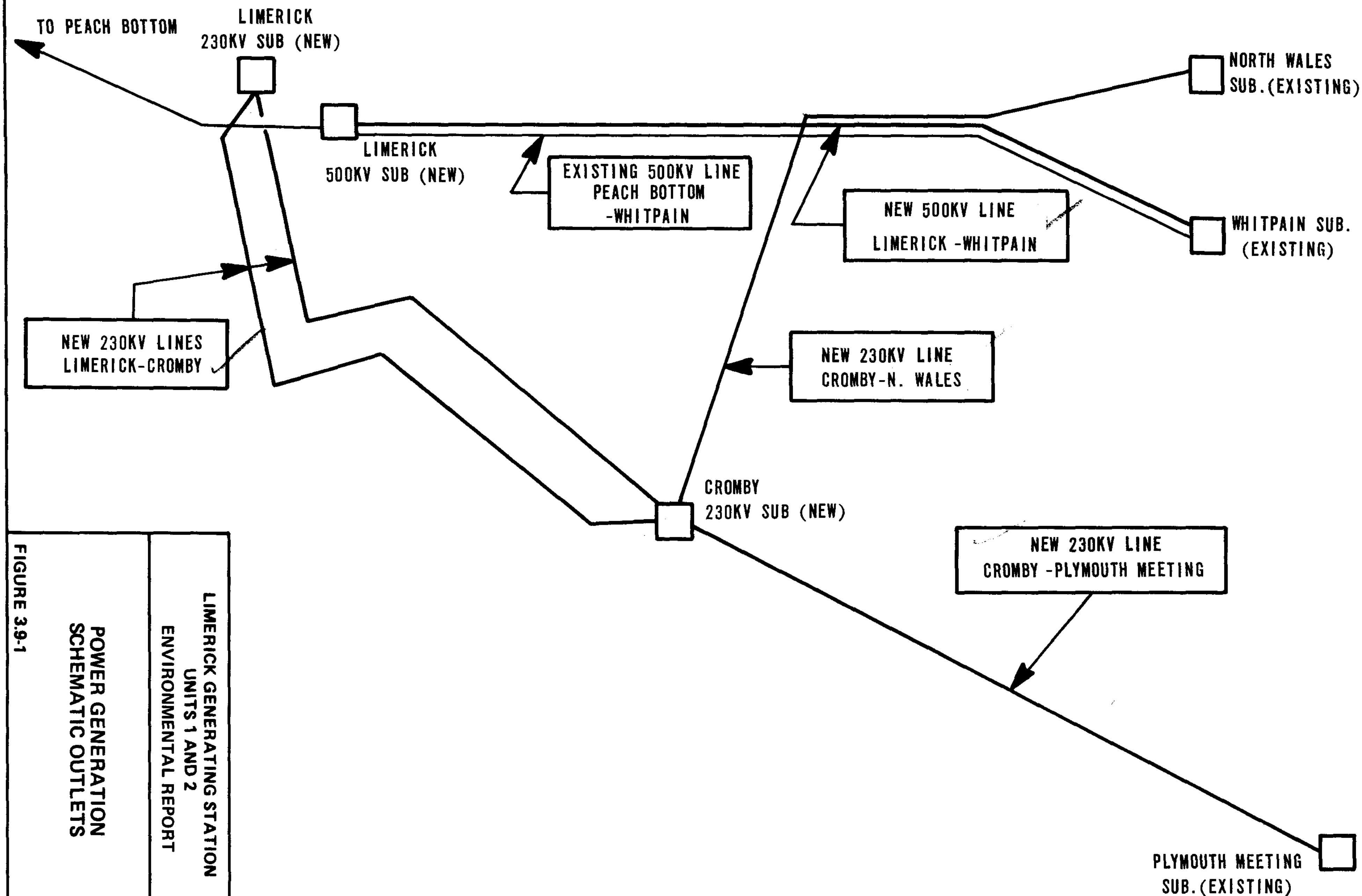
3.9.4.1 Limerick

A 500-kV substation (895 x 784 feet) is located about 1200 feet southeast, and a 230-kV substation (512 x 398 feet) is located about 250 feet northeast of the station structure. A control structure will be constructed at each substation. These control structures will be one-story, prefabricated metal structures, approximately 40 x 65 feet. A color will be selected that will harmonize with the surroundings.

The ambient noise levels of the 230-kV and 500-kV substations should be the same levels as those reported for the general plant area in Section 2.7. There are no federal or state noise standards.

3.9.4.2 Cromby

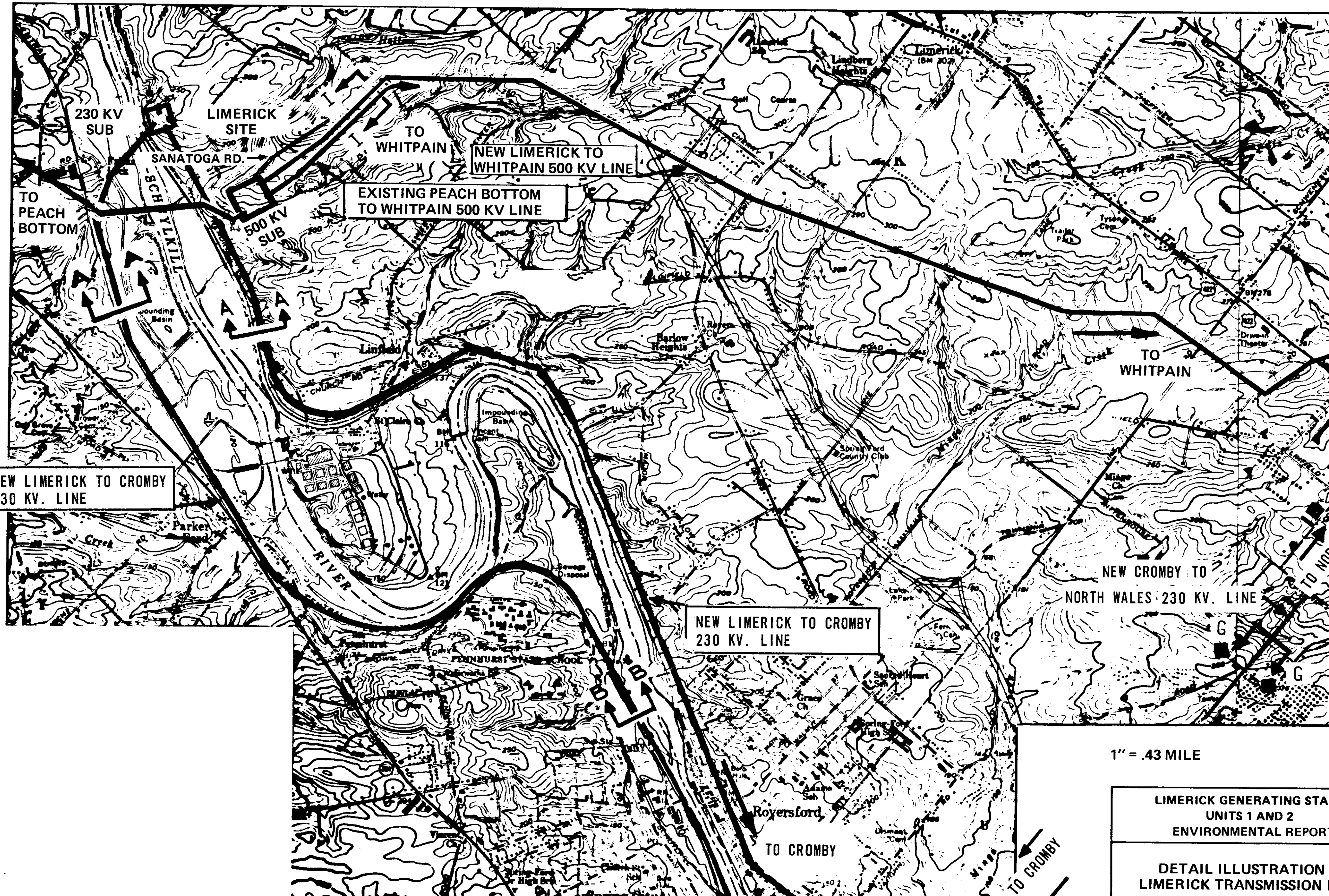
A 230-kV substation (350 x 400feet) will be located at Cromby Generating Station approximately 400 feet south of the station structure. The substation will be adjacent to an existing 69-kV substation and an existing 33-kV substation.



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

POWER GENERATION
SCHEMATIC OUTLETS

FIGURE 3.9-1



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

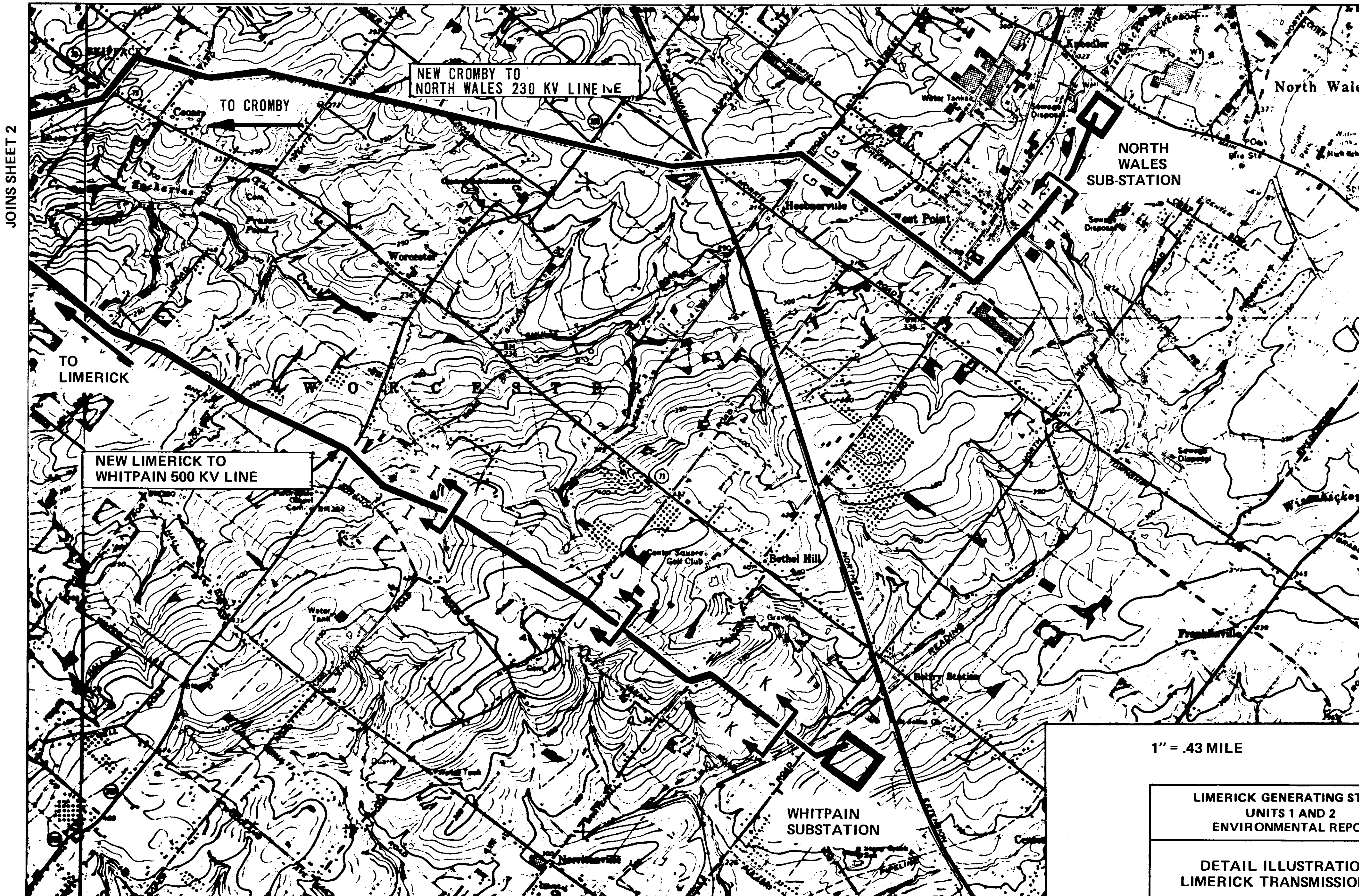
FIGURE 3.9-2 SHEET 1 OF 16

1" = .43 MILE

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2 SHEET 2 OF 16

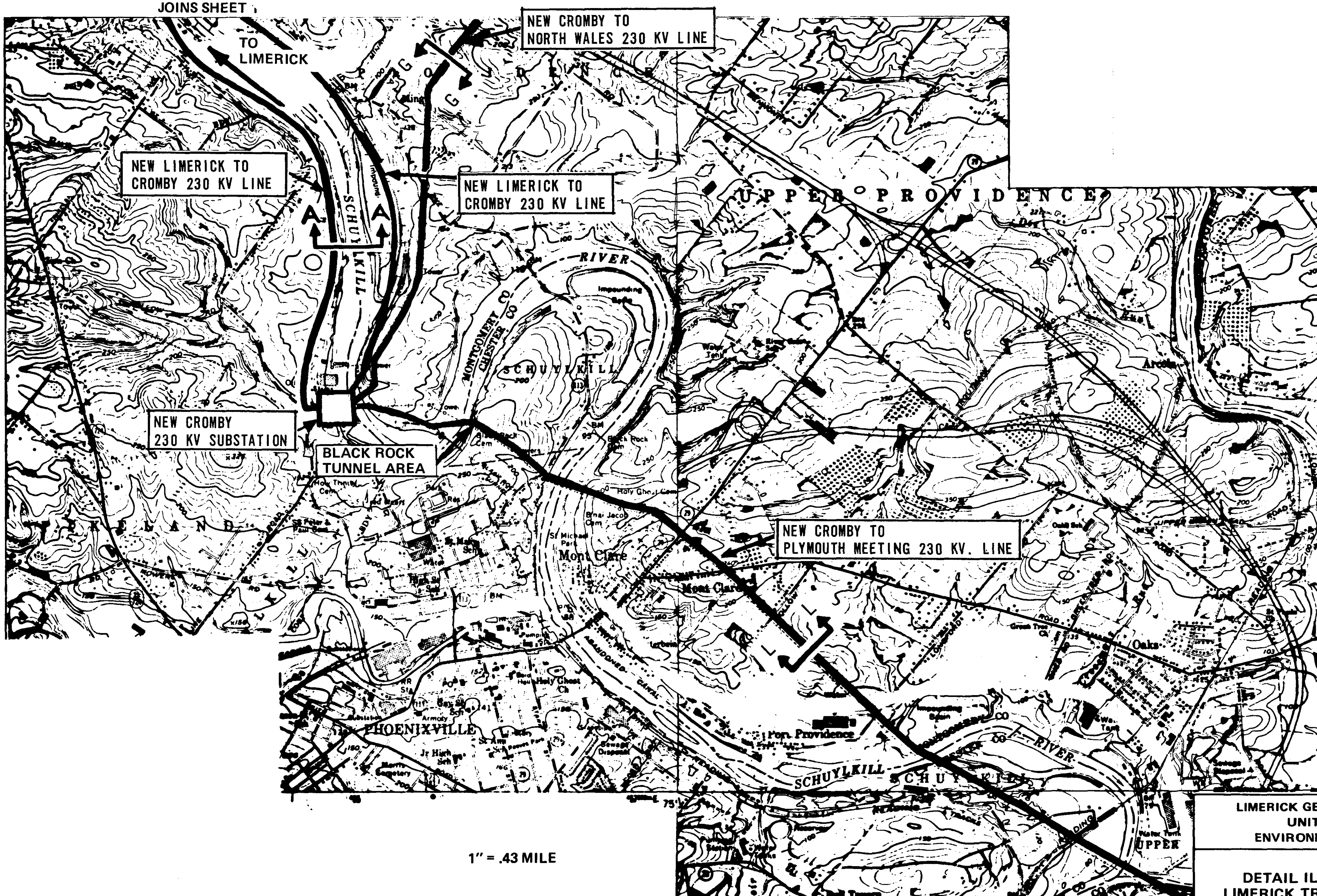


LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

SHEET 3 OF 16



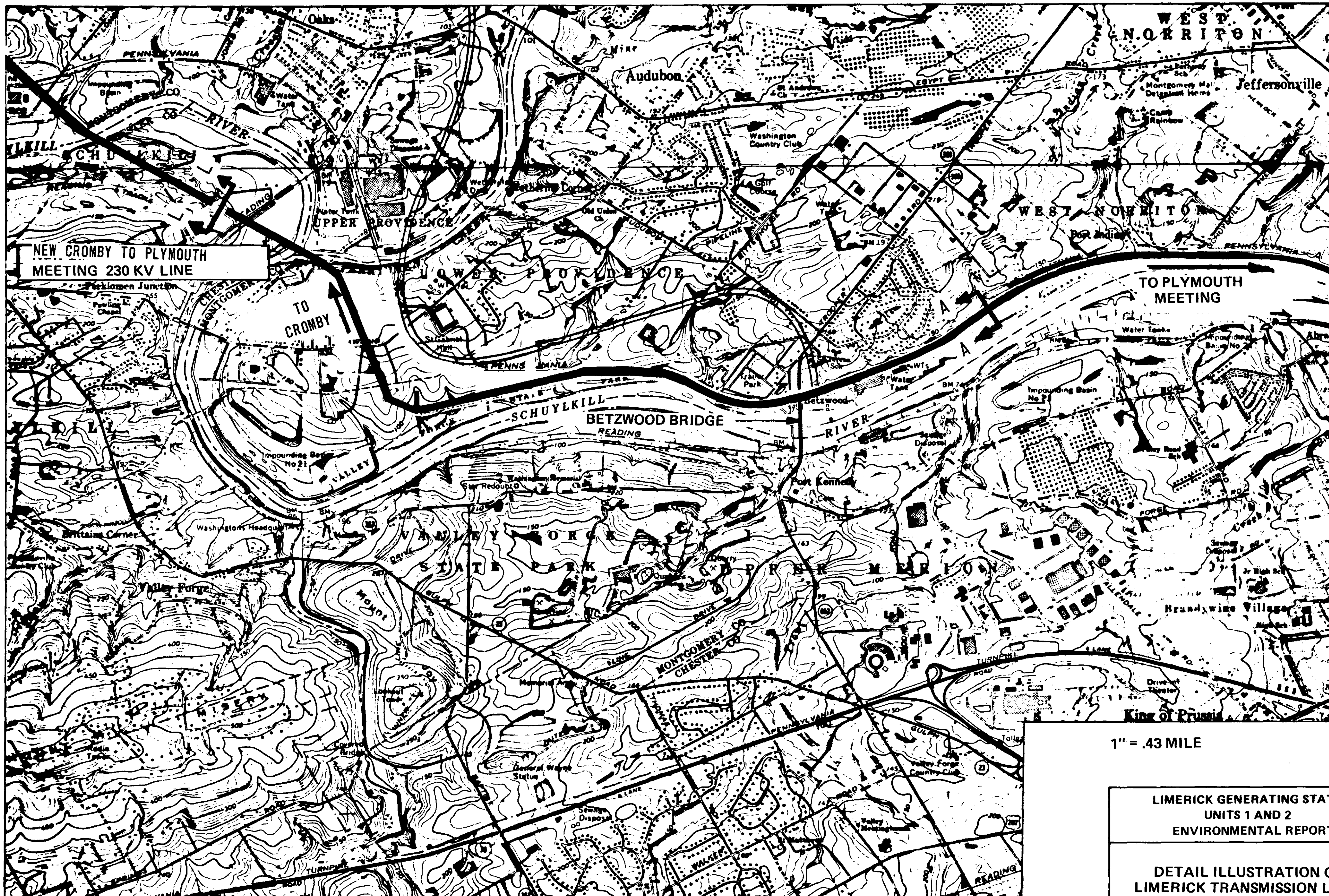
LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

SHEET 4 OF 16

JOINS SHEET 4



JOINS SHEET 6

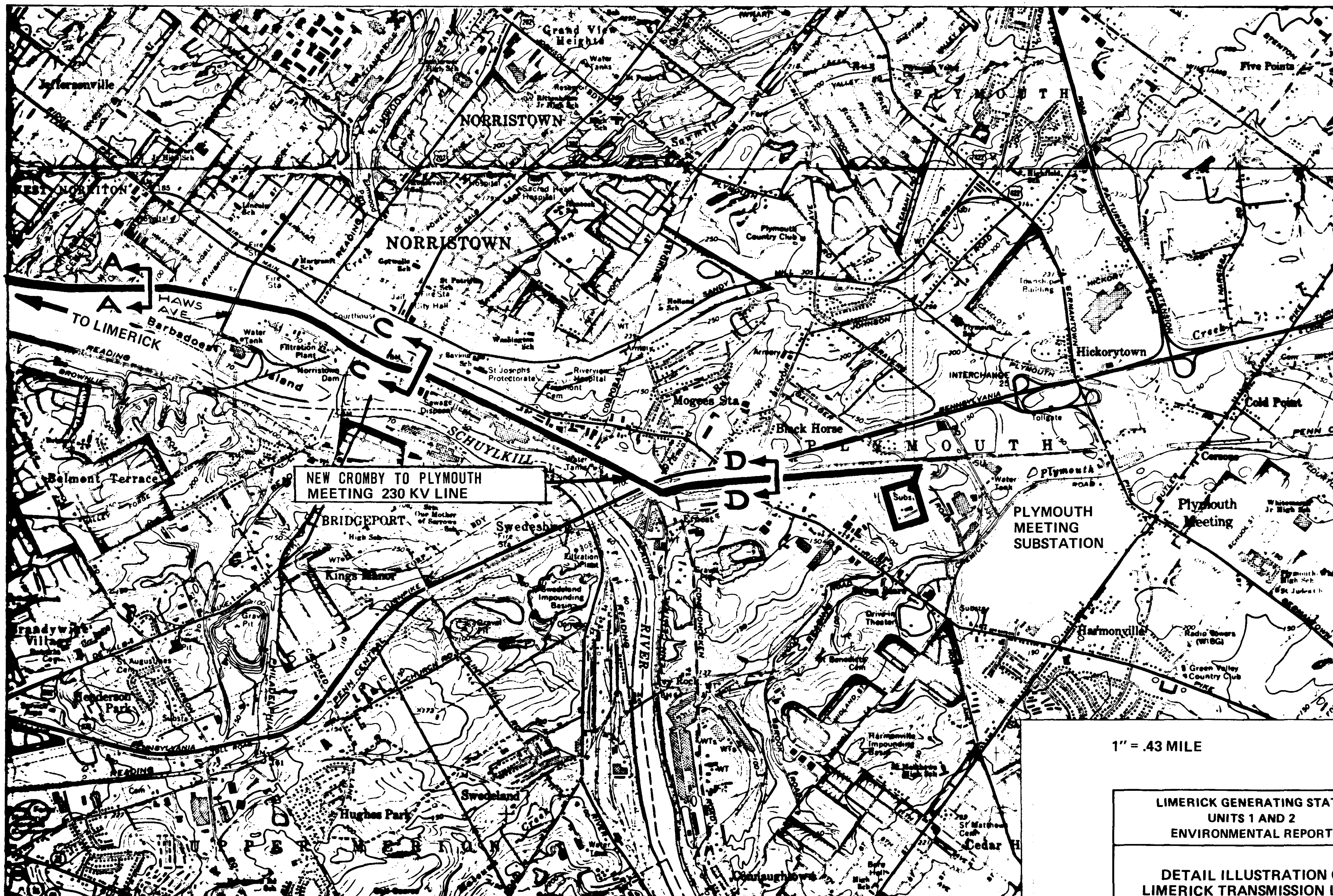
1" = .43 MILE

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2 SHEET 5 OF 16

JOINS SHEET 5

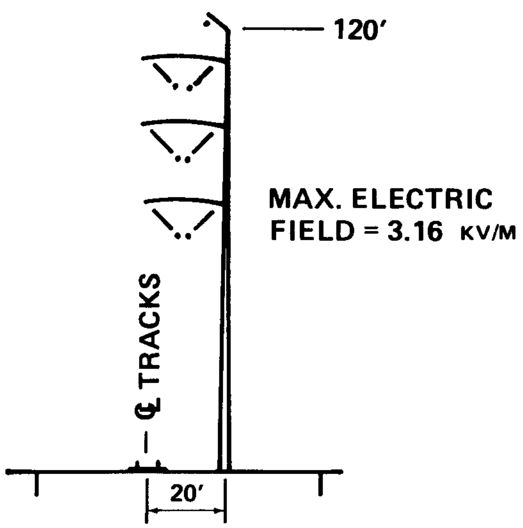


LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF LIMERICK TRANSMISSION LINES

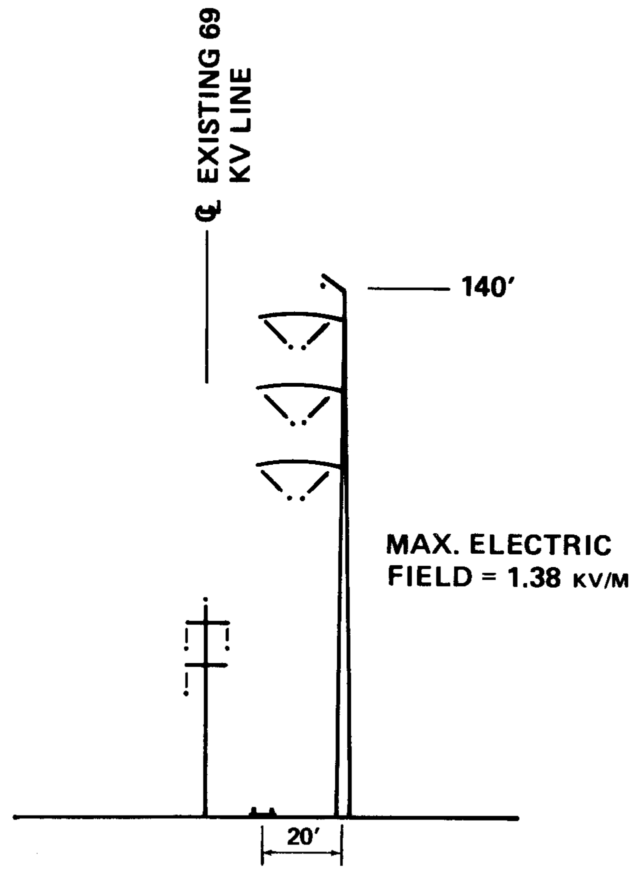
FIGURE 3.9-2 SHEET 6 OF 16

NOTE:
TRIANGULAR CONFIGURATION MAY BE USED WHERE R.O.W. IS ADEQUATE.



75' RAILROAD R.O.W.

A - A
1"=50'



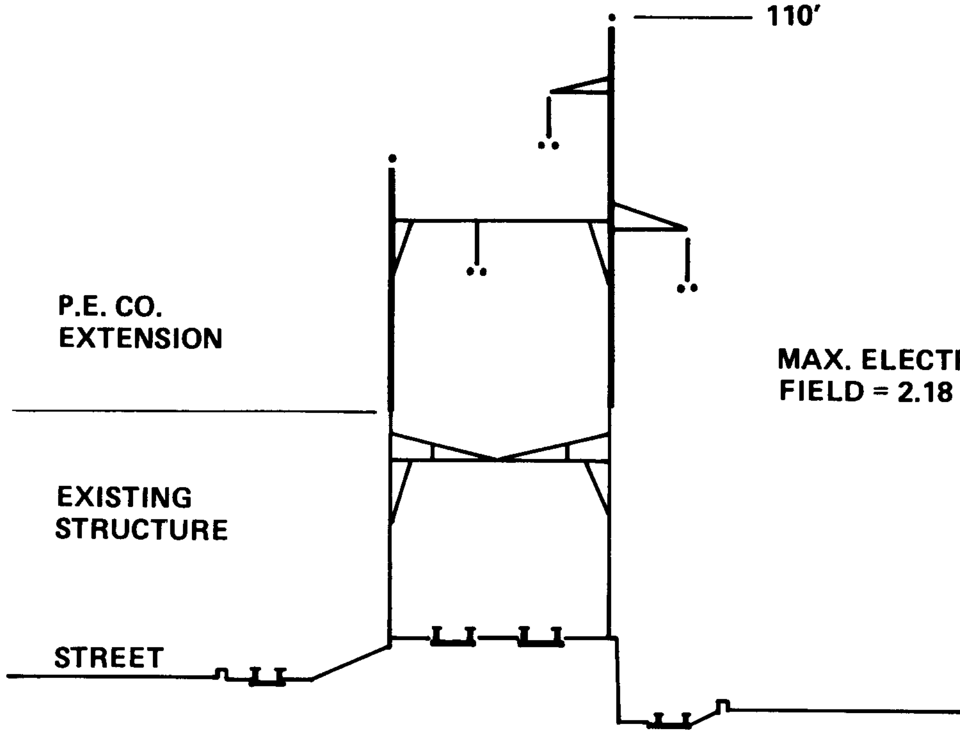
VARYING RAILROAD R.O.W. WIDTH

B - B
1"=50'

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF LIMERICK TRANSMISSION LINES

FIGURE 3.9-2



RAILROAD OVERBUILD

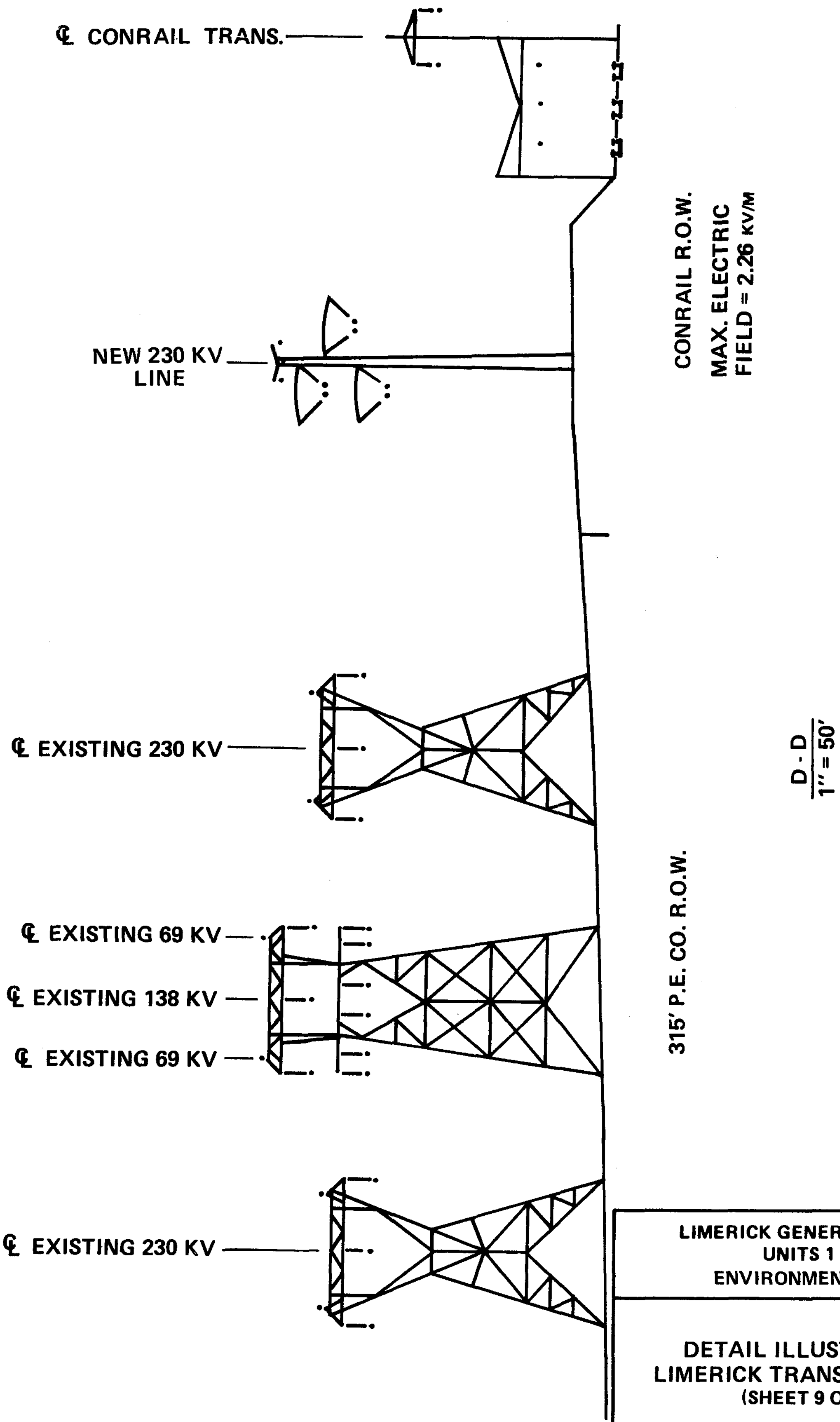
C - C
1" = 30'

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

SHEET 8 OF 16

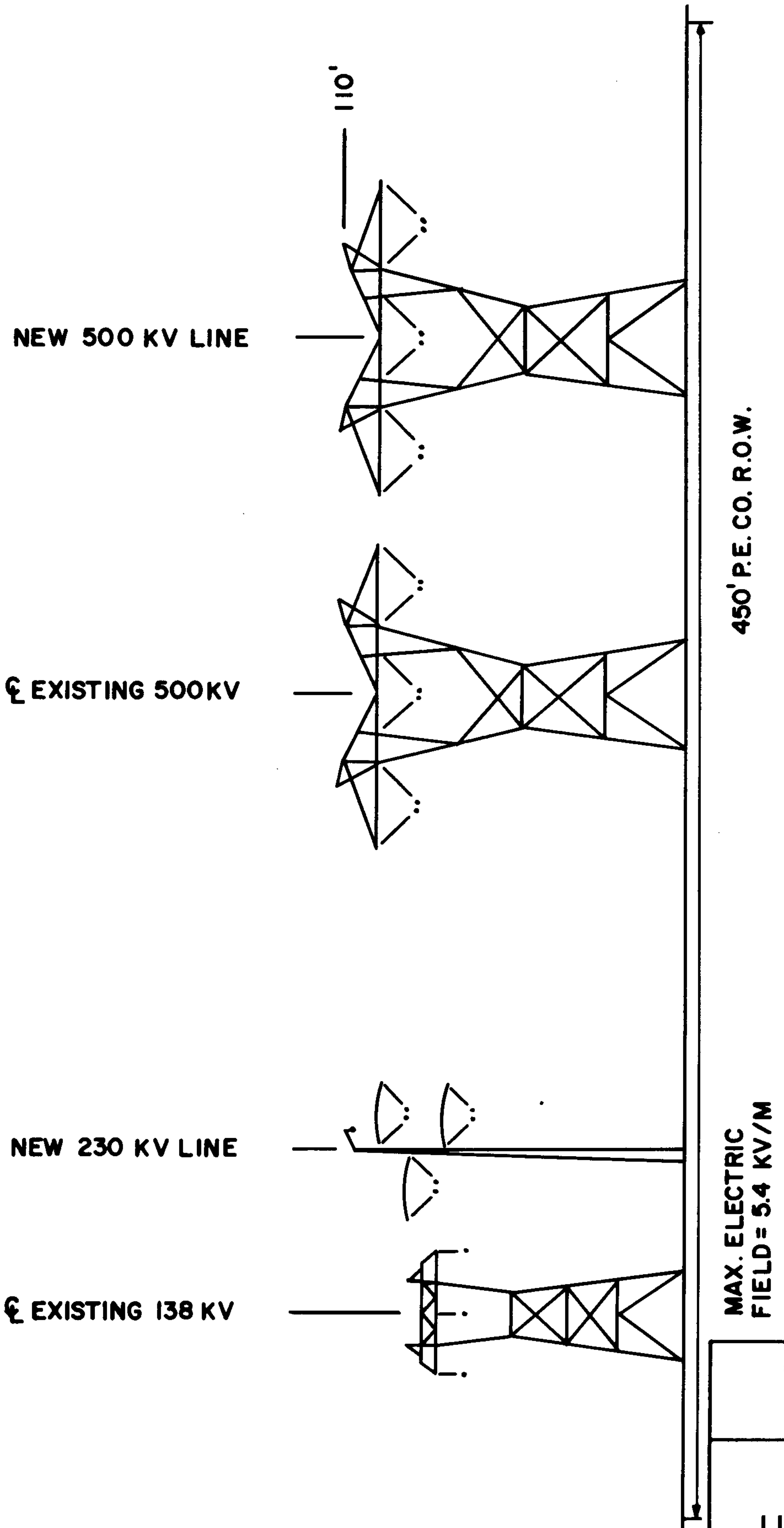


LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES
(SHEET 9 OF 16)

FIGURE 3.9-2

REV. 14, 07/83



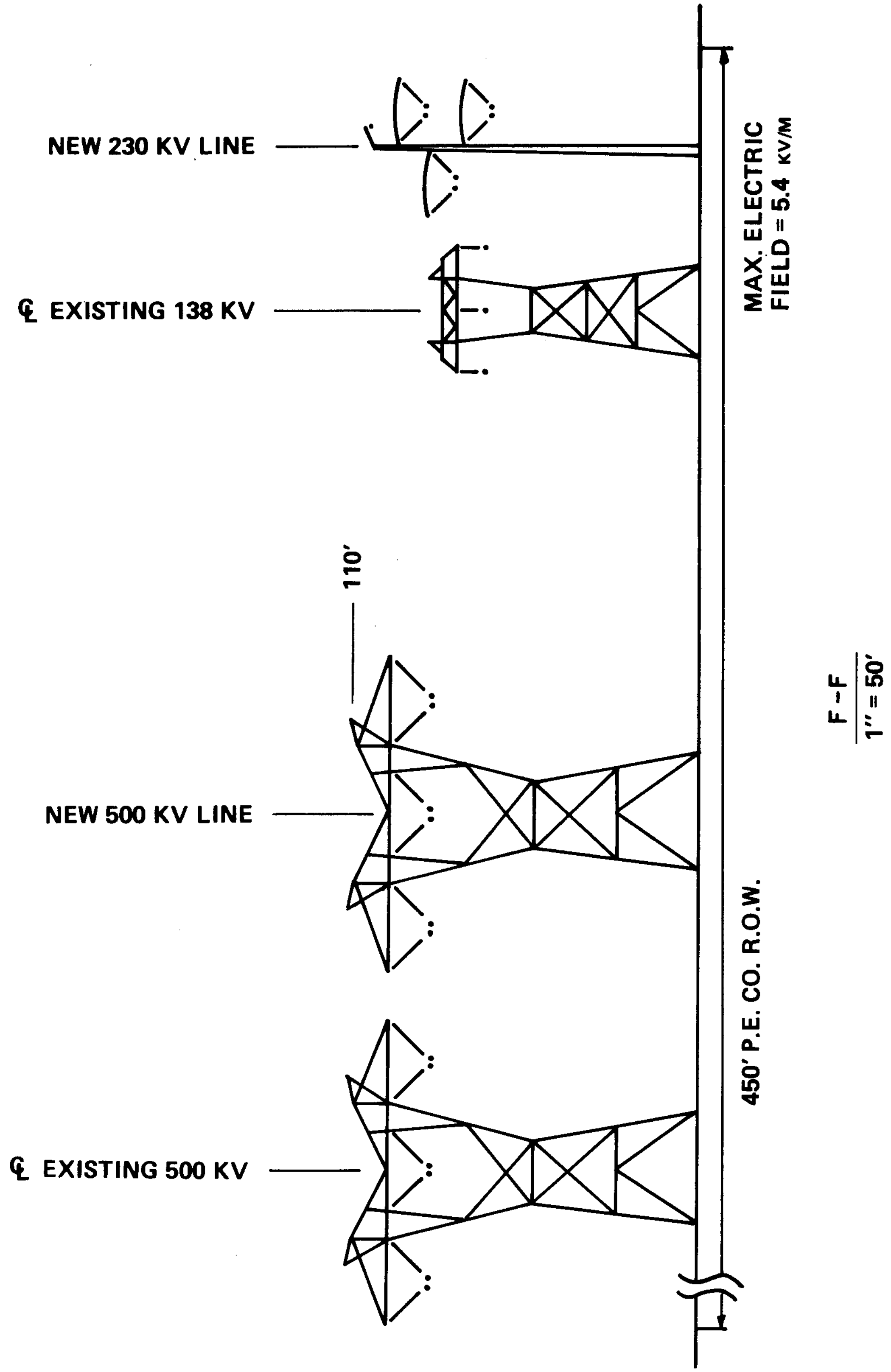
E – E
1" = 50'

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

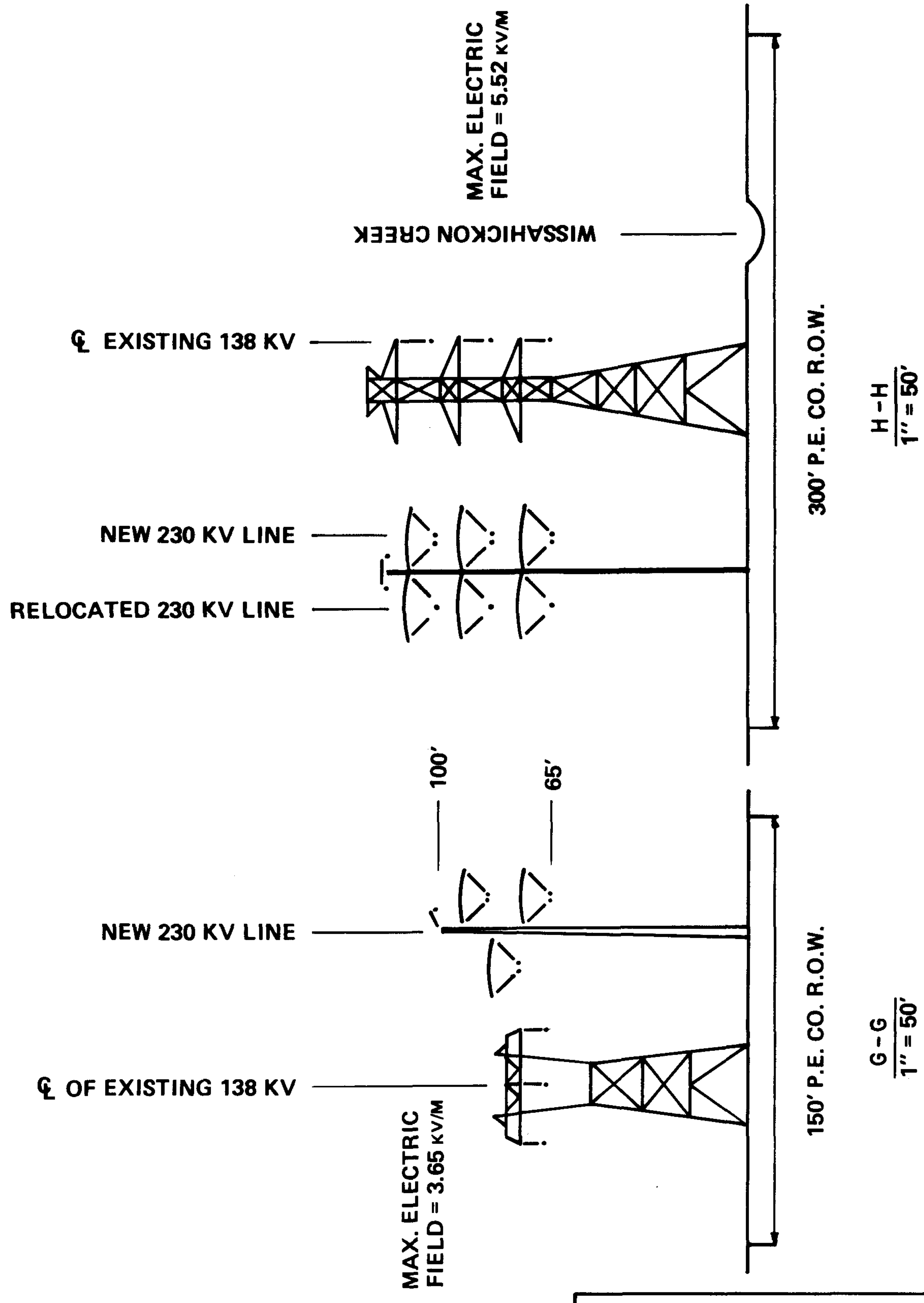
SHEET 10 OF 16



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

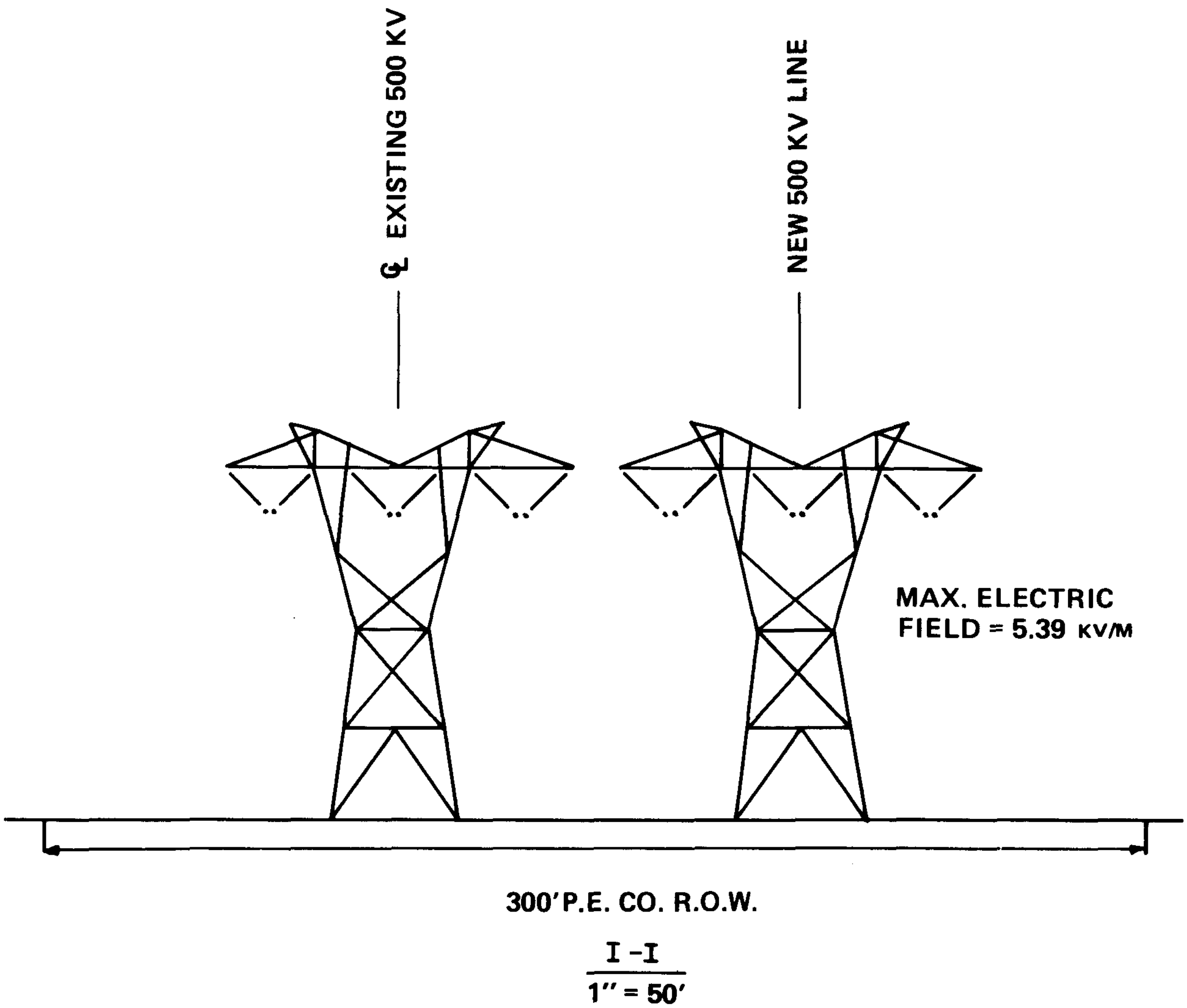
FIGURE 3.9-2 SHEET 11 OF 16



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

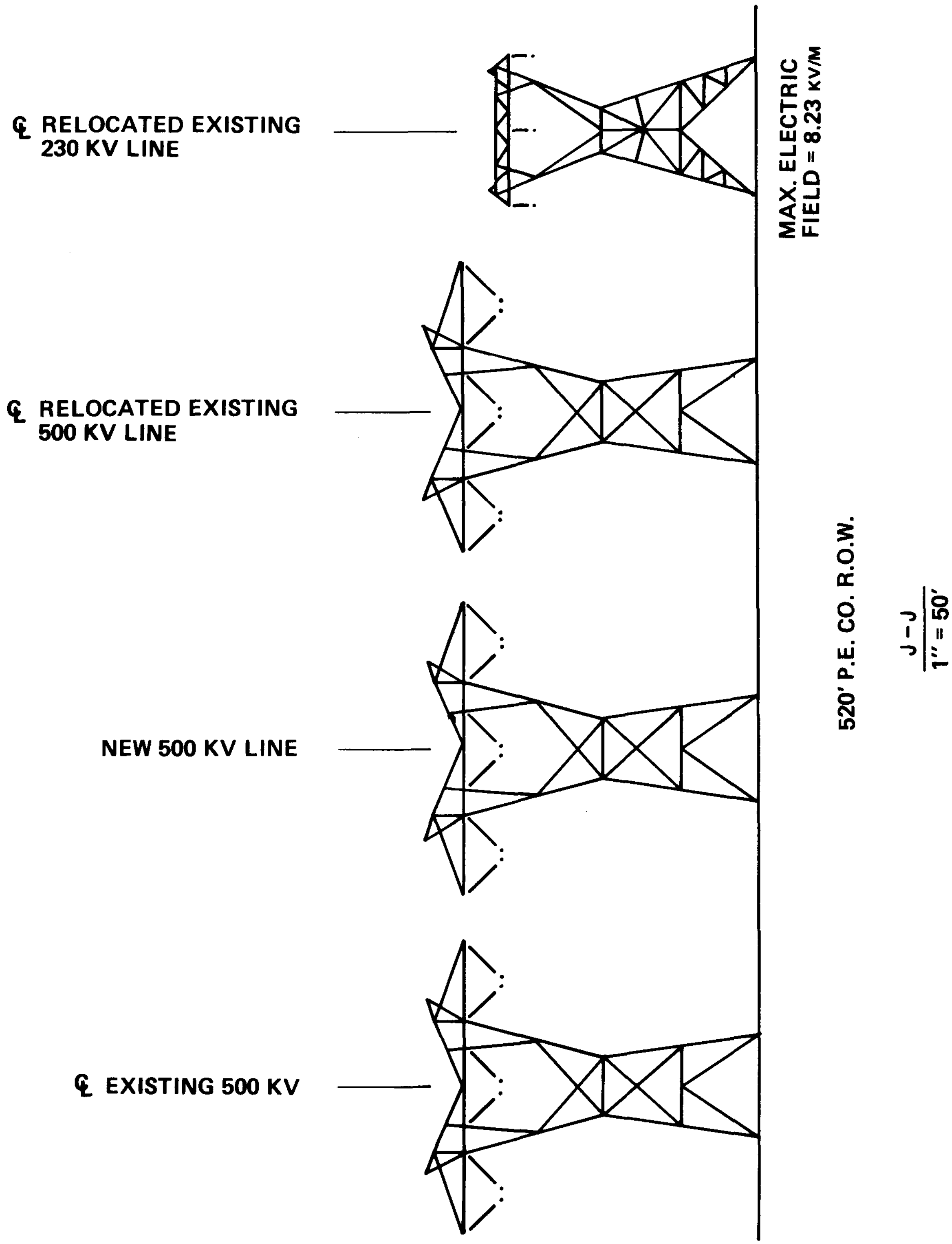
FIGURE 3.9-2 SHEET 12 OF 16



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

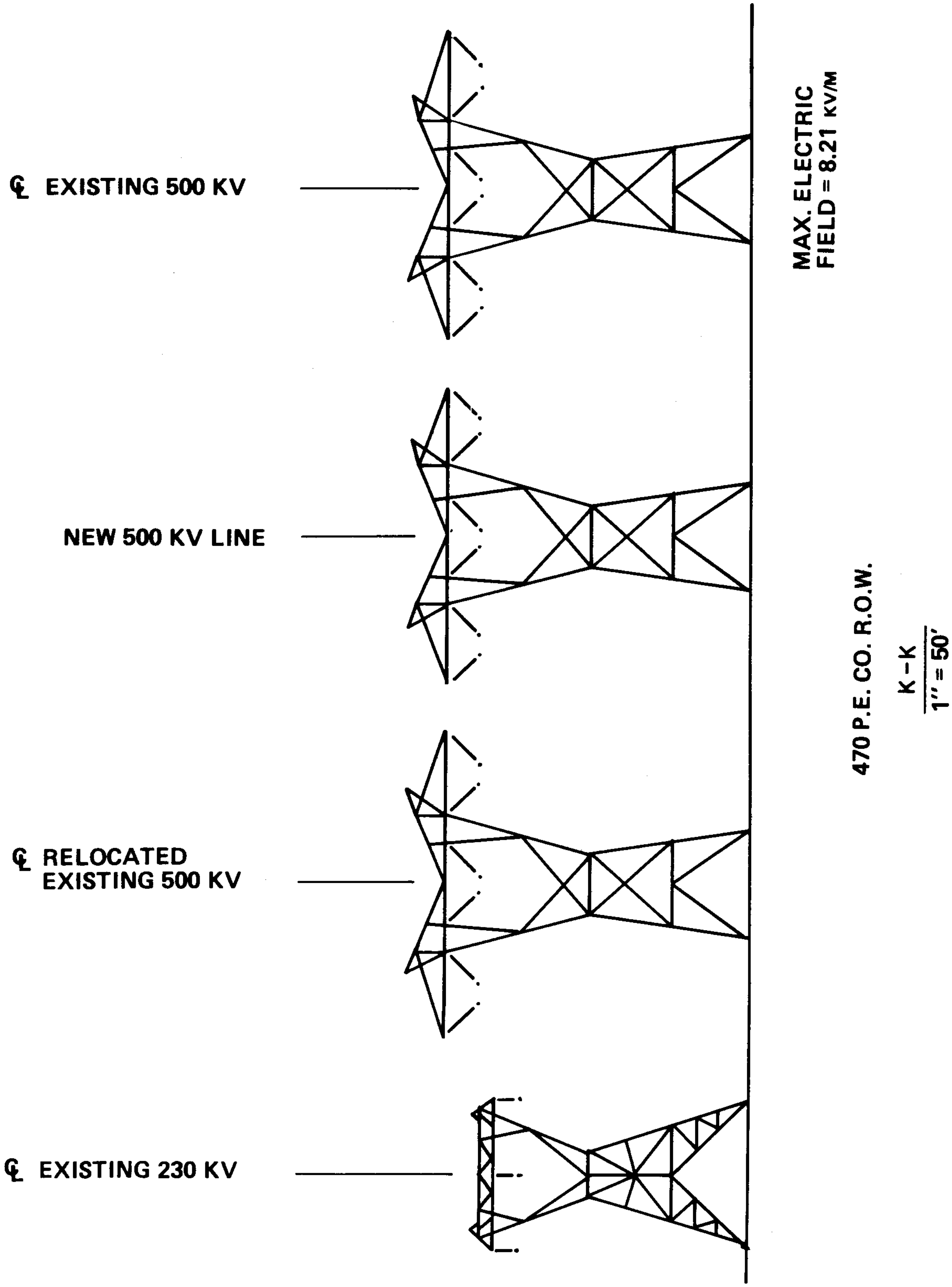
FIGURE 3.9-2 SHEET 13 OF 16



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

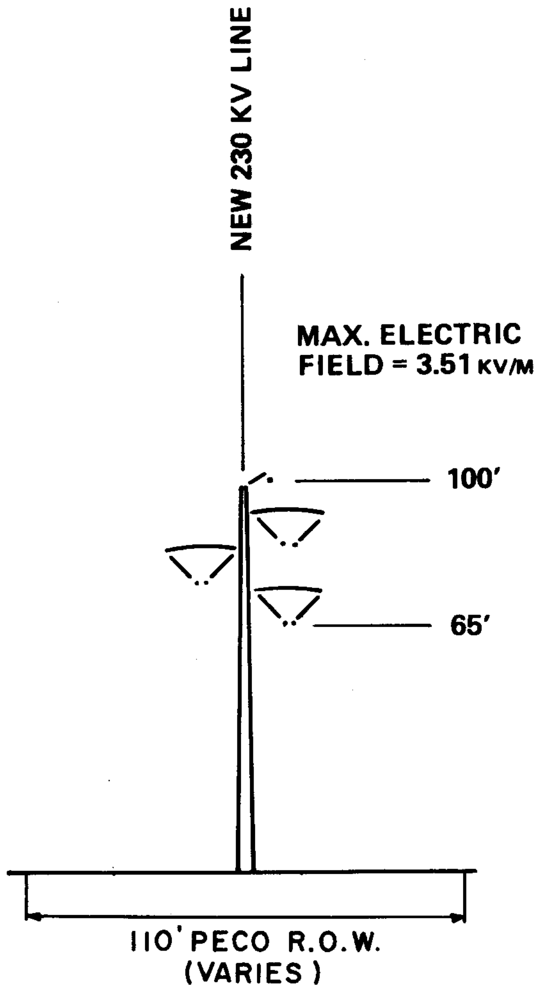


LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

SHEET 15 OF 16



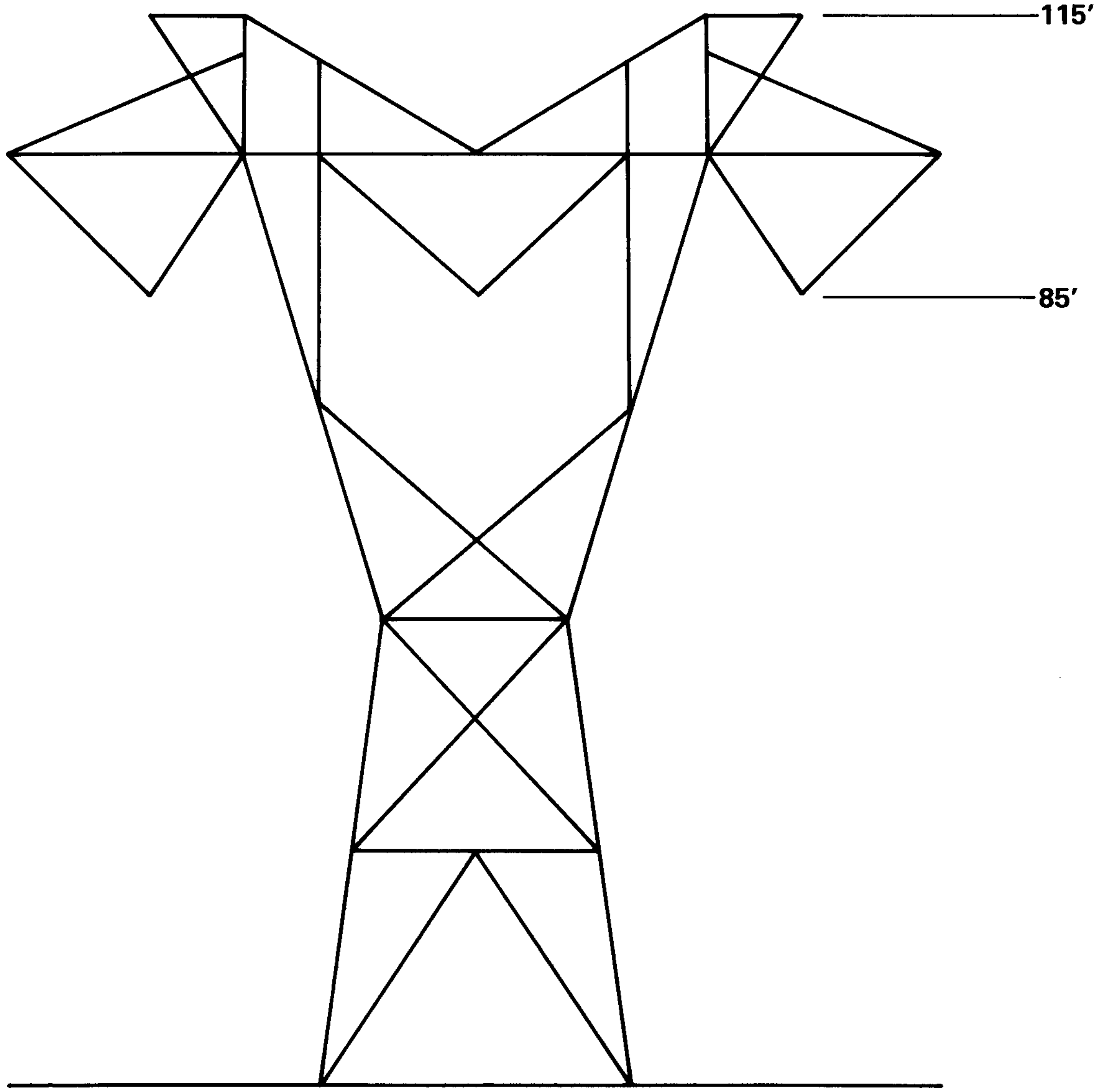
L-L
1″ = 50′

LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

DETAIL ILLUSTRATION OF
LIMERICK TRANSMISSION LINES

FIGURE 3.9-2

SHEET 16 OF 16



LIMERICK GENERATING STATION
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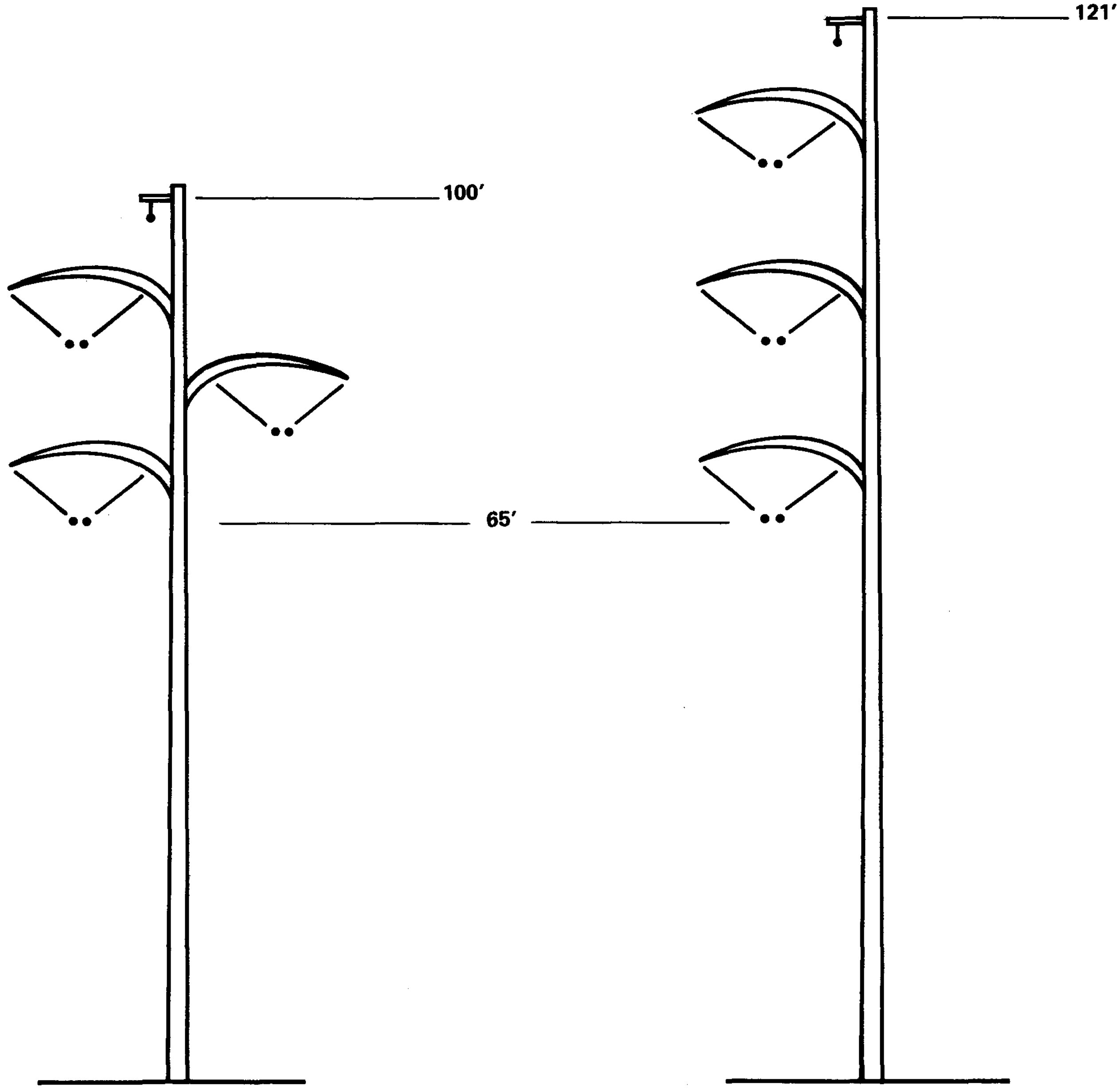
500 KV SINGLE CIRCUIT
LATTICE STEEL STRUCTURE

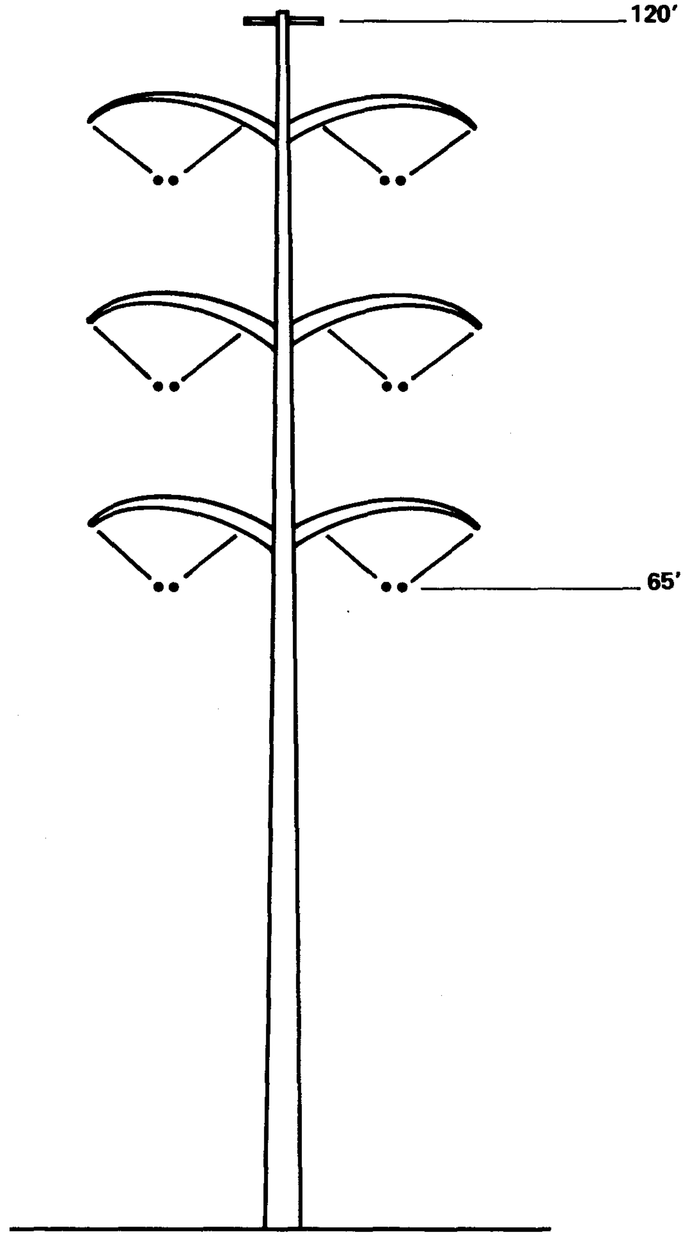
FIGURE 3.9-3



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

VERTICAL AND TRIANGULAR CONDUCTOR CONFIGURATION ON SINGLE CIRCUIT STRUCTURES

FIGURE 3.9-4



LIMERICK GENERATING STATION
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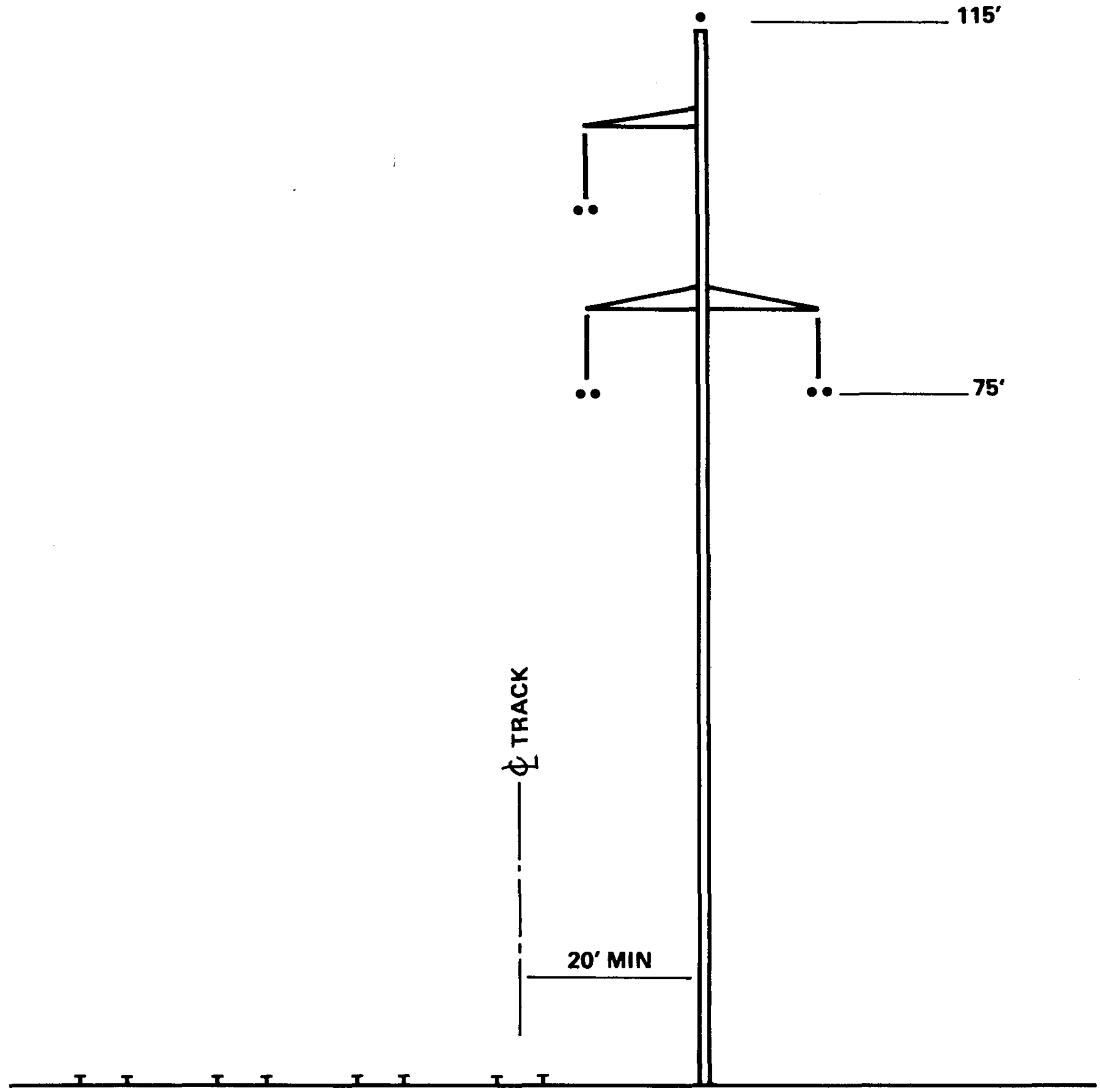
DOUBLE CIRCUIT VERTICAL
TUBULAR STRUCTURES

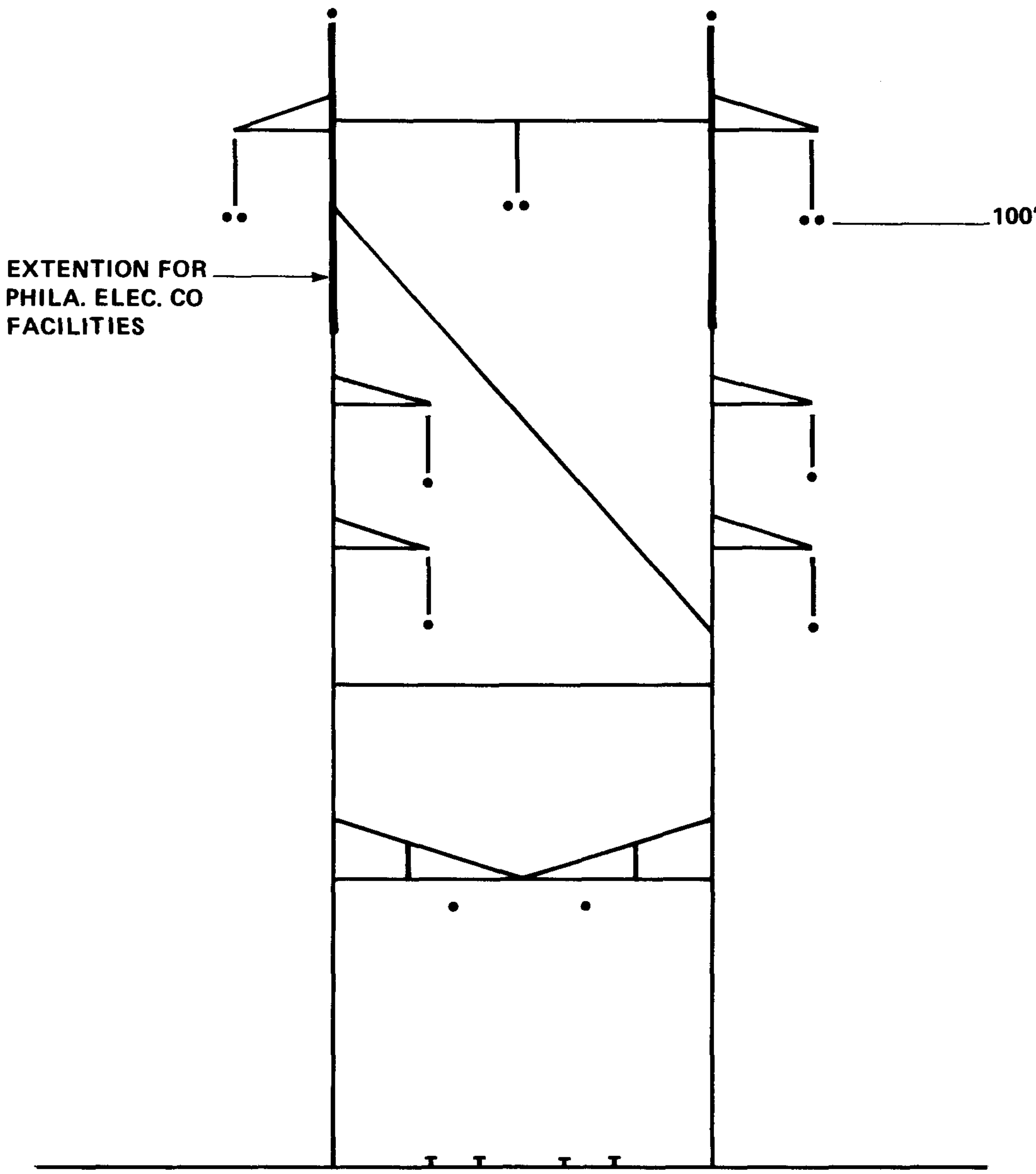
FIGURE 3.9-5



LIMERICK GENERATING STATION
UNITS 1 AND 2
ENVIRONMENTAL REPORT

WIDE FLANGE (WF) TYPE
STEEL STRUCTURE

FIGURE 3.9-6



LIMERICK GENERATING STATION
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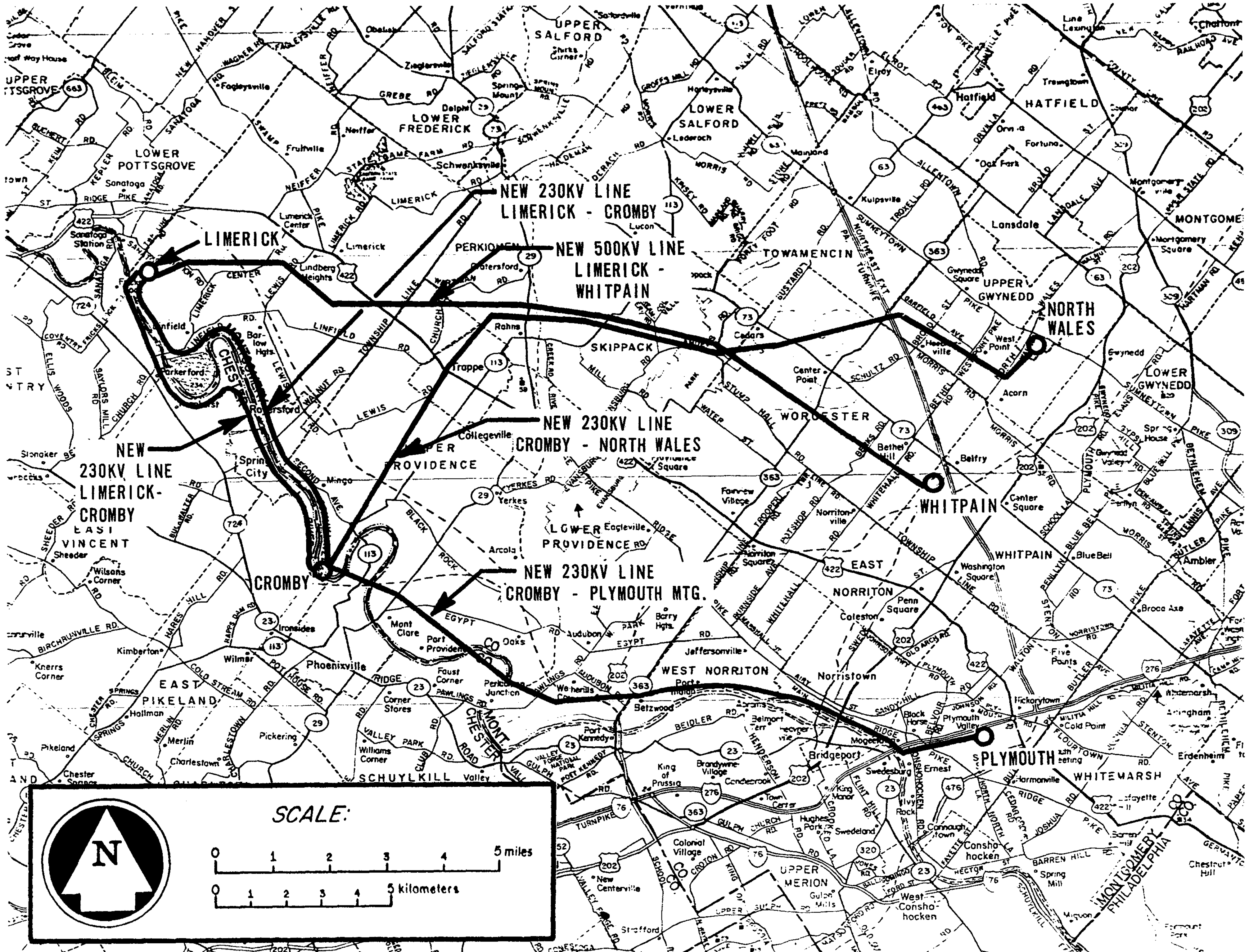
WIDE FLANGE (WF) TYPE STRUCTURE SHOWING PECO FACILITY EXTENSION

FIGURE 3.9-7



LIMERICK GENERATING STATION
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TRANSMISSION LINE ROUTING

FIGURE 3.9-8 REV. 12, 04/83