

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

EPA-330/2-79-022

Evaluation of Runoff and Discharges
from
New Jersey Zinc Company
Palmerton, Pennsylvania

NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
DENVER, COLORADO

DECEMBER 1979



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Cordinator of this project was Richard W. Warner; Mr. Warner directed the preparation of the Project Plan, supervised the field investigation, established project priorities, and coordinated the preparation of this report. Requests for additional information should be addressed to Mr. Warner.

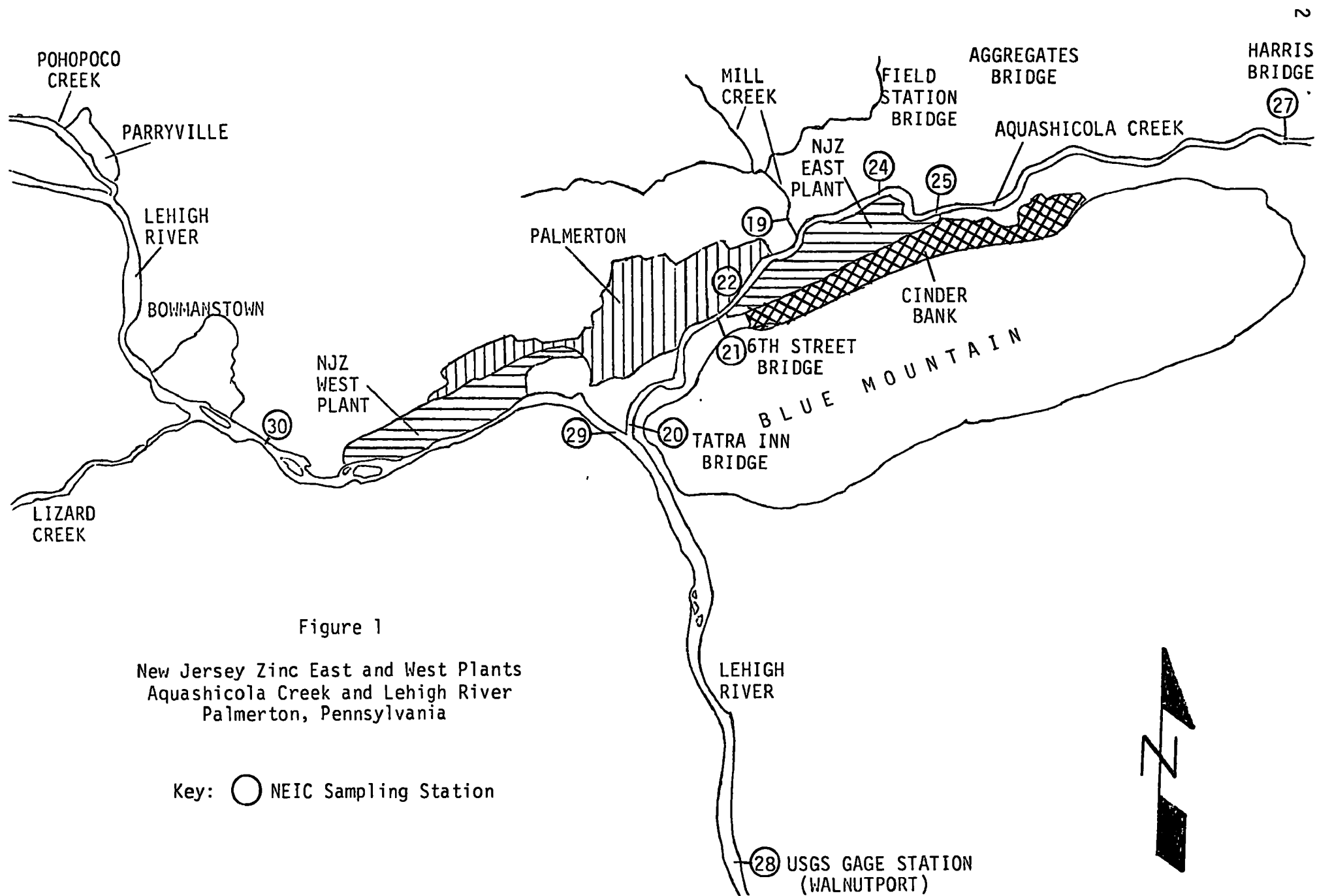
Principal investigators having major responsibilities were as follows: Barrett E. Benson - process evaluation; Thomas Burns - receiving water and effluent evaluations; Alan Peckham - geology, runoff and seepage; Richard W. Warner - biological evaluations. The Best Management Practices evaluation was developed primarily by Mr. Benson and Mr. Peckham, with contributions from Mr. Burns and Mr. Warner.

I. INTRODUCTION

From May 1 to 15, 1979, the National Enforcement Investigations Center (NEIC) conducted an investigation of direct and indirect discharges from a zinc smelter at Palmerton, Pennsylvania, and the impact of these discharges on the receiving waters. The New Jersey Zinc (NJZ) Division of Gulf and Western Natural Resources Group operates two plants in the Palmerton vicinity, a West Plant built in 1898 and an East Plant built in 1910 [Figure 1]. The East Plant, the subject of this investigation, is on the south bank of Aquashicola Creek, about 3.2 km (2 mi) upstream of the confluence with the Lehigh River. The facility produces metallic zinc, zinc oxide, cadmium, ammonia, sulfuric acid, carbon dioxide and indium. The Company employs about 1,500 people and operates 24-hours/day, 365 days/year.

Operations commenced at the East Plant in 1913, and since then approximately 30 million m. tons (33 million tons) of process residue (slag) from both the East and West Plants have been deposited in and around the East Plant. The disposal area, referred to as the Cinder Bank, now extends for about 3.2 km (2 mi) along the foot of Blue Mountain, along the bank of Aquashicola Creek and behind the East Plant. Surface-runoff and groundwater-seepage discharges from the Cinder Bank enter Aquashicola Creek, both upstream of the East Plant and in the reach bordering the plant.

Aquashicola Creek originates about 10 km (6 mi) east of Palmerton and flows generally southwest to the Lehigh River. The creek intercepts Buckwha Creek about 0.8 km (0.5 mi) upstream of Harris Bridge and intercepts Mill Creek near the East Plant's main gate. At the time of the NEIC investigation, Aquashicola Creek was classified as a coldwater fish stream by the Pennsylvania Department of Environmental Resources



(DER). Effective October 8, 1979, however, this classification was changed to a trout-stocking stream for the reach from Buckwha Creek to the mouth. This new classification also includes protection for the following uses: warmwater fishes; potable, industrial, livestock, wildlife and irrigation water supply; boating, fishing, water contact sports and esthetics. The trout stocking stream classification also applies to the Lehigh River in the Palmerton vicinity. The specific water quality criteria applicable to this classification are listed in Appendix A and summarized in Table 1.

EPA Region III has reported to NEIC that the Cinder Bank discharges to Aquashicola Creek contain high concentrations of zinc, cadmium, and possibly other priority pollutants*, and have resulted in a negative impact on stream water quality. However, the Company's NPDES permit (No. PA 0012751, effective January 16, 1975 - January 16, 1980) limits only discrete Outfall discharges from the East and West Plants, without addressing the Cinder Bank discharges. The Pennsylvania DER is in the process of reissuing a new NPDES permit for the East and West Plants and EPA Region III has proposed that the new permit contain provisions to control runoff and seepage pollution by authority of Section 304e of the 1977 Clean Water Act (Best Management Practices). It has also been proposed that the new permit [Table 2] reflect limitations based on the effluent guidelines developed for the zinc processing industry, and on the Pennsylvania water quality standards.

The Director of the Enforcement Division of EPA Region III requested that NEIC conduct an investigation of the NJZ East Plant and Aquashicola Creek to evaluate the impact of the plant on the creek. Specific objectives of the project were to:

* Priority Pollutants are derived from the June 7, 1976 Natural Resources Defense Council (NRDC) vs. Russell Train (USEPA) Settlement Agreement.

Table 1
RECEIVING WATER QUALITY CRITERIA^a
AQUASHICOLA CREEK^a AND LEHIGH RIVER^b
Palmerton, Pennsylvania

Parameter	Criteria
Protected uses	trout stocking, warm water fish; domestic, industrial, livestock, wildlife and irrigation water supply; boating fishing, water contact
Aluminum	≤ 0.1 of the 96-hour LC50 ^c
Alkalinity	≤ 20 mg/l as CaCO ₃
Arsenic	≤ 0.05 mg/l
Bacteria	Fecal coliform $\leq 200/100$ ml for May 1 - Sept. 30 Fecal coliform $\leq 2000/100$ ml for Oct. 1 - April 30 (based on geometric mean - 5 consecutive samples)
Chromium	≤ 0.05 mg/l (as hexavalent chromium)
Copper	≤ 0.1 of the 96-hour LC50 ^c
Cyanide	≤ 0.005 mg/l as free cyanide
Dissolved Oxygen	≤ 6.0 mg/l average for Feb. 16 - July 31 ≤ 5.0 mg/l minimum for Feb. 16 - July 31 ≤ 5.0 mg/l average for Aug. 1 - Feb. 15 ≤ 4.0 mg/l minimum for Aug. 1 - Feb. 15
Fluoride	≤ 2.0 mg/l
Iron	≤ 1.5 mg/l (total); ≤ 0.3 mg/l (dissolved)
Lead	≤ 0.05 mg/l or ≤ 0.01 of the 96-hour LC50 ^c (whichever is less)
Manganese	≤ 1.0 mg/l
Nickel	≤ 0.01 of the 96-hour LC50 ^c
Nitrite plus Nitrate	≤ 10.0 mg/l as Nitrogen
pH range	6.0 to 9.0 standard units
Phenolics	≤ 0.005 mg/l
Temperature	For the period Feb. 15 to July 31, no rise when ambient temperature is 74°F or above; not more than 5°F rise above ambient temperature until stream temperature reaches 74°F, not to be changed by more than 2°F during any one-hour period; for the remainder of the year, no rise when ambient temperature is 87°F or above; not more than a 5°F rise above ambient temperature until stream temperature reaches 87°F, not to be changed by more than 2°F during any one-hour period.

Table 1 (Continued)
 RECEIVING WATER QUALITY CRITERIA
 AQUASHICOLA CREEK^a AND LEHIGH RIVER^b
 Palmerton, Pennsylvania

Parameter	Criteria
Total Dissolved Solids	≤500 mg/l (average); ≤750 mg/l (maximum)
Zinc	≤0.01 of the 96-hour LC50 ^c

For parameters not listed, the general criterion that these substances shall not be inimical or injurious to the designated water uses applies.

-
- a,b These criteria apply to Aquashicola Creek in the reach from Buchwha Creek to the mouth, and to the Lehigh River in the reach from the Route 903 Bridge at Jim Thorpe to the Allentown Dam.
- c LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters.

Table 2
DRAFT EFFLUENT LIMITATIONS^a - NPDES PERMIT NO. PA0012751
NEW JERSEY ZINC COMPANY - EAST PLANT
Palmerton, Pennsylvania

Parameter	Units	101	001 ^b	002	003 ^c	004	005	010 ^d	011 ^e	012	016 ^e	019
Total Zinc	Avg mg/l	3.5	NA ^f	0.7	NA	0.6	2.0	NA	5.0	0.3	NA	5.0
	Max mg/l	7.0	NA	1.1	NA	1.8	4.0	NA	10.0	0.6	NA	10.0
	Avg kg/day (1b/day)	11(24.4)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Max kg/day (1b/day)	22(48.8)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Cadmium	Avg mg/l	0.1	NA	0.01	NA	0.02	0.02	NA	0.5	0.01	NA	0.5
	Max mg/l	0.4	NA	0.02	NA	0.04	0.04	NA	1.0	0.02	NA	1.0
	Avg kg/day (1b/day)	0.3(0.7)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Max kg/day (1b/day)	1.3(2.8)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Lead	Avg mg/l	2.5	NA	-	-	-	0.1	NA	2.5	0.05	NA	2.5
	Max mg/l	5.0	NA	-	-	-	0.2	NA	5.0	0.1	NA	5.0
Total Iron	Avg mg/l	1.5	NA	0.5	-	1.5	-	-	1.5	-	-	1.5
	Max mg/l	3.0	NA	1.0	-	3.0	-	-	3.0	-	-	3.0
Total Mn.	Avg mg/l	-	-	-	-	2.0	-	-	-	-	-	-
	Max. mg/l	-	-	-	-	4.0	-	-	-	-	-	-
TSS	Avg mg/l	15	NA	NA	NA	NA	NA	NA	25	NA	NA	25
	Max mg/l	30	NA	30	NA	30	30	NA	50	20	NA	50
	Avg kg/day (1b/day)	47(104)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Max kg/day (1b/day)	95(209)	NA	4.1(9.0)	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	Avg mg/l	0.05	-	-	-	-	-	-	-	-	-	0.1
	Max mg/l	0.1	-	-	-	-	-	-	-	-	-	0.2
	Avg kg/day (1b/day)	0.14(0.3)	-	-	-	-	-	-	-	-	-	NA
	Max kg/day (1b/day)	0.32(0.7)	-	-	-	-	-	-	-	-	-	NA
Selenium	Avg mg/l	2.5	-	-	-	-	-	-	-	-	-	5.0
	Max mg/l	5.0	-	-	-	-	-	-	-	-	-	10.0
	Avg kg/day (1b/day)	7.0(17.4)	-	-	-	-	-	-	-	-	-	NA
	Max kg/day (1b/day)	15.8(34.9)	-	-	-	-	-	-	-	-	-	NA
Oil/Grease	Inst. Max mg/l	30	NA	30	-	30	30	-	-	-	-	30
	Avg mg/l	NA	NA	15	-	NA	NA	-	-	-	-	NA
	Avg kg/day (1b/day)	NA	NA	2.0(4.5)	-	NA	NA	-	-	-	-	NA
pH Range - SU		-	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	-	6.0-9.0
Maximum Temperature °C		-	NA	NA	NA	NA	NA	NA	-	NA	-	-
Monitoring Requirements ^g (key below)		A,D,J,O	C,F,L,N,R	A,F,M,N,R	C,F,N,R	A,D,J,N,P	B,E,K,N,Q	C,H,N,R	G,P	C,H,N,R	I	G,J,P

a Limitations are based on Best Practicable Control Technology Currently Available (BPT) and on Pennsylvania Water Quality Standards. All metals and TSS limits for Outfalls 101-010 and 012 are on a net basis; all other concentration limits are on a gross basis.

b No net addition from cooling water.

c No net addition for all pollutants in cooling water - discharge shall consist of storm water and non-contact cooling water only.

d No net addition from process or cooling water.

e Discharge shall not contain any process or cooling water

f NA means specific limits not applicable but monitoring requirements do not apply for these parameters.

g A = Measure flow 1/week; B = Measure flow 1/2 weeks; C = Measure flow 1/month; D = 24-hour flow composite for TSS/metals 1 week; E = 24-hour flow composite for TSS/metals 1/2 weeks; F = 24-hour flow composite for TSS/metals 1/month; G = Grab for TSS/metals 1/week during precipitation runoff; H = Grab for TSS/metals 1/month; I = Grab for TSS/metals 1/3 months during precipitation runoff; J = Grab for oil/grease 1/week; K = Grab for oil/grease 1/2 weeks; L = Grab for oil/grease 1/month; M = 3 Grabs within 24-hrs for oil/grease 1 month, N = "in-situ" temperature measurement 1/week; O = Continuously measure/record pH; P = Grab for pH 1/week; Q = Grab for pH 1/2 weeks; R = Grab for pH 1/month.

1. Measure the quality of Cinder Bank runoff and seepage and assess the influence of runoff and seepage on Aquashicola Creek and Lehigh River water quality.
2. Evaluate the NJZ East Plant discharges with respect to developed effluent guidelines and water quality standards.
3. Develop Best Management Practices for controlling runoff and seepage.

II. SUMMARY AND CONCLUSIONS

SUMMARY OF INVESTIGATION

From May 1 to 15, 1979, NEIC conducted an investigation of the New Jersey Zinc Company's East Plant at Palmerton, Pennsylvania. The study consisted of a characterization of Aquashicola Creek, an evaluation of the Cinder Bank and its impact on the creek, an evaluation of East Plant discharges, and development of Best Management Practices for the plant.

Aquashicola Creek stream characterization included seven consecutive days of water sampling, flow measurement and field measurement for pH and temperature, as well as sediment sampling, benthic population studies, periphyton sampling and fish survival tests. Based on data from five of the sampling days, mass balance calculations were performed to characterize zinc and cadmium levels in the reach from Harris Bridge to the 6th Street Bridge. Additional limited studies were conducted on the Lehigh River in the Palmerton vicinity.

The Cinder Bank was evaluated in terms of physical features, including area, volume, configuration, stability, runoff, infiltration, and erosion characteristics. Four sets of grab samples for total and dissolved metals analysis were collected of Blue Mountain runoff, runoff and seepage from the Cinder Bank; two sets of water samples were collected for metals analysis from wells in the vicinity of the East Plant. Field measurements were performed for pH, temperature and conductivity.

East Plant effluent characterization was conducted for seven consecutive days at ten permitted Outfalls, and for twelve days at the

main process discharge Outfall 001. Monitoring at Outfall 001 was conducted five extra days to characterize the discharge before a reduction in plant operations began on May 5. Influent and effluent sampling was conducted for six days at the Waste Acid Treatment Plant. Composite and grab samples were collected and analyzed for TSS, total metal, and oil and grease; also flow, pH and temperature were measured. Bioassay tests were conducted to measure the toxicity of all East Plant discharges.

Based on the results of these studies and an investigation of East Plant processes and operations, Best Management Practices for controlling the impact of the plant on Aquashicola Creek were developed. These practices specifically address the Cinder Bank, raw materials and waste sludge handling, and waste treatment strategies.

CONCLUSIONS

Stream Characterization

There were significant contributions of zinc, cadmium and manganese to Aquashicola Creek in the reach from Harris Bridge to the 6th Street Bridge, located just downstream from the East Plant. Zinc and cadmium loads each increased about thirty times in this reach, while manganese increased sevenfold. No increases in metals were noted between the 6th Street Bridge and the Tatra Inn Bridge at the mouth.

Based on five-day average data, most of the zinc and cadmium load was contributed to Aquashicola Creek by groundwater and runoff sources:

aquifer draining from the waste sludge storage area. Groundwater from the deep wells at the west end of the plant is much less susceptible to metals contamination than are the shallow wells.

Effluent Characterization

The only East Plant discharges that contributed significant amounts of metals to Aquashicola Creek were Outfalls 001 and 011. The combination of these Outfalls accounted for 93 and 90%, respectively, of the zinc and cadmium discharged. However, as was noted in the stream characterization conclusions, the total of all East Plant discharges accounted for only 18 and 8% of the zinc and cadmium contributions to the creek. The remainder is attributable to non-point sources.

Decreased acid plant operations that began on May 5 significantly affected the water quality at Outfall 001. The net zinc and cadmium concentrations at this Outfall from May 1 to 6 averaged 3.2 mg/l and 0.08 mg/l, respectively. Average net loads for these metals were 49 kg/day and 1.2 kg/day, respectively. Metals concentrations and loads during this normal production period were from two to ten times greater than during the seven monitoring days after the decrease.

The manual pH control system at the waste acid treatment plant effluent was completely inadequate, resulting in numerous and severe fluctuations in pH at Outfall 001. There were a total of 105 excursions outside the range of 6.0 to 9.0, in times ranging from 1 to 432 minutes. These excursions occurred more frequently and for longer periods when production was at normal levels. Instantaneous pH measurements outside the 6.0 to 9.0 range occurred 25% of the time.

Outfall 001 was acutely toxic to rainbow trout. The LC_{50} was a mixture of 88% effluent and 12% Aquashicola Creek water. The primary

toxicant appeared to be dissolved zinc. Excessive pH variation probably accelerated test fish response to dissolved zinc concentrations. It is probable that significantly higher toxicity levels would be measured at Outfall 001 during normal plant operations. Zinc and cadmium concentrations were two to four times greater during the period of normal operations (May 1 to 5) than they were during the bioassay test period, and pH fluctuations beyond the 6.0 to 9.0 range were more frequent, severe, and longer.

Outfall 011 drains shallow groundwater from the waste sludge storage area and other parts of the East Plant with a potential for metals contamination. Since Outfall 011 contained an average cadmium concentration of 0.75 mg/l -- the highest detected during this study -- and 79% of the cadmium load entered Aquashicola Creek in this reach, it is apparent that the shallow groundwater in this area of the plant was severely contaminated. Zinc concentrations in Outfall 011 were also very high, averaging 66 mg/l. This discharge was acutely toxic to rainbow trout. The LC_{50} for Outfall 011 was a mixture of 1% effluent and 99% Aquashicola Creek water. The primary toxicant appeared to be dissolved zinc. Because of the high metals concentrations and the resulting toxicity, Outfall 011 should be treated prior to discharge.

There were no significant levels of pollutants found in permitted discharges 002-005, 012 and 014-016. Outfall 010 contained high concentrations of zinc and cadmium on several days. However, the flow at this station averaged only 23 m³/day (6,000 gal/day) and the discharge would be easily treated.

Best Management Practices

Because runoff from Blue Mountain is not severely contaminated with zinc, cadmium, and other metals, it should be isolated from the

Cinder Bank. Therefore, all runoff from Blue Mountain should be segregated from and diverted around the Cinder Bank and discharged directly into Aquashicola Creek. Since runoff from Blue Mountain can be reduced by restoring and maintaining the vegetation, the NJZ Company should begin revegetating the Blue Mountain area adjacent to the East Plant and complete the revegetation within 5 years.

To prevent contamination of Aquashicola Creek by runoff and seepage from the Cinder Bank, all Cinder Bank runoff east of the NEIC Station 68 (NJZ Station 10A) must be collected and conveyed to lined surface impoundments. The impounded runoff should be monitored; if the zinc and cadmium concentrations are greater than 5 and 0.5 mg/l, respectively, the impounded runoff must be treated to reduce the concentrations to these levels.

The NEIC data of Cinder Bank runoff west of the Aggregates Bridge were inconclusive. Therefore, Cinder Bank runoff from this area should be monitored. If the zinc and cadmium concentrations exceed 5 and 0.5 mg/l, respectively, then the runoff must be collected and treated before discharge to Aquashicola Creek.

To minimize infiltration, the Cinder Bank must be contoured; slopes of 4 to 1 should be constructed with an S-shaped profile having the shortest possible straight segment. Runoff from precipitation, seeps, and springs should be collected in channels and conveyed to the surface impoundments.

Because the Cinder Bank is unstable, eroded, and highly permeable -- which contributes most of the contaminated flow to the groundwater -- the revegetation of the Cinder Bank by the NJZ Company should be accelerated and completed within the next 5 years.

The raw-material storage and handling areas have a high potential of contaminating Aquashicola Creek and the groundwater. Therefore, these areas should be lined with impervious materials and diked. Water contained within the diked area must be treated before discharge to reduce the zinc and cadmium concentrations below 5 and 0.5, mg/l, respectively. As an alternative, buildings could be built over the raw-material storage and handling areas.

Because the entrained water in the sludge from the waste acid treatment plant leaches metals and then infiltrates to the groundwater, the sludge storage area must be lined with an impervious liner and diked. Water contained within the diked area must be treated to reduce the zinc and cadmium concentrations below 5 and 0.5 mg/l before discharge.

To prevent contamination of Aquashicola Creek and groundwater from non-point sources on the East Plant site, it is necessary to construct drains and sewers throughout the site to quickly remove runoff to the creek. The runoff should be monitored; if zinc and cadmium concentrations are greater than 5 and 0.5 mg/l, respectively, the runoff must be treated. The NJZ Company should also reevaluate the drainage system and eliminate the sources of contamination.

III. STUDY METHODS

Throughout the course of this study, EPA and NEIC standardized monitoring procedures were followed. Specific applications were in the areas of sampling and flow measurement techniques, sample preservation, Chain-of-Custody and document control. Analytical methodologies are discussed and referenced in Appendix B. An evaluation of NJZ self-monitoring laboratory was conducted on November 28, 1978 and the results of that inspection are in Appendix C.

STREAM CHARACTERIZATION

On seven consecutive days, May 8 through 14, 1979, water quality characterization was conducted on a reach of Aquashicola Creek from the Harris Bridge to the confluence with the Lehigh River. Additional water quality sampling was performed at three locations on the Lehigh River for the same seven days.

Water Sampling

Table 3 presents the stream water quality characterization program, detailing NEIC station numbers, descriptions and locations [Figure 1] sampling dates, and types of samples collected. The basis of the program was seven consecutive days of flow-weighted grab sampling of Aquashicola Creek stream water at the following points:

1. A control station upstream of any influence from the east plant discharges or the Cinder Bank (Station 27 at Harris Bridge).

Table 3
 AQUASHICOLA CREEK AND LEHIGH RIVER
 WATER QUALITY CHARACTERIZATION PROGRAM
 New Jersey Zinc - East Plant
 Palmerton, Pennsylvania
 May 8-14, 1979

NEIC Station No.	Station Description	Location	Sampling Dates May (1979)	Remarks
27	Aquashicola Creek at Harris Bridge	On upstream side of Harris Bridge, about 8.4 km (5.2 mi) upstream of confluence with Lehigh River	8-14	One flow-weighted grab collected each day; individual aliquots kept on May 9 and 13
25	Aquashicola Creek at Aggregates Bridge	Aggregates Bridge is approxi- mately 4.9 km (3.0 mi) upstream of confluence with Lehigh River	9,13	Eight individual aliquots collected from equally-spaced cross sections on each of two days
24	Aquashicola Creek at Field Station Bridge	10 m (33 ft) upstream of Field Station Bridge about 3.7 km (2.3 mi) upstream of confluence with Lehigh River	8-14	One flow-weighted grab collected each day; individual aliquots kept on May 9 and 13
19	Mill Creek	15 m (48 ft) upstream of Dela- ware Avenue Bridge abutment, about 3.0 km (1.9 mi) upstream of Aquashicola Creek mouth	8-14	One flow-weighted grab collected each day
22	Aquashicola Creek at USGS gage station	About 2.2 km (1.4 mi) upstream of mouth	none	Flow measurement only
21	Aquashicola Creek at 6th Street Bridge	32 m (106 ft) downstream from 6th Street Bridge (downstream from outfall 016), about 1.9 km (1.2 mi) upstream of mouth	10-14	One flow-weighted grab collected each day; individual aliquots kept on May 13

Table 3 (Cont'd.)
 AQUASHICOLA CREEK AND LEHIGH RIVER
 WATER QUALITY CHARACTERIZATION PROGRAM
 New Jersey Zinc - East Plant
 Palmerton, Pennsylvania
 May 8-14, 1979

NEIC Station No.	Station Description	Location	Sampling Dates May (1979)	Remarks
20	Aquashicola Creek at Tatra Inn Bridge	3 m (10 ft) upstream of the Tatra Inn Bridge, about 0.2 km (0.1 mi) upstream of mouth	8-14	One flow-weighted grab collected each day; individual aliquots kept on May 9 and 13
30	Lehigh River upstream of West Plant	1 km (0.6 mi) downstream from Bowmanstown Bridge over Route 248, about 4 km (2.5 mi) upstream of Aquashicola Creek	8-14	One equal volume grab collected each day
29	Lehigh River upstream of Aquashicola Creek	Approximately 18 m (60 ft) upstream of confluence with Aquashicola Creek	8-14	One equal volume grab collected each day
28	Lehigh River below Aquashicola Creek	Near USGS Gage Station at Walnutport, approximately 3.5 km (2.2 mi) downstream from Aquashicola Creek	8-14	One equal volume grab collected each day

2. A point downstream from a major portion of the Cinder Bank, but upstream of all plant discharges (Station 24 at the Field Station Bridge).
3. A point downstream of all plant discharges and the Cinder Bank (Station 20 at the Tatra Inn Bridge).

Flow-weighted grab samples were collected from the Mill Creek discharge (Station 19) for the seven days and, for the last five days (May 10 to 14), an additional flow-weighted grab of Aquashicola Creek water was collected daily at the 6th Street Bridge (Station 21), just downstream from the last New Jersey Zinc east plant discharge (Outfall 016).

Each of the four Aquashicola Creek stations (20, 21, 24 and 27) was divided into eight equal width sampling sections across the stream; at Mill Creek (Station 19) there were four sampling sections. Each flow-weighted grab sample consisted of individual aliquots collected from each of the sampling sections, proportioned according to the flow in each section, and combined into one sample. On two of the seven days, May 9 and 13, an additional aliquot was collected from each sampling section and kept as a separate sample at Stations 27, 24, 21 (May 13 only) and 20. Also collected on each of these two days, were samples from eight equal width stream sections of Aquashicola Creek near the Aggregate Bridge (Section 25).

All Aquashicola Creek samples were collected in coordination with the stream time-of-travel as determined by a dye study performed on May 6, 1979.

In addition to the Aquashicola Creek sampling program, seven consecutive days (May 8 through 14) of water quality sampling was conducted at the following three locations on the Lehigh River:

1. A point upstream of the New Jersey Zinc west plant (Station 30).
2. A point downstream from the west plant but upstream of the confluence with Aquashicola Creek (Station 29).
3. A point sufficiently downstream from the confluence to allow mixing of the two streams (Station 28).

At each of these three stations, grab samples were collected daily by combining equal volume aliquots of the stream cross-section.

All stream samples were preserved and shipped to the NEIC laboratory in Denver for total metal analyses.

Flow Measurement

Flow measurements for mass loading calculations at four Aquashicola Creek Stations (20, 21, 24 and 27) and at Mill Creek (Station 19) were performed using standard stream gaging techniques.* Starting with the seven-day prestudy period (May 1 to 7) and continuing through the seven days of monitoring, measured flows at these five stations** were referenced to known flows at the USGS gage station (Station 22).

Once a measured flow at any of the five stations was linked to a reference flow at the gage station, that flow was not remeasured until the gage station flow changed more than 10% from the reference flow. If the gage station flow changed more than 10% from the previous reference flow, a new reference flow was established and flows at the five stations were measured and linked to the new reference flow.

* Water Measurement Manual, U.S. Department of Interior, Bureau of Reclamation, Second Edition, 1967, pages 107-136.

** As noted in Table 3, sampling and flow measurement at Station 21 was performed for only five days (May 10 to 14).

The stream cross-sections at each of the four main Aquashicola Creek stations (20, 21, 24 and 27) and at the Mill Creek station (19) were divided into eight and four sampling sections, respectively. These sampling sections were further subdivided into flow sections for stream gauging purposes. After each stream gauging, the flow sections within each sampling section were combined to determine the flow in the sampling section and the proportion to the total stream flow. This information was used in flow-weighting the grab samples as discussed previously. On those occasions when flow measurement at a station was not necessary because the flow was linked to a reference flow (as noted above), flow-weighted aliquots were based on the previously measured flow.

Field Measurements

Field measurements for pH and temperature were performed at each stream sampling station daily from May 8 through 14.

Sediment Sampling

Seven sediment sampling sites [Figure 1] were selected on Aquashicola Creek and four were selected on the Lehigh River to coincide with stations which were also selected for collection of flow data, water quality and biological observations. Three of these stations, one on Aquashicola Creek (27) and two on the Lehigh River (99 and 30) were selected as background stations which were not expected to show direct influences of discharges or erosional (sediment) impacts from NJZ properties. Two additional stations were selected on the Lehigh River, one (29) between the NJZ West plant and the confluence of Aquashicola Creek and the Lehigh River and one (28) at the U.S. Geological Survey gauging stations at Walnutport, downstream of all NJZ facilities at Palmerton.

To assess the effects of the New Jersey Zinc Company (NJZ) East Plant on Aquashicola Creek and the Lehigh River, benthic macroinvertebrates were collected from selected sites [Table 4]. Aquashicola Creek was sampled in the reach between Harris Bridge upstream of the NJZ Cinder Bank and confluence of the stream with the Lehigh River. On the Lehigh River samples were collected from Bowmanstown, Pennsylvania, upstream of Aquashicola Creek, downstream to Walnutport, Pennsylvania. Examination of the immediate vicinity of NJZ discharges was emphasized, with samples from that reach of Aquashicola Creek more numerous than from more distant reaches.

Benthic macroinvertebrates were quantitatively sampled, using a Surber sampler at three sites (cross stream transects) per station. In addition, qualitative samples were taken at each location by sampling all available habitats, including the screening of sediments of manual removal of organism from beneath rocks, logs, and debris. Organisms collected only in qualitative samples were arbitrarily assigned values of one/sq. m of stream bed and were counted with the quantitative samples. In the laboratory, the 70% alcohol-preserved samples were separated from the debris, identified and counted. Results of quantitative sampling were expressed as number of organism per square meter of stream bed.

Periphyton Sampling

Aquashicola Creek and Lehigh River periphyton populations in the Palmerton, Pennsylvania area were sampled by exposing floating wooden racks containing microscope slides at 9 Stations. The racks were exposed for 9 days, commencing May 5, 1979, with the exception of Harris and Aggregates Bridges which were exposed for 7 and 8 days, respectively. After exposure, slides containing attached growths were preserved and used to determine periphytic algal population densities and periphytic chlorophyll a concentrations. Standardized, EPA-approved methods of analysis were used.

Table 4
 BENTHIC MACROINVERTEBRATE SAMPLING STATIONS
 AQUASHICOLA CREEK AND LEHIGH RIVER, PENNSYLVANIA
 May, 1979

Station	Description
27	Aquashicola Creek at Harris Bridge
32	Aquashicola Creek 1/2 way between Harris Bridge and Aggregate Bridge
25	Aquashicola Creek at Aggregate Bridge
23	Aquashicola Creek at Main Gate Bridge
31	Aquashicola Creek 1/2 way between USGS Gaging Station and 6th Street Bridge
21	Aquashicola Creek at 6th Street Bridge
20	Aquashicola Creek at Tatra Inn Bridge
34	Lehigh River at Hwy. 895 Bridge in Bowmanstown, PA
35	Lehigh River 450 meters upstream of Aquashicola Creek
33	Lehigh River 180 meters downstream of Aquashicola Creek
37	Lehigh River 1.4km downstream of Hwy. 873 Bridge (Slatington, PA)
36	Lehigh River 180 meters downstream of Main St. Bridge in Walnutport, PA.

Fish Survival Tests

In-situ fish exposures were done at eight sites in Aquashicola Creek (Stations 20, 21, 22, 23, 24, 25, 27 and 011) and these sites in the Lehigh River (Stations 28, 29 and 30). The purpose of the tests was to determine if discharges from NJZ East Plant and runoff and seepage from the Cinder bank are acutely toxic to indigenous fish populations. The test fish were golden shiners approximately 10 cm (4 in) in total length.

Exposure cages were constructed from 10 liter plastic buckets perforated with numerous 10 mm (3/8 in) circular holes. Approximate volumetric flushing time for these cages was 3 to 5 minutes. Each container was anchored to the stream bed at sufficient water depth to ensure complete submersion. The test fish were placed in each exposure cage.

Stream water at each test site was monitored for temperature, pH and dissolved oxygen concentration. Each cage was checked daily and dead fish removed.

CINDER BANK EVALUATION

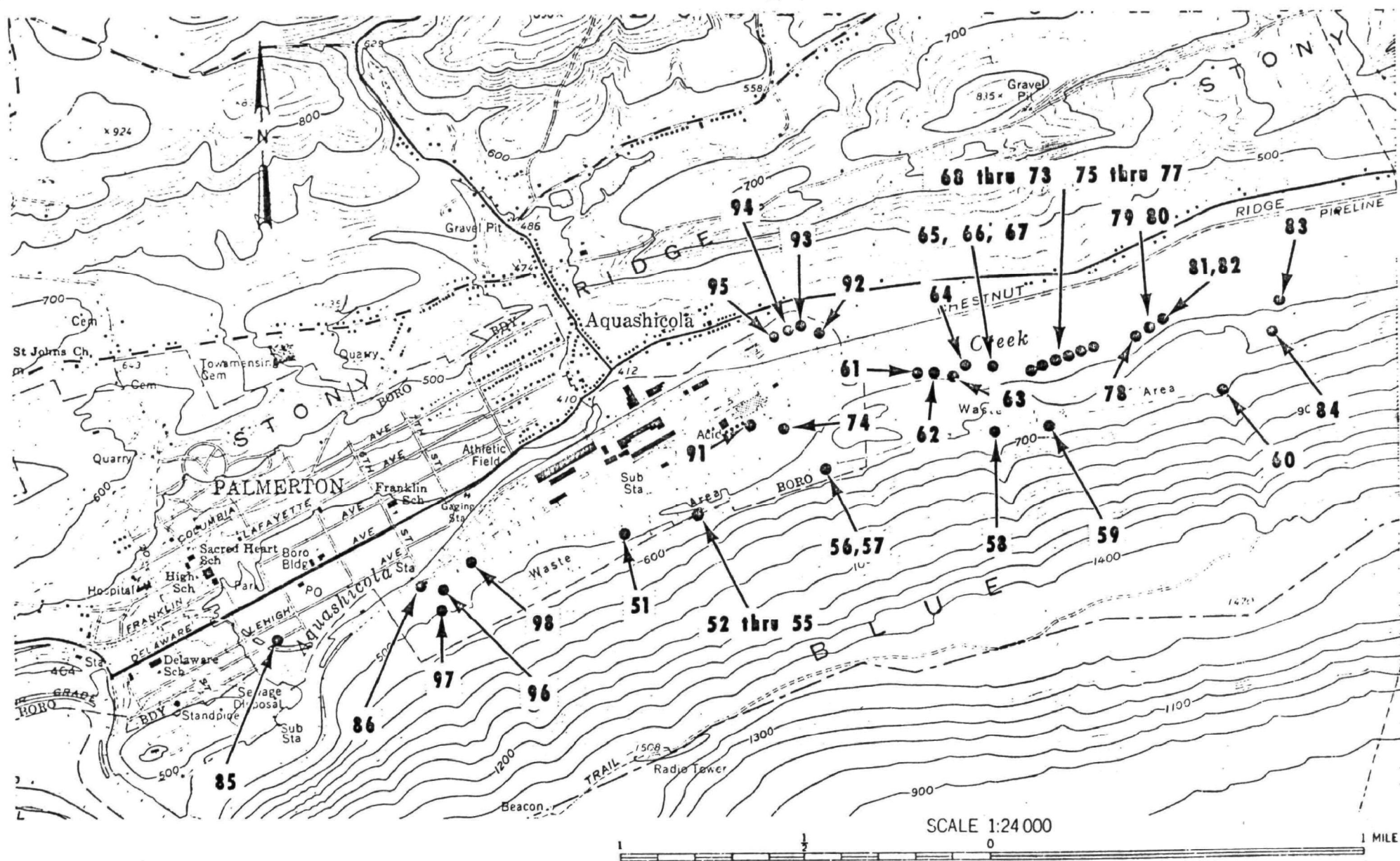
Visual and photographic observations of the Cinder Bank and Blue Mountain were made during a reconnaissance visit to Palmerton in November 1978. Descriptions of the Cinder Bank and selection of Blue Mountain, Cinder Bank and well sampling stations [Table 5 and Figure 21] were based on these observations and on a detailed site review in May 1979 just prior to the survey.

Table 5
CINDER BANK SAMPLING STATION DESCRIPTIONS
[See Figure for Key]

Station No.	Description
51	An intermittent seep along the south side of the roadway to the west end of the Cinder Bank. Location is due south of the Oxide East and Zinc Powder buildings.
52	The same as NJZ seep No. 1. This spring issues from an iron pipe at the southwest side of a small bog south of railroad tracks near where roadway first parallels the tracks enroute to east end of Cinder Bank.
53	The same as NJZ seep No. 2 and is in the middle of the same bog described above.
54	A small seep in the middle of the bog described above and is about midway between NJZ seeps Nos. 2 and 3.
55	The same as NJZ seep No. 3 which issues from an iron pipe at the eastern edge of the bog described above and flows directly into drainage beside railroad tracks.
56	A small rill flowing off of Blue Mt. at the junction of the mountain slope with the Cinder Bank about 50 yds (46 m) southwest of NJZ seep No. 4 and about 200 yd (183 m) east of Cinder Bank road crossing of railroad.
57	The same as NJZ seep No. 4 which flows into a pool along roadside about 50 yd (46 m) through Cinder Bank from Station No. 56.
58	The same as NJZ Cinder Bank sampling Station No. 5 which is a rill draining a large gulch on Blue Mt. 0.8 mi (1.3 km) west of the east end of the Cinder Bank.
59	The same as NJZ Cinder Bank sampling Station No. 6 which is a small rill draining through rocks into a small pond on South side of Cinder Bank roadway 0.6 mi (1 km) west of the east end of the Cinder Bank.
60	Equivalent to NJZ Cinder Bank sampling Station No. 6A which is a rill on Blue Mt. at the east end of the Cinder Bank and was sampled at the confluence of two rills about 50 yd (46 m) downstream of NJZ No. 6A.
61	A seep at the toe of the Cinder Bank about 200 ft (60 m) southwest of Aggregate's Bridge on south side of roadway along base of Cinder Bank.
62	A seep at the toe of the Cinder Bank about 150 ft (45 m) southwest of Aggregate's Bridge on the south side of the roadway along base of Cinder Bank.
63	A seep near the base of the Cinder Bank about 150 ft (45 m) southeast of Aggregate's Bridge on the south side of upper roadway.
64	The same as NJZ Cinder Bank sampling Station No. 7 and is located below the Cinder Bank at Aggregate's Bridge on the south side of Aquashicola Creek.
65	The same as NJZ Cinder Bank sampling Station No. 8 and is located along the south side of the road at base of the Cinder Bank and between the PP&L (Penn. and Power and Light) access road and the PP&L Substation.
66	The same as NJZ Cinder Bank sampling Station No. 9 and is immediately adjacent to and east of Station No. 65.
67	The same as NJZ Cinder Bank sampling Station No. 10 and is a seep issuing from the base of the Cinder Bank in the gutter of the road along the base of the Cinder Bank and south of Aquashicola Creek. This seep is about 30 ft (9 m) east of Station No. 66.

Table 5 (Continued)
CINDER BANK SAMPLING STATION DESCRIPTION

Station No.	Description
68	The same as NJZ Cinder Bank sampling Station No. 10A and issues from the base of the Cinder Bank by the side of the road along the base of the Cinder Bank and is due south of the PP&L (Penn. Power & Light) substation.
69 - 73	A group of seeps and rills which drain over bedrock from the base of the Cinder Bank to Aquashicola Creek along the 120 yd (110 m) stretch of the road east of Station No. 68 and along the base of the Cinder Bank.
74	A seep at the base of the Cinder Bank south of the Waste Acid Plant sludge storage area at the east end (head) of the drainage ditch southeast of the Acid Plant.
75	The same as NJZ Cinder Bank sampling Station No. 16, is southeast of PP&L substation and about 50 yds (45 m) east of NJZ Cinder Bank sampling Station No. 15 along road between base of Cinder Bank and Aquashicola Creek.
76	The same as NJZ Cinder Bank sampling Station No. 17, is southeast of the PP&L substation and about 100 yds (90 m) east of NJZ Cinder Bank sampling Station No. 16.
77	The same as NJZ Cinder Bank sample Station No. 18 and is about 150 yds (137 m) east of NJZ Cinder Bank sample Station No. 17 along south side of road at base of the Cinder Bank and above Aquashicola Creek.
78	The same as NJZ Cinder Bank sampling Station No. 18A and is located at base of Cinder Bank above Aquashicola Creek due south of old red farm buildings along highway east of Palmerton.
79	The same as NJZ Cinder Bank sampling Station No. 18B and is located at the fork in the road along the base of and near east end of the Cinder Bank and across the road from an experimental grass seeded plot.
80	The same as NJZ Cinder Bank sampling Station No. 18C and is located at base of the Cinder Bank about 25 yds (23 m) east of NJZ Cinder Bank sampling Station 18B and is in the same fork in the road.
81	The same as NJZ Cinder Bank sampling Station No. 19, is about 100 yds (90 m) east of 18C and on the south side of road just uphill of a deep gully which drains to Aquashicola Creek.
82	The same as NJZ Cinder Bank sampling Station No. 20, is about 100 ft (30 m) east of NJZ No. 19, is on the north side of the road in a deep gully beside a large boulder of consolidated "cinder" and drains to Aquashicola Creek.
83	At the lower culvert on a rill which drains off of Blue Mt. east of the Cinder Bank under PP&L's high tension line.
84	The NJZ diversion ditch around the east end of the Cinder Bank and was sampled at the culvert under roadway at the northeast corner of the base of the Cinder Bank and about 80 yds (73 m) west of the PP&L high-tension power line.
85	The City Center drain which traverses the park and discharges into Aquashicola Creek at the sewage treatment plant (STP). The sampling point was at the intersection of the drain with the driveway into the STP.
86	Drainage off of Blue Mt. at the Palmer Water Company maintenance building at the south side of the railroad tracks due south of the 6th Street Bridge.
87	The Cinder Bank drainage ditch adjacent to the weir at Station No. 06.
88	The combined flow of stations numbered 65, 66 and 67 and discharges to Aquashicola Creek through a culvert under the roadway at the base of the Cinder Bank east of Aggregate Bridge. Stations numbered 65, 66 and 67 are equivalent to New Jersey Zinc Co. stations numbered 8, 9 and 10.



**Figure 2. Blue Mountain Runoff, Cinder Bank Runoff and Seepage
and Groundwater (Well) Sampling Locations**

Physical Characteristics

The general physical size and nature of the Cinder Bank and its composition were based on visual and photographic observations as well as discussions with the New Jersey Zinc Company staff.

Blue Mountain Runoff

Sampling sites on Blue Mountain and at the City Center Drain in Palmerton were selected to represent local background levels of metals in waters which had not been in contact with the Cinder Bank or other plant site areas suspected or known to be contaminated with metals. Four sets of grab samples were collected from each of these stations, except those which did not flow continuously throughout the survey. Aliquots for analysis of both total and dissolved metals were collected in all cases and were preserved and filtered in accordance with standard methods. Temperature, specific conductance and pH measurements were made on each sample at the time of collections.

Cinder Bank Seepage and Runoff

Station numbers 61 to 82 and 87 are seepage and runoff from the Cinder Bank and compared with data from the Blue Mountain Runoff Stations are intended to provide a basis for qualitatively evaluating the effects of the Cinder Bank on the metals load in Aquashicola Creek. Four sets of grab samples were collected from each of these Stations, except those which did not flow continuously throughout the survey. Aliquots for analysis of both total and dissolved metals were collected in all cases and were preserved and filtered in accordance with standard methods. Temperature, specific conductance and pH measurements were made on each sample at the time of collections.

Well Sampling

Station numbers 91 to 98 are wells in the vicinity of the NJZ East Plant. One well, Station No. 95, was not sampled. Two sets of grab samples were collected from each of the other wells during the survey. Aliquots for both total and dissolved metals analysis were collected in all cases and were preserved and filtered in accordance with standard methods. Temperature, specific conductance and pH measurements were made on each sample at the time of collection. The resulting data were used to determine the extent to which metals infiltration in the sub-surface may have affected groundwater quality.

EFFLUENT CHARACTERIZATION

During May 1 to 15, 1979, the NEIC conducted wastewater characterization of the eleven permitted Outfalls (001-005, 010-012, 014-016) and four intake and background locations at the New Jersey Zinc East Plant.

Sampling Program

Table 6 presents the effluent characterization sampling program, detailing NEIC station numbers and descriptions, locations, [Figures 3 and 4] dates and hours of composite sampling, grab sampling Stations, and sampling and flow measurement methods. The basis of the program was seven consecutive days of 24-hour composite sampling at each of the seven major Outfalls and grab sampling at the four groundwater, runoff and intermittent discharges. In order to allow calculation of "net" concentrations and loads, the NEIC sampling program included concurrent monitoring of Aquashicola and Pohopoco Creek intake waters and Outfall 005 background waters originating from Blue Mountain on the south side of the East Plant.

Table 6
EFFLUENT CHARACTERIZATION SAMPLING PROGRAM
New Jersey Zinc - East Plant
Palmerton, Pennsylvania
May 1-15, 1979

NEIC Station No.	Station Description	Location	Sampling Period May 1979	Daily Composite Period	Method of Composite Sampling	Flow Measurement Method
01	Outfall 001	Walkway bridge over 001 discharge channel About 2 m (6 ft) upsewer of NJZ 3 foot Cippoletti weir	1-6 8-15	1700-1700 0600-0600	Automatic	NJZ 3 foot Cippoletti weir with NEIC recorder
02	Outfall 002	At the end of the 15 cm (6 in) ID pipe from which the waste stream is discharged	8-15	0700-0700	Manual	10 l (2 64 gal.) bucket and stopwatch
03	Outfall 003	At the end of the 30 cm (12 in) ID pipe from which the waste stream is discharged to Aquashicola Creek	8 9-10,11-12,14-15 ^a	Grab Samples Only 0700-0700	Manual	NEIC 90° V-notch weir with recorder
04	Outfall 004	At the 1.3 m x 1.3 m (4 ft x 4 ft) manhole about 3 m (10 ft) south of the main plant road and about 200 m (600 ft) upsewer of the 004 discharge	8-15	0700-0700	Automatic	NEIC 90° V-notch weir with recorder
05	Outfall 005	At the end of the 91 cm (36 in) ID pipe about 3 m (10 ft) upsewer of the NJZ 90° V-notch weir over which the waste stream is discharged	8-15	0800-0800	Automatic	NJZ 90° V-notch weir with recorder
06	Outfall 005 - Background 1	At NJZ 90° V-notch weir on 2 m x 2 m (6 ft x 6 ft) Square concrete runoff collection drain on north side of cinder bank	8-9 ^b	0700-0700	Manual	NJZ 90° V-notch weir
07	Outfall 005 - Background 2	At NJZ 90° v-notch weir about 2 m (6 ft) upsewer of large diameter conduit leading to Station 06	8-15	0700-0700	Automatic	NJZ 90° v-notch weir with NEIC recorder
08	Aquashicola Creek Intake	At NJZ No. 3 pump house near field station bridge; samples collected from wet well after screening	1-6 8-15	1700-1700 0600-0600	Automatic	NJZ DP Cell with Bailey Meter/Recorder
09	Pohopoco Creek Intake	At 91 cm (36 in) pressure main in Booster Pump House	8-15	0700-0700	Manual (Equal-volume)	None
10	Outfall 010	In the 010 discharge channel about 6 m (20 ft) upstream of the discharge to Aquashicola Creek	8-15	0700-0700	Manual	NEIC 45° V-notch weir

Table 6 (Cont'd.)
 EFFLUENT CHARACTERIZATION SAMPLING PROGRAM
 New Jersey Zinc - East Plant
 Palmerton, Pennsylvania
 May 1 - 15, 1979

NEIC Station No.	Station Description	Location	Sampling Period May 1979	Daily Composite Period	Method of Composite Sampling	Flow Measurement Method
11	Outfall 011	At manhole on 011 drain about 15 m (50 ft) south of main plant road	8-15	0700-0700	Manual	NEIC 90° V-notch weir with recorder
12	Outfall 012	At the end of the 30 cm (12 in) pipe from which the waste stream is discharged to Aquashicola Creek	8-14	Grab Samples Only		10 l (2.64 gal.) bucket and stopwatch
14	Outfall 014	At the 014 discharge to Aquashicola Creek on the upstream side of the No. 1 and 2 pump house intake structure	8-14	Grab Samples Only		Bucket and Stopwatch
15	Outfall 015	At the 015 discharge to Aquashicola Creek as it flows over the NJZ 90° V-notch weir	8-14	Grab Samples Only		NJZ 90° V-notch weir
16	Outfall 016	At the 60 cm x 60 cm (2 ft x 2 ft) concrete manhole on the 016 drain about 23 m (75 ft) upsewer from the discharge to Aquashicola Creek	8-14	Grab Samples Only		NEIC 90° V-notch weir
17	NJZ WWTP Influent	At the sump at the influent to the NJZ Waste Acid Treatment Plant	9-15	0700-0700	Manual (Equal-volume)	None
18	NJZ WWTP Effluent	At the overflow from the final clarifier at the NJZ Waste Acid Treatment Plant	9-15	0700-0700	Manual (Equal-volume)	None

a The composite sampling period at station 03 for these three days began at 0700 on the first day of each pair and ended at 0700 on the second.

b No measureable flow after 1105 on May 9.

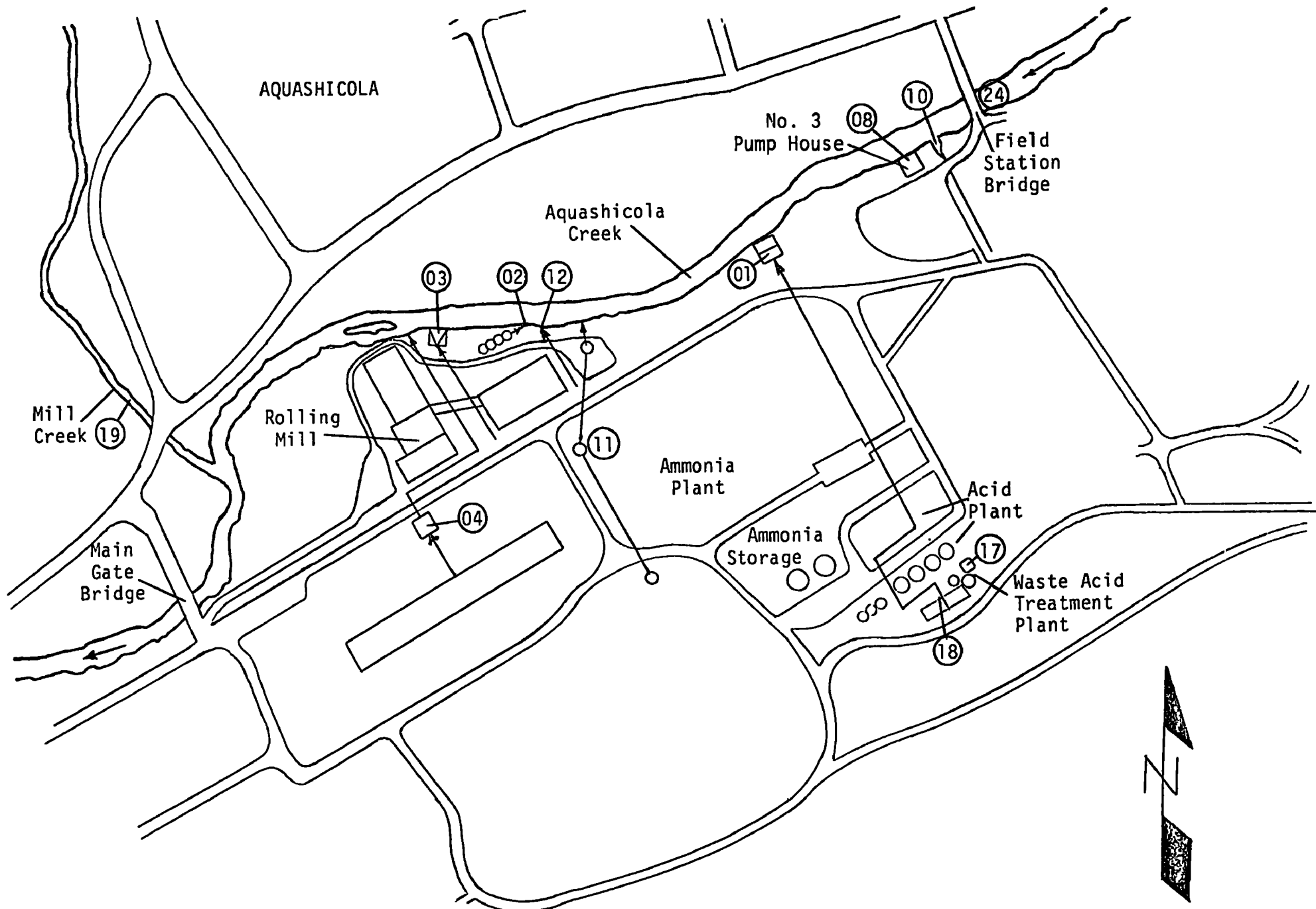


Figure 3. Effluent Monitoring Station Locations (East Half)
 New Jersey Zinc Company - Palmerton, Pennsylvania
 May 1-15, 1979

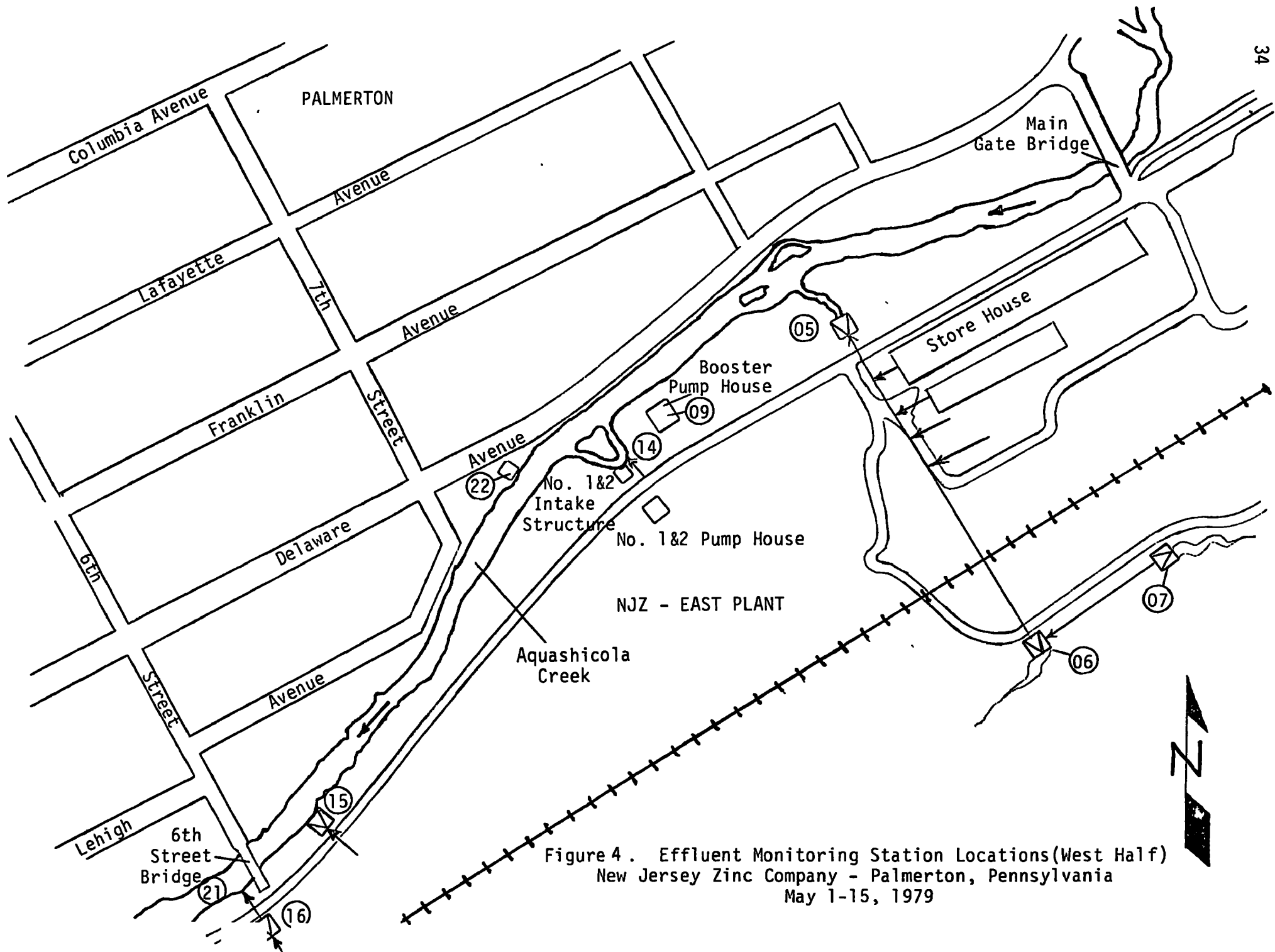


Figure 4. Effluent Monitoring Station Locations(West Half)
 New Jersey Zinc Company - Palmerton, Pennsylvania
 May 1-15, 1979

During the period May 1 through 6, monitoring was conducted for five extra days at the main process discharge [Outfall 0011] and the Aquashicola Creek Intake. It was learned on May 1 that the Company would soon be shutting down portions of the acid plant: the No. 3 roaster on May 5 and one Peabody scrubber on May 6. The extra five days of monitoring allowed comparison of effluent characteristics at Outfall 001 before and after the process change. The Aquashicola Creek Intake was sampled to allow determination of "net" discharges.

At each Station where automatic sampling is specified, individual aliquots of the discharge were collected hourly by a SERCO automatic sampler and composited on a flow-weighted basis after each 24-hour period. At manual composite stations, individual aliquots of the discharge were collected at two-hour intervals and continuously composited on a flow-weighted basis.* All composite samples were analyzed for total suspended solids (TSS) and total and dissolved metals. The grab samples collected daily at Outfalls 012, 014, 015 and 016 were also analyzed for these parameters. At Stations 01 to 09, two grab samples for oil and grease were collected daily during the May 8 to 14 period.

Flow Measurement

The flow measurement method used at each sampling location is listed in Table 6. Flow was recorded continuously at the five automatic sampling stations, and the flow charts were used for flow compositing at the end of each 24-hour sampling period. At the five stations where flow was measured manually, instantaneous flows were measured each two hours, concurrent with collection of each composite aliquot, allowing for flow-weighting of the aliquot. These instantaneous flows were recorded in the field data records for each Station.

* Exceptions to this were Stations 09, 17 and 18 where the samples were composited on an equal volume basis. In addition, the sampling interval at Stations 17 and 18 was four hours rather than two.

At each of the five Stations (01, 05, 06, 07, 15) where a NJZ weir was used to measure flow, the devices were inspected by NEIC personnel during the set-up portion of the survey. In all cases, the devices were found to meet the requirements* for proper installation. An NJZ differential pressure cell used to measure the flow at the Aquashicola Creek Intake was calibrated by Company personnel on May 5. This calibration was observed by NEIC personnel. The NJZ flow recording instrument at Outfall 005 was calibrated by NEIC personnel before the start of the sampling program.

Field Measurements

Field measurements for pH and temperature were performed daily at each of the 17 listed stations [Table 6]. At Outfall 001 (Station 01) the pH of the discharge was measured and recorded continuously in accordance with the permit monitoring requirements.

Bioassay Tests

From May 8 to 17, 1979 a series of screening** and 96-hour continual flow-through bioassay tests were conducted on selected effluent discharges of the New Jersey Zinc East Plant at Palmerton, Pennsylvania. The purpose of the tests was to measure acute toxicity of the effluents toward trout.

Screening tests were 24-hour static bioassays done on Outfall 001, 002, 003, 004, 005, 010, and 012. The tests consisted of exposing 10 fish to four concentrations (100%, 50%, 25%, 10%) of each effluent

* Water Measurement Manual, U.S. Department of Interior; Bureau of Reclamation, Second Edition, 1967, pages 7-42.

** A preliminary, short term, static range finding test used to determine the concentrations of effluent to be used in a 96-hour flow through bioassay.

as well as a dilution water control. Test chambers were of all glass construction and 38 liter (10 gal) capacity. Test chambers were not aerated prior to or at any time during the 24-hour exposure period. All test chambers were monitored for pH, temperature and dissolved oxygen concentration immediately prior to and at the completion of each test.

Continual flow 96-hour bioassays were done on Outfalls 001 and 011. The tests were performed according to EPA Standard Methods*. A proportional diluter was used to provide a series of six effluent concentrations and a 100% dilution water control. Test chambers were of all glass construction and of 8-liter capacity. Flow rates were regulated to deliver a minimum of nine volumetric exchanges of test solution to a test chamber for a 24-hour period. Each test chamber contained ten fish and each concentration was done in duplicate, exposing 20 test fish per test concentration.

The test fish used were "young of the year" rainbow trout (Salmo gairdneri) averaging 46mm total length. The fish were obtained from the Lamar National Fish Hatchery and acclimated to Aquashicola Creek water for a minimum of 96-hours prior to testing.

Dilution water was obtained from Aquashicola Creek at the Harris Bridge (Station 27). The dilution water was stored in 1100-liter (300 gal) epoxy-coated wooden reservoirs and was replenished daily. Effluent from Outfall 001 was obtained by direct and continuous pumping to the bioassay laboratory. Effluent from Outfall 011 was obtained from single, daily 113-liter (30 gal) grab samples.

All test chambers were monitored daily for pH, temperature, and dissolved oxygen concentrations. In addition, the high and low concentrations were analyzed for total alkalinity. Water temperature in

* Environmental Protection Agency, 1978 "Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organism", EPA-600/4-78-012 revised July, 1978.

the test chambers was maintained at $17^{\circ}\text{C} \pm ^{\circ}\text{C}$ by use of a constant temperature, recirculating water bath.

Mortalities in each test chamber were recorded at 24-hour intervals. Dead fish were removed whenever observed. The 96-hour LC_{50} values were estimated using EPA approved statistical methods.

IV. PROCESS INVESTIGATIONS

RECONNAISSANCE INSPECTION

Prior to conducting the field survey, process inspections were conducted to determine operating practices, raw material uses, waste treatment and disposal methods. The inspections were conducted November 28 to 31, 1978 and March 6 to 9, 1979, and consisted of extensive interviews between NEIC and Company officials. East process was described in detail by the Company officials, then those processes located at the East Plant were verified by NEIC personnel. Plant personnel were also interviewed concerning procedures and operating methods.

Observations During Survey

During the reconnaissance inspections, operating procedures were observed by NEIC personnel, including number of units in service, wastewater flows, and air emissions. In May 1979, NEIC personnel again observed the operating procedures to determine if production had been modified or altered during the field survey.

Several changes had been made prior to the survey. The No. 3 roaster in the Acid Department was shut down from 3:00 p.m. on May 5 to 9:45 p.m. on May 28. The Company had informed NEIC several weeks prior to the survey that this roaster would be down for its scheduled maintenance. Because each roaster provides the SO₂ gas for its acid plant, the acid plant production was decreased by approximately 33%. The amounts and quality of wastewater discharged from NPDES Outfall 001 were affected by this shutdown. The decrease in flow was estimated by Company official to be 5,450 m³/day (1.44 mgd).

The No. 2 roaster was also down from 7:15 a.m. to 12:40 p.m. on May 8 because acid was leaking to a sewer which flows to Outfall 001. A new acid addition system had been installed prior to the NEIC survey and had not been thoroughly checked. As acid was being added to new acid tanks, it was leaving the tanks through an open valve. Company officials decided to use the old tanks until after the survey, then the new system would be fully checked before being placed on line. The roaster was shut down for the 5½-hour period to convert the acid addition system back to the older tanks. Company personnel stated that they noticed the problem only after the No. 3 roaster had been shut down and acid may have been leaking into the sewer for several days.

Normally, water for process use and cooling is obtained from Aquashicola and Pohopoco Creeks, however, with the No. 3 roaster down, a Company representative thought that the East Plant was being supplied entirely by Aquashicola Creek.

On May 9, a brown substance was being discharged from Outfall 001 at 11:00 a.m.. This was reportedly due to maintenance work on a Peabody scrubber; the trays were being washed down and the wastewater was discharged to a surface drain.

PRODUCTION FACILITIES

The East and West plants comprise the NJZ production facilities in Palmerton, Pennsylvania. The East and West plants are connected by a narrow gauge railroad which transports raw and intermediate products between processes. The East Plant consists of the acid, ferroalloy, oxide-east, and rolling mill operations while the slab zinc and oxide-west processes are located in the West Plant. Support services for the plants are located in three office buildings near the center of Palmerton. Today the facility employs 1,500 people including hourly and salaried personnel.

Products and the rated capacity are shown in Table 7. Production of the zinc alloy Spiegeleisen, a residue from the Waelz kiln operation treated in the electric furnace, ceased in 1976. A schematic of the process flow from raw materials to the finished products is shown in Figure 5.

PROCESS DESCRIPTION EAST PLANT

Raw Materials

Raw materials are brought into the East Plant for storage. Zinc sulfides are transported from the NJZ Friedensville, Pennsylvania mine, located about 56 km (35 miles) from Palmerton. Zinc silicates and oxides are transported approximately 113 km (70 miles) from NJZ's Ogdensburg, New Jersey mine. Additional materials are purchased from Canada and other areas, or supplied by NJZ mines in Tennessee and Virginia.

The concentrates are stockpiled either in the 25,00 ton storage building (completed in August 1975) or on the ground adjacent to the building. Because the raw material has varying concentrations of zinc, sulfur, silicates, and oxides, the concentrates are stockpiled by composition. The storage areas inside the building are segregated by concrete walls forming bins. The concentrates are transferred into the storage building via a belt conveyor which discharges into the bins. To reduce fugitive emissions, the storage building is kept under negative pressure; the suction is provided by a baghouse. Fines from the baghouse are returned to the building via screw conveyor. The baghouse is not very effective according to NJZ officials, however the atmosphere in the building is not dusty because the concentrates are fairly moist and settle rapidly.

Some of the raw material stored outside is covered with canvass or plastic, however most of the material is exposed. Runoff from the

Table 7
 PRODUCTS AND PRODUCTION CAPACITIES
 NEW JERSEY ZINC COMPANY
 PALMERTON, PA

Product	Capacity m tons/day	tons/day
Ammonia	100	110
Carbon dioxide	100	110
Cadmium	0.45	0.5
Metal Powder	19	21
Sulfuric Acid	454	500
Zamak Alloy	45	50
Zinc Metal	272	300
Zinc Dust	27	30
Zinc Oxide (French Process)	118	130
Zinc Oxide (American Process)	145	160

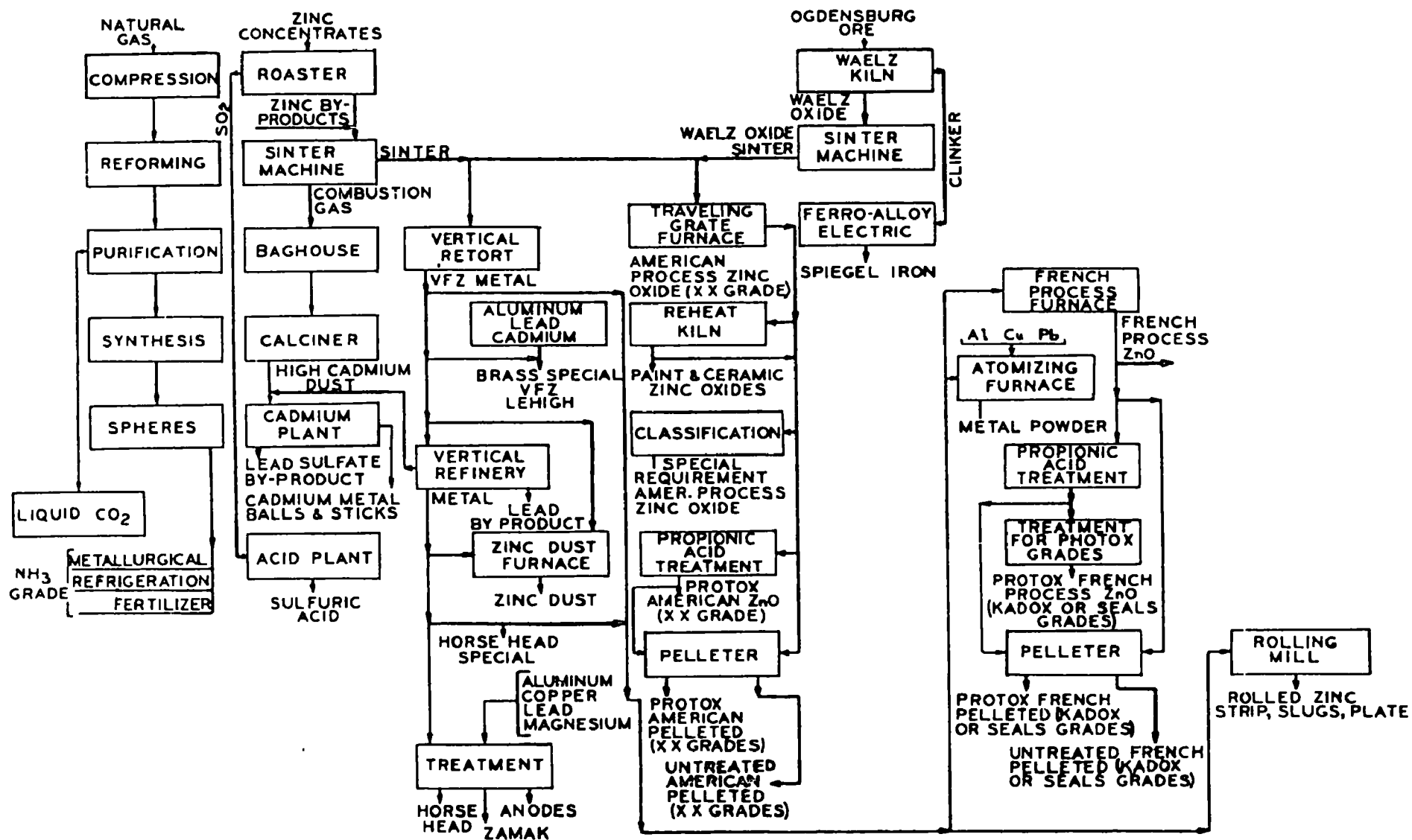


Figure 5. Process Flow Sheet Raw Materials to Finished Products

New Jersey Zinc Company

Palmerton, Pa.

storage area is not collected to prevent it from reaching Aquashicola Creek.

Additional raw materials, coal, limestone and bentonite clay, are stockpiled adjacent to the ferro-alloy department between the north side of the railroad trestle* and the cinder bank. Runoff collects behind the trestle and is removed by pumping to the south side of the trestle to storm drains which empty into the Aquashicola Creek via NPDES Outfall 005. There are storm drains between the cinder bank and the storage area, but runoff from the storage area does not reach these because the land slopes away from the drains to the trestle.

Roasting

Concentrates containing excessive moisture are dried to less than 5% moisture in gas- or oil-fired rotary dryers before discharging to the storage bin [Figure 6]. There are two stub-shaft flash roasters, both about 7.6 m (25 ft) in diameter. The combustion chamber in one is 8.5 m (28 ft) high and the other 9.8 m (32 ft) high. The roasters, operated in parallel, are designated Nos. 2 and 3; No. 1 no longer exists. The dried concentrates are discharged from the storage bin into the roaster drying hearths. The discharge from the lower drying hearth is ground to approximately 93% - 325 mesh in wind-swept ball mills. The finely ground concentrate is collected by a cyclone and blown into the top of the combustion chamber with air in excess of that required for conversion of the zinc sulfide to zinc oxide, and of the sulfur to sulfur dioxide. Each roaster is provided with two grinding systems and two concentrate burners which, with the dual gas handling systems, enable operation at 2/3 of capacity. The roasted concentrate collected on the two hearths under the combustion chamber is discharged from the roaster to the sinter plant.

* The incoming raw material is off-loaded into process feed bins or onto the storage area on the north side of the trestle.

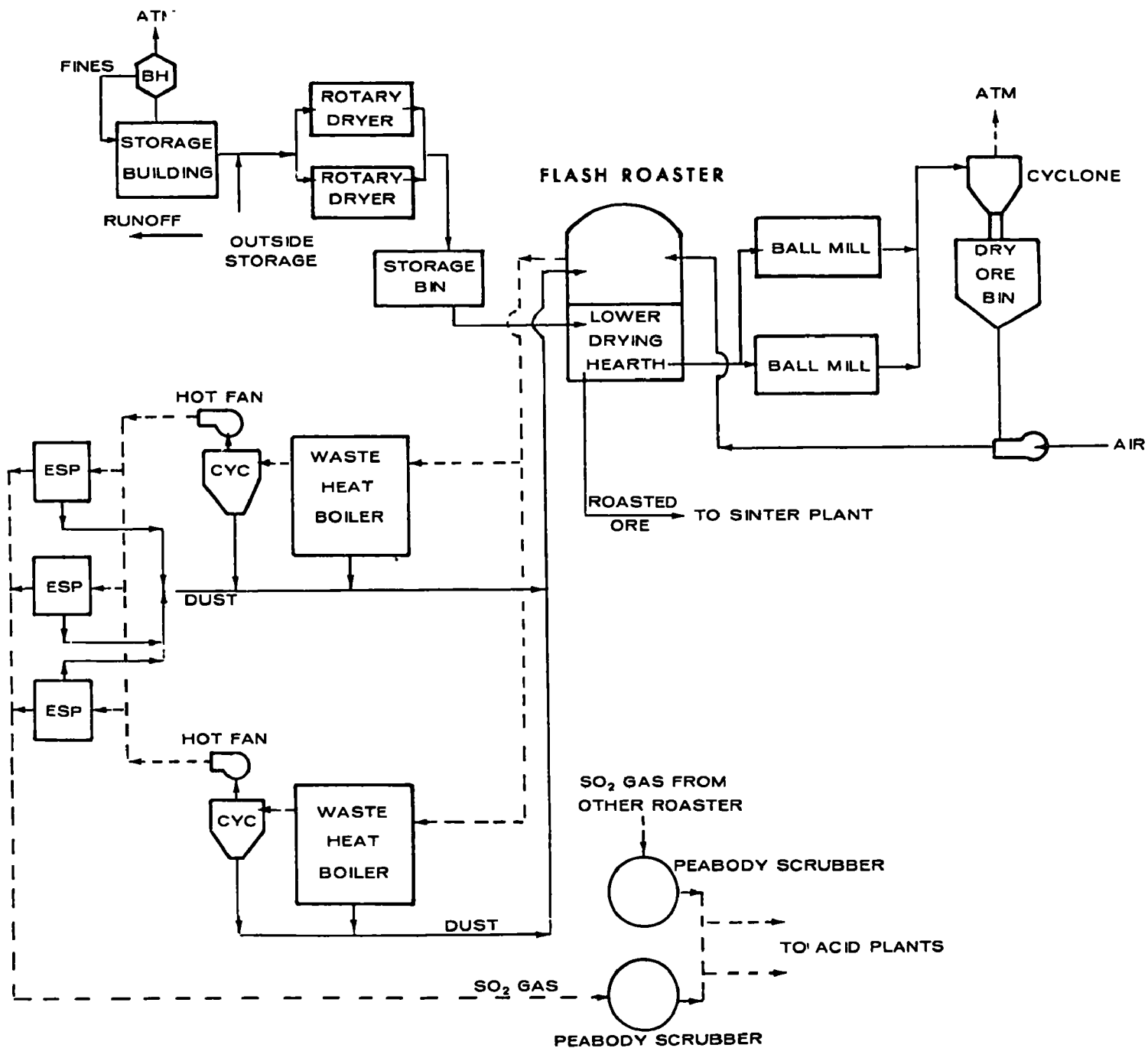


Figure 6. Raw Material Handling And Roasting Process
New Jersey Zinc Company, Palmerton, PA

The 1,000°C gas containing 7 to 8% sulfur dioxide is continually withdrawn from each roaster. Each roaster has a dual gas handling system consisting of two single pass, water-tube waste-heat steam boilers (450 psig) and two cyclones with hot fans. The gas from the hot fans is collected in a manifold system connected to three electrostatic precipitators (ESP's). Each roaster dual gas system is served by three ESP's, operated in parallel. About 50% of the roaster feed is collected as dust and returned to the roaster. The SO₂ gas is washed and cooled further by water sprays in two cooling towers (Peabody scrubbers), one for each roaster, and converted to sulfuric acid in the two acid plants.

Fugitive emissions are partially controlled with three MikroPulse* baghouses; there are about 100 pickup points throughout the roasting area. The recovered material is returned to the feed preparation operation.

The roasters run about 11½ months/year, 24 hours/day, 7 days/week. Each roaster is shut down for maintenance for 2 weeks, one roaster in May and the other in October.

Acid Production

The gas from the roaster ESP's passes through the Peabody scrubbers operated in parallel, to remove particulates and cool the gas [Figure 7]. Aquashicola Creek water is used for the Peabody scrubbers on a single-pass basis and is discharged to the wastewater treatment plant. After passing through the scrubber, the washed gas can be sent to either Leonard-Monsanto acid plant, however each acid plant uses its own roaster about 90% of the time.

* MikroPul Corporation

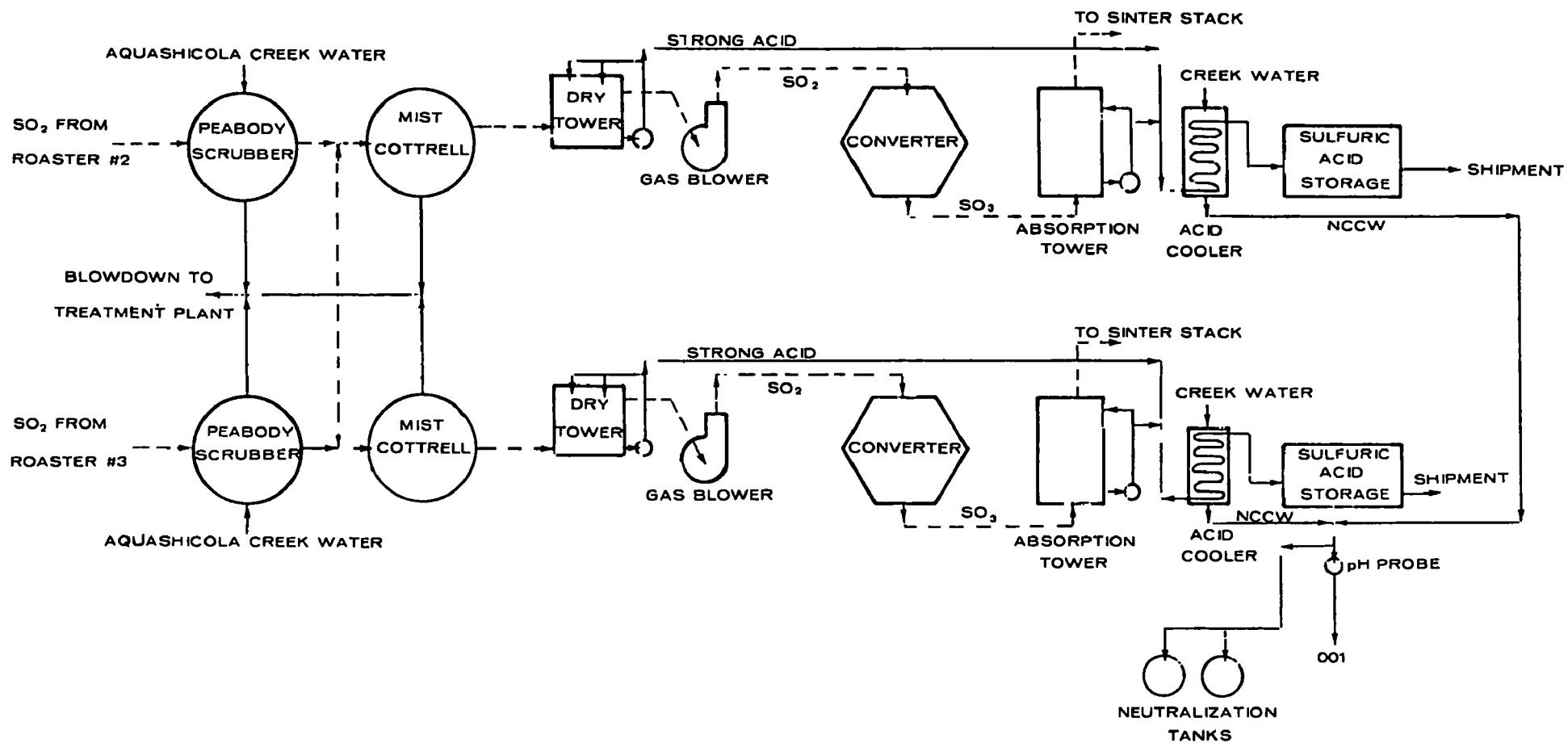


Figure 7. Sulfuric Acid Production, New Jersey Zinc Company, Palmerton, PA

The washed gas from the scrubbers passes through Cottrell acid mist eliminators and then through a ceramic packed tower for drying by contact with sulfuric acid. The blowdown from the Cottrell units is discharged to the wastewater treatment plant. The gas is pulled from the Cottrell mist eliminator through a blower to a converter which changes sulfur dioxide to sulfur trioxide with a vanadium pentoxide catalyst. The SO_3 is sent to an absorption tower where strong sulfuric acid is continually recirculated. The unabsorbed gas from the absorbing tower is sent to the sinter process stack. The SO_3 is absorbed in the strong acid which is sent through an acid cooler. Cooling water from Aquashicola Creek is sprayed on the acid cooler cast iron pipes (heat exchanger) on a once-through basis. The cooled acid is stored in 4 large and 3 small steel tanks prior to shipment. About 70% of the acid is shipped by truck and the rest by railroad tank car.

The non-contact cooling water from the acid cooler is discharged to Aquashicola Creek via NPDES Outfall 001. If there is a leak in the acid coolers, the pH is sensed and the water collected in the basin underneath the coolers is pumped to 2 neutralization tanks adjacent to the wastewater treatment plant. Feed water pumps to the coolers are shut off and diversion pumps turned on manually when the diversion pumps are off, the cooling water overflows the basin to the pH probe.

Two grades of acid are produced, 99% 66°Be and 93% 66°Be . The latter is traded to a Company in the Philadelphia, Pennsylvania area which ships directly from Palmerton to its customers. The Philadelphia Company in turn supplies 93% acid to NJZ's Gloucester City titanium dioxide plant.

Sintering

The sintering process is located in the acid production area. The roasted concentrates from the roasting operation are processed in

a Dwight-Lloyd downdraft sintering machine to change the physical structure to one more amenable to vertical retort smelting and for cadmium and lead elimination [Figure 8].

Approximately 23 m tons (25 tons)/hour of roasted ore are "conditioned" with water or zinc sulfate solution recycled from the cadmium metal production sponge tank, mixed with anthracite cool dust and recycled fines in a pug mill. When the cadmium plant is not running, water is added as the conditioner. This mix is fed to rotary drum pelletizers. The pellets are fed to the sinter machine and placed on top of a hearth layer consisting of large size return sinter. The hearth layer is on top of a moving grate. The bed passes under a fuel oil-fired ignition box, and due to the downdraft, ignition proceeds downwardly. Just before the discharge side of the sinter machine, rotating scalper removes the top portion of the bed from which most of the lead and cadmium has been removed. With each pass through the sinter machine, lead and cadmium are driven off as a fume through the sinter grate. (Less than 50% of the sinter material is recycled). The downdraft fume and combustion products are sucked through a cyclone and fan and collected dry in a baghouse. The gas from the baghouse is emitted through the 300 ft. stack; the baghouse fumes are calcined and sent to the cadmium production area. The recovered material from the cyclone is returned to the belt conveyor under the sinter machine.

The scalped material is removed to two finished sinter bins which feed two rod mills. Water is added to the sinter product for dust control after grinding in the mills before being delivered to the Slab Zinc Department for metal production. The remaining cake on the moving grate, after scalping, is crushed and recycled to the pelletizing system.

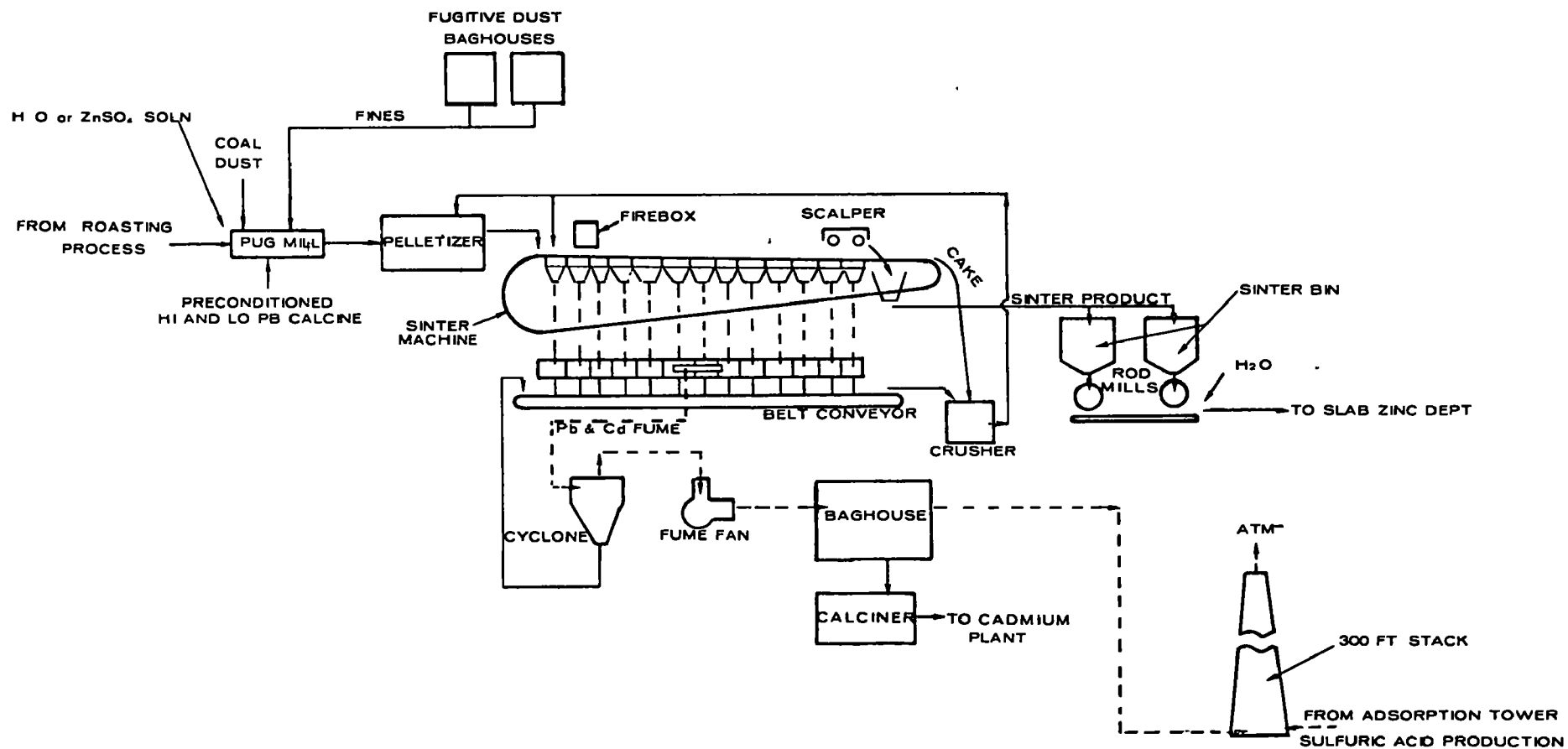


Figure 8. Sintering Process Acid Department, New Jersey Zinc Company
Palmerton, PA

The fugitive dusts are controlled with two Mikro-Pulse air bag-houses. The collected material is returned to the feed preparation equipment.

The sintering operation is the major source of cadmium, lead, and zinc emissions (through the 300 ft. stack). The particulate emissions are between 0.04 and 0.05 grains/ft³ which exceed the State regulation of 0.02 grains/ft³.

There are no wastewater sources in the sintering process.

Cadmium Metal Production

Cadmium metal is produced on a batch basis requiring from 3 to 4 days [Figure 9]. The operation is dependent upon the amount of stored sinter fume; each batch requires 4,535 to 5,440 kg (10,000 to 12,000 lb) of sinter fume. The production runs 24 hours/day, 7 days/week.

The calcined sinter, which is fine and dense, is ground in a wet ball mill and pumped to a wash tank to make a slurry. The slurry is pumped to a leach tank and mixed with sulfuric acid. The amount of acid added varies depending upon the acidity of the water in the wash tank. About 10 grams/liter of SO₄ is required in the leach tank. Lead sulfate is precipitated in the leach tank, filtered in a plate and frame press, drummed and sold. The filtrate from the press is pumped to a purification tank, mixed with limestone (for pH control 4.5 - 4.8), and potassium permanganate (oxidizer). After purification, the underflow is pumped to another plate and frame press. The residue waste from the press is recycled to the wash tank. The filtrate is sent to the sponge tank (called sponge because of texture of material) and mixed with zinc dust to displace the cadmium. The zinc dust is made in the Slab Zinc Department. The zinc sulfate solution from the sponge tank is sent to the sinter process.

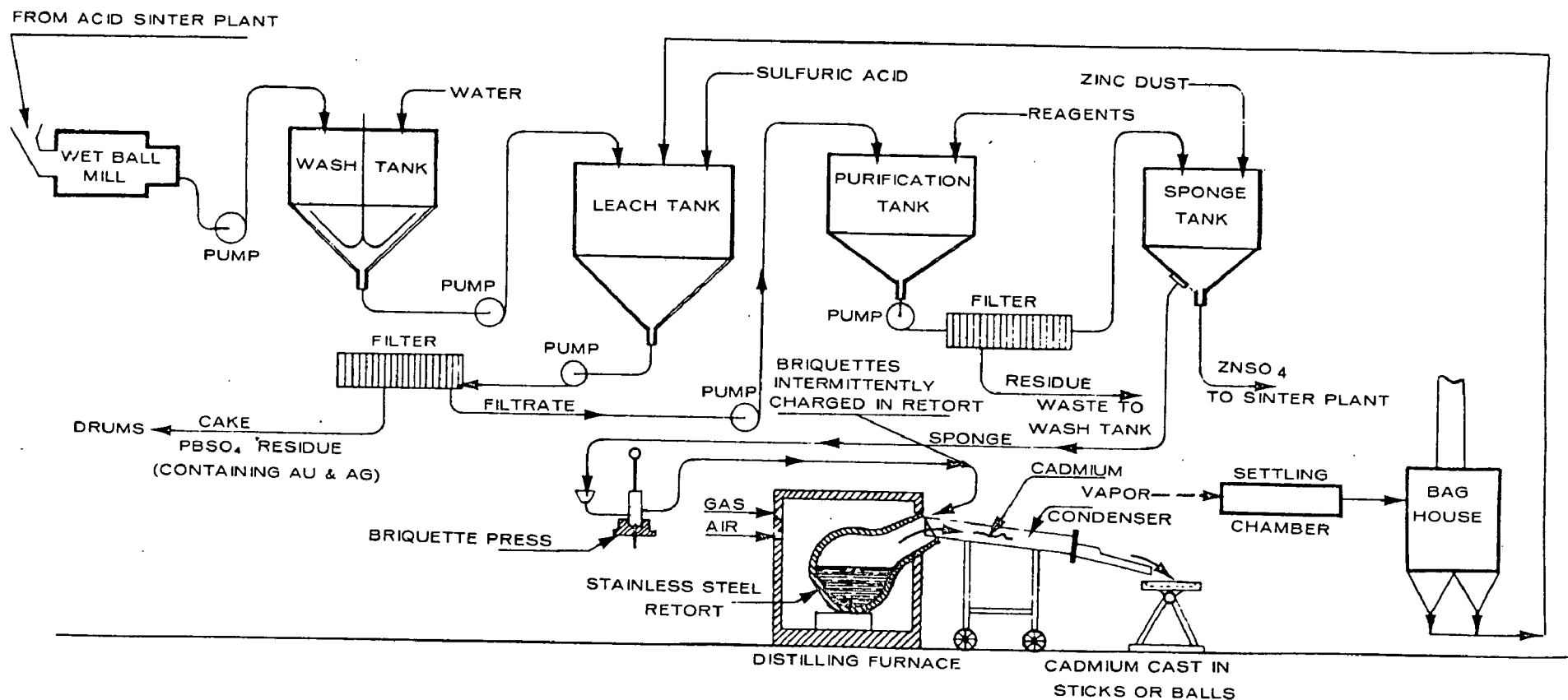


Figure 9. Cadmium Metal Production, New Jersey Zinc Company, Palmerton, PA

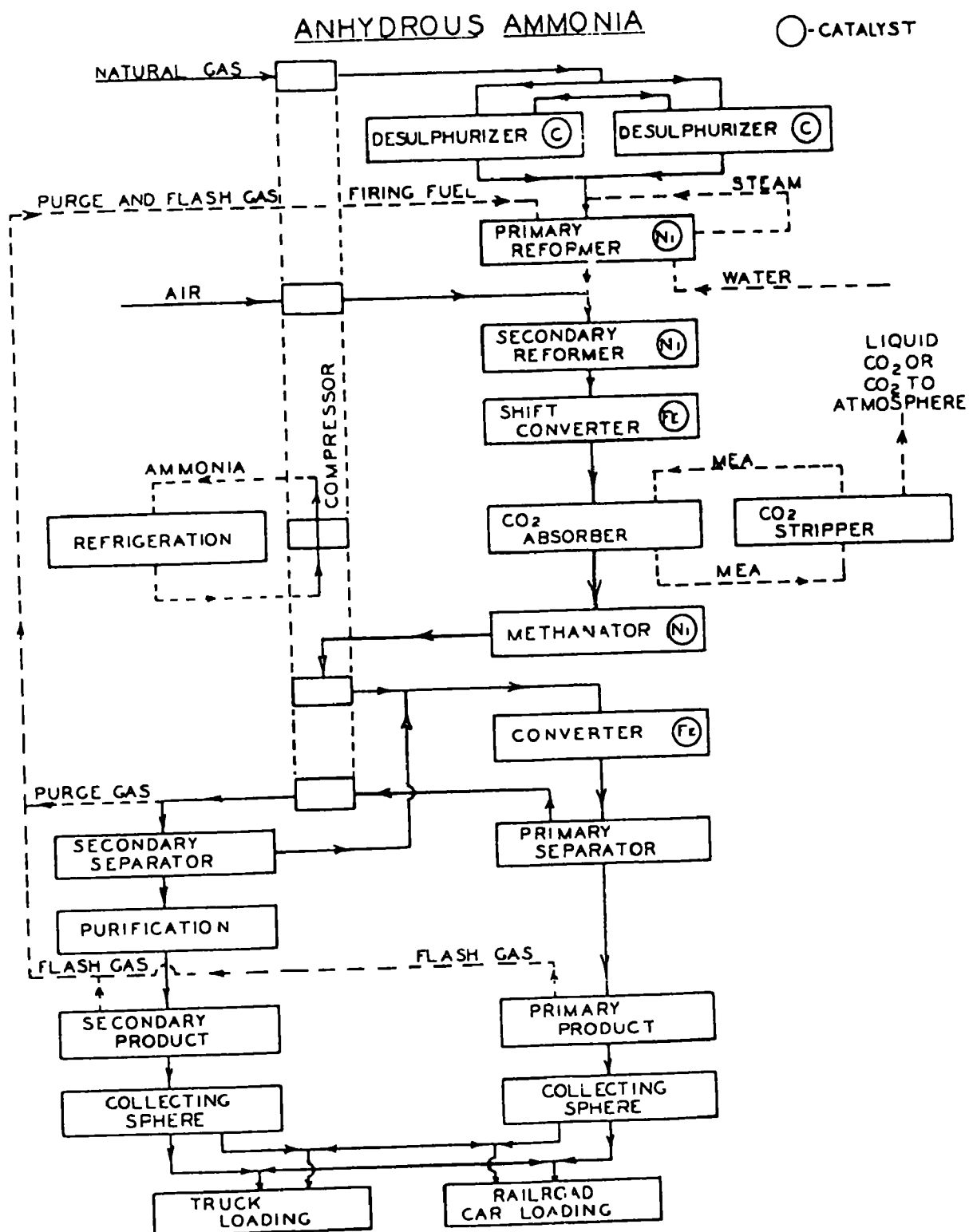
The sponge material is pressed into briquettes which are placed in a steel retort bottle, about 1.2 m (4 ft) high and 0.6 m (2 ft) in diameter and distilled in a furnace. Cadmium vapors are condensed in an air condenser and the cadmium flows onto a mold stand or into a melting pot for casting. Vapors from the distilling furnace and casting pot are collected in a hood over the mold area and sent to a settling chamber followed by a baghouse. The baghouse fines are placed in drums and recycled to the leach tank. The retort residue is dumped into a box which is vented to the baghouse. The semidry residue powder containing 60 to 65% cadmium, zinc, and high temperature refractory materials go to an experimental sponge tank, and then transferred to the sponge tank. The bottle residue can be recycled through the entire process if not placed in the experimental sponge tank.

The baghouse is reportedly 98% efficient, but a test has not been conducted to confirm this. There is no visible plume. Based on a material balance, the process loses 0.07 kg (0.15 lb)/hr which is equivalent to 0.02 grains/ft³. The State standard is 0.04 grains/ft³. The stack is 8.5 m (28 ft) high and the gas temperature is 49°C (120°F). The bags are replaced on a specified cycle. The discarded bags are hauled away for disposal by a commercial carrier.

Wastewater produced is minimal and recycled. Liquid from the briquette press is collected in a floor drain and recycled to the wash tank. Gutters have been placed around the wet processing area and spills are recycled.

Anhydrous Ammonia Production

Anhydrous ammonia is produced 24 hours/day, 7 days/week. The plant was installed in 1963 and has a nominal capacity of 100 m tons (110 tons)/day [Figure 10].



**Figure 10. Anhydrous Ammonia Production
New Jersey Zinc Company
Palmerton, Pa.**

Carbon dioxide from the stripper is compressed and chilled for liquifaction, then stored in 200 ton insulated cylinders. The CO₂ is very pure and the plant is Kosher. The CO₂ is purchased by Carbon Air and Liquid Carbonic. When the CO₂ plant is shutdown, the CO₂ is vented to the atmosphere. Water and ammonia are used to chill the CO₂ gas. The chill water: 1,135 liters/min (300 gpm), is discharged to Aquashicola Creek via NPDES Outfall 001.

Non-contact cooling water (NCCW) from Aquashicola Creek, recycled through a cooling tower, is chemically treated before use. A chromate solution supplied by BETZ is added along with sulfuric acid and chlorine. The blowdown from the cooling tower, 38 liters/min (10 gpm), is sent to the wastewater treatment plant. The cooling tower has a throughput of 17 to 18 m³/min (4,500-4,800 gpm). Compressor condensate [15 l (4 gal)/day], passes through an oil trap and is discharged through Outfall 001.

The desludgers are regenerated every 15 days with natural gas which flows back into the natural gas line. Previously, the desludgers were regenerated with steam. The heavy hydrocarbons from regeneration were put in 55 gal drums and hauled away commercially to an oil reclamation facility.

Flash gas is returned to the reformer for firing. Therefore, the only emission is from the 2,00 ton ammonia storage spheres. These two low pressure spheres, 28 to 30 lbs, vent to the atmosphere when the pressure builds up.

Ferro-Alloy Waelz Process

Ore from the Sterling mine at Ogdensburn, New Jersey consists of approximately 30% franklinite, an oxide of zinc, iron and manganese; 32% willemite, a silicate of zinc; slightly less than 2% zincite, an oxide of zinc; and 56% combined gangue silicates and carbonates. The ore is

lead-free. As mined, Sterling ore assays 15 to 23% zinc. The ore is crushed and screened at the mine before being shipped to Palmerton.

Because Sterling ore is not amenable to flotation, recovery of the zinc is by means of reduction, vaporization and oxidation in four Waelz Kilns [Figure 11]. The kiln charge consists of ore mixed with proper amounts of anthracite coal and limestone which is conveyed to the kilns from the storage bins. Water is added to the charge as a conditioner to moisten and agglomerate the feed so that it does not carry over in the zinc oxide fume which leaves the kiln at the charging end. Prior to July 1976, a filter slurry was added to the charge. The slurry was from the scrubber water treatment system for the ferroalloy (Spiegeleisen) electric furnace. After the electric furnace was shutdown in July 1976, water has been used as a conditioner.

There are four kilns: Nos. 1, 2, 3, and 5. Number 4, not in use, is a smaller kiln and was used to reheat material for the electric furnace. The four kilns range in size from 3 m (10 ft) in diameter by 43 m (140 ft) long to 3.7 m (12 ft) in diameter by 49 m (160 ft) long. Feed to the kilns ranges between 9 to 11 m tons (10 to 12 tons) per hour, depending upon the kiln size and charge conditions. Only three kilns are used, the fourth is used as a standby unit. While the heat developed by the oxidation reactions resulting in ZnO and CO_2 is usually sufficient to sustain the zinc reduction, additional heat can be supplied by burning pulverized bituminous coal, oil, or natural gas.

The charge is fed into the kiln above the dust chamber. A hot fan pulls a suction on the kiln. As the ore travels through the kiln, the zinc is vaporized and oxidized and pulled from the feed end of the kiln through the hot fan to a baghouse. The pipes between the kiln and fan, and fan and baghouse, are several hundred ft long to allow for cooling to protect the bags. Excess air can be added to the pipes for additional cooling. The hot fans move air between 914 to 1,220 m (3,000 to 4,000 ft)/minute. Excess air, 110,000 scfm, is supplied at the fuel side

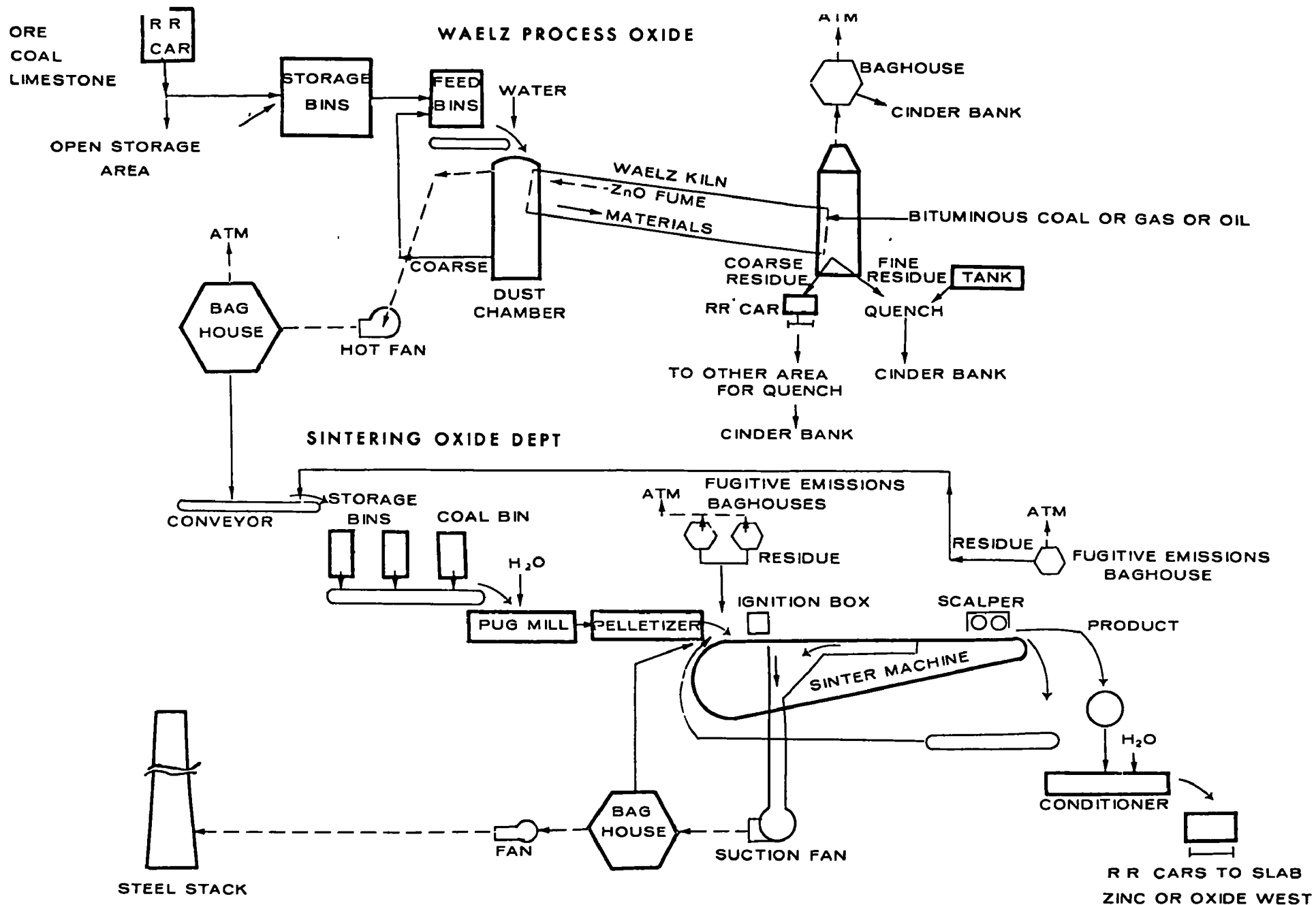


Figure 11. Ferro Alloy Process, New Jersey Zinc Company, Palmerton, PA

of the kiln. The automatic 10-compartment dust tube chamber collects both the coarse products which are recycled to the bin preceding conditioning and the zinc oxide from the gas stream previously cooled by radiation losses and introduction of ambient air.

The solid residues, containing 20 to 24% iron and 10% manganese are discharged from the kiln. A pneumatic ram bar and Cardox CO₂ charges (inserted in the kiln from the outside) are used to break up the large agglomerates in the kiln. The solid residue was processed in two 9,000 KVA, 3 electrode, open-arc electric furnaces where the iron and the manganese were recovered as a nominal 20% manganese iron called Spiegel-eisen.

The residue is now hauled by the interplant railroad to the Cinder Bank for disposal. The fine solid residue is conveyed to the ground below each kiln (except kiln No. 1) and quenched. There are three quench water supply tanks, one for each kiln (2, 3, and 5). After quenching, the fines are loaded into railroad side-dump cars for disposal. The coarse residue from the kilns falls directly into railroad cars and is hauled to another area of the East plant for quenching. The fine residue from kiln No. 1 also falls into the railroad car with the coarse residue. The coarse residue is quenched in the railroad cars, removed by crane, then placed inside dump cars for disposal. There are not sufficient side-sump cars to eliminate the transfer operation after quenching. The quenching of the coarse material is done at another location to prevent the moisture from quenching from reaching the baghouse.

The quench areas below the kilns for the fine residue do not have a discharge or sewer line. The water either remains on the ground or is liberated as steam. The coarse quench water is sprayed onto the railroad cars. Some of the water spills to the ground and collects in pools. There is no sewer line serving this area.

There are three large baghouses, all located in one building. The piping is such that all of the kilns can use all of the baghouses. There is one small baghouse common to all of the kilns and fugitive emission control.

One significant source of air pollution can occur at the fuel end of the kiln where the residue exists. Certain conditions in the kiln can occur which result in puffs of gases and fumes being released. Hoods have been placed at the exit ends to collect the emissions. The hoods are connected to one common baghouse. The residue from the baghouse is hauled to the Cinder Bank. During the November 1978 reconnaissance, the baghouse had been in operation for 30 days and had a 60-day operating permit from the State.

The zinc oxide (ZnO) recovered by the baghouses is sintered on a 1.1 m (3.5 ft) wide by 10 m (33 ft) long downdraft machine in exactly the same manner as that used for the roasted sulfide concentrates. The ZnO material and anthracite coal (dust type) is conveyed to a pug-mill and thoroughly mixed. The mixture is pelletized and fed to the traveling grate sinter machine. Fuel oil is used for ignition. The downdraft created by the suction fan is collected in a baghouse before exiting through an 18 m (60 ft) high by 1.8 m (5.9 ft) diameter steel stack.

The scalper at the end of the sinter machine removes the product from the top of the moving bed; the scalped material is ground in a rod mill. The lower bed material is recycled to the pelletizer. The sintered product is conditioned with water after the pelletizing, placed in railroad cars and transported to the Slab Zinc Department vertical retort process or to Oxide West.

Fugitive emissions in the sinter plant are collected by three separate dust control systems. Two pulse jet baghouses (with a single fan for both) serve the feed end area of the sinter machine and a third

baghouse serves the product end of the machine. The residue from the two baghouses at the feed end is returned to the sinter machine. The residue from the third baghouse is collected in drums and dumped onto the conveyor from the Waelz Oxide Process which feeds the storage bins.

The sinter building is not in compliance with fugitive emissions. The Company plans to add more baghouses to the dusty areas at the bin loading area and the conveyor from the Waelz Oxide Process to comply with the 20% opacity regulation.

The steel stack is in compliance with the State particulate regulation of 0.02 grains/gt³; sulfur oxide is less than 500 ppm and therefore in compliance. The stack emissions were monitored according to EPA Method 5 with the Pennsylvania provision which includes wet portion soluble sulfates.

Wastewater sources from the Ferro-Alloy Department include 2.6 m³ (700 gal)/min of non-contact cooling water at the residue end used to cool supports, grizzlies (which separate the fines and coarse) and hoppers; 75 l (20 gal)/min of cooling water from two air compressors with water-jacketed coolers; a total of 95 l (25 gal)/min from the 5 hot fans water-cooled bearings; and 38 l (10 gal)/min of non-contact cooling water from sinter machine ignition box. The cooling water and surface runoff is discharged to Aquashicola Creek from NPDES Outfall 004. The Ferro-Alloy Department contributes most of the manganese to the Creek. The pH of the wastewater is higher than background levels due to the limestone in the feed.

Rolled Zinc

The rolling mill usually operates 5 days/week, 16 hours/day. About 3,900 m tons (4,300 tons) of rolled zinc are produced per year. Slabs of zinc are brought over from the West Plant's Slab Zinc Department in

railroad cars, melted and cast into two sizes in molds. The molds are placed in the annealing furnace, then put through the roll mill, and coiled. The coil is put in a stretcher-leveler to make very precise widths and to remove distortions. Finally, the rolls are put through the finish rolls to produce sheets of specified thickness. These can be split into different widths requested by the customer. Finished rolls go through a Gale interceptor to remove penetrating oil, as well as vegetable, peanut, and palm oils. The rolls are then shipped to customers.

The rolling mill discharges wastewater through NPDES Outfalls 002, 003 and 012. Wastewater flow is small when compared to the other processes. Outfall 002 carries contact cooling water from the rough roll operation, finish roll and from bearing cooling. The vegetable oil recovered in the separator is recycled to the process. The other oils recovered in the separator are picked up by a commercial hauler for disposal. The discharge from Outfall 002 exceeds the O/G effluent limitations according to Company officials. After leaving the oil-separator, the wastewater flows through 4 septic tanks prior to discharge to Aquashicola Creek.

Outfall 003 carries non-contact cooling water from the two electric induction furnaces used for alloying. The furnaces are not used on a daily basis, therefore the discharge is intermittent.

Indirect cooling water (contacts mold only) from slab casting is discharged from Outfall 012. There is a continuous flow during the day, averaging as much as 225 l (60 gal)/min. over the eight-hour period when casting is done.

Oxide East

In the French Process, 1,360 kg (3,000 lb) zinc ingots and scrap zinc are melted, placed into ladles, and hoisted to a feed pot [Figure 12].

The molten zinc is metered (no flow device, operator judgment determines amount) from the feed pot through a feed box into any of three distillation columns.

Silicon carbide trays are heated in the furnace zone of the column with natural gas; air is preheated in the heat recuperator. The molten zinc, vaporized in the furnace zone, is conducted to the blow box where the preheated air is introduced. Zinc oxide is formed in the vapor. The vapor is withdrawn through the hood over the blow box and the high-purity zinc oxide is collected in a baghouse. The zinc oxide is packed in 23 kg (50 lb) paper bags or in cardboard boxes for storage or shipment.

The bottom of the distillation column collects lead and iron and residual zinc which flows into a liquating pot. The molten mixture is dipped out of the pot and cast into 23 kg (50 lb) slabs. The slabs are predominantly lead.

Each column has a baghouse to recover product. The product throughput for each column is 38 m tons (42 tons)/day. Each column has two fans, each fan is rated at 35,000 scfm. The stack exhaust for each column is 1,400 scfm.

If a leak occurs in the distillation column, the zinc oxide would be emitted through the recuperator stack along with waste gas. The flow would be diverted to a baghouse. The baghouse was installed in mid-1977 and it never had been used as of November 1978. This baghouse serves all three columns.

Wastewater sources include non-contact cooling water, 379 l (100 gal)/min, from water jacketed air compressors and 340 l (90 gal)/min of non-contact cooling water from four screw conveyors in a ZnO process considered confidential by the Company. These cooling waters are discharged to Aquashicola Creek from NPDES Outfall 005.

Zinc powder and copper based powder are produced in the Oxide-East Department [Figure 13]. Slab zinc, ingot copper and piglead are melted in three Ajax tilting 80 kW induction furnaces, atomized with compressed air and collected as powder in cyclones. After screening and blending, the powder is packed in steel drums and shipped. Each shift produces 2.7 m tons (3 tons) of copper based powder and 3.6 m tons (4 tons) of zinc powder.

A baghouse is used to collect the dusts from various points in the metal powder plant. The residue from the baghouse is drummed and sold to a commercial hauler.

Zinc powder is also produced by the same process using only zinc ingots in another building. The zinc ingots do not require a melting furnace (induction furnace) and can be placed directly into atomizer furnace.

Water is not used in the zinc powder production area, and all solid residue is either recycled or sold as scrap.

Research Field Station

The research field station is used for pyrometallurgical simulations for research, producing special zinc oxide and indium products and producing metal powders. All wastewater is discharged to the field station lagoon which discharges to the wastewater treatment plant.

In the furnace building, used for pyrometallurgical research, steam condensate is collected in sumps and drains to NPDES outfall 010. There are no other sources of water.

Metal powders, zinc oxide and indium are made by batch process in the main building. Zinc oxide from Oxide West is brought to the field

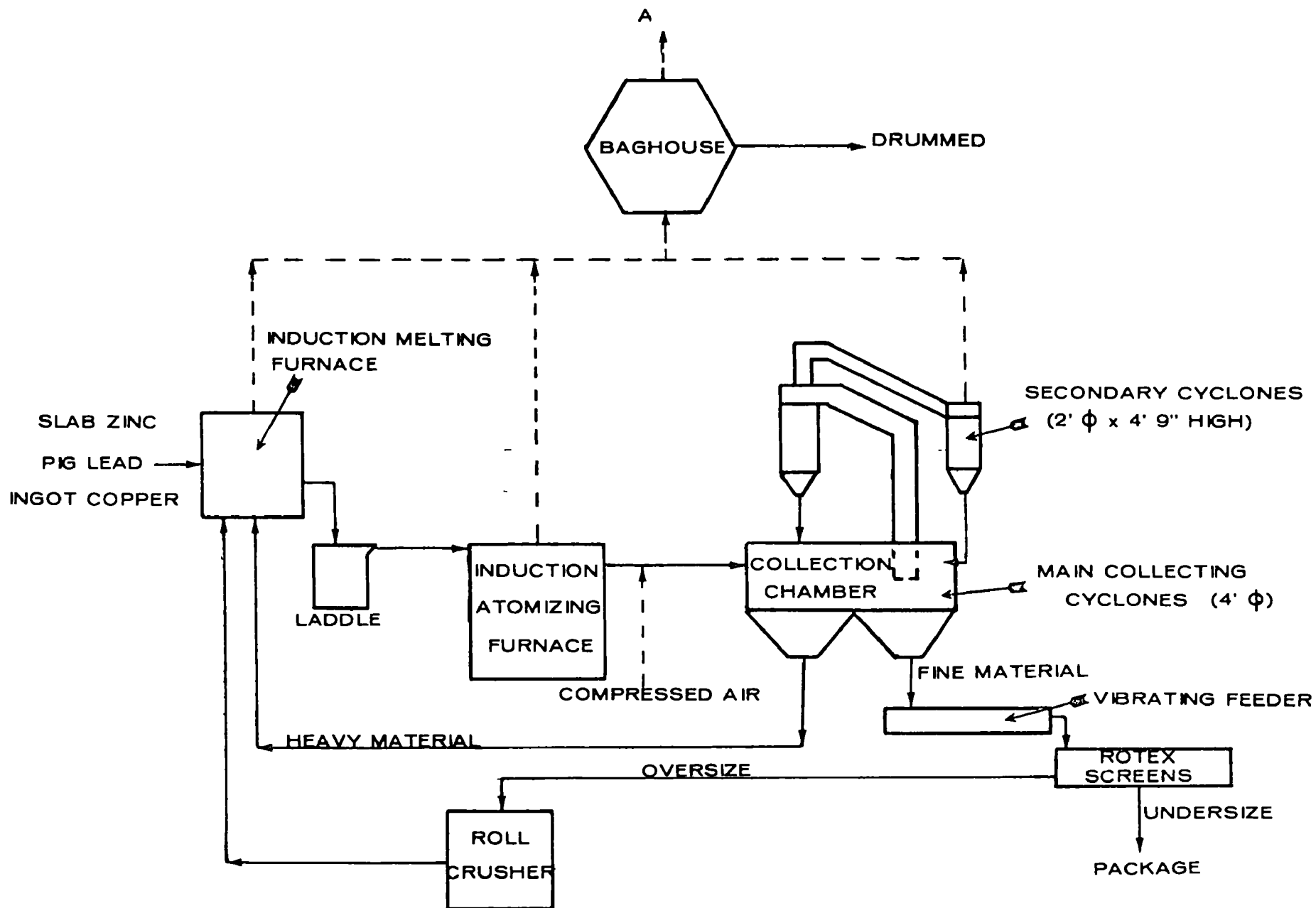


Figure 13. Oxide East - Metal Powder
New Jersey Zinc Company
Palmerton, PA

station and stirred in water. Alum is added, the mixture is filtered and dried. The dried filter cake is micropulverized, calcined to change surface properties and packaged. The filtrate is collected in a holding tank. At the end of the production day, the filtrate is refiltered before being discharged to the lagoon. The total wastewater flow from the operation is about 38 l (100 gal)/batch and contains varying concentrations of zinc oxide, iron and alum. There are four batches/shift, 12 batches/day for 5 days/week. A baghouse is used to control process emissions. About 7 to 8 kg (15 to 18 lb) of product is recovered daily and returned to Oxide West.

The indium process began in April 1976 [Figure 14]. Indium chloride, zinc chloride and lead chlorine slag are dissolved in hydrochloric acid. The indium is precipitated with zinc strips to produce a sponge material which is made into briquettes or cast for shipment. Wash waters from the purification processes are recycled to the dissolving tank. Liquor from the sponge tanks are neutralized with sodium bicarbonate to pH greater than 9. The precipitate from neutralization is filtered and sent to the Ferro-Alloy Process; the filtrate is sent to the lagoon. The batch discharge is minimal, 6,000 (1,585 gal) and occurs twice/month. Residue from the dissolving tank is leached a second time in the dissolving tank with 30% hydrochloric acid, then washed with scrubber water from the slag process and sold or disposed of by commercial contractor. According to NJZ personnel, the material does not have a market value. There are no emission control devices required for the process.

The slag for the indium process is made in another area of the main building. Pig lead is melted, then reacted with chlorine gas to produce chlorides of zinc, lead and indium. The slag is skimmed from the molten metal and cast into slabs. The indium free lead is either returned to the French Process, if indium concentration is several tenths percent or greater, or sold if the indium concentration is low.

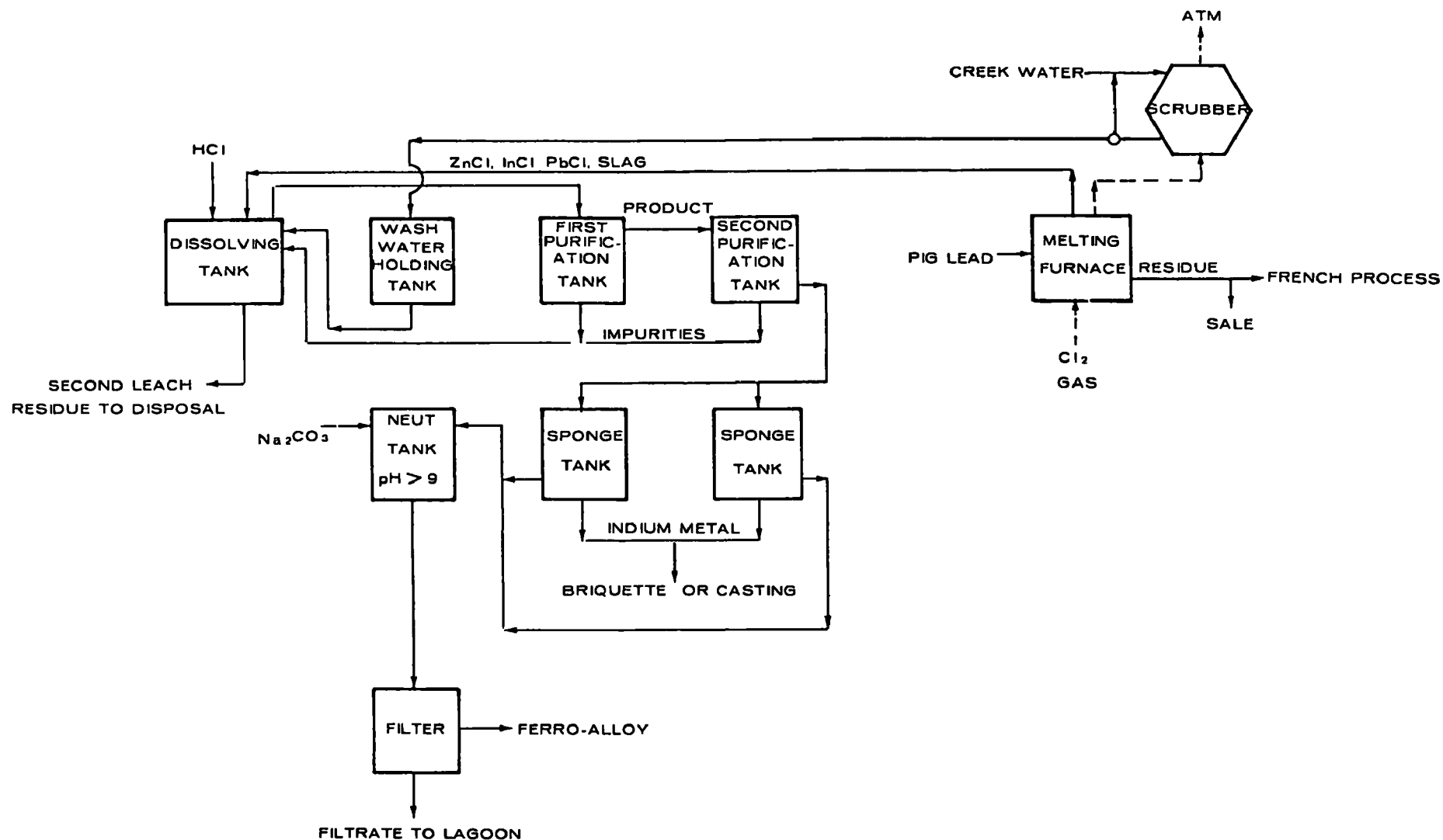


Figure 14. Indium Metal Production Field Station
New Jersey Zinc Company, Palmerton, PA

A water scrubber and Brinks mist eliminator is used to collect fumes. The scrubber water is recirculated through the scrubber and also is sent to the holding tank used for leaching the residue from the dissolving tank.

PROCESS DESCRIPTION WEST PLANT

Slab Zinc Department

Vertical retort furnaces, a development of the New Jersey Zinc Company, are used to process sintered concentrates and other zinc-bearing materials into metallic zinc [Figure 15]. In excess of 90,700 m tons (100,000 tons) per year of slab zinc are produced in 43 vertical retorts which range in size from 1.8 m (6 ft) long by 9 m (30 ft) high to 2.4 m (8 ft) long by 11 m (37.5 ft) high. Production in the retorts ranges from 5.4 m tons (6 tons)/day in the smaller to 10.9 m tons (12 tons)/day in the largest.

Ore sinter, anthracite dust coal, clay, and bituminous coal are transported to weigh hoppers which proportionally feed the charge to a mix house. The bituminous coal is finely ground in rod mills prior to mixing; the rod mills are sealed and the grinding mechanisms are kept tight to control dust emissions. Sulfate liquor from the paper industry is added as a binder and represents about 3.8% of the charge. There are three mix houses, operated in parallel, which prepare the charge for roll-pressing into briquettes. The raw materials from the weigh hoppers are fed into very large chasers (Mullers); each chaser has two 5,900 kg (13,000 lb) rolls which mix the materials with a knead-like or rolling-sliding motion to insure a uniform, dense feed. Mechanical scrapers bring the material back towards the center of the chaser where it drops into a conveyor. A small quantity of water is added to each chaser. Numbers 1 and 3 mix houses each have 4 chasers in series; No. 2 mix house has 2 chasers in series.

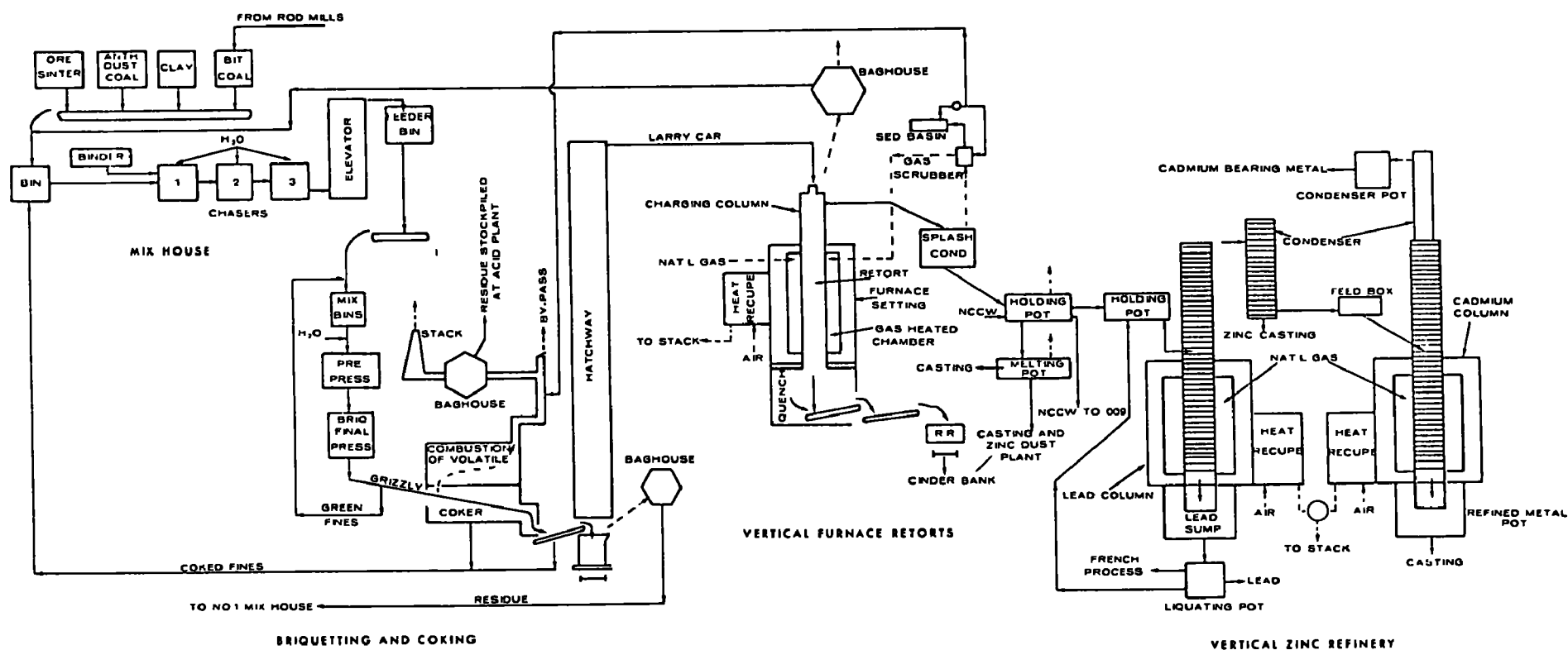


Figure 15. Slab Zinc Department, New Jersey Zinc Company, Palmerton, PA

The materials are best conveyed from the mix house to the vertical retort briquette press mix bins. The material is mixed, water added, and pre-pressed into small briquettes. These briquettes are then pressed into large loaf-shaped briquettes. The discharge from each of the 8 briquette presses constitutes a continuous charge over a grizzly (grates which slip over each other in a slow, step-like motion) to each of 8 parallel cokers which operate autogenously on the heat provided by the combustion of the volatile material in the bituminous coal component. The grizzly separates the fines from the charge and returns them to the pre-press mix bin via a skip hoist. Volatiles are driven off to a combustion chamber and the hot, cooked briquettes are withdrawn from the coker-holding hopper on a specified cycle for charging to each of the 43 vertical retorts. The gas stream from the combustion chamber is sprayed with water for cooling as it passes through the coker stack. The water is atomized by using sonic nozzles and compressed air, thus eliminating a wastewater source.

Each coker stack is vented to its own baghouse. There is one spare baghouse and baghouse stack for standby purposes. The coker stacks have a covered bypass for venting to the atmosphere if the power goes out and the fans stop. The bypass caps will also open to protect the baghouse if the gas stream temperature is too high. Accretions buildup in the line from the coker stack to the baghouse which are cleaned manually. The bypass is opened 0.5% of the time for safety purposes to allow cleaning. According to Company officials, the State has not issued an operating permit because of the planned bypassing.

The coked material (glowing briquettes) passes over a grizzly and is discharged into buckets on railroad cars (tapping). The tapping, done under a hatchway, is controlled by a baghouse; the exhaust from each tapping is 30,000 scfm. The baghouse residue is pneumatically conveyed to a holding bin, then taken by railroad car to the No. 1 mix house for reprocessing. The green fines (material not fully coked) are separated on the grizzly and returned by conveyor to the mix house.

The briquettes are then sent to the vertical furnaces. There are five batteries of retorts, A through E; a battery is the vertical furnace. Batteries A, B, and C each consist of 8 retorts, battery D consists of 10 retorts, and battery E consists of 9 retorts. The 9 retorts in battery E are 10.7 m (35 ft) high and the remaining 34 retorts are 9.8 m (32 ft) high.

The buckets are hoisted, four at a time, from the railroad cars through the hatchway and weighed. The manually-operated structure which suspends the buckets and contains the hoist is called a Larry car. The charge from the buckets is fed into the retorts every 90 minutes. The emissions from the charging to the retorts are controlled by baghouses. The zinc oxide collected in the baghouses is returned to the mix house. There are 3 baghouses, one for batteries A and B, one for batteries C and D, and one for battery E. Each baghouse is rated at 14,600 scfm; less than 0.01 grains/ft³ are emitted according to Company officials. Only one bucket at a time is emptied into the retorts. Continuous operation of the retorts on a batch-wise charge is ensured by the holding capacity of the charge columns atop each of the tall, gas-tight, silicon carbide refractory retort structures.

Each of the two thin, parallel retort sidewalls is heated externally by combustion of natural gas in a firing chamber, one wall of which is the retort sidewall. Heat for reduction and vaporization of the zinc is transmitted through the highly conductive silicon carbide walls to the briquetted charge. The operating temperature is 1,180°C and requires 14 days of preheating before the briquettes can be added. Combustion air is preheated in brick recuperators. The recuperators have internal walls which separate the air and the exhaust gases from the retorts. The exhaust gases provide the heat for the combustion air. The exhaust gas is emitted through natural shaft stacks. Batteries C, D, and E each have a stack while batteries A and B share a common stack.

The zinc and carbon monoxide vapors rise through the retort to the upper extension and are drawn through a downwardly-sloping conduit into the zinc splash condenser where the vapors are cooled and condensed by contact with a copious shower of molten zinc. The carbon monoxide goes through a condenser stack to a water scrubber which removes additional zinc. The carbon monoxide is returned to the vertical furnace setting (area outside the gas heated chamber). The condensed zinc is incorporated into the molten zinc and is collected into a trough along with the "scrubber blue powder," a form that zinc takes when it has not been condensed. The blue powder accretion buildup in the condenser stack base has to be scraped out periodically. The scrubber blue powder is removed manually with a shovel every shift.

The water from the scrubber is recirculated to a settling basin, then back to the scrubber. The recirculation pumps have a capacity of 3.4 m^3 (900 gal)/min. The blowdown from the settling basin is used as the water spray in the 8 coker stacks. No bleed-off water is discharged; if cyanide is detected in the discharges to Aquashicola Creek, it indicates that there is leakage in the system.

It requires 8 hours for the briquettes to travel through the retort. The briquettes are removed from the bottom of the retorts, quenched, and removed by screw conveyor to a belt conveyor which empties into railroad cars. Approximately 113,400 m tons (125,000 tons)/year of spent briquettes, containing 4 to 6% zinc, are sent to the Cinder Bank for disposal. The residue from each battery is analyzed daily for zinc content. The residue, when stockpiled on the Cinder Bank, is segregated by concentration piles containing 4% zinc and piles containing 6% zinc.

There is one splash condenser per retort; the molten zinc from the condensers flow into a brick-lined trough common to all retorts in a battery. The brick-lined trough empties into a holding pot. The five holding pots, one for each battery, discharge to a melting pot (zinc

not melted but kept in molten state) for casting. Most of the molten zinc can be diverted to the vertical zinc refinery process by trough or by ladle before reaching the melting pot. The Company has developed molten metal pumps to transfer the molten zinc to other process buildings. To keep the molten zinc "cool" in the melting pot, a water-filled coil is lowered into the molten metal to reduce the temperature. The non-contact cooling water is discharged to NPDES Outfall 009 and averages 4.8 m³ (1,275 gal)/min. for all retorts.

The molten zinc from the melting pot is cast without further refining into ingots. Small ingots, less than 23 kg (50 lb), are automatically cast; manual casting is done for the 544 kg (1,200 lb), 907 kg (2,000 lb), and 1,360 kg (3,000 lb) ingots. The molten zinc can also be transferred from the melting pot to the Zinc Dust plant.

The molten zinc from the vertical retorts is sent to a holding pot at the vertical refinery; zinc slabs can be melted in the holding pot if necessary. The vertical refinery consists of 8 first-stage distillation columns and 4 second-stage columns with a total capacity of 181 m tons (200 tons) net/day of special high grade zinc. (The zinc from the vertical furnaces is galvanizing quality). The first-stage columns remove the high-boiling impurities, such as iron and lead, and the second stage columns separate the low-boiling impurities such as cadmium.

The molten zinc is charged into the first-stage columns containing silicon carbide trays. The temperature is carefully controlled for selective refining. The lead is kept molten and the zinc and cadmium is vaporized. The lead flows into a liquating pot, stratifies, and is scooped out after it settles. The upper strata metal is returned to the melting pot. The material in the liquating pot is called "runoff." After the lead has settled, some of the runoff is removed and cast into ingots for the French Process. In the upper

portion of the distillation column, the temperature is lower and the lead carried with zinc and cadmium vapor is condensed and drips back down to the trays in the hotter portion.

At the top of the distillation column, a refractory connector connects to another column for selective condensing of zinc and cadmium. The zinc, 99.9% pure, is collected at the bottom of the condensing column and cast into large ingots. The condensed cadmium is sent to the cadmium column where the impurities are removed. The cadmium vapor is condensed at the top of the column and the impurities are discharged to a refined metal pot, then cast.

Combustion air is preheated in recuperators by the exhaust gases from the columns. The exhaust gases are emitted through 4 stacks. Each stack serves two first-stage and one second-stage column. Because natural gas is used for heating and does not contact the product, there are no emission controls. However, the silicon carbide refractory in the columns develops cracks, and zinc vapor escapes and forms zinc oxide in the combustion zone and is emitted through the stack.

Oxide West

Coal and Zinc ore briquettes are formed to produce zinc oxide by the American Process in traveling grate furnaces [Figure 16]. The anthracite dust coal is placed into a bin which empties onto a series of screens and belt conveyors which size the coal and feed the German-manufactured Eirich Mixer. Bentonite clay and water are added to the mixer. The mixture goes to a briquette press. After pressing, the briquettes are either dried in a new Proctor and Schwartz dryer or in an older dryer and conveyed to a storage bin. Both dryers are oil-fired.

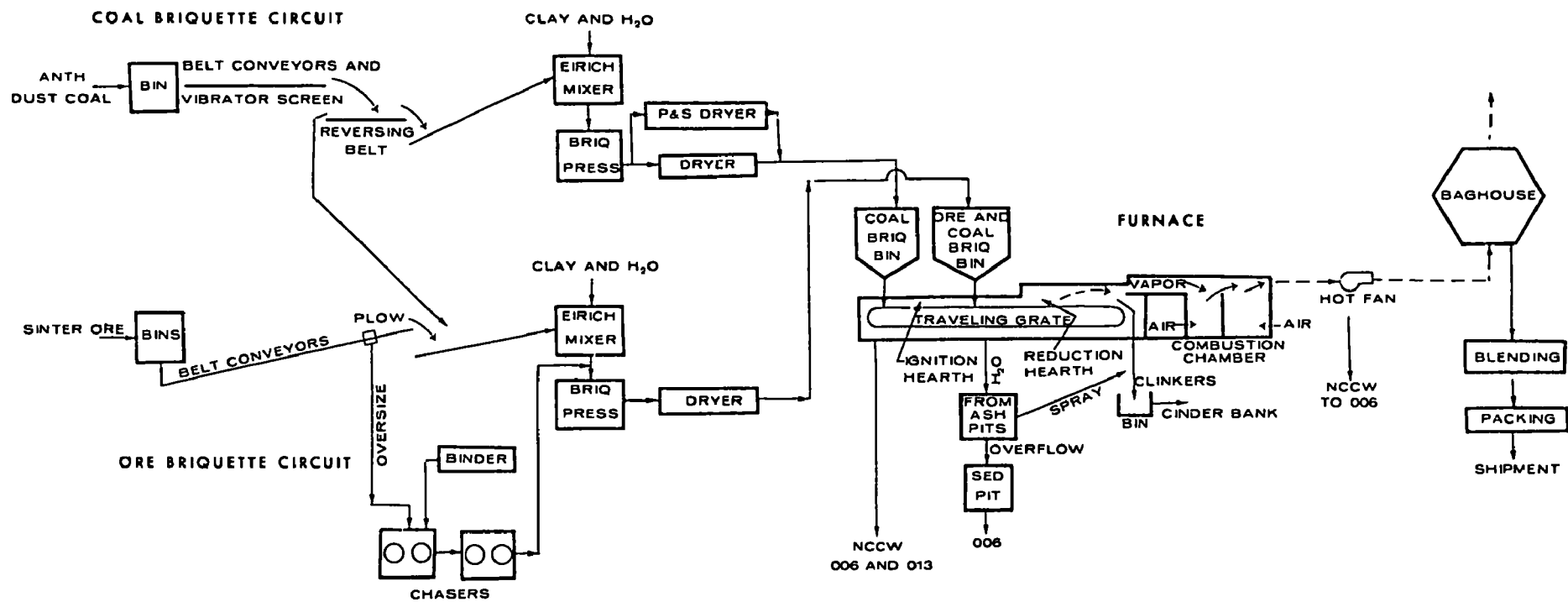


Figure 16. Oxide West - American Process, New Jersey Zinc Company, Palmerton, PA.

Ore briquettes are made in similar fashion. The sinter ore from the Roasting and Sintering operation in the East Plant's Acid Department is mixed with bentonite clay, anthracite dust coal and sulfite liquor (when chasers are used) or water (when Eirich Mixer used). After drying, the ore briquettes are placed in a storage bin.

Weigh hoppers under the storage bins provide a proportional mix onto five traveling grate furnaces. The ore briquettes are placed in a layer on top of the ignited coal briquettes which supply the heat for zinc reduction (Zinc is vaporized in a reducing atmosphere produced by the carbon). The vapor mixes with air in the combustion chamber and zinc oxide fume particles are formed. The fumes are conveyed through hot fans to a bagroom which services all 5 furnaces. The zinc oxide dust is collected in hoppers on the bottom of the baghouse, carried by fork lift to a blending bin and packed in paper bags, or rubber and steel drums. The zinc oxide is also treated with propionic acid, reheated or pelletized, when required by customers. The ducting from the furnaces to the baghouse discharges into a manifold system which empties inside the bags. Each bag is 46 cm (18 in) in diameter and 9.1 m (30 ft) long. Mechanical shakers are used to clear the bags.

The spent briquettes drop into a concrete basin at the end of the grate. Water sprays over the material as it drops. The material is removed by a Payloader and stored on the ground until loaded into railroad cars for disposal on the Cinder Bank.

Between the air blow boxes on the grate furnace, there are pans (called "ash pits") which collect the material falling through the grates. Water is kept in the pans to keep them from burning up and to produce steam for cooling the grates. The pans also overflow (approximately 19 liters (5 gal/min) due to too much water being added. The floors under the furnaces are washed daily. All wastewater flows to the

basement. The water is collected in a large sump, pumped to the end of the furnace's traveling grate conveyors and sprayed over the spent briquettes. If excess water accumulates in the sump, it is pumped to another concrete basin and allowed to settle. After settling, the supernatant is pumped to NPDES outfall 006 and the Lehigh River. Residue is sent to the Cinder Bank.

Non-contact cooling water for the furnaces is discharged from NPDES Outfalls 006 and 013 when four furnaces are running. The flows average 1.4 m^3 (375 gal)/min and 0.95 m^3 (250 gal)/min, respectively. The non-contact cooling water from the hot fan, 190 l (50 gal)/min, the reheater screw conveyor, 378 l (100 gal)/min, and water from the rotary compressor and vacuum pumps, 260 l (69 gal)/min each, are discharged from outfall 006.

Normal procedures are to run two or three furnaces; all 5 are not run at the same time. Up to 52,600 m tons (58,000 tons) of zinc can be produced yearly with four furnaces operating continuously.

Zinc Dust Process

Zinc dust is produced from the molten zinc or slab zinc from the Vertical Furnace process. This process was developed by the Company and was discussed during the November reconnaissance. Because the Company stated that the process is CONFIDENTIAL, it will not be described in this report.

There are no wastewater sources in the operations. Fugitive dusts are controlled in the packing areas with a baghouse designed by the Company. The air flow was reported as 5,300 scfm. Six of the ten furnaces in the operation, fired by oil or natural gas, have been modified and do not produce emissions from material charges. The charges to the

remaining four furnaces are controlled with a 2,000 scfm Mikro-Pulse baghouse; the pick-up points above the four furnaces are connected to a common manifold system.

The State regulations for particulates is 0.04 grams/ft³ and an opacity of 20%. Company officials reported that the furnace baghouse is in compliance. The State has issued an operating permit for the furnace baghouse; because the packing area baghouse was installed prior to 1972, it does not require an operating permit.

WASTEWATER TREATMENT - EAST PLANT

Wastewater from the East Plant processes is discharged to Aquashicola Creek along with high volumes of non-contact cooling water (NCCW), contact cooling water, surface runoff and water from seeps. NCCW comprises the majority of the discharges. Process and cooling water is obtained from the Aquashicola Creek and Pohopoco Creek. The only treatment is sand filtration for water used in the ammonia plant cooling tower. A description of the discharges from each NPDES Outfall is summarized in Table 8.

The process wastewater generated in the Acid Department is treated in the Waste Acid Treatment Plant prior to discharge to Outfall 001 [Figure 17]. Blowdown from the acid plants' gas scrubbers and Cottrell mist eliminators, tail gas condensate and cooling tower blowdown from the ammonia plant, laboratory sink wastes and washwater from finished acid railroad cars and storage tanks are collected in a sump and pumped to the inlet sump of the treatment system. Wastewaters from the Research Field Station are discharged to a lagoon adjacent to NPDES Outfall 001 for removal of suspended solids and flow equalization. The wastewater is pumped to the sump preceding the inlet sump to the Waste Acid Treatment Plant. During heavy rainfall, the lagoon may overflow and discharge through Outfall 001.

Table 8
WASTEWATER DISCHARGES TO AQUASHICOLA CREEK
NEW JERSEY ZINC COMPANY
Palmerton, Pennsylvania

NPDES Outfall	Flow ¹ /m ³ /day	mgd	Sources
001	19,600	5.2	Waste acid treatment process (P); ^b sinter fire box compressors, screw conveyors (NCCW); ^b ammonia plant after cooler/in cooler on CO ₂ compressor, catch basins (NCCW); backwash from sand filters (P); catch basins through processing area (R) ^b
002	98	0.026	Rolling Mill chill water from castings, contract cooling water from the rough mill bearings and contact cooling water from finish roll (after 0.1 separation).
003	19	0.005	NCCW from Rolling Mill induction furnace and surface runoff.
004	4,080	1.08	Waelz kiln quench water, NCCW from air compressors, NCCW from Waelz kilns, NCCW hot fan bearings, NCCW from firebox, air compressor blowdown (after passing through oil separator), railroad car drainage, and surface runoff.
005	4,080 ^c	1.08	Oxide East Frech Process NCCW, compressor condensate, NCCW from compressors, boiler blowdown (once/shift), backwash (P) from sand filters used to treat boiler make-up water, washwater (P) from mobile equipment cleaning (after treatment in a settling pit and oil trap), and surface runoff from the Cinder Bank.
006 ^w	3,270	0.864	NCCW from Oxide West American Process hot fans, reheater screws, conveyors, vacuum pumps, rotary compressors and surface runoff.
007 ^w	2,450	0.648	Mobile equipment washwater (P), sand filter and softener backwash (P), compressor blowdown after oil-separation (P), NCCW from compressors, and surface runoff from Palmerton.

Table 8 (continued)
 WASTEWATER DISCHARGES TO AQUASHICOLA CREEK
 NEW JERSEY ZINC COMPANY
 Palmerton, Pennsylvania

NPDES Outfall	Flow ^a /m ³ /day	mgd	Sources
008 ^w	-	-	Receives overflow from Outfall 009.
009 ^w	8,175	2.16	Wastewater from locomotive and r.r. crane repair shop (P), after oil skimming; NCCW from refinery casting molds; NCCW from retort condensers; compressor blowdown after skimming; and surface runoff.
010	53	0.014	Steam condensate, surface runoff, and NCCW from air compressor after cooler at Research Field Station.
011	136	0.036	Steam condensate, steam condensate from thaw shed, and surface runoff (Pipe plugged at Blue Mountain).
012	106	0.028	NCCW from slab casting in the Rolling Mill and surface runoff.
013 ^w	1,362	0.36	NCCW from the Oxide West American Process traveling grate furnaces and surface runoff.
014	-	-	Surface runoff; no flow observed for past 3 years.
015	-	-	Surface runoff
016	-	-	Surface runoff
017 ^w	-	-	Runoff from coal pile to concrete channel

a Flow estimates by NJZ (in mad).

b (P) = process wastewater; (NCCW) = non-contact cooling water; (R) = runoff

c Includes 3,050 m³/day (8.06 x 10⁵ gpd) of runoff and seepage from Cinder Bank

w Indicates outfalls located in West Plant

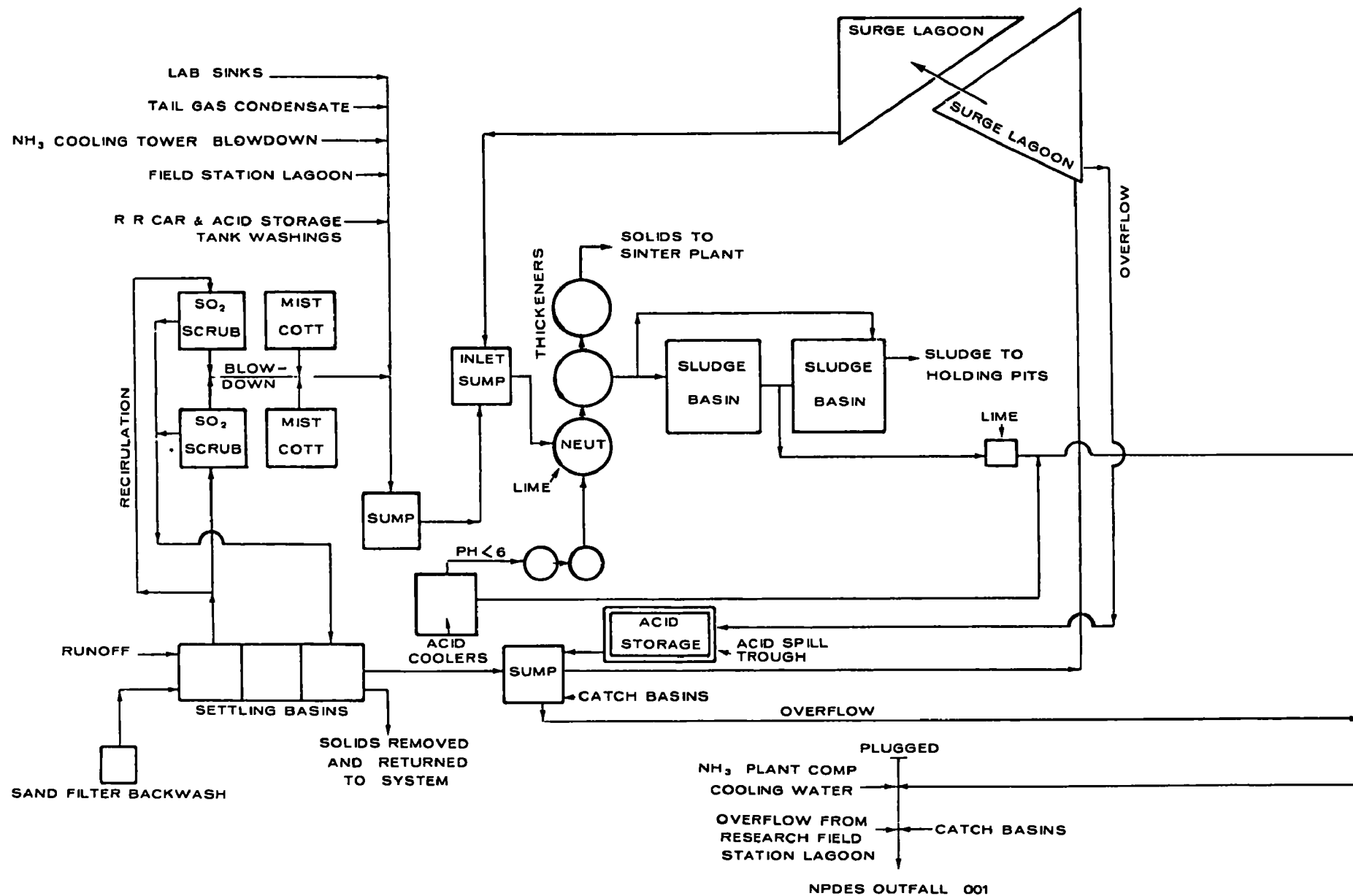


Figure 17. Waste Acid Treatment Plant And Waster Sources On Outfall 001
New Jersey Zinc Company Palmerton, PA East Plant

The acidic wastewater containing high concentrations of dissolved metals is pumped into the neutralization tank and mixed with lime slaked in an adjacent building. The lime feed rate is automatically controlled by a pH sensor which maintains the pH at 11.2. The neutralized waste is transferred to two thickeners, operated in series. The underflow from the first thickener is sent to the other thickener for concentration. The solids from the second thickener are sent to the sinter process and the overflow is sent to the roasters, sinter plant and hot roast process or recycled to the second thickener. The overflow from the first thickener is discharged to the two sludge lagoons, operated in parallel for solids removal. Because the solids cannot be removed from the first thickener as fast as they accumulate, the thickener is emptied into the sludge lagoons every 3 to 4 days. The settled sludge is removed from the lagoons every 4 to 14 days by a railroad crane car and dumped into railroad cars. The sludge, containing 50 to 60% water, is stockpiled outdoors in the southeast part of the East Plant used for storing raw materials. The sludge is stored for about one-year period during which it is returned to the process at the roaster. The amount returned depends upon the sulfur content of the roaster feed due to combustion requirements. The storage area has not been lined to prevent infiltration, however, the area has been diked with the sludge itself to minimize runoff. Currently more sludge is being stored than is recycled, therefore the solids are also being stockpiled on the Cinder Bank. The sludges contain high concentrations of metals removed in the neutralization process.

The supernatant from the sludge lagoons is discharged to the sewer terminating at Outfall 001. Additional sources of wastewater, primarily non-contact cooling water, also flow into the sewer. The pH of the effluent is monitored at the outfall; when the pH falls outside the permitted range, an alarm sounds to alert the Acid Department operators. The operators must manually turn on the equipment which add either acid

or lime. Due to the delay caused by flow time between The Outfall and pH adjustment locations, the pH of the effluent frequently is outside the permitted range.

The water from the Peabody scrubbers is recycled between three settling basins. The settled solids are removed by crane and returned to the process. Seeps from springs and runoff from the raw material concentrate storage area drain to the settling basins. The backwash from the sand filters used to treat the ammonia plant cooling tower make-up water is discharged to the settling basins. The overflow from the basins flows to a sump which also receives runoff from catch basins and leaks or spills collected in the spill trough surrounding the sulfuric acid storage tanks. The water in the sump is pumped to either the south or north surge lagoons. The combined capacity of the lagoons is about 5,680 m³ (1.5x10⁶ gal). The north lagoon receives flow only when solids are being cleaned out of the south lagoon. A flexible hose must be placed on the pipe discharging to the south lagoon to reroute the flow to the north lagoon. The south lagoon overflows to the north lagoon. The effluent from the north surge lagoon flows by gravity to the inlet sump serving the waste acid treatment plant. If the south lagoon overflows, the wastewater drains to the acid spill trough. If the influent flow to the sump receiving the settling basin overflow exceeds the capacity of the three pumps, the overflow is discharged to the sewer terminating at Outfall 001.

Other wastewater sources discharged from Outfall 001 include cooling water from the ammonia plant incooler/outcooler on the carbon dioxide compressor and surface runoff from the ammonia plant and acid and No. 2 fuel oil storage areas.

SOLID WASTE DISPOSAL (CINDER BANK)

Residues from the various processes are either recycled to the operations or are disposed of on the Cinder Bank. The Company has stored the residues for 80 years in a segregated fashion based on the zinc content. To date, technology has not been developed which would allow for the economic recovery of the metals. The Cinder Bank is approximately 4 km (2.5 miles) long and about 60 m (200 ft) high. The Cinder Bank lies between the East Plant and Blue Mountain. According to Company estimates, the Cinder Bank contains between 27 to 32 million m tons (30 to 35 million tons) of residue.

The residues are transported to the top of the Cinder Bank either by the plant railroad inside dump gondola cars or by truck. The residue is moved after dumping by heavy equipment. The Cinder Bank is also graded by the heavy equipment to minimize erosion. The oldest residue is on the west end of the Cinder Bank. Some of the residue is still hot and produced "hot spots" within the disposal area. Company officials stated that part of the Cinder Bank was used as a disposal area for commercial and residential refuse from Palmerton. Some of the refuse is reportedly smoldering inside the Cinder Bank due to contact with the hot residue.

Some of the residue from the Cinder Bank is recovered by a contractor and reused by cinder block manufacturers or is used for cindering icy roads by highway maintenance departments. Approximately 3.2 million m tons (3.5 million tons) have been reclaimed since 1957. The residues have also been sold to the cement industry as a cement additive and used by the railroads as fill material.

The Company has been experimenting since 1976 with various grasses, trees, plants, etc., to develop a revegetation program for the Blue Mountain area behind the plant; the natural vegetation has been destroyed

by plant air emissions. The experimentation has also included the development of a Cinder Bank vegetation program. According to Company proposals, the program will revegetate at least 20 acres/year, and maintain the existing vegetation beginning in 1981, pending on the results of tests. The area requiring vegetation is estimated to be between 445 and 485 hectares (1,100 and 1,200 acres).

During periods of runoff, contaminated storm water flows into Aquashicola Creek via surface ditches and Company sewers, and percolates through the Cinder Bank to the groundwater. The groundwater recharges the creek and also seeps out through the Cinder Bank. The Company has attempted to isolate Blue Mountain runoff from the Cinder Bank with little success. Pipes were placed at the surface discharges of two rills to convey this water over the Cinder Bank. The pipes on top of the Cinder Bank froze, split and were not repaired. As a result, the water flows into the Cinder Bank.

The Cinder Bank has been contoured to a slope approaching 2 to 1 which is unstable. Additional contouring is required to stabilize the slopes and to transport runoff from the Cinder Bank as quickly as possible.

WATER SUPPLY

The industrial water supply system at the East Plant is a complex network of mains and feeder pipes. Aquashicola and Pohopoco Creeks are the water sources. The intake water is not treated beyond screening except for the ammonia plant non-contact cooling water which is sand-filtered, treated with a BETZ chromate solution and chlorinated.

Under normal condition, the main intake source is Aquashicola Creek, which is pumped into the system from the No. 3 Pump House located

near the Field Station Bridge. The pump station operates 24 hours/day at a constant rate of 17,400 m³/day (3,200 gpm), regardless of conditions in the plant. This water is the normal source for the processes at the east half of the plant; processes discharging from Outfalls 001 and 010 are supplied by water from Aquashicola Creek. In an emergency, Aquashicola Creek water may be pumped from the Nos. 1 and 2 Pump House, but this is a rare occurrence.

The second intake source is Pohopoco Creek, a Lehigh River tributary which flows from the Beltzville Dam about 8 km (5 mi) north of Palmerton. The Pohopoco Creek intake station is managed by the Palmerton Water Company and gravity feeds from the Parryville Dam to the NJZ West Plant through a 75 cm (30 in) diameter main. Some Pohopoco Creek water is used in the West Plant and the rest is pumped up 45 m (150 ft) in elevation to three 7,600 m³ (2,000,000 gal) water storage tanks. The water flows by gravity from these storage tanks to the East Plant [elevation drop approximately 50 m (170 ft) through a 60 cm (24 in) diameter main] and is distributed on a demand basis to the west half of the plant via the Booster Pump House. Pohopoco Creek is the normal source water for processes discharging to NPDES Outfalls 002, 003, 004, 005 and 012, but can be used under unusual circumstances, to supply the entire East Plant by using the booster pumps.

While the Company has designated the source of water which eventually is discharged from each NPDES outfalls, the complexity of the piping network makes it difficult to determine whether certain Outfalls contain water originally supplied by Aquashicola Creek, Pohopoco Creek or a combination of both. All the valves in the system are normally wide open to allow water consumption on a demand basis. Because the Aquashicola Creek water is pumped in at a constant rate while the Pohopoco Creek water gravity flows to make up the difference for the west half of the East Plant, any process changes or shutdowns that cause a decrease in demand for Aquashicola Creek water in the east half, can

result in the excess being pumped farther west into the piping network. The Aquashicola Creek water may therefore displace or mix with some of the Pohopoco Creek water. The determination of the water source supplying the majority of the water discharged from each Outfall, which is required to compute the net effluent concentrations specified in the NPDES permit, is aided by the different characteristics of the two source waters. Pohopoco Creek water is piped in from 8 km (5 mi) away and contains relatively low concentrations of metals - about 0.10 mg/l zinc and 0.003 mg/l cadmium. Conversely, Aquashicola Creek water has much higher levels of zinc and cadmium at the East Plant intake, due largely to infiltration of contaminated groundwater. The respective zinc and cadmium concentrations are usually in the ranges of 1 to 2 mg/l and 0.02 to 0.08 mg/l.

In theory, the designation of a particular source for a particular Outfall can be made by sampling the industrial water supply at a point close to the Outfall and comparing the results with the source characteristics. In practice, the Company collects samples of the industrial water supply in the Rolling Mill close to Outfalls 002, 003, 004 and 012. A comparison of the results with source water characteristics showed the water in this area to be from Pohopoco Creek. Outfall 005 is the process Outfall closest to the Pohopoco Creek intake and is assumed to use this source exclusively.

V. FINDINGS

STREAM CHARACTERIZATION

The results of field measurements and analyses performed on Aquashicola Creek, Mill Creek, and Lehigh River water quality samples collected during the May 8 to 14, 1979 survey are presented below in Tables 9 through 17.

Water Quality and Flow Measurement

Table 9 presents total metals concentrations and mass loadings from seven days of sampling and flow measurement at four Aquashicola Creek Stations* and one Mill Creek Station [Figure 1]. The results are presented on a daily basis and follow the course of the creek from the farthest upstream Station (Harris Bridge) to the mouth (Tatra Inn Bridge).

The data indicate significant increases of zinc, cadmium, and manganese concentrations and loads in the reach of Aquashicola Creek between Harris Bridge and the 6th Street Bridge. Mass loads for these metals decreased between 6th Street and the Tatra Inn Bridges but this was caused largely by 19% decreases in the flow over the same segment of the creek. The metals contribution from Mill Creek was relatively insignificant.

Based on 7-day averages (5 days at the 6th Street Bridge), zinc and cadmium loads each increased about 30 times from Harris Bridge to

* There were only five days of sampling at one of the four Stations - Station 21 at 6th Street Bridge.

Table 9
AQUASHICOLA CREEK AND MILL CREEK METALS SAMPLING DATA
New Jersey Zinc - East Plant
Palmerton, Pennsylvania
May 8-14, 1979

NEIC Station No.	Station Description	Flow		Total Zinc		Total Cadmium		Total Lead		Total Iron		Total Manganese	
		m ³ /day x 10 ³	cfs (mgd)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)
	Detection Limit			0.08 ^a		0.005 ^a 0.002 ^b		0.01 ^c		0.08 ^a		0.02 ^a	
May 8, 1979													
27	Aquashicola Creek at Harris Bridge	350	143 (92)	ND ^d	0 (0)	ND ^b	0 (0)	ND	0 (0)	0.18	63 (140)	0.03	10 (22)
24	Aquashicola Creek at Field Station Bridge	336	137 (88)	0.62	210 (460)	0.007 ^b	2.4 (5.3)	0.01	3.4 (7.5)	0.10	34 (75)	0.22	74 (160)
19	Mill Creek	24	10 (6.5)	ND	0 (0)	ND ^b	0 (0)	0.01	0.24 (0.54)	0.09	2.2 (4.9)	ND	0 (0)
21	Aquashicola Creek at 6th Street Bridge	e	e	e		e		e		e		e	
20	Aquashicola Creek at Tatra Inn Bridge	220	90 (58)	0.92	200 (440)	0.05 ^a	11 (24)	ND	0 (0)	0.15	33 (73)	0.19	42 (93)
May 9, 1979													
27	Aquashicola Creek at Harris Bridge	313	128 (83)	ND	0 (0)	ND ^b	0 (0)	0.01	3.1 (6.8)	0.10	31 (68)	0.03	9.4 (21)
24	Aquashicola Creek at Field Station Bridge	277	113 (73)	0.55	150 (330)	0.007 ^b	1.9 (4.2)	ND	0 (0)	0.10	28 (62)	0.17	47 (100)
19	Mill Creek	22	9.0 (5.8)	ND	0 (0)	ND ^b	0 (0)	ND	0 (0)	0.08	1.8 (4.0)	0.02	0.44 (0.97)
21	Aquashicola Creek at 6th Street Bridge	e	e	e		e		e		e		e	
20	Aquashicola Creek at Tatra Inn Bridge	242	99 (64)	0.74	180 (400)	0.03 ^a	7.3 (16)	0.02	4.8 (11)	0.15	36 (79)	0.15	36 (79)

Table 9 (Cont'd.)
AQUASHICOLA CREEK AND MILL CREEK METALS SAMPLING DATA
New Jersey Zinc - East Plant
Palmerton, Pennsylvania
May 8-14, 1979

NEIC Station No.	Station Description	Flow		Total Zinc		Total Cadmium		Total Lead		Total Iron		Total Manganese	
		m ³ /day x 10 ³	cfs (mgd)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)
	Detection Limit			0.08 ^a		0.005 ^a 0.002 ^b		0.01 ^c		0.08 ^a		0.02 ^a	
May 10, 1979													
27	Aquashicola Creek at Harris Bridge	313	128 (83)	ND	0 (0)	ND ^b	0 (0)	ND	0 (0)	0.15	47 (100)	0.04	13 (29)
24	Aquashicola Creek at Field Station Bridge	277	113 (73)	0.52	140 (310)	0.005 ^b	1.4 (3.1)	ND	0 (0)	0.12	33 (73)	0.20	55 (120)
19	Mill Creek	22	9.0 (5.8)	0.11	2.4 (5.3)	ND ^b	0 (0)	ND	0 (0)	ND	0 (0)	0.02	0.44 (0.97)
21	Aquashicola Creek at 6th Street Bridge	321	131 (85)	0.81	260 (570)	0.04 ^a	13 (29)	0.01	3.2 (7.1)	0.16	51 (110)	0.22	71 (160)
20	Aquashicola Creek at Tatra Inn Bridge	242	99 (64)	0.70	170 (370)	0.03 ^a	7.3 (16)	ND	0 (0)	0.14	34 (75)	0.18	44 (97)
May 11, 1979													
27	Aquashicola Creek at Harris Bridge	313	128 (83)	ND	0 (0)	ND ^b	0 (0)	0.01	3.1 (6.8)	0.14	44 (97)	0.03	9.4 (21)
24	Aquashicola Creek at Field Station Bridge	277	113 (73)	0.38	110 (240)	0.006 ^b	1.7 (3.7)	ND	0 (0)	0.15	41 (90)	0.17	47 (100)
19	Mill Creek	22	9 (5.8)	ND	0 (0)	ND ^b	0 (0)	ND	0 (0)	0.08	1.8 (4.0)	0.03	0.66 (1.5)
21	Aquashicola Creek at 6th Street Bridge	321	131 (85)	0.92	290 (640)	0.03 ^a	9.6 (21)	0.01	3.2 (7.1)	0.15	48 (110)	0.20	64 (140)
20	Aquashicola Creek at Tatra Inn Bridge	242	99 (64)	0.59	140 (310)	0.03 ^a	7.3 (16)	0.01	2.4 (5.3)	0.14	34 (75)	0.16	39 (86)

Table 9 (Cont'd)
 AQUASHICOLA CREEK AND MILL CREEK METALS SAMPLING DATA
 New Jersey Zinc - East Plant
 Palmerton, Pennsylvania
 May 8-14, 1979

NEIC Station No	Station Description	Flow		Total Zinc		Total Cadmium		Total Lead		Total Iron		Total Manganese	
		m ³ /day x 10 ³	cfs (mgd)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)
	Detection Limit			0.08 ^a		0.005 ^a 0.002 ^b		0.01 ^c		0.08 ^a		0.02 ^a	
May 12, 1979													
27	Aquashicola Creek at Harris Bridge	272	111 (72)	ND	0 (0)	ND ^b	0 (0)	ND	0 (0)	0.14	38 (84)	0.03	8.1 (18)
24	Aquashicola Creek at Field Station Bridge	279	114 (74)	0.56	160 (350)	0.006 ^b	1.7 (3.7)	0.01	2.8 (6.2)	0.13	36 (79)	0.21	59 (130)
19	Mill Creek	17	7 (4.5)	ND	0 (0)	ND ^b	0 (0)	0.02	0.34 (0.75)	0.20	3.4 (7.5)	0.03	0.51 (1.1)
21	Aquashicola Creek at 6th Street Bridge	301	123 (79)	0.81	240 (530)	0.04 ^a	12 (26)	ND	0 (0)	0.27	81 (180)	0.22	66 (150)
20	Aquashicola Creek at Tatra Inn Bridge	296	121 (78)	0.70	210 (460)	0.03 ^a	8.9 (20)	0.01	3.0 (6.6)	0.19	56 (120)	0.18	53 (120)
May 13, 1979													
27	Aquashicola Creek at Harris Bridge	272	111 (72)	0.23	63 (140)	ND ^b	0 (0)	0.01	2.7 (6.0)	0.23	62 (140)	0.05	14 (31)
24	Aquashicola Creek at Field Station Bridge	279	114 (74)	0.58	160 (350)	0.012 ^b	3.3 (7.3)	ND	0 (0)	0.14	39 (86)	0.27	75 (170)
19	Mill Creek	17	7 (4.5)	0.16	2.7 (6.0)	ND ^b	0 (0)	0.01	0.17 (0.37)	0.11	1.9 (4.2)	0.04	0.68 (1.5)
21	Aquashicola Creek at 6th Street Bridge	301	123 (79)	0.80	240 (530)	0.04 ^a	12 (26)	ND	0 (0)	ND	0 (0)	0.31	93 (210)
20	Aquashicola Creek at Tatra Inn Bridge	296	121 (78)	0.83	250 (550)	0.04 ^a	12 (26)	0.01	3.0 (6.6)	0.16	47 (100)	0.28	83 (180)

Table 9 (Cont'd.)
AQUASHICOLA CREEK AND MILL CREEK METALS SAMPLING DATA
New Jersey Zinc - East Plant
Palmerton, Pennsylvania
May 8-14, 1979^f

NEIC Station No	Station Description	Flow		Total Zinc		Total Cadmium		Total Lead		Total Iron		Total Manganese	
		m ³ /day x 10 ³	cfs (mgd)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)	mg/l	kg/day (lb/day)
	Detection Limit			0.08 ^a		0.005 ^a 0.002 ^b		0.01 ^c		0.08 ^a		0.02 ^a	
May 14, 1979													
27	Aquashicola Creek at Harris Bridge	313	128 (83)	ND	0 (0)	0.007 ^b	2.2 (4.9)	ND	0 (0)	0.23	72 (160)	0.04	13 (29)
24	Aquashicola Creek at Field Station Bridge	279	114 (74)	0.43	120 (260)	0.006 ^b	1.7 (3.7)	ND	0 (0)	0.12	33 (73)	0.19	53 (120)
19	Mill Creek	22	9 (5.8)	0.09	2.0 (4.4)	ND ^b	0 (0)	ND	0 (0)	0.14	3.1 (6.8)	0.03	0.66 (1.5)
21	Aquashicola Creek at 6th Street Bridge	321	131 (85)	0.94	300 (660)	0.04 ^a	13 (29)	ND	0 (0)	0.78	250 (550)	0.31	100 (220)
20	Aquashicola Creek at Tatra Inn Bridge	242	99 (64)	0.73	180 (400)	0.04 ^a	9.7 (21)	0.01	2.4 (5.3)	0.19	46 (100)	0.18	44 (97)
7 Day Averages ^f													
27	Aquashicola Creek at Harris Bridge	306	125 (81)	0.03 ^g	9.0 (20)	0.001 ^g	0.31 (0.68)	0.004 ^g	1.3 (2.9)	0.17	51 (112)	0.04	11 (24)
24	Aquashicola Creek at Field Station Bridge	287	117 (76)	0.52	150 (330)	0.007	2.0 (4.4)	0.003 ^g	0.89 (2.0)	0.12	35 (77)	0.21	59 (130)
19	Mill Creek	21	8.6 (5.6)	0.05 ^g	1.0 (2.2)	0	0 (0)	0.005 ^g	0.11 (0.24)	0.10	2.0 (4.4)	0.02	0.48 (1.1)
21	Aquashicola Creek at 6th Street Bridge	313	128 (83)	0.86	270 (600)	0.04	12 (26)	0.004 ^g	1.3 (2.9)	0.27	86 (190)	0.25	79 (174)
20	Aquashicola Creek at Tatra Inn Bridge	255	104 (67)	0.75	190 (420)	0.04 0.04	9.1 (20)	0.009 ^g	2.2 (4.9)	0.16	41 (90)	0.19	49 (110)

a Analysis was by flame atomic absorption for all zinc, iron and manganese samples; cadmium samples analyzed by flame AA have superscript 'a'.
b Analysis was by flameless atomic absorption for cadmium samples with superscript 'b'.

c Analysis was by ICAP for all lead samples.

d ND means not detected (less than the detection limit) and assigned a value of zero for all load and averaging computations; hence, all averages involving ND value are conservative.

e Sampling at 6th Street Bridge began on May 10, 1979.

f Average concentrations back-calculated from average load and flow data. Averages for 6th Street Bridge Station (Station 21) are for 5 days only.

g Average is less than detection limit.

Table 10
Total Metals (Zinc/Cadmium) Contributions to Aquashicola Creek
New Jersey Zinc - East Plant
Palmerton, Pennsylvania

Source	Total Zinc		Total Cadmium	
	kg/day	lb/day	kg/day	lb/day
May 10, 1979				
1. Aquashicola Creek at Harris Bridge - Background Conditions	0	0	0	0
2. Aquashicola Creek-Net gain, Harris Bridge to Field Sta. Bridge ^a	140	310	1.4	3.1
3. Aquashicola Creek-Net gain, Field Sta. Bridge to 6th St. Bridge ^a	120	260	12	26
4. Total contribution from East Plant Discharges (Net Loads)	66	150	1.1	2.4
5. Groundwater contribution between Field Sta. Bridge & 6th St. Bridge	54	120	11	24
6. Total groundwater contribution bet. Harris Bridge & 6th St. Bridge ^a	190	420	12	26
7. Total metals increase between Harris Bridge & 6th St. Bridge ^a	260	570	13	29
May 11, 1979				
1. Aquashicola Creek at Harris Bridge - Background Conditions	0	0	0	0
2. Aquashicola Creek-Net gain, Harris Bridge to Field Sta. Bridge ^a	110	240	1.7	3.7
3. Aquashicola Creek-Net gain, Field Sta. Bridge to 6th St. Bridge ^a	180	400	7.9	17
4. Total contribution from East Plant Discharges (Net Loads)	55	120	0.8	1.8
5. Groundwater contribution between Field Sta. Bridge & 6th St. Bridge	120	260	7.1	16
6. Total groundwater contribution bet. Harris Bridge & 6th St. Bridge ^a	230	510	8.8	19
7. Total metals increase between Harris Bridge & 6th St. Bridge ^a	290	640	9.6	21
May 12, 1979				
1. Aquashicola Creek at Harris Bridge - Background Conditions	0	0	0	0
2. Aquashicola Creek-Net gain, Harris Bridge to Field Sta. Bridge ^a	160	350	1.7	3.7
3. Aquashicola Creek-Net gain, Field Sta. Bridge to 6th St. Bridge ^a	80	180	10	22
4. Total contribution from East Plant Discharges (Net Loads)	32	70	0.6	1.3
5. Groundwater contribution between Field Sta. Bridge & 6th St. Bridge	48	110	9.4	21
6. Total groundwater contribution bet. Harris Bridge & 6th St. Bridge ^a	210	460	11	24
7. Total metals increase between Harris Bridge & 6th St. Bridge ^a	240	530	12	26
May 13, 1979				
1. Aquashicola Creek at Harris Bridge - Background Conditions	63	140	0	0
2. Aquashicola Creek-Net gain, Harris Bridge to Field Sta. Bridge ^a	97	210	3.3	7.3
3. Aquashicola Creek-Net gain, Field Sta. Bridge to 6th St. Bridge ^a	80	180	8.7	19
4. Total contribution from East Plant Discharges (Net Loads)	45	100	1.1	2.4
5. Groundwater contrib. between Field Sta. Bridge & 6th St. Bridge	35	80	7.6	17
6. Total groundwater contribution bet. Harris Bridge & 6th St. Bridge ^a	130	290	11	24
7. Total metals increase between Harris Bridge & 6th St. Bridge ^a	180	400	12	26
May 14, 1979				
1. Aquashicola Creek at Harris Bridge - Background Conditions	0	0	2.2 ^b	4.9 ^b
2. Aquashicola Creek-Net gain, Harris Bridge to Field Sta. Bridge ^a	120	260	-0.5 ^b	-1.1 ^b
3. Aquashicola Creek-Net gain, Field Sta. Bridge to 6th St. Bridge ^a	180	400	11	24
4. Total contribution from East Plant Discharges (Net Loads)	32	70	0.7	1.5
5. Groundwater contribution between Field Sta. Bridge & 6th St. Bridge	150	330	10	22
6. Total groundwater contribution bet. Harris Bridge & 6th St. Bridge ^a	270	600	10	22
7. Total metals increase between Harris Bridge & 6th St. Bridge ^a	300	660	11	24
5-day Average				
1. Aquashicola Creek at Harris Bridge - Background Conditions	13	29	0.4	0.9
2. Aquashicola Creek-Net gain, Harris Bridge to Field Sta. Bridge ^a	130	290	1.5	3.3
3. Aquashicola Creek-Net gain, Field Sta. Bridge to 6th St. Bridge ^a	130	290	10	22
4. Total contribution from East Plant Discharges (Net Loads)	46	100	0.9	2.0
5. Groundwater contribution between Field Sta. Bridge & 6th St. Bridge	84	190	9.1	20
6. Total groundwater contribution bet. Harris Bridge & 6th St. Bridge ^a	210	460	11	24
7. Total metals increase between Harris Bridge & 6th St. Bridge ^a	260	570	12	26

^a Excluding Mill Creek contribution which has been subtracted.

^b Negative number indicates apparent loss of cadmium between Harris Bridge and Field Station.

Table 11
 PROFILE OF TOTAL ZINC AND TOTAL CADMIUM CONCENTRATIONS OF VARIOUS CROSS-SECTIONS OF AQUASHICOLA CREEK^a
 New Jersey Zinc, Company - East Plant
 Palmerton, Pennsylvania
 May 9 and 13, 1979

NEIC Sta.	Description	May 1979	Section 1 ^b		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7		Section 8 ^b	
Total Zinc (Zn) and Total Cadmium (Cd) - All values in mg/l																		
			Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd
20	Aquashicola Creek at Tatra Inn Bridge	9 13	0.66 0.82	0.03 0.03	0.66 0.85	0.03 0.04	0.67 0.83	0.03 0.04	0.68 0.81	0.03 0.03	0.69 0.82	0.03 0.03	0.65 0.83	0.03 0.03	0.65 0.80	0.03 0.03	0.66 0.82	0.04 0.04
21	Aquashicola Creet at 6th Street Bridge	13 ^c	0.90	0.04	0.87	0.04	0.82	0.03	0.86	0.04	0.85	0.04	0.90	0.05	0.95	0.04	0.98	0.04
24	Aquashicola Creek at Field Station Bridge	9 13	0.35 0.52	0.002 ^d ND ^{d,e}	0.35 0.49	0.003 ^d 0.002 ^d	0.36 0.44	0.002 ^d 0.002 ^d	0.58 0.52	0.018 ^d 0.008 ^d	0.39 0.53	0.005 ^d 0.004 ^d	0.47 0.52	0.005 ^d 0.007 ^d	0.87 0.66	0.009 ^d 0.009 ^d	1.0 0.88	0.015 ^d 0.015 ^d
25	Aquashicola Creek at Aggregates Bridge	9 ^f 13 ^g	0.17 0.69	ND ^d 0.002 ^d	0.21 0.68	0.002 ^d 0.002 ^d	0.17 0.58	ND ^d 0.003 ^d	0.24 0.57	ND ^d ND ^d	0.40 0.52	ND ^d ND ^d	0.38 0.52	0.002 ^d 0.002 ^d	0.47 0.53	0.003 ^d 0.002 ^d	0.44 0.48	ND ^d 0.003 ^d
27	Aquashicola Creek at Harris Bridge	9 13	ND ND	ND ^d ND ^d	ND ND	ND ^d ND ^d	ND ND	ND ^d ND ^d	ND ND	ND ^d ND ^d	ND 0.09	ND ^d 0.006 ^d	ND ND	ND ^d 0.007 ^d	ND ND	ND ^d ND ^d	ND ND	ND ^d ND ^d

a Each cross-section of Aquashicola Creek was divided into eight equal-width sub-sections and one grab sample for total metals was collected from each of the sub-sections on each of the dates listed.

b Section 1 is closest to the left bank (looking upstream) and Section 8 is closest to the right bank.

c No sampling at this Station on May 9.

d Some Cadmium analysis by flameless atomic absorption; all other analyses (cadmium and zinc) by flame AA

e ND means Not Detected (below detection limit).

f Sampling site was upstream of Aggregates Bridge.

g Sampling site was downstream from Aggregates Bridge.

Table 12
 LEHIGH RIVER - METALS SAMPLING DATA^a
 Palmerton, Pennsylvania
 May 8 - 14, 1979

Station Number and Description	Total ^b Zinc mg/l	Total ^c Cadmium mg/l	Total ^d Lead mg/l	Total ^b Iron mg/l	Total ^b Manganese ^e mg/l
May 8, 1979					
Station 30 - Lehigh River above NJZ West Plants	0.09	ND	ND	0.26	0.14
Station 29 - Lehigh River upstream of Aquashicola Creek	ND	ND	ND	0.23	0.13
Station 28 - Lehigh River below Aquashicola Creek	ND	0.003	0.01	0.12	0.12
May 9, 1979					
Station 30 - Lehigh River above NJZ West Plants	ND	ND	ND	0.17	0.13
Station 29 - Lehigh River upstream of Aquashicola Creek	0.27	ND	0.01	0.27	0.20
Station 28 - Lehigh River below Aquashicola Creek	0.11	0.002	ND	0.12	0.13
May 10, 1979					
Station 30 - Lehigh River above NJZ West Plants	ND	ND	ND	0.16	0.11
Station 29 - Lehigh River upstream of Aquashicola Creek	ND	ND	ND	0.26	0.12
Station 28 - Lehigh River below Aquashicola Creek	0.13	0.004	0.01	0.14	0.12
May 11, 1979					
Station 30 - Lehigh River above NJZ West Plants	ND	ND	ND	0.55	0.15
Station 29 - Lehigh River upstream of Aquashicola Creek	0.19	0.006	ND	0.16	0.17
Station 28 - Lehigh River below Aquashicola Creek	ND	ND	ND	0.22	0.13
May 12, 1979					
Station 30 - Lehigh River above NJZ West Plants	ND	ND	ND	0.20	0.13
Station 29 - Lehigh River upstream of Aquashicola Creek	ND	ND	ND	0.73	0.14
Station 28 - Lehigh River below Aquashicola Creek	0.09	0.002	0.01	0.09	0.13
May 13, 1979					
Station 30 - Lehigh River above NJZ West Plants	ND	ND	ND	0.13	0.12
Station 29 - Lehigh River upstream of Aquashicola Creek	0.10	ND	ND	0.17	0.13
Station 28 - Lehigh River below Aquashicola Creek	0.12	0.002	ND	0.14	0.14
May 14, 1979					
Station 30 - Lehigh River above NJZ West Plants	ND	ND	ND	0.15	0.12
Station 29 - Lehigh River upstream of Aquashicola Creek	ND	ND	ND	0.19	0.13
Station 28 - Lehigh River below Aquashicola Creek	0.12	0.002	ND	0.14	0.12
7-day Average ^f					
Station 30 - Lehigh River above NJZ West Plants	0.01	ND(0)	ND(0)	0.23	0.13
Station 29 - Lehigh River upstream of Aquashicola Creek	0.08	0.001	0.0014	0.29	0.15
Station 28 - Lehigh River below Aquashicola Creek	0.08	0.002	0.004	0.14	0.13

a All data based on one grab sample per day at each station.

b All zinc, iron and manganese samples analyzed by flame atomic absorption; detection limits are 0.08 mg/l, 0.08 mg/l, and 0.02 mg/l, respectively.

c All cadmium samples analyzed by flameless atomic absorption; detection limit is 0.002 mg/l.

d All lead samples analyzed by ICAP; detection limit is 0.01 mg/l.

e ND means not detected (below detection limit) and assigned a value of zero for averaging computations, hence all averages involving ND values are conservative.

f Average values are presented, even if below detection limit.

Table 13
pH AND TEMPERATURE DATA
MILL CREEK, AQUASHICOLA CREEK AND LEHIGH RIVER
Palmerton, Pennsylvania
May 8-14, 1979

NEIC Station No.	Station Description	Date (Time) May 1979	pH (su)	Temperature (°C)
19	Mill Creek	8 (0955)	6.7	13
		9 (1133)	7.0	18
		10 (0725)	6.5	14
		11 (0804)	6.9	14
		12 (0840)	6.8	15
		13 (0843)	6.9	14
		14 (0709)	6.9	13
		Average Temperature		14
20	Aquashicola Creek at Tatra Inn Bridge	8 (1242)	8.8	17
		9 (1616)	8.5	21
		10 (1200)	7.3	19
		11 (1212)	7.6	19
		12 (1110)	6.9	16
		13 (1130)	7.2	15
		14 (1123)	6.5	14
		Average Temperature		17
21	Aquashicola Creek at 6th Street Bridge	10 (1115)	7.2	18
		11 (1102)	8.2	17
		12 (1017)	6.8	16
		13 (1030)	6.9	15
		14 (1025)	6.5	14
		Average Temperature		16
24	Aquashicola Creek at Field Station Bridge	8 (1048)	6.8	14
		9 (1310)	7.5	18
		10 (0956)	6.8	17
		11 (1042)	7.1	17
		12 (0905)	6.8	15
		13 (0956)	6.9	14
		14 (0939)	6.7	14
		Average Temperature		16
25	Aquashicola Creek at Aggregates Bridge	9 (1223)	6.9	18
		13 (0818)	7.4	14
		Average Temperature		16

Table 13 (Cont'd)
pH AND TEMPERATURE DATA
MILL CREEK, AQUASHICOLA CREEK AND LEHIGH RIVER
Palmerton, Pennsylvania
May 8-14, 1979

NEIC Station No.	Station Description	Date (Time) May 1979	pH (su)	Temperature (°C)
27	Aquashicola Creek at Harris Bridge	8 (0712)	7.6	12
		9 (0952)	6.8	16
		10 (0650)	6.5	16
		11 (0704)	6.4	15
		12 (0635)	7.3	15
		13 (0638)	7.6	13
		14 (0652)	6.8	13
		Average Temperature		14
28	Lehigh River below Aquashicola Creek	8 (1928)	7.2	19
		9 (1810)	6.5	20
		10 (1429)	6.4	19
		11 (1440)	6.7	19
		12 -	6.7	16
		13 (1450)	6.8	16
		14 -	6.3	14
		Average Temperature		18
29	Lehigh River Upstream of Aquashicola Creek	8 (1647)	7.0	19
		9 (1740)	6.9	-
		10 (1359)	a	20
		11 (1415)	6.8	18
		12 (1410)	6.5	17
		13 -	7.7	16
		14 (1357)	6.4	15
		Average Temperature		17
30	Lehigh River Upstream of West Plant	8 (1500)	6.5	18
		9 (1655)	7.0	20
		10 (1316)	-	18
		11 (1347)	6.7	18
		12 (1250)	6.7	16
		13 -	6.8	16
		14 (1314)	6.5	14
		Average Temperature		17

a pH meter malfunctioned

Table 14

SEDIMENT METAL ANALYSES - AQUASHICOLA CREEK
AND LEHIGH RIVER (ICAP-AES)
(ug/g)

Elem.	Har. Br. 27-01	Le. Riv. Bo. Br. 99-01	Le. Riv. Pal. Br. 30-01	Agr. Br. 25-01	Fld. Sta. Br. 24-01*	Main Gate Dr. 23-01	USGS Gage 22-01	6th St. Br. 21-01	Tatra Inn Br. 20-01	Le. Riv. above Le. Cr. 29-01	Le. Riv. Walnut P. 28-01*
Zinc	840.	420.	600.	6,200.	17,000.	29,000.	42,000.	14,060.	11,000.	1,100.	2,600.
admium	13.	2.	3.	39.	120.	420.	210.	58.	95.	10.	15.5
anganese	570.	520.	1,100.	5,400.	15,500.	13,000.	20,000.	9,700.	9,900.	360.	2,000.
cad	52.	99.	70.	1,000.	820.	1,400.	310.	870.	490.	35.	125.
opper	57.	86.	35.	1,300.	500.	600.	350.	368.	300.	25.	94.
ron	24,000.	22,000.	32,000.	40,000.	49,000.	63,000.	52,000.	35,000.	34,000.	12,000.	24,000.
chromium	38.	35.	32.	45.	46.5	48.	38.	51.	56.	6.	30.
ickie	41.	37.	36.	35.	31.	51.	66.	38.	36.	22.	29.
odium	2,000.	3,600.	2,300.	2,400.	2,500.	1,500.	1,300.	2,100.	3,500.	640.	2,450.
	Avg			Avg							
inc	620			(x32)							
admium	6			(x26)							
anganese	730			(x16.8)							
cad	73			(x11.2)							
opper	59			(x9.7)							
ron	26,000			(x1.75)							
chromium	35			(x1.3)							
ickie	38			(x1.1)							
odium	2,670			(x0.83)							

* Average of duplicate analyses (sample splits) made for quality control.

Table 15
BENTHIC MACROINVERTEBRATES
LEHIGH RIVER AND AQUASHICOLA CREEK, PENNSYLVANIA
May, 1979²
(Number per M²)

Organisms	Stations	27	32	25	23	31	21	20	34	35	33	37	36
Annelida													
Oligochaeta												11	
Naididae													
Insecta													
Ephemeroptera													
Baetidae									11				
Baetis	97	161	195	11	21								
Pseudocloeon	54												
Centroptilum	86		32										
Leptophlebiidae													
Paraleptophlebia	54												
Heptageniidae													
Iron						11							21
Stenonema	323	75	22										
Epemerellidae													32
Epemerella	291	172	118		21								
Siphonuridae													
Ameletus	43												
Isorhynchia	21												
Siphonurus	86		21										
Tricoptera													
Hydropsychidae										11	11		
Diplectrona						33		11	183	43	104	65	11
Hydropsyche	22	258	205										
Glossosomatidae													
Acanetulus	21												
Brachycentridae													
Brachycentrus			11										
Polycentropodidae													
Polycentropus		21											
Leptoceridae													
Oecetis						11							
Liraphephillidae													
Arctophila	11								43				
Goera	21	32	11									11	
Pycnopsyche	54												
Phlebotomidae													
Chimarra		11											
Rhyacophiliidae									43			21	
Atopsyche	11	11	11			11							
Plecoptera													
Perlidae													
Isogenus	21		11				11						
Perlidae													
Acronetia		11	11			11	11			22	11		21
Leopelia						11							
Paragnetina	11	11											
Peltoperlidae													
Peltoperla	21												
Coleoptera													
Psephenidae													
Psephenus	32	11					11						11
Diptera													
Tabanidae													
Tabanus			11								11		
Simuliidae													
Cnephia		43	215			54	140					11	
Chironomidae													
Ablabesmyia	65					11					11		
Brillia						11							
Cardiocladius						11	11						
Chironomus	11	11	53	64	75	21		11	43		11	11	
Cricotopus			11		11	11							
Diamesa	21			11					11		32		
Eulimnoria	65			11		11						11	
Lauterborniella	11					21						11	
Microdsectra						21							
Ortochladius	312	97	53	194	237	441		22	75	11	86	11	
Paralauterborniella						21							
Polypedilus	11			11		11	22				43		
Pseudochironomus	11			11		11	11						
Rheotanytarsus	53	11				32	22				11		
Smittia						11							
Stictochironomus				21									
Tanytarsus	11	11	11	11			11						
Trissocladius		11				11							
Mollusca													
Physidae													
Physa		11											
Total No. of kinds	29	18	17	9	23	13	3	7	4	10	9	5	
Number/M ²	1,851	969	1,007	345	669	744	44	409	87	331	163	96	

Table 16
LEHIGH RIVER AND AQUASHICOLA CREEK PERIPHYTON
MAY 5-14, 1979

No.	Location	River Km	Periphytic Algal Populations - Number/cm ² (%)							Chlorophyll mg/cm ²	Vorticella
			Filamentous Blue-Green	Green	Unicellular Green	Flagellates	Diatoms Pennate	Centric	Total		
27	Aquashicola Creek at Harris Bridge	8.4	256(1)	428(1)	342(1)		38,646(96)	428(1)	40,100		
25	Aquashicola Creek at Aggregates Bridge	4.9	239(1)	86(1)	51(1)	17(1)	19,152(97)	188(1)	19,733	69	
24	Aquashicola Creek at Field Station Bridge	3.7	34(1)	51(1)	17(1)	17(1)	4,754(96)	86(2)	4,959	27	
23	Aquashicola Creek at Main Gate Bridge	3.0	718(1)	205(1)	376(1)	86(1)	56,020(97)	222(1)	57,627	314	51
22	Aquashicola Creek at USGS Gage Station	2.2	462(1)	188(1)	530(1)	51(1)	55,113(98)	86(1)	56,430	1141	222
21	Aquashicola Creek at 6th Street Bridge	1.9	598(2)	51(1)	496(1)	17(1)	36,235(96)	205(1)	37,602	342	51
20	Aquashicola Creek at Tatra Inn Bridge	0.2	471(4)	150(1)	107(1)		10,037(93)	43(1)	10,808	143	
30	Lehigh River above West Plant (near Bowmanstown Bridge)		214(21)	14(1)	43(4)		741(73)		1,012	7	43
28	Lehigh River below Aquashicola Creek (3.5 Km downstream from Aquashicola Creek)		214(8)	214(8)	28(1)	14(1)	2,252(81)	43(2)	2,765	13	

Table 17
IN-SITU FISH SURVIVAL^a
 Lehigh River and Aquashicola Creek
 May 11 - 14, 1979

Station No	Aquashicola Creek								Lehigh River		
	20	21	22	23	011	24	25	27	28	29	30
% Survival	80	60	80	80	90	100	90	100	100	100	100
D.O. mg/l	12.6	11.0	10.2	10.2	10.5	10.6	10.5	10.3	10.0	9.7	10.1
pH (Range)	6.8-7.7	6.8-7.8	6.8-7.5	6.9-7.6	7.3-7.8	7.2-9.0	7.2	7.1-7.2	7.1	6.3-7.1	6.9-7.

a Expressed as percent.

the 6th Street Bridge. The respective average values for zinc and cadmium were 9.0 kg/day and 0.31 kg/day at Harris Bridge and 270 kg/day and 12 kg/day at the 6th Street Bridge. The average manganese load increased from 11 kg/day to 79 kg/day over the same stream reach, a seven-fold increase. Although the average iron load showed a 68% increase in this reach of the creek, the individual daily concentrations and loads showed that there was no consistency to this trend. Also, no significant trends are evident with the lead data, since most measured concentrations were at or below the detection limit.

Table 10 presents daily mass contributions of zinc and cadmium to Aquashicola Creek in the reach from Harris Bridge to Field Station Bridge and from Field Station Bridge to 6th Street Bridge. This table incorporates total zinc and cadmium loadings from all NJZ East Plant discharges with Table 9 load data in order to differentiate between discharge contributions and groundwater contributions to the creek. Data from May 8 and 9 are not included in this table because no sampling was conducted at the 6th Street Bridge Station on these days and a mass balance could not be performed. Data from the Tatra Inn Bridge station are also excluded because the previously mentioned loss of flow makes mass balance calculations unworkable. The data from this table have been incorporated into Figure 18 which graphically shows the sources of the zinc and cadmium contributions at the three Stations listed.

The data in Table 10 and Figure 18 clearly indicate that the majority of the zinc and cadmium in Aquashicola Creek is contributed by groundwater sources rather than the East Plant discharges. The 5-day average data demonstrates that 82% of the zinc increase and 92% of the cadmium increase between Harris Bridge and 6th Street Bridge was from groundwater intrusion.

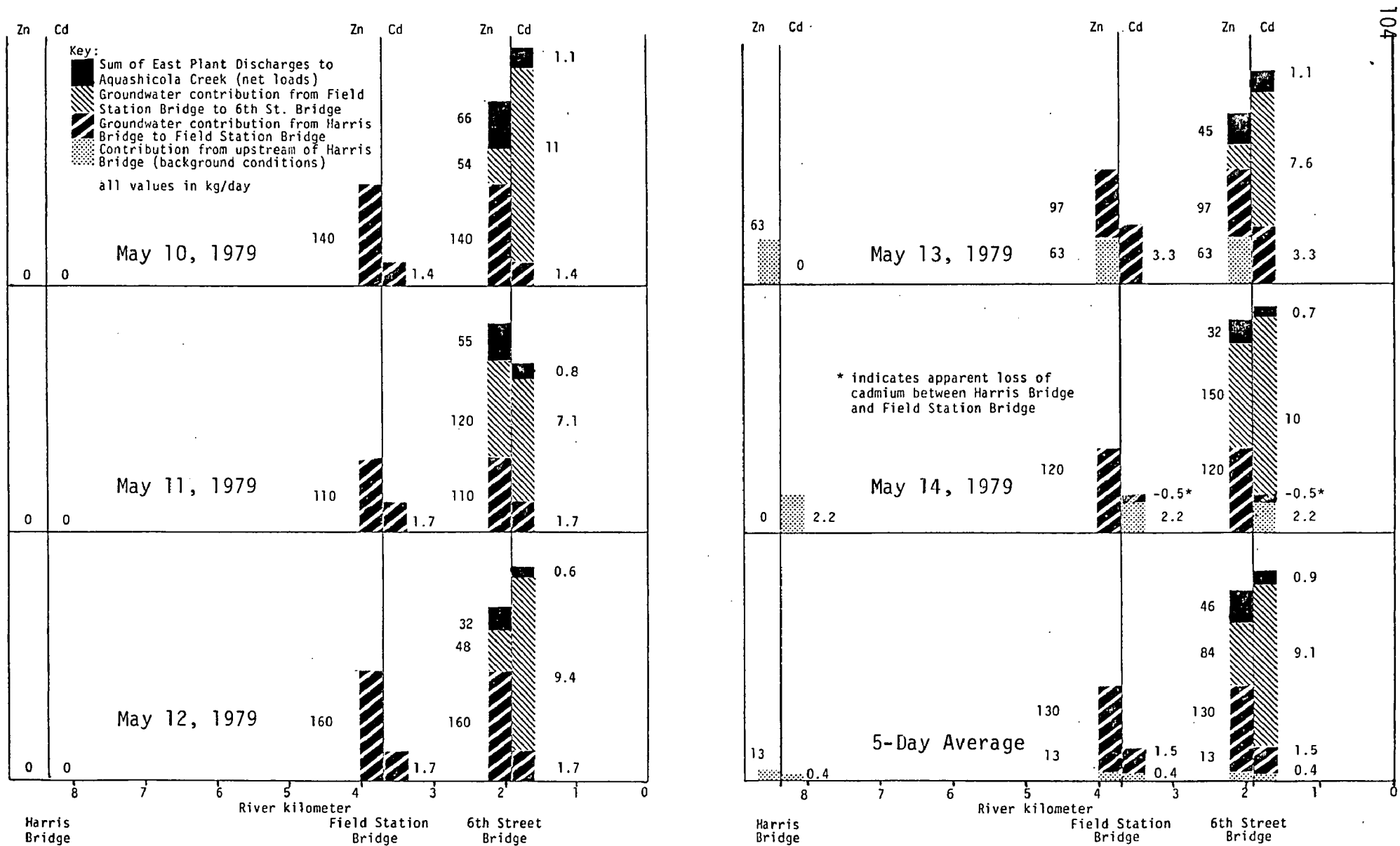
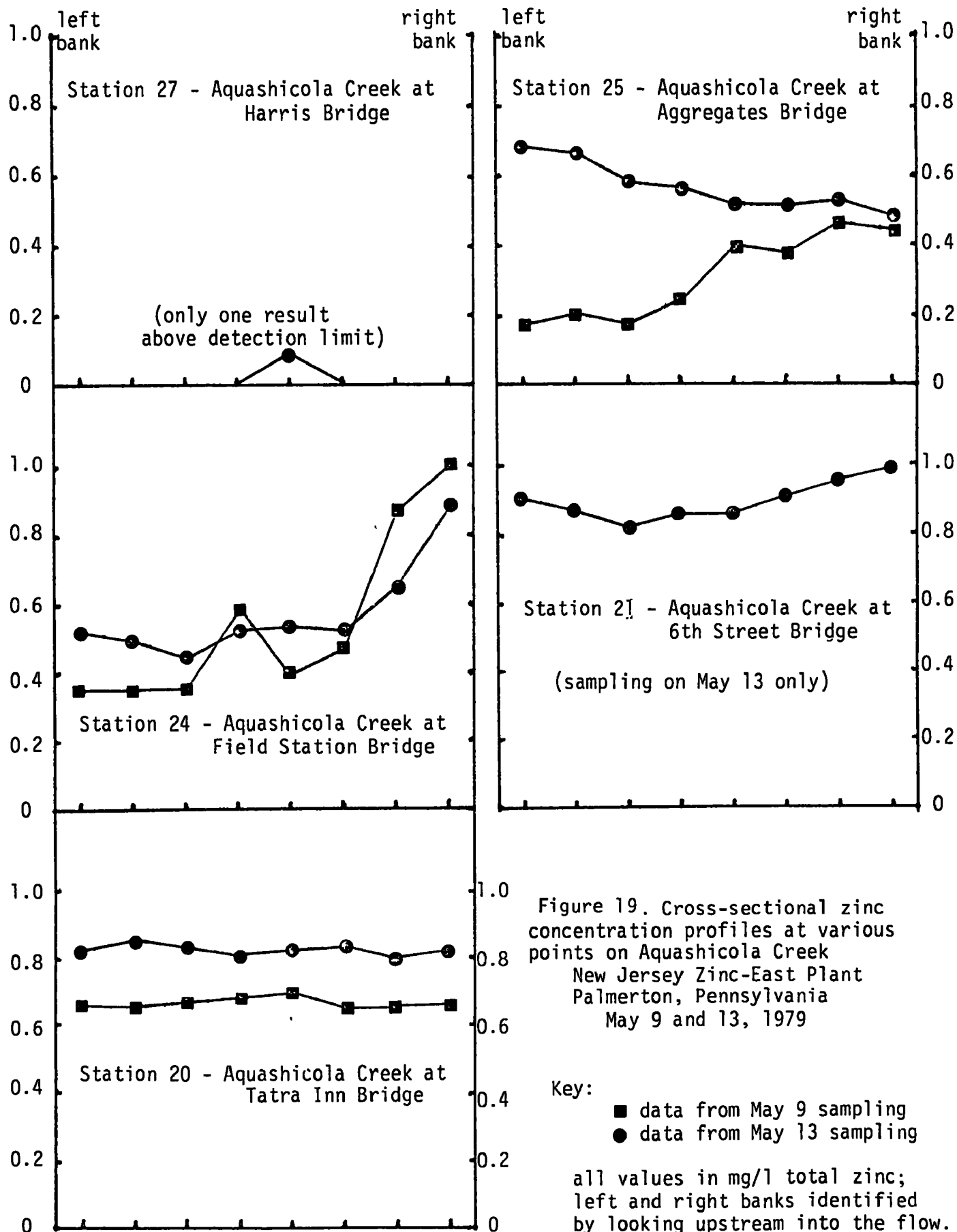


Figure 18. Total Metals (zinc and Cadmium) Contributions to Aquashicola Creek
New Jersey Zinc Company - East Plant
Palmerton, Pennsylvania
May 10-14, 1979

Table 11 presents data profiling zinc and cadmium concentrations at five Aquashicola Creek cross-sections on two days, May 9 and 13. Zinc concentration data were incorporated into Figure 19 to graphically illustrate cross-section profiles. In all instances the left and right banks were designated looking upstream. Thus the Cinder Bank and the East Plant are on the right bank.

At Aggregate Field Station and 6th Street Bridges, the zinc and cadmium concentrations were generally higher near the right bank of the creek. This trend is strongest at Field Station Bridge where zinc and cadmium concentrations were from two to eight times greater on the right side than on the left. The data from the first day of sampling at Aggregates Bridge shows a conclusive profile with much higher concentrations on the right side. The sampling site on this day was about 30 m (100 ft) upstream of the bridge. On the second sampling day, however, the site was changed to the downstream side of the bridge and the mixing action from the water being channeled through the bridge's culverts was the probable cause for the higher left side concentrations on the 2nd day. The data from the Harris Bridge and Tatra Inn Bridge Stations indicate uniform concentrations of the two metals at these cross-sections.

Table 12 presents total metals results of seven days of water quality sampling at three Lehigh River Stations - upstream of the NJZ West Plant, downstream from the West Plant but upstream of Aquashicola Creek, and downstream from Aquashicola Creek. Zinc, cadmium, and lead concentrations, especially the seven-day averages, indicate some influence from the West Plant and a lesser influence from Aquashicola Creek. However, many concentrations were found to be near or less than their respective detection limits, making it difficult to distinguish trends. The iron and manganese data show no trends.



Field Measurements

The pH and temperature data collected from the receiving water quality stations on Aquashicola Creek, Mill Creek and Lehigh River are presented in Table 13. A comparison of these data with the State of Pennsylvania receiving water quality criteria [Table 1], show that on no occasion were these parameters outside or above their respective limits at any of the sampling locations.

Sediment Quality

Zinc concentrations in sediments from the background Stations (27, 99 and 30) ranged from 420 $\mu\text{g/g}$ to 840 $\mu\text{g/g}$ and averaged 620 $\mu\text{g/g}$. The Stations (25, 24, 23, 22, 21 and 20) adjacent to the NJZ Cinder Bank, East Plant and downstream on Aquashicola Creek to its confluence with the Lehigh River ranged from 6,200 $\mu\text{g/g}$ to 42,000 $\mu\text{g/g}$ and averaged 19,900 $\mu\text{g/g}$ [Table 14]. This is 32 times the average of the background stations.

Cadmium concentrations in sediments from the background stations ranged from 2 to 13 $\mu\text{g/l}$ and averaged 6 $\mu\text{g/g}$. The Stations (25, 24, 23, 22, 21 and 20) adjacent to NJZ's Cinder Bank, East Plant and downstream on Aquashicola Creek to its confluence with the Lehigh River ranged from 39 $\mu\text{g/g}$ to 420 $\mu\text{g/l}$ and averaged 157 $\mu\text{g/g}$. This is 26 times the average of the background stations.

Similarly manganese, lead and copper showed corresponding increases adjacent to the Cinder Bank and East Plant areas as compared to the background stations of about 17%, 11%, and 10%, respectively.

Background concentrations of zinc in stream sediment in southeastern Pennsylvania are generally less than 200 parts per million (ppm) according to Rose. He recognized anomalously high zinc concentration in stream sediments of the upper Lehigh River Valley and attributed this occurrence to the presence of the zinc smelter at Palmerton.

Therefore it is probable that the background stations selected for this survey show from 200 to 400 ppm zinc from smelter dust drift and fallout.

McMean² confirmed Rose's findings and also indicated that natural cadmium, lead and copper concentrations in stream sediments would not be expected to exceed 1 to 30 and 20 to 40 ppm, respectively.

Hence, the high concentrations of metals in Aquashicola Creek and in the Lehigh River sediment are attributed to discharges from New Jersey Zinc Company's facilities including erosion from the Cinder Bank and fallout of fugitive zinc and cadmium bearing particles and direct emissions from process operations.

Benthic Macroinvertebrates

Both Aquashicola Creek and the Lehigh River were characterized by a well-entrenched channel, moderate gradient and frequent large cobble-filled riffles over a hard-rock bottom. Throughout the study area, including reference (control) sites, benthic macroinvertebrate population levels were low (44 to 1851/m²) indicating that both Aquashicola Creek and the Lehigh River are not highly productive [Table 15]. According to the system developed by Madsen³, where productivity is based on numbers of benthic macroinvertebrates/m², both streams would fall into the "poor productivity" category.

In Aquashicola Creek at Station 27, the reference station, the benthos reflected good water quality. The 29 kinds of organisms collected were well distributed among the forms present. Conditions began to deteriorate at the next two downstream sites, Stations 32 and 25, where about a 40% reduction in the number of kinds and 45% reduction in numbers/m² occurred. This reach of the stream is influenced by runoff from the NJZ Cinder Bank and changes in the benthos

population are attributed to the high heavy metal concentrations of the runoff. Roback⁴ presented data that would support the conclusion that metals concentrations in the stream were sufficiently high to cause the more sensitive forms to disappear.

At Station 23, kinds and numbers of organisms were reduced severely. Aquashicola Creek in this reach carries runoff, NJZ process wastes and materials contributed by Mill Creek. Mill Creek was organically enriched, causing the benthos at Station 23 to be dominated by dipterans. Partial recovery was evident at Station 31 where 23 kinds of organisms, again well distributed, were found, but in low population densities.

Downstream at Station 21, the number of kinds decreased to 13, reflecting poor water quality. Water quality also was low at Station 20, where only three kinds of benthic organisms were found.

Weber⁵ reported that when a reduction occurs in both numbers/m² and in the number of taxa the condition is usually due to a toxic component in water. Such conditions of low-level, chronically toxic heavy metals occur in the downstream reach of Aquashicola Creek.

Conditions found in the Lehigh River, both upstream and downstream of Aquashicola Creek, reflect typical conditions for large, organically enriched, eastern U.S. rivers. No apparent effect of Aquashicola Creek on the river was observed.

Periphyton

Periphyton communities reflected the influence of NJZ facilities in several ways. Attached algal populations responded to the toxicity of Cinder Bank runoff and seepage by decreasing from about 40,000 organisms per cm² at reference Station 27 to about 20,000 and 5,000/cm²

in the reach adjacent to the Cinder Bank [Table 16]. This toxicity induced decrease also was reflected in low chlorophyll concentrations of 69 and 27 $\mu\text{g}/\text{cm}^2$.

Organic enrichment was apparent in the reach of Aquashicola Creek downstream from the Field Station Bridge. At Stations 23 and 22, attached algal populations increased to about 58,000 and 56,000/ cm^2 , and chlorophyll increased to about 300 and 1100 $\mu\text{g}/\text{cm}^2$, respectively. Bacteria-feeding Vorticella, protozoa typically found in waters contaminated by untreated sewage, were found at Stations 23, 22, and 21; this suggests that the apparent enrichment was caused by discharges of inadequately treated domestic waste.

Aquashicola Creek periphyton communities recovered partially at Station 20; the number of attached algae decreased to about 11,000/ cm^2 and chlorophyll decreased to about 140 $\mu\text{g}/\text{cm}^2$. It appears that wastes carried by Aquashicola Creek did not influence Lehigh River periphyton significantly; communities were similar in numbers and composition upstream and downstream from the creek confluence [Table 16].

Fish Survival

Mortalities among in-situ test fish occurred at six of eleven exposure sites. Significant mortality (greater than the 10% allowable for the control group) only occurred at Stations 20, 21, 22, and 23; this is the reach of Aquashicola Creek extending from the mouth to approximately 3 river kilometers upstream [Table 17]. This stretch of the creek receives both NJZ effluent and Cinder Bank runoff and seepage.

There appears to be a correlation between total zinc concentration and mortality. At Station 24, the average total zinc concentration during the exposure period was 0.49 mg/l [Table 9] and no

mortality of test fish was recorded. Station 21 had an average total zinc concentration of 0.87 mg/l, and produced the highest mortality of any site (40%). At Station 20, near the mouth of Aquashicola Creek, total zinc concentration was somewhat lower at 0.71 mg/l and 20% mortality occurred.

CINDER BANK EVALUATION

Physical Characteristics, Runoff and Seepage

The Cinder Bank is located along the base of the north slope of Blue Mountain, south and east of the town of Palmerton between Aquashicola Creek and the upper slopes of Blue Mountain. The Cinder Bank is composed of slag, cinders, briquettes and miscellaneous debris associated with the smelting and refining of zinc and cadmium ores.

Much of the Cinder Bank residue is in the form of briquettes from the vertical retorts and contains residual metals and carbonaceous material. As a result of either incomplete quenching or spontaneous combustion large portions smolder continuously and several of these areas are posted as "Fire Areas". In areas that have not been physically disturbed, large cracks form in the surface roughly parallel to the outer edge. Occasionally large blocks of partially consolidated residue come off of the main mass of the Cinder Bank and tumble down the steep north slope toward Aquashicola Creek. As the cracks develop, steam and smoke issue from them leaving sublimated yellowish deposits on the adjacent surfaces. These cracks and resulting broken rough surfaces provide avenues for rapid infiltration and percolation of rain and snow melt, and facilitate leaching of soluble constituents from the Cinder Bank.

Since NJZ operations began at Palmerton in 1898, the Cinder Bank has been built to its present dimensions which are: 2.3 miles (3.7 km)

long, 0.1 to 0.2 miles (0.16 to 0.32 km) wide and a few feet (less than one) to about 200 feet (60 m) thick. NJZ officials report that there are about 30×10^6 tons of smelter residue and other waste in the Cinder Bank. Because of the irregular configuration of the Cinder Bank and the unknown pre-Cinder Bank topography, the exact volume of the Cinder Bank is not known, but it is estimated to be about 40×10^6 yds³ (30×10^6 m³).

Evidence of mineral leachate from the Cinder Bank is abundant. Table 18 lists field and laboratory measurements of pH, specific conductance and metals (Cd, Fe, Mn, Pb, and Zn) in runoff from Blue Mountain above the Cinder Bank. The pH of the runoff ranged from 5.0 to 9.7 and averaged 7.3. Specific conductance ranged from 65 μ mhos/cm to 210 μ mhos/cm and averaged 153 μ mhos/cm. In contrast, the runoff and seepage below the Cinder Bank, Table 19 had a pH range of from 4.3 to 8.2 and averaged 6.3. The specific conductance of seeps and springs at and near the base of the Cinder Bank ranged from 260 μ mhos/cm to 3,500 μ mhos/cm and averaged nearly 1,000 μ mhos/cm. Specific conductance in μ mhos multiplied by a factor of 0.65 ± 0.1 approximates the residue (total dissolved solids) on evaporation in parts/million⁶. Increase in mineralization of the average of the low levels seeps and springs over that of the runoff from Blue Mountain is about 6.5 times.

Cadmium and zinc were detected in all samples of runoff from Blue Mountain and in all samples from seeps and springs near the base of the Cinder Bank. The average concentration of dissolved cadmium in samples of Blue Mountain runoff was 0.012 mg/l whereas the average of samples from the seeps and springs at the base of the Cinder Bank was 0.118 mg/l or about 10 times higher than the runoff not influenced by the Cinder Bank. The average of all dissolved zinc concentrations in Blue Mountain runoff samples was about 1.4 mg/l and that of seeps and springs at the base of the Cinder Bank was 35 mg/l or about 24 times greater than in Blue Mountain runoff.

Table 18
BLUE MOUNTAIN RUNOFF ABOVE AND AROUND CINDER BANK
(mg/l)

Sta. No.	Seq. No.	pH	Sp. Cond. (μ mhos/cm)	Cd		Fe		Mn		Pb		Zn	
		SU		T	D	T	D	T	D	T	D	T	D
52	01	6.6	180	0.05 ^c	0.012 ^b	ND ^c	ND ^b	ND ^c	0.01 ^b	ND ^a	ND ^b	2.3 ^c	2.3 ^b
	02	6.6	210	0.013 ^b	0.012 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	1.9 ^b	2.1 ^b
	03	-	190	0.011 ^b	0.011 ^b	ND ^b	4.3 ^b	ND ^b	ND ^b	ND ^b	ND ^b	1.9 ^b	2.0 ^b
	04	6.5	200	0.01 ^c	0.011 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	1.9 ^c	2.0 ^b
53	01	6.4	165	0.01 ^c	0.019 ^b	ND ^c	ND ^b	0.02 ^c	0.02 ^b	ND ^a	ND ^b	3.2 ^c	3.3 ^b
	02	6.0	125	0.022 ^b	0.018 ^b	ND ^b	ND ^b	0.02 ^b	0.02 ^b	ND ^b	ND ^b	3.0 ^b	3.1 ^b
	03	-	160	0.019 ^b	0.018 ^b	ND ^b	ND ^b	0.02 ^b	0.02 ^b	ND ^b	ND ^b	3.1 ^b	3.1 ^b
	04	6.4	160	0.01 ^c	0.019 ^b	ND ^c	ND ^b	0.02 ^c	0.02 ^b	ND ^a	ND ^b	3.1 ^c	3.1 ^b
54	01	6.9	95	0.01 ^c	0.020 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	2.5 ^c	2.5 ^b
	02	5.8	155	0.022 ^b	0.020 ^b	0.32 ^b	ND ^b	0.10 ^b	ND ^b	0.05 ^b	ND ^b	2.6 ^b	2.4 ^b
	03	-	140	0.019 ^b	0.019 ^b	0.20 ^b	ND ^b	0.06 ^c	ND ^b	0.02 ^a	ND ^b	2.4 ^b	2.4 ^b
	04	6.7	150	0.02 ^c	0.017 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	2.4 ^c	2.4 ^b
55	01	7.1	110	ND ^a	0.004 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.64 ^c	0.64 ^b
	02	6.2	110	0.006 ^b	0.003 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.56 ^b	0.56 ^b
	03	-	100	0.006 ^b	0.003 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.55 ^b	0.54 ^b
	04	6.2	110	0.004 ^a	0.003 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.52 ^c	0.52 ^b
56	01	6.9	80	0.03 ^c	0.025 ^b	0.84 ^c	ND ^b	0.12 ^c	ND ^b	0.043 ^a	ND ^b	3.1 ^c	1.5 ^b
	02	6.7	100	0.028 ^b	0.024 ^b	0.85 ^b	ND ^b	0.10 ^b	ND ^b	0.043 ^b	ND ^b	2.0 ^b	1.4 ^b
	03	-	90	0.021 ^b	0.019 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	1.2 ^b	1.1 ^b
	04	6.6	105	0.02 ^c	0.020 ^b	0.15 ^c	ND ^b	0.03 ^c	ND ^b	0.029 ^a	ND ^b	1.6 ^c	1.3 ^b
57	01	6.9	130	0.02 ^c	0.020 ^b	0.73 ^c	ND ^b	0.12 ^c	ND ^b	0.10 ^a	ND ^b	2.4 ^c	1.6 ^b
	02	5.6	140	0.017 ^b	0.018 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	1.5 ^b	1.6 ^b
	03	-	125	0.020 ^b	0.019 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	1.5 ^b	1.6 ^b
	04	6.6	145	0.02 ^c	0.020 ^b	4.0 ^c	ND ^b	0.38 ^c	ND ^b	0.29 ^c	ND ^b	4.7 ^c	1.8 ^b

Table 18 (Continued)
 BLUE MOUNTAIN RUNOFF ABOVE AND AROUND CINDER BANK
 (mg/l)

Sta. No.	Seq. No.	pH SU	Sp. Cond. (μ mhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
58	01	7.1	110	0.005 ^a	0.005 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.54 ^c	0.58 ^b
	02	6.4	110	0.006 ^b	0.006 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.54 ^b	0.52 ^b
	03	-	100	0.005 ^b	0.006 ^b	0.08 ^b	ND ^b	ND ^c	ND ^b	ND ^b	ND ^b	0.52 ^b	0.52 ^b
	04	6.5	120	0.008 ^a	0.006 ^b	ND ^c	ND ^b	ND ^c	ND ^b	0.005	ND ^b	0.58 ^c	0.54 ^b
59	01	6.9	120	0.01 ^c	0.010 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.6 ^c	0.67 ^b
	02	5.9	120	0.012 ^b	0.008 ^b	0.09 ^b	ND ^b	0.02 ^b	ND ^b	ND ^b	ND ^b	0.72 ^b	0.63 ^b
	03	-	80	0.013 ^b	0.010 ^b	0.13 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.73 ^b	0.63 ^b
	04	6.5	125	0.01 ^c	0.010 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.64 ^c	0.61 ^b
60	01	6.5	70	ND ^a	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.34 ^c	0.32 ^b
	02	6.9	65	0.005 ^b	ND ^b	0.08 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.28 ^b	0.27 ^b
	03	-	80	0.005 ^b	0.003 ^b	ND ^b	ND ^b	0.02 ^b	ND ^b	ND ^b	ND ^b	0.34 ^b	0.29 ^b
	04	6.5	90	ND ^a	0.003 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.35 ^c	0.29 ^b
83	01	7.6	100	0.004 ^a	0.003 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.49 ^c	0.39 ^b
	02	6.4	80	0.004 ^b	0.002 ^b	0.11 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.50 ^b	0.32 ^b
	03	-	80	0.004 ^b	0.004 ^b	0.09 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.45 ^b	0.32 ^b
	04	7.9	60	0.004 ^a	0.004 ^b	ND ^c	ND ^b	0.02 ^c	ND ^b	ND ^a	ND ^b	0.53 ^c	0.34 ^b
84	01	7.2	130	0.02 ^c	0.029 ^b	ND ^c	0.03 ^b	0.02 ^c	ND ^b	ND ^a	ND ^b	3.0 ^c	2.9 ^b
	02	6.4	155	0.034 ^b	0.034 ^b	0.32 ^b	0.10 ^b	ND ^b	ND ^b	0.02 ^b	ND ^b	2.7 ^b	2.9 ^b
	03	7.5	170	0.02 ^c	0.026 ^b	0.39 ^c	0.04 ^b	0.02 ^c	0.02 ^b	ND ^a	ND ^b	2.9 ^c	2.4 ^b
85	01	7.8	260	0.005 ^c	0.005 ^b	ND ^c	ND ^b	0.04 ^c	0.04 ^b	0.003 ^a	ND ^b	0.60 ^c	0.63 ^b
	02	8.6	290	0.008 ^b	0.003 ^b	0.20 ^b	ND ^b	0.07 ^b	0.04 ^b	0.02 ^b	ND ^b	0.53 ^b	0.26 ^b
	03	-	300	0.009 ^b	0.006 ^b	0.13 ^b	ND ^b	0.06 ^b	0.06 ^b	ND ^b	ND ^b	0.83 ^b	0.75 ^b
	04	9.7	420	0.01 ^c	0.005 ^b	0.15 ^c	0.03 ^b	0.09 ^c	0.06 ^b	0.012 ^a	ND ^b	0.54 ^c	0.21 ^b

Table 18 (continued)
BLUE MOUNTAIN RUNOFF ABOVE AND AROUND CINDER BANK
(mg/l)

Sta. No.	Seq. No.	pH	Sp. Cond. (µmhos/cm)	Cd		Fe		Mn		Pb		Zn	
		SU		T	D	T	D	T	D	T	D	T	D
86	01	7.1	110	0.02 ^c	0.031 ^b	0.10 ^c	ND ^b	0.06 ^c	0.03 ^b	0.036 ^a	ND ^b	2.4 ^c	2.3 ^b
	02	5.0	160	0.033 ^b	0.035 ^b	0.30 ^b	0.12 ^b	0.09 ^b	0.08 ^b	0.03 ^b	ND ^b	2.7 ^b	2.9 ^b
	03	-	510	0.017 ^b	0.010 ^b	4.8 ^b	5.1 ^b	0.25 ^b	0.36 ^b	0.04 ^b	0.033 ^b	1.1 ^b	1.0 ^b
	04	5.4	550	0.009 ^c	0.008 ^b	8.8 ^c	9.3 ^b	0.24 ^c	0.23 ^b	0.084 ^a	0.080 ^b	1.2 ^c	0.96 ^b

a = Analysis by flameless atomic adsorption spectroscopy (flameless AAS)
 b = Analysis by inductively coupled argon plasma - atomic emission spectroscopy (ICAP-AES)
 c = Analysis by flame atonic adsorption spectroscopy (flame AAS)
 D = Dissolved
 T = Total
 SU = Standards units

Table 19
CINDER BANK RUNOFF AND SEEPAGE QUALITY
(mg/l)

Sta.	Seq.	pH SU	Spe. Cond. (μ mhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
61	01	6.6	540	0.03 ^c	0.006 ^b	9.8 ^c	ND ^b	5.5 ^c	3.1 ^b	0.60 ^c	ND ^b	7.0 ^c	2.5 ^b
	02	6.6	700	0.28 ^b	0.005 ^b	4.5 ^b	ND ^b	3.5 ^b	ND ^b	0.31 ^b	ND ^b	4.5 ^b	0.99 ^b
	03	-	725	0.017 ^b	0.004 ^b	2.1 ^b	ND ^b	1.8 ^b	ND ^b	0.16 ^b	ND ^b	2.5 ^b	0.95 ^b
	04	6.5	750	0.03 ^c	0.004 ^b	10 ^c	ND ^b	5.6 ^c	ND ^b	0.64 ^c	ND ^b	7.0 ^c	0.79 ^b
62	01	6.0	925	0.02 ^c	0.015 ^b	ND ^c	ND ^b	6.1 ^c	7.0 ^b	ND ^c	ND ^b	4.3 ^c	4.4 ^b
	02	6.0	650	0.021 ^b	0.013 ^b	1.7 ^b	ND ^b	3.7 ^b	2.6 ^b	0.11 ^b	ND ^b	5.5 ^b	3.5 ^b
	03	-	775	0.026 ^b	0.014 ^b	0.34 ^b	ND ^b	2.1 ^b	2.2 ^b	0.06 ^b	ND ^b	3.6 ^b	3.5 ^b
	04	6.0	775	0.01 ^c	0.012 ^b	0.31 ^c	ND ^b	2.1 ^c	1.9 ^b	0.02	ND ^b	3.7 ^c	3.5 ^b
63	01	7.0	625	0.02 ^c	0.018 ^b	ND ^c	ND ^b	0.03 ^c	ND ^b	0.006 ^a	ND ^b	1.1 ^c	1.2 ^b
	02	7.1	600	0.040 ^b	0.021 ^b	3.0 ^b	ND ^b	1.7 ^b	ND ^b	0.013 ^b	ND ^b	3.9 ^b	1.3 ^b
	03	-	650	0.018 ^b	0.011 ^b	0.15 ^b	ND ^b	0.05 ^b	ND ^b	ND ^b	ND ^b	1.1 ^b	0.84 ^b
	04	6.9	520	0.02 ^c	0.020 ^b	0.12 ^c	ND ^b	0.06 ^c	ND ^b	0.007 ^a	ND ^b	1.4 ^c	1.4 ^b
64	01	7.1	440	0.004 ^a	0.003 ^b	0.17 ^c	ND ^b	0.02 ^c	ND ^b	ND ^a	ND ^b	0.51 ^c	0.51 ^b
	02	7.0	500	0.007 ^b	0.005 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.56 ^b	0.57 ^b
	03	-	465	0.007 ^b	0.003 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.65 ^b	0.63 ^b
	04	6.7	480	0.006 ^a	0.006 ^b	ND ^c	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.69 ^c	0.69 ^b

Table 19 (continued)
CINDER BANK RUNOFF AND SEEPAGE QUALITY
(mg/l)

Sta.	Seq.	pH SU	Spe. Cond. (μmhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
65	01	7.5	260	ND ^a	0.002 ^b	ND ^c	ND ^b	0.02 ^c	ND ^b	0.006 ^a	ND ^b	0.32 ^c	0.32 ^b
	02	7.1	280	0.006 ^b	0.004 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.36 ^b	0.33 ^b
	03	-	280	0.006 ^b	0.003 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.38 ^b	0.36 ^b
	04	7.2	280	ND ^a	0.003 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.36 ^c	0.38 ^b
66	01	7.4	1025	0.006 ^a	0.006 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.65 ^c	0.69 ^b
	02	7.0	1100	0.008 ^b	0.006 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.78 ^b	0.73 ^b
	03	-	800	0.008 ^b	0.005 ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.73 ^c	0.72 ^b
	04	7.0	775	0.01 ^a	0.005 ^b	ND ^c	ND ^b	0.04 ^c	ND ^b	ND ^a	ND ^b	0.73 ^c	0.72 ^b
67	01	8.0	1200	0.01 ^c	0.009 ^b	1.9 ^c	ND ^b	0.92 ^c	ND ^b	0.12 ^a	ND ^b	2.5 ^c	1.0 ^b
	02	7.6	1050	0.023 ^b	0.010 ^b	3.5 ^b	ND ^b	1.5 ^b	ND ^b	0.27 ^b	ND ^b	3.7 ^b	0.78 ^b
	03	-	1000	0.015 ^b	0.010 ^b	0.12 ^b	ND ^b	0.03 ^b	ND ^b	ND ^b	ND ^b	1.6 ^b	0.88 ^b
	04	7.7	1000	0.01 ^c	0.008 ^b	0.56 ^c	ND ^b	0.28 ^c	ND ^b	0.026 ^a	ND ^b	1.3 ^c	0.89 ⁶
69	01	5.8	1200	0.17 ^c	0.22 ^b	ND ^c	ND ^b	0.16 ^c	0.17 ^b	ND ^a	ND ^b	26 ^c	22 ^b
	02	6.2	1375	0.26 ^b	0.25 ^b	0.38 ^b	ND ^b	0.17 ^b	0.12 ^b	0.02 ^b	ND ^b	25 ^b	22 ^b
	03	-	1300	0.25 ^b	0.26 ^b	0.10 ^b	ND ^b	0.14 ^b	0.13 ^b	ND ^b	ND ^b	26 ^c	24 ^b
	04	5.9	1000	0.19 ^c	0.25 ^b	0.10 ^c	ND ^b	0.16 ^c	0.13 ^b	0.005 ^a	ND ^b	26 ^c	24 ^b

Table 19 (continued)
CINDER BANK RUNOFF AND SEEPAGE QUALITY
(mg/l)

Sta.	Seq.	pH SU	Spe. Cond. (μ mhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
70	01	4.3	1200	0.33 ^c	0.44 ^b	0.17 ^c	0.01 ^b	4.3 ^c	3.9 ^b	0.024 ^a	ND ^b	63 ^c	61 ^b
	02	4.9	1325	0.51 ^b	0.54 ^b	1.5 ^b	ND ^b	3.2 ^b	3.1 ^b	0.03 ^b	ND ^b	61 ^b	63 ^b
	03	-	1300	0.25 ^b	0.26 ^b	0.10 ^b	ND ^b	3.3 ^b	3.3 ^b	ND ^b	ND ^b	68 ^b	69 ^b
	04	5.2	1200	0.37 ^c	0.53 ^b	1.4 ^c	ND ^b	3.2 ^c	3.1 ^b	0.046 ^a	ND ^b	66 ^c	69 ^b
71	01	4.7	1050	0.22 ^c	0.32 ^b	0.61 ^c	ND ^b	3.4 ^c	3.3 ^b	0.05 ^a	0.05 ^b	53 ^c	55 ^b
	02	4.6	1250	0.33 ^b	0.35 ^b	1.4 ^b	ND ^b	4.1 ^b	4.0 ^b	0.14 ^b	0.07 ^b	50 ^b	56 ^b
	03	-	1400	0.31 ^b	0.34 ^b	0.19 ^b	ND ^b	3.8 ^b	4.0 ^b	0.08 ^b	0.05 ^b	51 ^b	58 ^b
	04	4.9	1250	0.25 ^c	0.33 ^b	2.2 ^c	ND ^b	4.5 ^c	3.8 ^b	0.25 ^c	0.04 ^b	55 ^c	56 ^b
72	01	4.4	1600	0.29 ^c	0.39 ^b	ND ^c	0.10 ^b	160 ^c	114 ^b	0.11 ^a	0.10 ^b	240 ^c	230 ^b
	02	4.6	2000	0.38 ^b	0.39 ^b	0.18 ^b	0.10 ^b	94 ^b	112 ^b	0.13 ^b	0.13 ^b	202 ^b	218 ^b
	03	-	2000	0.35 ^b	0.37 ^b	0.15 ^b	0.10 ^b	92 ^b	113 ^b	0.09 ^b	0.10 ^b	200 ^b	216 ^b
	04	4.8	1900	0.27 ^c	0.37 ^b	ND ^c	0.10 ^b	160 ^b	110 ^b	0.09 ^a	0.08 ^b	230 ^c	218 ^b
73	01	6.3	540	0.05 ^c	0.06 ^b	ND ^c	ND ^b	2.4 ^c	2.3 ^b	0.02 ^a	ND ^b	30 ^c	26 ^b
	02	7.0	900	0.02 ^c	0.013 ^b	9.4 ^c	ND ^b	1.4 ^c	0.05 ^b	0.23 ^c	ND ^b	4.4 ^c	1.1 ^b
74	01	7.4	370	0.01 ^c	0.007 ^b	0.29 ^c	ND ^b	0.14 ^c	ND ^b	0.029 ^a	ND ^b	1.9 ^c	1.1 ^b

Table 19 (continued)
CINDER BANK RUNOFF AND SEEPAGE QUALITY
(mg/l)

Sta.	Seq.	pH SU	Spe. Cond. (µmhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
75	01	6.6	700	0.07 ^c	0.080 ^b	ND ^c	ND ^b	0.06 ^c	0.03 ^b	ND ^a	ND ^b	19 ^c	17 ^b
	02	6.4	700	0.080 ^b	0.080 ^b	1.1 ^b	ND ^b	0.05 ^b	0.04 ^b	0.05 ^b	ND ^b	18 ^b	17 ^b
	03	-	710	0.081 ^b	0.084 ^b	0.19 ^b	ND ^b	0.08 ^b	0.03 ^b	ND ^b	ND ^b	17 ^b	17 ^b
	04	6.5	725	0.07 ^c	0.087 ^b	8.2 ^c	ND ^b	3.4 ^c	0.03 ^b	0.37 ^c	ND ^b	22 ^c	18 ^b
76	01	7.6	950	0.01 ^c	0.014 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.61 ^c	0.70 ^b
	02	7.6	975	0.019 ^b	0.016 ^b	0.31 ^b	ND ^b	0.08 ^b	0.03 ^b	ND ^c	ND ^b	0.80 ^c	0.78 ^b
	03	-	850	0.017 ^b	0.018 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	0.80 ^c	0.78 ^b
	04	7.9	975	0.02 ^c	0.020 ^b	1.0 ^c	ND ^b	0.36 ^c	ND ^b	0.072 ^a	ND ^b	1.8 ^c	0.79 ^b
77	01	4.6	825	0.13 ^c	0.18 ^b	ND ^c	ND ^b	7.6 ^c	7.6 ^b	ND ^a	ND ^b	37 ^c	36 ^b
	02	4.3	850	0.19 ^b	0.20 ^b	ND ^b	ND ^b	6.2 ^b	6.6 ^b	ND ^b	ND ^b	34 ^b	34 ^b
	03	-	800	0.18 ^b	0.19 ^b	ND ^b	ND ^b	5.8 ^b	6.1 ^b	ND ^b	ND ^b	34 ^b	34 ^b
	04	4.3	800	0.13 ^c	0.18 ^b	ND ^c	ND ^b	5.9 ^c	5.8 ^b	ND ^a	ND ^b	36 ^c	34 ^b
78	01	5.9	2400	0.20 ^c	0.28 ^b	0.22 ^c	0.06 ^b	150 ^c	117 ^b	0.17 ^a	0.10 ^b	110 ^c	103 ^b
79	01	5.9	2300	0.18 ^c	0.24 ^b	ND ^c	ND ^b	37 ^c	31 ^b	ND ^a	ND ^b	97 ^c	99 ^b
80	01	6.7	3500	0.20 ^c	0.28 ^b	ND ^c	ND ^b	0.67 ^c	0.79 ^c	0.008 ^a	ND ^b	86 ^c	85 ^b

Table 19 (continued)
CINDER BANK RUNOFF AND SEEPAGE QUALITY
(mg/l)

Sta.	Seq.	pH SU	Spe. Cond. (µmhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
81	01	6.7	1500	0.08 ^c	0.12 ^b	1.0 ^c	ND ^b	0.65 ^c	0.02 ^b	0.14 ^a	ND ^b	103 ^c	100 ^b
	02	6.3	1600	0.10 ^b	0.11 ^b	1.6 ^b	ND ^b	0.87 ^b	0.02 ^b	0.10 ^b	ND ^b	91 ^b	102 ^b
	03	-	1500	0.094 ^b	0.10 ^b	0.08 ^b	ND ^b	0.03 ^b	0.01 ^b	ND ^b	ND ^b	91 ^b	102 ^b
	04	6.7	1400	0.07 ^c	0.093 ^b	ND ^b	ND ^b	0.11 ^c	0.01 ^b	0.007 ^a	ND ^b	100 ^c	100 ^b
82	01	7.1	1350	0.017 ^a	0.014 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	8.9 ^c	8.0 ^b
87	01	4.6	625	0.13 ^c	0.18 ^b	ND ^c	ND ^b	7.6 ^c	7.6 ^b	ND ^a	ND ^b	37 ^c	36 ^b
	02	-	650	0.65 ^b	0.05 ^b	0.17 ^b	ND ^b	0.21 ^b	0.16 ^b	ND ^b	ND ^b	3.9 ^b	1.1 ^b
	03	8.2	650	0.05 ^c	0.05 ^b	ND ^c	ND ^b	0.20 ^c	0.17 ^b	0.014 ^a	ND ^b	4.1 ^c	1.3 ^b
88	01	7.5	420	0.005 ^a	0.004 ^b	ND ^c	ND ^b	ND ^c	ND ^b	0.11 ^a	ND ^b	0.48 ^b	0.44 ^b
	02	-	450	0.006 ^b	0.005 ^b	ND ^c	ND ^b	ND ^b	ND ^b	ND ^b	ND ^b	0.46 ^b	0.45 ^b
	03	7.3	420	0.004 ^a	0.005 ^b	ND ^c	ND ^b	ND ^c	ND ^b	NA ^a	NB ^b	0.57 ^c	0.47 ^b

a = Analysis by flameless atomic adsorption spectroscopy (flameless AAS)

b = Analysis by inductively coupled argon plasma - atomic emission spectroscopy (ICAO-AES)

c = Analysis by flame atonic adsorption spectroscopy (flame AAS)d = Dissolved

y = Total

SU = Standard units

The highest concentrations of cadmium and zinc observed were in samples from seeps and springs along the eastern 0.6 mile (1 km) at the base of the Cinder Bank. These samples also exhibited low pH values from 4.3 to about 6 standard units.

Data from samples of Blue Mountain runoff and seeps and springs at the base of the Cinder Bank show clearly that cadmium and zinc are being leached from the Cinder Bank and contribute to the contamination of Aquashicola Creek.

Dissolved iron, manganese, and lead concentrations were low or not detectable in most samples, and are not considered significant in this investigation.

Average annual precipitation in the vicinity of Palmerton is about 46 in (117 cm) of which about 49% falls during the growing season (May to September); average annual runoff is about 24 in (61 cm). The drainage area directly above Aquashicola Creek to the crest of Blue Mountain in the reach spanned by the NJZ East Plant and the Cinder Bank is about 1,100 acres (4.5×10^6 sq m). Therefore, the average annual runoff to Aquashicola Creek from the area of investigations is about 2,200 acre ft (2.70×10^6). Assuming that runoff and seepage flows and metals concentrations during the survey were representative of average conditions, the average annual loads of cadmium and zinc contributed to Aquashicola Creek in the reach between the east end of the Cinder Bank and the 6th Street Bridge would be estimated at about 0.48 tons/yr (435 kg/yr) and 110 tons/yr (100,000 kg/yr) zinc, respectively.

Groundwater Quality

Specific conductance of groundwater samples from seven wells on the East Plant site ranged from 130 to 800 micromhos per centimeter

($\mu\text{mho/cm}$). Calculated total dissolved solids concentrations ranged from 85 mg/l to 520 mg/l. Generally, waters of this quality are considered acceptable for public drinking water supply. However, zinc concentrations in groundwater ranged from 0.003 mg/l to 3.2 mg/l, and cadmium concentrations ranged from 0.002 mg/l to 0.024 mg/l. Zinc was detected in all seven wells sampled and cadmium was detected in four of the seven wells samples [Table 20].

Higher levels of zinc and cadmium were detected in the two wells designated as Stations 93 and 94. These wells are located on the east side of the Field Station between the Cinder Bank and raw materials storage area on the south and Aquashicola Creek on the north. Because of this location and the presumed direction of natural groundwater flow from south (Blue Mountain) to north (Aquashicola Creek), it is likely that the high metals concentrations in the wells resulted from leachate originating in the Cinder Bank and the raw materials storage area. Pumping of the wells in this well field induces groundwater flow toward the well field from the surrounding shallow alluvial (sand and gravel) aquifer adjacent to Aquashicola Creek. Because these wells are within 200 ft (60 m) of the Creek, it is probable that a large proportion of the water produced from these wells is induced infiltration from the Creek. The dilution of the groundwater provided by this infiltration results in metals concentrations somewhat lower than would be expected in the shallow aquifer if no pumping and induced infiltration were occurring.

Station No. 92 is the well farthest east in the well field east of the NJZ Field Station, and is in the bend of Aquashicola Creek. The Creek is only about 100 ft (30 m) northeast of the well. This well appears to be little affected by percolating leachate from the Cinder Bank and the raw materials storage area [Table 20].

Table 20
ANALYSES OF WELL WATER SAMPLES IN THE VICINITY OF PALMERTON, PA
(mg/l)

Station	Sequence	pH SU	Sp. Cond (µmhos/cm)	Cd		Fe		Mn		Pb		Zn	
				T	D	T	D	T	D	T	D	T	D
91	01	7.7	260	ND ^a	ND ^b	ND ^c	0.03 ^b	0.06 ^c	0.06 ^b	ND ^a	ND ^b	0.08 ^c	0.03 ^b
	02	7.6	270	ND ^a	ND ^b	ND ^c	ND ^b	0.06 ^c	0.05 ^b	ND ^a	ND ^b	0.12 ^c	0.006 ^b
92	01	6.8	270	ND ^a	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.70 ^c	0.63 ^b
	02	6.8	300	ND ^a	0.002 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.62 ^c	0.58 ^b
93	01	6.9	540	0.02 ^c	0.024 ^b	ND ^c	ND ^b	0.05 ^c	ND ^b	ND ^a	ND ^b	3.2 ^c	3.2 ^b
	02	7.2	600	0.02 ^c	0.021 ^b	ND ^c	ND ^b	0.04 ^c	0.05 ^b	ND ^a	ND ^b	2.4 ^c	2.6 ^b
94	01	6.1	800	0.01 ^c	0.016 ^b	0.39 ^c	0.10 ^b	0.06 ^c	0.06 ^b	ND ^a	ND ^b	1.6 ^c	1.6 ^b
	02	6.6	600	0.01 ^c	0.011 ^b	ND ^c	ND ^b	0.06 ^c	0.06 ^b	ND ^a	ND ^b	1.2 ^c	1.2 ^c
96	01	7.0	320	ND ^a	ND ^b	0.15 ^c	ND ^b	ND ^b	ND ^c	ND ^b	0.036 ^a	ND ^b	0.015 ^b
	02	7.0	340	ND ^a	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	ND ^c	0.003 ^b
97	01	8.2	130	ND ^a	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	ND ^c	0.033 ^b
	02	7.4	140	ND ^a	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	ND ^c	0.008 ^b
98	01	7.2	550	ND ^a	ND ^b	ND ^c	ND ^b	ND ^c	ND ^b	0.016 ^a	ND ^b	0.70 ^c	0.62 ^b
	02	7.0	520	ND ^a	0.002 ^b	ND ^c	ND ^b	ND ^c	ND ^b	ND ^a	ND ^b	0.57 ^c	0.55 ^b

a = Analysis by flameless atomic adsorption spectroscopy (flameless AAS)

b = Analysis by inductively coupled argon plasma - atomic emission spectroscopy (ICAP-AES)

c = Analysis by flame atomic adsorption spectroscopy (flame AAS)

d = Dissolved

t = Total

SU = Standard units

Station No. 91 is the deep well adjacent to the Acid Plant. It is an artesian well that was open and flowing throughout the survey. The artesian pressure in the deep aquifer tapped by this well is apparently great enough to prevent infiltration of contaminated surface water and shallow groundwater. No cadmium and only low concentrations of zinc were detected in this well.

Station Nos. 96, 97, and 98 are wells at the west end of the East Plant area on the lower flank of Blue Mountain near the Palmer Water Company maintenance building and a railroad switching yard. These wells are referred to by the Palmer Water Company as "deep wells", ranging in depth from about 200 ft (60 m) to more than 400 ft (120 m). The aquifers tapped by these wells are bedrock aquifers of small yield and have little or no direct contact with surface waters or the shallow alluvial aquifer. A small amount of cadmium was detected in Station No. 98 and low concentrations of zinc were detected in each of these three wells [Table 20].

EFFLUENT CHARACTERIZATION

The results of field measurements, analyses and tests performed on NJZ East Plant discharges during the May 1 to 15, 1979 survey are presented in Tables 21 through 40.

Water Quality Metals

Table 21 presents total metals data from composite and grab samples collected at the East Plant's eleven permitted Outfalls (001-005, 010-012, 014-106). The concentration data have all been corrected for analytical and sampler blanks. The gross data are presented on the first line for each day and the net data are on the second line. The background station used to compute the net concentrations at each

TABLE 21
TOTAL METALS DATA^a
NEW JERSEY ZINC - EAST PLANT DISCHARGES
Palmerton, Pennsylvania
May 8-14, 1979

Station Number & Description (Background Sta)	Date May 1979	Flow		Total Zinc ^b			Total Cadmium ^{b,c,d}			Total Lead ^{c,d}			Total Iron ^b			Total Manganese ^b		
		m ³ /day x 1000	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Station 01- Outfall 001	2	15.9	4.21	4.9	78	170	0.12 ^b	1.9	4.2	0.12 ^c	1.9	4.2	0.57	9.1	20	0.26	4.1	9.0
				3.7	59	130	0.09	1.4	3.1	0.11	1.7	3.7	0.43	6.8	15	0.06	1.0	2.2
(Station 08 - Aquashicola Creek)	3	15.1	3.98	5.4	82	180	0.12 ^b	1.8	4.0	0.23 ^c	3.5	7.7	0.73	11	24	0.37	5.6	12
				4.0	60	130	0.10	1.5	3.3	0.21	3.2	7.1	0.52	7.9	17	0.14	2.1	4.6
	4	16.8	4.43	4.9	82	180	0.11 ^b	1.8	4.0	0.26 ^c	4.4	9.7	0.41	6.9	15	0.26	4.4	9.7
				3.7	62	140	0.09	1.5	3.3	0.25	4.2	9.3	0.30	5.0	11	0	0	0
	5	15.3	4.04	3.4	52	110	0.06 ^b	0.9	2.0	0.18 ^c	2.8	6.2	0.46	7.0	15	0.24	3.7	8.2
				2.1	32	71	0.04	0.6	1.3	0.17	2.6	5.7	0.28	4.3	9.5	0.03	0.5	1.1
	6	13.7	3.63	3.4	47	100	0.11 ^b	1.5	3.3	0.09 ^c	1.2	2.6	0.55	7.5	17	0.26	3.6	7.9
				2.4	33	73	0.09	1.2	2.6	0.08	1.1	2.4	0.41	5.6	12	0.02	0.3	0.7
5-day average		15.4	4.06	4.4	68	150	0.10	1.6	3.5	0.18	2.8	6.2	0.54	8.3	18	0.28	4.3	9.5
				3.2	49	110	0.08	1.2	2.6	0.17	2.6	5.7	0.38	5.9	13	0.05	0.8	1.8
	9	13.1	3.47	1.7	22	49	0.04 ^b	0.5	1.1	0.08 ^c	1.0	2.2	0.35	4.6	10	0.22	2.9	6.4
				0.8	10	22	0.02	0.3	0.7	0.07	0.9	2.0	0.15	2.0	4.4	0.03	0.3	0.7
	10	14.5	3.82	1.8	26	57	0.05 ^b	0.7	1.5	0.21 ^c	3.0	6.6	0.43	6.2	14	0.21	3.0	6.6
				0.9	13	29	0.03	0.4	0.9	0.20	2.9	6.4	0.26	3.8	8.4	0†	0†	0†
	11	15.1	3.98	2.5	38	84	0.06 ^b	0.9	2.0	0.08 ^c	1.2	2.6	0.56	8.5	19	0.25	3.8	8.4
				1.5	23	51	0.04	0.6	1.3	0.07	1.1	2.4	0.26	3.9	8.6	0	0	0
	12	14.9	3.94	1.1	16	35	0.04 ^b	0.6	1.3	0.08 ^c	1.2	2.6	0.26	3.9	8.6	0.18	2.7	6.0
				0.3	4	9	0.02	0.3	0.7	0.06	0.9	2.0	0.06	0.9	2.0	0†	0†	0†
	13	15.0	3.95	1.0	15	33	0.03 ^b	0.4	0.9	0.03 ^c	0.4	0.9	0.31	4.6	10	0.19	2.8	6.2
				0.2	3	7	0.01	0.2	0.4	0.02	0.3	0.7	0.27	4.0	8.8	0†	0†	0†
	14	14.9	3.93	1.2	18	40	0.07 ^b	1.0	2.2	0.06 ^c	0.9	2.0	0.27	4.0	8.8	0.21	3.1	6.8
				0.5	7	15	0.05	0.7	1.5	0.05	0.7	1.5	0.06	0.9	2.0	0†	0†	0†
Duplicate sample*	14	14.9	3.93	1.2	18	40	0.10 ^b	1.5	3.3	0.05 ^c	0.7	1.5	0.24	3.6	7.9	0.19	2.8	6.2
				0.5	7	15	0.08	1.2	2.6	0.05	0.7	1.5	0.03	0.4	0.9	0†	0†	0†
	15	14.3	3.77	1.0	14	31	0.04 ^b	0.6	1.3	0.06 ^c	0.9	2.0	0.33	4.7	10	0.19	2.7	6.0
				0.3	4	9	0.03	0.4	0.9	0.05	0.7	1.5	0.10	1.4	3.1	0.02	0.3	0.7
7-day average		14.5	3.84	1.4	21	46	0.05	0.7	1.5	0.08	1.2	2.6	0.36	5.2	11	0.21	3.0	6.6
				0.6	9	20	0.03	0.4	0.9	0.08	1.1	2.4	0.17	2.4	5.3	0.01	0.1	0.2
12-day average		14.9	3.93	2.8	41	90	0.07	1.0	2.2	0.13	1.9	4.2	0.44	6.5	14	0.23	3.5	7.7
				1.7	26	57	0.05	0.8	1.8	0.11	1.7	3.7	0.26	3.9	8.6	0.03	0.4	0.9

TABLE 21 (Cont'd)
TOTAL METALS DATA^a
NEW JERSEY ZINC - EAST PLANT DISCHARGES
Palmerton, Pennsylvania
May 8-14, 1979

Station Number & Description (Background Sta.)	Date May 1979	Flow		Total Zinc ^b			Total Cadmium ^{b,c,d}			Total Lead ^{c,d}			Total Iron ^b			Total Manganese ^b		
		m ³ /day x 1000	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Station 04 - Outfall 004	9	3.3	0.86	0.15 0.05 ^g	0.5 0.2	1.1 0.4	0.007 ^c 0.004 ^g	0.02 0.01	0.04 0.02				0.04 0†	0.1 0†	0.2 0†	0.01 0†	0.03 0†	0.07 0†
(Station 09 - Pohopoco Creek)	10	3.1	0.83	0.40 0.27	1.2 0.8	2.6 1.8	0.008 ^c 0.001	0.02 0.003	0.04 0.007				0.38 0†	1.2 0†	2.6 0†	0.19 0†	0.59 0†	1.3 0†
	11	3.0	0.79	0† 0†	0† 0†	0† 0†	0.001 ^c 0†	0.003 0†	0.007 0†				0.03 0†	0.1 0†	0.2 0†	0† 0†	0† 0†	0† 0†
	12	3.0	0.80	0.56 0.44	1.7 1.3	3.7 2.9	0.004 ^c 0.003	0.01 0.009	0.02 0.02				0.30 0†	0.9 0†	2.0 0†	0.12 0	0.36 0	0.79 0
	13	3.0	0.79	0.03 0† ^g	0.1 0†	0.2 0†	0.004 ^c 0.001 ^g	0.01 0.003	0.02 0.007				0† 0†	0† 0†	0† 0†	0† 0†	0† 0†	0† 0†
	14	2.9	0.76	0.26 0.26	0.8 0.8	1.8 1.8	ND ^c 0	0 0	0 0				0.23 0.06	0.7 0.2	1.5 0.4	0.09 0.04	0.26 0.12	0.57 0.26
	15	2.9	0.76	0† 0†	0† 0†	0† 0†	0.009 ^c 0.008	0.03 0.02	0.07 0.04				0 0†	0 0†	0 0†	0.01 0†	0.03 0†	0.07 0†
7-day average		3.0	0.80	0.20 0.13	0.6 0.4	1.3 0.9	0.005 0.002	0.01 0.006	0.02 0.01				0.13 0.01	0.4 0.03	0.9 0.1	0.06 0.01	0.18 0.02	0.40 0.04
													Total Copper ^b					
Station 05 - Outfall 005 (characteristics as discharged - gross values only)	9	1.3	0.34	0.56	0.7	1.5	0.02 ^b	0.03	0.07	0.01 ^d	0.01	0.02	ND	0	0			
	10	1.1	0.29	0.46	0.5	1.1	0.02 ^b	0.02	0.04	ND ^d	0	0	ND	0	0			
	11	1.1	0.29	1.1	1.2	2.7	0.04 ^b	0.04	0.09	0.11 ^c	0.12	0.26	0.02	0.02	0.04			
	12	1.1	0.29	4.1	4.5	9.9	0.06 ^b	0.07	0.2	0.13 ^c	0.14	0.31	0.03	0.03	0.07			
	13	1.1	0.29	0.68	0.8	1.8	0.01 ^b	0.01	0.02	ND ^d	0	0	0.02	0.02	0.04			
	14	1.1	0.30	0.54	0.6	1.3	0.01 ^b	0.01	0.02	0.01 ^d	0.01	0.02	ND	0	0			
	15	1.1	0.29	0.39	0.4	0.9	0.01 ^b	0.01	0.02	ND ^d	0	0	ND	0	0			
7-day average		1.1	0.30	1.1	1.2	2.6	0.02	0.03	0.07	0.04	0.04	0.09	ND	0.01	0.02			

TABLE 21 (Cont'd)
TOTAL METALS DATA^a
NEW JERSEY ZINC - EAST PLANT DISCHARGES
Palmerton, Pennsylvania
May 8-14, 1979

Station Number & Description (Background Sta.)	Date May 1979	Flow		Total Zinc ^b			Total Cadmium ^{b,c,d}			Total Lead ^{c,d}			Total Copper			Manganese ^b		
		m ³ /day x 1000	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	Mg/l	kg/day	lb/day
Station 05 - Outfall 005	9	0.52	0.13	0†	0†	0†	0.027	0.014	0.031	0.02	0.01	0.02	0	0	0			
				0†	0†	0†	0.024 ^g	0.012	0.026	0.02	0.01	0.02	0	0	0			
[Process Load Characteristics ^m]	10	0.76	0.20	0.3	0.2	0.4	0.022	0.017	0.037	0†	0†	0†	0	0	0			
				0.2	0.2	0.4	0.015	0.011	0.024	0†	0†	0†	0	0	0			
(Stations 06, 07 & 09)	11	0.86	0.23	1.0	0.9	2.0	0.050	0.043	0.095	0.14	0.12	0.26	0.02	0.02	0.04			
				0.7	0.6	1.3	0.043	0.037	0.082	0.13	0.11	0.24	0.02	0.02	0.04			
	12	0.87	0.23	4.8	4.2	9.3	0.071	0.062	0.14	0.17	0.14	0.31	0.03	0.03	0.07			
				4.7	4.1	9.0	0.070	0.061	0.13	0.15	0.13	0.29	0.03	0.03	0.07			
	13	0.90	0.24	0.7	0.6	1.3	0.009	0.008	0.018	0†	0†	0†	0.02	0.02	0.04			
				0.6 ^g	0.5	1.1	0.006 ^g	0.005	0.011	0†	0†	0†	0.02	0.02	0.04			
	14	0.91	0.24	0.4	0.4	0.9	0.011	0.010	0.022	0.01	0.01	0.02	0	0	0			
				0.4	0.4	0.9	0.010	0.009	0.020	0.01	0.01	0.02	0	0	0			
	15	0.94	0.25	0.2	0.2	0.4	0.010	0.009	0.020	0†	0†	0†	0	0	0			
				0.2	0.2	0.4	0.009	0.008	0.018	0†	0†	0†	0	0	0			
7-day average		0.82	0.23	1.1	0.9	2.0	0.028	0.023	0.051	0.05	0.04	0.09	0.01	0.01	0.02			
				1.0	0.8	1.8	0.024	0.020	0.044	0.05	0.04	0.09	0.01	0.01	0.02			
Station 10 - Outfall 010	9	0.023	0.006	1.8	0.04	0.09	0.041 ^b	0.9 ^e	0.03 ^f	ND ^d	0	0						
				0.9	0.02	0.04	0.021	0.5 ^e	0.02 ^f	0†	0†	0†						
(Station 08 - Aquashicola Creek)	10	0.023	0.006	1.8	0.04	0.09	0.041 ^b	0.9 ^e	0.03 ^f	0.01 ^d	0.2 ^e	0.007 ^f						
				0.9	0.02	0.04	0.026	0.6 ^e	0.02 ^f	0.005	0.1 ^e	0.004 ^f						
	11	0.023	0.006	2.1	0.05	0.11	0.041 ^b	0.9 ^e	0.03 ^f	0.01 ^d	0.2 ^e	0.007 ^f						
				1.1	0.03	0.07	0.021	0.5 ^e	0.02 ^f	0.005	0.1 ^e	0.004 ^f						
	12	0.023	0.006	60	1.4	3.1	0.089 ^b	2.0 ^e	0.07 ^f	0.02 ^d	0.5 ^e	0.02 ^f						
				59	1.4	3.1	0.074	1.7 ^e	0.06 ^f	0	0	0						
	13	0.026	0.007	3.3	0.09	0.20	0.105 ^b	2.7 ^e	0.10 ^f	0.03 ^d	0.8 ^e	0.03 ^f						
				2.5	0.06	0.15	0.085	2.2 ^e	0.08 ^f	0.02	0.5 ^e	0.02 ^f						
	14	0.034	0.009	79	2.7	6.0	0.186 ^b	6.3 ^e	0.22 ^f	0.08 ^c	2.7 ^e	0.10 ^f						
				78	2.7	6.0	0.171	5.8 ^e	0.20 ^f	0.08	2.7 ^e	0.10 ^f						
	15	0.019	0.005	2.7	0.05	0.11	0.057 ^b	1.1 ^e	0.04 ^f	0.02 ^d	0.4 ^e	0.01 ^f						
				2.0	0.04	0.09	0.047	0.9 ^e	0.03 ^f	0.01	0.2 ^e	0.007 ^f						
7-day average		0.023	0.006	27	0.62	1.4	0.091	2.1 ^e	0.07 ^f	0.03	0.7 ^e	0.02 ^f						
						1.	0.0	1.7 ^e	0.16 ^f	0.02	0.	0.						

TABLE 21 (Cont'd)
TOTAL METALS DATA^a
NEW JERSEY ZINC - EAST PLANT DISCHARGES
Palmerton, Pennsylvania
May 8-14, 1979

Station Number & Description (Background Sta.)	Date May 1979 (Collection Time)	Flow		Total Zinc ^b			Total Cadmium ^{b,c,d}			Total Lead ^{c,d}			Total Iron ^b			Total Manganese ^b		
		m ³ /day x 1000	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Station 11 - Outfall 011	9	0.61	0.160	64	39	86	0.77 ^b	0.47	1.0									
	10	0.60	0.159	75	45	99	0.72 ^b	0.43	0.95									
(no background - gross values only)	11	0.60	0.159	70	42	93	0.76 ^b	0.46	1.0									
	12	0.57	0.151	78	44	97	0.76 ^b	0.43	0.95									
	13	0.56	0.149	50	28	62	0.77 ^b	0.43	0.95									
	14	0.56	0.148	61	34	75	0.73 ^b	0.41	0.90									
	15	0.40	0.106	67	27	60	0.75 ^b	0.30	0.66									
7-day average		0.56	0.147	66	37	82	0.75	0.42	0.93									
Station 12 Outfall 012 ⁿ	8(0845)	0.34	0.09	0.19 0.09 ^g	0.06 0.03	0.13 0.07	ND ^c 0	0 0	0	0.013 ^c 0.008	4 ^e 3 ^e	0.1 ^f 0.1 ^f						
	(Station 09 Pohopoco Creek ^o)	9(0805)	0.45	0.12	0.21 0.08	0.09 0.04	0.20 0.09	ND ^c 0†	0 0†	0 0†	ND ^d 0	0 0						
	9(1020)	0.38	0.10	0.22 0.09	0.08 0.03	0.18 0.07	ND ^c 0†	0 0†	0 0†	0.01 ^d 0.005	4 ^e 2 ^e	0.1 ^f 0.07 ^f						
	10(0750)	0.49	0.13	0.30 0.03	0.15 0.01	0.33 0.02	ND ^c 0†	0 0†	0 0†	0.01 ^d 0	5 ^e 0	0.2 ^f 0						
	10(0925)	0.42	0.11	0.25 0†	0.10 0†	0.22 0†	ND ^c 0†	0 0†	0 0†	0.010 ^c 0	4 ^e 0	0.1 ^f 0						
	11(0755)	0.42	0.11	0.23 0.11	0.10 0.05	0.22 0.11	ND ^c 0	0 0	0 0	ND ^d 0†	0 0†	0 0†						
	11(1005)	0.42	0.11	0.14 0.02	0.06 0.01	0.13 0.02	ND ^c 0	0 0	0 0	0.01 ^d 0†	4 ^e 0†	0.1 ^f 0†						
	14(0755)	0.45	0.12	0.42 0.42	0.19 0.19	0.42 0.42	0.004 ^c 0.003	2 ^e 1 ^e	0.07 ^f 0.04 ^f	0.01 ^d 0	4 ^e 0	0.1 ^f 0						
	14(1005)	0.49	0.13	0.23 0.23	0.11 0.11	0.24 0.24	ND ^c 0	0 0	0 0	0.010 ^c 0	5 ^e 0	0.2 ^f 0						
Average		0.42	0.11	0.24 0.12	0.10 0.05	0.22 0.11	ND 0	0.2 ^e 0.1 ^e	0.007 ^f 0.004 ^f	0.007 0.002	3 ^e 1 ^e	0.1 ^f 0.04 ^f						

TABLE 21 (Cont'd)
TOTAL METALS DATA^a
NEW JERSEY ZINC - EAST PLANT DISCHARGES
Palmerton, Pennsylvania
May 8-14, 1979

Station Number & Description (Background Sta.)	Date May 1979 (Collection Time)	Flow		Total Zinc ^b			Total Cadmium ^{b,c,d}			Total Lead ^{c,d}			Total Iron ^b			Total Manganese ^b		
		m ³ /day x 1000	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
Station 14 - Outfall 014 ⁿ	8(1317)	3.3 ^P	880 ^Q	3.8	0.013	0.029	0.02 ^b	0.07 ^e	0.002 ^f									
	9(1325)	7.2 ^P	1900 ^Q	4.1	0.030	0.066	0.02 ^b	0.14 ^e	0.005 ^f									
	(no background - gross values only)	10(1325)	5.7 ^P	1500 ^Q	4.1	0.023	0.051	0.02 ^b	0.11 ^e	0.004 ^f								
	11(0915)	4.9 ^P	1300 ^Q	4.4	0.022	0.049	0.02 ^b	0.10 ^e	0.004 ^f									
	12(0920)	3.0 ^P	780 ^Q	4.5	0.014	0.031	0.02 ^b	0.06 ^e	0.002 ^f									
	13(0920)	2.0 ^P	520 ^Q	4.2	0.008	0.018	0.02 ^b	0.04 ^e	0.001 ^f									
	14(0920)	1.5 ^P	390 ^Q	4.2	0.006	0.013	0.02 ^b	0.03 ^e	0.001 ^f									
7-day average		3.9 ^P	1000 ^Q	4.4	0.017	0.037	0.02	0.08 ^e	0.003 ^f									
Station 15 - Outfall 15 ⁿ	8(1350)	0.30	0.079	1.6	0.48	1.1	0.03 ^b	9.0 ^e	0.32 ^f									
	9(1350)	0.28	0.073	1.7	0.48	1.1	0.02 ^b	5.6 ^e	0.20 ^f									
	(no background - gross values only)	10(1335)	0.25	0.067	1.7	0.42	0.93	0.02 ^b	5.0 ^e	0.18 ^f								
	11(0935)	0.21	0.056	1.8	0.38	0.84	0.02 ^b	4.2 ^e	0.15 ^f									
	12(0935)	0.17	0.046	1.9	0.32	0.71	0.02 ^b	3.4 ^e	0.12 ^f									
	13(0940)	0.17	0.046	1.8	0.31	0.68	0.02 ^b	3.4 ^e	0.12 ^f									
	14(0940)	0.16	0.041	1.8	0.29	0.64	0.02 ^b	3.2 ^e	0.11 ^f									
7-day average		0.22	0.058	1.7	0.38	0.84	0.02	4.8 ^e	0.17 ^f									
Station 16- Outfall 016 ⁿ	8(1335)	0.045	0.012	2.8	0.13	0.29	0.03 ^b	1.4 ^e	0.05 ^f									
	9(1350)	0.030	0.008	2.4	0.072	0.16	0.03 ^b	0.90 ^e	0.03 ^f									
	(no background - gross values only)	10(1335)	<0.019	<0.005	2.3	<0.044	<0.10	0.02 ^b	<0.38 ^e	<0.01 ^f								
	11(0935)	<0.019	<0.005	2.1	<0.040	<0.09	0.02 ^b	<0.38 ^e	<0.01 ^f									
	12(0935)	<0.019	<0.005	2.1	<0.040	<0.09	0.02 ^b	<0.38 ^e	<0.01 ^f									
	13(0940)	0.47	0.125	0.39	0.18	0.40	0.01 ^b	4.7 ^e	0.17 ^f									
	14(0940)	0	0	-	0	0	-	0	0									
7-day average		0.038	0.009	2.3	<0.044	<0.10	0.02	0.22 ^e	0.003 ^f									

TABLE 21 (Cont'd)
TOTAL METALS DATA^a
NEW JERSEY ZINC - EAST PLANT DISCHARGES
Palmerton, Pennsylvania
May 8-14, 1979

Detection Limit	Total Zinc	Total Cadmium	Total Lead	Total Iron	Total Manganese	Total Copper
	0.08 ^b	0.005 ^b 0.002 ^c 0.002 ^d	0.005 ^c 0.01 ^d	0.08 ^b	0.02 ^b	0.02 ^b

- a - All data have been corrected for both sampler and analytical blanks. Gross concentrations and mass loads are displayed on the first line for each day, and net values are displayed on the second line. All samples are 24-hour composites unless noted otherwise. Average concentrations were back-calculated from average flows and average mass loads.
- b - Analysis was by flame atomic absorption for all zinc, iron, manganese and copper samples; cadmium samples analyzed by flame AA have superscript "b".
- c - Analysis was by flameless atomic absorption for cadmium and lead samples with superscript "c."
- d - Analysis was by ICAP for cadmium and lead samples with superscript "d."
- e - Load in units of grams/day
- f - Load in units of ounces/day.
- g - On two of the monitoring days, May 9 and 13, zinc and cadmium concentrations at the Pohopoco Creek Intake were from 20 to 59 times greater than the averages of the other five days. These two samples were judged to be contaminated and the averages of the other five days were used in computing net concentrations for zinc and cadmium for these two days at stations 02, 03, 04, 05 and 12
- h - ND means not detected (below the detection limit) and assigned a value of zero for load and averaging calculations; hence averages involving ND values are conservative.
- i - Average of two instantaneous readings.
- j - Average of two grab samples.
- k - Negligible flow; no sample collected.
- l - Average of 3 composite samples.
- m - Outfall 005 process load characteristics were computed by:
1. Subtracting the Station 06 and 07 flow and load contributions from the Station 05 "as discharged" characteristics to obtain the gross process flows and loads,
 2. back - calculating the gross process concentrations, and
 3. subtracting the Station 09 background concentrations to obtain the net process values.
- Background values (concentrations and/or loads) for Stations 06, 07, 08, and 09 are in Appendix _____.
- n - Grab samples only.
- o - Metals concentrations from Station 09 composite samples were used as background for Station 12 samples.
- p - m³/day
- q - gallons/day
- † - Values less than zero are presented and averaged as zero.
- * - Duplicate sample data not included in averages.

Table 22
WASTE ACID TREATMENT PLANT SAMPLING DATA^a AND REMOVAL EFFICIENCIES^b
New Jersey Zinc - East Plant
Palmerton, Pennsylvania
May 10 - 15, 1979

Date ^c May 1979	Sampling Location	TSS		Total Zinc ^d		Total Cadmium ^d		Total Lead ^d		Total Iron ^d		Tot. Manganese ^d		Tot. Arsenic ^e		Total Selenium ^e	
		mg/l	Rem Eff(%)	mg/l	Rem. Eff(%)	mg/l	Rem. Eff(%)	mg/l	Rem. Eff(%)	mg/l	Rem. Eff(%)	mg/l	Rem. Eff(%)	mg/l	Rem. Eff(%)	mg/l	Rem. Eff(%)
10	WWTP Influent	110	31	600	99+	4.3	99+	10	90	58	99	4.9	99	0.54 _f	100	3.8	85
	WWTP Effluent	76		2.2		0.023 ^e		1.0		0.69		0.05		ND		0.58	
11	WWTP Influent	60	42	410	99+	4.2	99+	6.0	92	34	98	4.5	99+	0.38	100	2.5	71
	WWTP Effluent	35		1.7		0.004 ^e		0.5		0.62		0.04		ND		0.72	
12	WWTP Influent	39	8	430	99+	3.5	100	4.3	88	26	99+	3.5	99+	0.34	100	1.9	64
	WWTP Effluent	36		1.1		ND ^e		0.5		0.16		0.02		ND		0.69	
13	WWTP Influent	45	53	520	99+	5.1	99+	7.2	93	27	99	2.8	99	0.41	100	4.4	66
	WWTP Effluent	21		1.6		0.008 ^e		0.5		0.26		0.03		ND		1.5	
14	WWTP Influent	30	37	440	99+	5.2	99+	5.6	91	18	96	2.9	99+	0.30	100	2.7	30
	WWTP Effluent	19		2.1		0.005 ^e		0.5		0.75		0.02		ND		1.9	
15	WWTP Influent	25	-60	327	99	3.5	99	5.2	94	14	96	2.5	98	0.38	99	1.7	6
	WWTP Effluent	40		4.2		0.040 ^e		0.3		0.56		0.05		0.004		1.6	
	Average Influent	52	27	450	99+	4.3	99+	6.4	92	30	98	3.5	99	0.39	100	2.8	57
	Average Effluent	38		2.2		0.013		0.6		0.51		0.04		ND		1.2	

a Data are based on 24-hour equal volume composite samples; aliquots were collected at 4-hour intervals.

b Removal efficiencies are based on concentration.

c Date listed is date 24-hour composite period ended.

d Zinc, lead, iron and manganese, and some cadmium analyses by flame AA.

e Arsenic and selenium samples analyzed by flameless atomic absorption. Some cadmium samples were analyzed by flameless AA and are indicated by superscript 'e'.

f ND means less than the detection limit and assigned a value of zero for averaging calculations.

Table 23
SUMMARY OF ZINC AND CADMIUM EFFLUENT LOAD DATA^a
NEW JERSEY ZINC - EAST PLANT
Palmerston, Pennsylvania
May 10 - 14, 1979

May 1979 Outfall	10		11		12		13		14		5-day Avg.	
	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd	Zn	Cd
001	23	0.6	4	0.3	3	0.2	7	0.7	4	0.4	8	0.4
002	0.015	0	0.040	0	0.001	0	0.008	0	0.065	0	0.026	0
003	0	0	0.01	0	0	0	0	0	0.04	0	0.01	0
004	0	0	1.3	0.009	0	0.003	0.8	0	0	0.023	0.042	0.007
005	0.6	0.037	4.1	0.061	0.4	0.005	0.4	0.009	0.2	0.008	1.1	0.024
010	0.03	0	1.4	0.002	0.06	0.002	2.7	0.006	0.04	0.001	0.85	0.002
011	42	0.46	44	0.43	28	0.43	34	0.41	27	0.30	35	41
012	0.005	0	0.03	0	0	0	0	0	0.15	0	0.037	0
014	0.023	0	0.022	0	0.014	0	0.008	0	0.006	0	0.014	0
015	0.42	0.005	0.38	0.004	0.32	0.003	0.31	0.003	0.29	0.003	0.34	0.004
016	<0.044	0	<0.040	0	<0.040	0	0.18	0.005	0	0	<0.06	0.001
Total ^c	66	1.1	55	0.8	32	0.6	45	1.1	32	0.7	46	0.9

a All loads are net kg/day.

b Dates were selected to match days on which a metals mass balance was performed on Aquashicola Creek

c Total loads were rounded to two significant figures.

Table 24
CONTINUOUS pH DATA - OUTFALL 001
New Jersey Zinc - East Plant
Palmerton, Pennsylvania
May 1-15, 1979

Date May 1979	Composite Period (hr)	pH <6.0 s.u.		pH >9.0 s.u.		Min. pH (time of occurrence, hr)	Max pH			
		Time Period	Minutes Elapsed	Time Period	Minutes Elapsed					
1-2	1800-1800	1529-1539	10	1515-1516	1	5.8 (1535)	9.6 (1557)			
				1557-1558	1					
	24-hour total	1 excursion	10	2 excursions	2					
	2-3	1800-1800			1805-1820	15	5.6 (1735)	10.3 (1607)		
				1840-1845	5					
				1848-1851	3					
				1909-1911	2					
				1447-1502	15					
				1532-1533	1					
			3	1542-1554	12					
1732-1735				1607-1631	24					
24-hour total			1 excursion	3	8 excursions	77				
3-4			1800-1800			1745-1800			15	7.1 (1801)
	24-hour total			0	1 excursion	15				
4-5	1800-1800			1800-1841	41	4.3 (1115)	>12.0 ^a (0316)			
				1908-0220	432					
				0227-0323	56					
				0325-0335	10					
				0336-0408	32					
				0411-0421	10					
				0425-0432	7					
				0706-0906	120					
		0909-0912	3	0912-0914	2					
		0917-0919	2	0920-1024	64					
				1038-1103	25					
		1108-1116	8	1116-1156	40					
				1212-1311	59					
				1334-1340	6					
		1411-1423	12	1423-1439	16					
				1451-1459	8					
				1501-1503	2					
				1507-1750	163					
				1753-1800	7					
		24-hour total	4 excursions	25	19 excursions			1,100		
5-6	1800-1800			1800-1820	20	6.3 (2145)	>12.0 ^a (0759)			
				1826-1907	41					
				2002-2027	25					
				2058-2115	17					
				2148-2205	17					
				0759-0800	1					
		24-hour total		0	6 excursions			121		
		6-8	No monitoring from May 6 at 1800 to May 8 at 0600							

Table 24 (Cont'd.)
 CONTINUOUS pH DATA - OUTFALL 001
 New Jersey Zinc - East Plant
 Palmerton, Pennsylvania
 May 1-15, 1979

Date May 1979	Composite Period (hr)	pH <6.0 s.u.		pH >9.0 s.u.		Min. pH (time of occurrence, hr)	Max pH				
		Time Period	Minutes Elapsed	Time Period	Minutes Elapsed						
8-9	0600-0600			0753-0759	6	2.8 (0123)	>12.0 ^a (1015)				
				0919-0936	17						
				1006-1029	23						
				1142-1145	3						
				1302-1325	23						
				1634-1657	23						
				1734-1842	68						
				1914-1930	16						
				2042-2313	151						
				2317-0111	114						
			0113-0125	12	0125-0140			15			
			0142-0153	11	0154-0211			17			
					0231-0324			53			
					0454-0527			33			
					0530-0559			29			
			24-hour total	2 excursions	23			15 excursions	591		
9-10	0600-0600			0611-0626	15	6.0 (1736)	>12.0 ^a (1500)				
				0646-0720	34						
				0730-0938	128						
				1045-1127	42						
				1147-1530	223						
				1600-1616	16						
				1641-1650	9						
				1739-1817	38						
				1824-1834	10						
				1837-1839	2						
				1852-1920	28						
				1928-1932	4						
				2135-2146	11						
				0136-0220	44						
			24-hour total		0			13 excursions	604		
		10-11	0600-0600					0648-0707	19	6.3 (0647)	11.4 (0652)
				0807-0809	2						
				1036-1039	3						
				1205-1257	52						
				1317-1442	85						
				1626-1657	31						
	24-hour total		0	6 excursions	192						
11-12	0600-0600			0754-0756	2	6.2 (0440)	11.8 (0944)				
				0933-0950	17						
				1700-1746	46						
				1805-1835	30						
				1842-1933	51						
				2109-2207	58						
				0013-0037	24						
				0416-0420	4						
				0442-0445	3						
				0508-0512	4						
	24-hour total		0	10 excursions	243						

Table 24 (Cont'd.)
 CONTINUOUS pH DATA - GULFALL 001
 New Jersey Zinc - East Plant
 Palmerton, Pennsylvania
 May 1-15, 1979

Date May 1979	Composite Period (hr)	pH <6.0 s.u.		pH >9.0 s.u.		Min. pH (time of occurrence, hr)	Max pH	
		Time Period	Minutes Elapsed	Time Period	Minutes Elapsed			
12-13	0660-0600			1933-1935	2	4.3 (0546)	11.1 (2052)	
				1939-1957	18			
				2033-2108	35			
				2110-2116	6			
			0534-0538	4				
			0546-0548	2				
			0549-0551	2				
24-hour total	3 excursions	8	4 excursions	61				
13-14	0600-0600	0641-0647	6	0648-0650	2	5.0 (0642)	>12.0 ^a (0649)	
		0657-0659	2					
		0709-0716	7					
		0952-1110	78					
24-hour total	4 excursions	93	1 excursion	2				
14-15	0600-0600			0907-0909	2	6.7 (0858)	10.6 (0908)	
				0911-0915	4			
		24-hour total		0	2 excursions	6		
Total for twelve 24-hour periods		16 excursions	282	89 excursions	2,989			

a - recorder had upper limit of 12 s.u.

Table 25
INSTANTANEOUS pH AND TEMPERATURE DATA
New Jersey Zinc - East Plant Discharges
Palmerton, Pennsylvania
May 1-15, 1979

Sta. No.	Description	Sequence No ^a or Time (hr)	Date: May 1979				
			2	3	4	5	6
01	Outfall 001		pH (su)		(hour of collection)		
		1	7.5 (1050)	10.6 (0755)	8.6 (0752)	10.6 (1755)	7.9 (0755)
		2		4.6 (0830)	10.0 (0935)		7.2 (1108)
		3		7.3 (2320)	9.2 (1745)		6.9 (1715)
		Min	7.5	4.6	8.6	10.6	6.9
		Max	7.5	10.6	10.0	10.6	7.9
			Temperature (°C)				
		Min	22	20	23	24	21
		Max	22	23	25	25	24
		Avg	22	21	24	24	22
			Date: May 1979				
			8-9	9-10	10-11	11-12	12-13
			13-14	14-15			
			pH (su)		(hour of collection)		
		1	8.6 (0655)	9.0 (0655)	11.7 (0650)	7.6 (0655)	7.0 (0644)
		2	8.7 (0658)	9.7 (0700)	9.6 (0700)	7.2 (0710)	6.9 (0700)
		3	6.5 (0858)	8.7 (0953)	6.8 (0945)	6.7 (1054)	7.0 (1020)
		4	8.2 (1406)	9.4 (1534)	7.1 (1511)	8.0 (1610)	8.3 (1450)
		5	8.9 (1717)	9.1 (1907)	6.8 (1905)	9.3 (1910)	7.5 (1910)
		6	9.0 (1920)	6.9 (2242)	7.3 (2250)	9.9 (2138)	9.4 (2121)
			9.4 (2204)				7.6 (1904)
							8.3 (2142)
							7.1 (0645)
		Min	6.5	6.9	6.8	6.7	6.9
		Max	9.4	9.7	11.7	9.9	9.4
			Temperature (°C)				
		Min	21	24	24	22	21
		Max	29	29	29	29	26
		Avg	25	26	27	26	24
02	Outfall 002		pH (su)				
		0900	6.8	7.0	8.2	7.8	7.4
		1100	7.1	7.0	6.4	8.0	7.7
		1300	7.1	7.2	7.5	7.3	7.6
		1500	7.0	7.0	7.1	7.0	7.4
		1700	7.2	8.0	7.0	7.0	5.6
		1900	6.6	8.2	4.1	6.5	8.2
		2100	7.1	7.8	8.4	b	7.8
		2300	8.2	7.8	7.7	b	7.1
		0100	6.2	7.8	8.0	6.9	8.2
		0300	6.8	7.6	7.8	7.2	b
		0500	6.7	7.1	6.7	8.5	6.5
							b
		Min	6.2	6.4	4.1	6.5	5.6
		Max	8.2	8.2	8.4	8.5	8.2

Table 25 (Cont'd.)
 INSTANTANEOUS pH AND TEMPERATURE DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Sta. No.	Description	Sequence No or Time (hr)	Date: May 1979						
			8-9	9-10	10-11	11-12	12-13	13-14	14-15
Outfall 002 continued			Temperature (°C)						
	Min	17	18	18	19	19	18	18	
	Max	21	21	23	22	21	20	20	
	Avg	19	20	20	20	20	19	19	
03	Outfall 003		pH (su)						
	0700	7.0	6.5	b	8.5	b	b	7.2	
	0900	---	7.4	b	7.9	b	b	8.2	
	1100	7.2	7.9	b	7.5	b	b	---	
	1300	---	7.1	b	7.6	b	b	8.0	
	1500	---	7.5	b	6.8	b	b	7.5	
	1700	---	8.2	b	8.2	b	b	8.8	
	1900	7.0	7.7	b	b	b	b	b	
	2100	---	b	b	b	b	b	b	
	2300	7.7	b	b	b	b	b	b	
	0100	b	b	b	b	b	b	b	
	0300	b	b	b	b	b	b	b	
	0500	b	b	b	b	b	b	b	
	Min	7.0	6.5	b	6.8	b	b	7.2	
	Max	7.7	8.2	b	8.5	b	b	8.8	
			Temperature (°C)						
	Min	11	13	b	15	b	b	15	
	Max	17	20	b	21	b	b	18	
	Avg	14	15	b	17	b	b	16	
04	Outfall 004		pH (su) (hour of collection)						
	1	7.2 (0708)	7.0 (0820)	8.0 (0810)	7.2 (0735)	7.2 (0740)	7.9 (0737)	7.4 (0741)	
	2	7.3 (1005)	7.4 (0850)	7.8 (0848)	8.1 (0810)	7.6 (1044)	7.5 (0755)	7.5 (0801)	
	3	7.3 (1125)	7.5 (1110)	6.7 (1007)	7.1 (1124)	7.1 (1504)	7.4 (1118)	7.3 (1000)	
	4	7.1 (1353)	7.1 (1550)	6.5 (1530)	6.9 (1622)	7.8 (2010)	7.1 (1622)	7.5 (1553)	
	5	7.1 (1656)	8.3 (2028)	6.1 (2020)	7.0 (2025)	7.8 (2136)	8.1 (2010)	7.2 (2001)	
	6	7.1 (2035)	7.1 (2254)	7.3 (2300)	6.9 (2150)		7.7 (2154)	7.4 (2201)	
	7	7.1 (2224)						7.3 (0701)	
	Min	7.1	7.0	6.1	6.9	7.1	7.1	7.2	
	Max	7.3	8.3	8.0	8.1	7.8	8.1	7.5	
			Temperature (°C)						
	Min	12	18	17	18	19	18	18	
	Max	19	20	21	21	21	21	20	
	Avg	16	18	19	19	20	19	19	
05	Outfall 005		pH (su) (hour of collection)						
	1	8.0 (0755)	8.2 (0830)	8.1 (0725)	8.8 (0720)	7.8 (0725)	8.3 (0725)	8.1 (0725)	
	2	7.1 (0759)	8.7 (0830)	9.6 (0815)	8.3 (0845)	7.0 (0945)	8.0 (0837)	7.4 (0840)	
	3	12.3 (1150)	7.0 (1126)	7.5 (1020)	8.7 (1116)	7.6 (1100)	7.5 (1138)	7.4 (1021)	
	4	7.7 (1338)	7.3 (1609)	7.3 (1552)	7.4 (1642)	7.6 (1519)	7.5 (1645)	7.7 (1621)	

Table 25 (Cont'd.)
 INSTANTANEOUS pH AND TEMPERATURE DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Sequence No. ^a			Date: May 1979						
Sta. No.	Description	or Time (hr)	8-9	9-10	10-11	11-12	12-13	13-14	14-15
	Outfall 005 continued	5	7.2 (1652)	8.1 (1936)	6.1 (1934)	8.1 (1944)	7.1 (1940)	7.2 (1935)	8.0 (1938)
		5	7.6 (1954)	7.0 (2307)	7.4 (2312)	7.0 (2203)	7.8 (2148)	7.7 (2208)	7.0 (2230)
		7	7.2 (2254)						7.7 (0745)
		Min	7.1	7.0	6.1	7.0	7.0	7.2	7.0
		Max	12.3	8.7	9.6	8.8	7.8	8.3	8.1
	Temperature (°C)								
		Min	14	15	15	15	15	16	15
		Max	17	18	19	19	18	18	17
		Avg	16	16	17	17	17	17	16
n6 Outfall 005 Background - 1			pH (su)						
	0700	7.4	7.6	b	b	b	b	b	
	0900	7.7	6.6	b	b	b	b	b	
	1100	7.8	8.0	b	b	b	b	b	
	1300	8.2	b	b	b	b	b	b	
	1500	8.4	b	b	b	b	b	b	
	1700	b	b	b	b	b	b	b	
	1900	b	b	b	b	b	b	b	
	2100	b	b	b	b	b	b	b	
	2300	b	b	b	b	b	b	b	
	0100	b	b	b	b	b	b	b	
	0300	b	b	b	b	b	b	b	
	0500	b	b	b	b	b	b	b	
	Min	7.4	6.6	b	b	b	b	b	
	Max	8.4	8.0	b	b	b	b	b	
			Temperature (°C)						
	Min	11	15	b	b	b	b	b	
	Max	28	20	b	b	b	b	b	
	Avg	19	18	b	b	b	b	b	
n7 Outfall 005 Background - 2			pH (su)		(hour of collection)				
	1	8.5 (0740)	8.0 (0715)	8.0 (0715)	9.5 (0710)	6.4 (0715)	8.8 (0720)	8.4 (0710)	
	2	9.0 (1135)	8.9 (0810)	8.9 (0800)	8.1 (0752)	8.2 (0755)	8.9 (0803)	8.7 (0810)	
	3	9.0 (1338)	9.0 (1115)	8.9 (1026)	7.9 (1110)	8.8 (1051)	8.9 (1130)	8.7 (1008)	
	4	8.9 (1642)	9.0 (1558)	8.7 (1544)	8.7 (1430)	8.6 (1513)	8.9 (1637)	8.9 (1607)	
	5	8.9 (1942)	8.8 (1930)	7.1 (1925)	8.3 (1935)	7.1 (1930)	9.1 (1928)	7.9 (1930)	
	6	8.7 (2247)	8.9 (2300)	8.9 (2303)	8.6 (2156)	8.9 (2140)	8.8 (2200)	8.7 (2217)	
	7							8.7 (0718)	
	Min	8.5	8.0	7.1	7.9	6.4	8.8	7.9	
	Max	9.0	9.0	8.9	9.5	8.9	9.1	8.9	

Table 25 (Cont'd.)
 INSTANTANEOUS pH AND TEMPERATURE DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Sta. No.	Description	Sequence No. or Time (hr)	Date: May 1979						
			8-9	9-10	10-11	11-12	12-13	13-14	14-15
Outfall 005 Background - 2 Continued									
			Temperature (°C)						
Max			21	22	22	22	17	17	16
Min			11	14	14	14	13	15	14
Avg			16	18	17	18	15	16	15
			Date: May 1979						
			2	3	4	5	6		
08 Aquashicola Creek Intake									
			pH (su)		(hour of collection)				
1			6.3 (1710)	7.2 (0820)	6.9 (0819)	6.1 (0655)	6.8 (0853)		
2			6.5 (2240)	6.5 (1710)	6.4 (1720)	6.4 (1725)	6.8 (1050)		
3				6.9 (2310)	6.5 (2120)		6.6 (1705)		
Min			6.3	6.5	6.4	6.1	6.6		
Max			6.5	7.2	6.9	6.4	6.8		
			Temperature (°C)						
Min			12	9	11	10	13		
Max			12	12	13	14	14		
Avg			12	10	12	12	13		
			Date: May 1979						
			8-9	9-10	10-11	11-12	12-13	13-14	14-15
			pH (su)		(hour of collection)				
1			7.4 (0624)	7.2 (0632)	7.4 (0628)	7.5 (0631)	7.3 (0624)	6.8 (0632)	6.6 (0643)
2			6.7 (0655)	6.6 (0655)	7.7 (0700)	8.2 (0700)	7.1 (0705)	7.1 (0700)	7.0 (0655)
3			7.0 (0848)	7.4 (1103)	7.1 (0940)	7.1 (1044)	7.3 (1009)	7.2 (1045)	7.3 (0930)
4			7.3 (1410)	7.4 (1526)	8.0 (1503)	7.9 (1602)	8.0 (1440)	7.5 (1603)	7.6 (1505)
5			7.4 (1703)	8.1 (1917)	6.1 (1907)	7.5 (1909)	6.9 (1910)	7.1 (1905)	6.7 (1914)
6			7.8 (1913)	7.3 (2248)	7.5 (2225)	7.3 (2136)	7.4 (2125)	7.4 (2135)	7.5 (2140)
7			7.4 (2155)						6.7 (0625)
Min			6.7	6.6	6.1	7.1	6.9	6.8	6.6
Max			7.8	8.1	8.0	8.2	8.0	7.5	7.6
			Temperature (°C)						
Min			12	15	17	15	15	15	14
Max			23	21	21	20	17	16	15
Avg			17	19	19	18	16	16	15
09 Pohopoco Creek Intake									
			pH (su)						
0700			7.8	6.3	8.0	8.9	7.7	8.0	7.3
0900			7.4	7.6	8.4	7.7	8.8	8.2	8.1
1100			7.4	8.2	6.4	8.4	7.7	7.8	---

Table 25 (Cont'd.)
 INSTANTANEOUS pH AND TEMPERATURE DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Sta. No.	Description	Sequence No. ^a or Time (hr)	Date: May 1979						
		8-9	9-10	10-11	11-12	12-13	13-14	14-15	
	Pohopoco Creek Intake (cont'd)	1300	7.4	8.0	10.0	9.5	8.1	8.2	8.3
		1500	7.7	7.9	6.2	7.1	5.8	6.8	7.5
		1700	7.5	9.3	7.2	7.3	8.6	8.5	9.5
		1900	7.9	8.3	6.1	6.7	7.1	8.1	7.7
		2100	7.5	7.5	10.1	7.7	8.2	7.6	8.8
		2300	8.0	8.0	8.4	7.3	7.2	8.5	7.7
		0100	6.3	8.5	8.5	7.0	6.1	7.6	6.4
		0300	6.5	7.8	8.2	7.4	7.1	7.5	7.1
		0500	7.3	7.8	7.2	8.9	---	6.7	8.8
		Min	6.3	6.3	6.1	6.7	5.8	6.7	6.4
		Max	8.0	9.3	10.1	9.5	8.8	8.5	9.5
			Temperature (°C)						
		Min	12	13	13	14	14	14	14
		Max	15	25	19	16	16	16	15
		Avg	13	15	15	15	15	14	14
	Outfall 010		pH (su)						
		0700	7.2	7.5	7.0	7.2	6.2	7.0	7.2
		0900	7.2	9.0	7.0	7.6	6.8	7.1	7.1
		1100	7.3	8.2	7.5	7.7	7.0	7.0	---
		1300	7.7	7.9	8.0	8.0	---	7.0	7.0
		1500	7.7	7.5	7.6	6.5	6.1	7.2	6.5
		1700	8.4	7.6	7.5	6.3	6.2	7.0	6.5
		1900	8.0	8.2	9.5	7.6	6.8	7.8	7.7
		2100	7.7	8.1	8.1	7.0	6.5	7.6	7.2
		2300	7.4	7.8	7.9	7.2	6.8	7.6	7.4
		0100	6.9	7.6	8.0	7.2	7.1	7.6	7.5
		0300	7.4	7.6	7.6	6.9	7.1	7.0	6.7
		0500	7.1	7.6	7.2	6.6	7.2	7.2	6.8
		Min	6.9	7.5	7.0	6.3	6.1	7.0	6.5
		Max	8.4	9.0	9.5	8.0	7.2	7.8	7.7
			Temperature (°C)						
		Min	24	24	25	20	19	19	19
		Max	29	31	30	30	22	22	23
		Avg	27	27	28	25	20	20	22
11	Outfall 011		pH (su)						
		0700	6.4	5.8	6.2	8.2	6.5	6.7	7.0
		0900	6.4	6.2	5.3	7.6	7.0	7.1	---
		1100	6.3	6.3	5.0	8.5	6.9	7.1	---
		1300	6.5	6.2	5.0	6.3	6.1	7.0	6.6
		1500	6.4	6.5	4.5	5.8	5.6	7.5	6.2
		1700	6.4	6.0	6.2	6.4	6.5	7.6	6.9
		1900	6.5	6.7	4.9	6.2	6.3	7.1	6.3
		2100	6.5	7.2	8.7	6.5	6.6	7.0	7.0
		2300	6.3	6.8	7.4	6.3	6.6	7.4	6.7
		0100	6.3	7.1	7.9	6.3	6.2	6.3	6.3
		0300	6.4	6.8	7.4	6.5	6.4	6.5	6.8
		0500	---	5	5.5	7.0	---	6.4	7.6

Table 25 (Cont'd.)
 INSTANTANEOUS pH AND TEMPERATURE DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Sta. No.	Description	Sequence No. ^a or Time (hr)	Date: May 1979						
			8-9	9-10	10-11	11-12	12-13	13-14	14-15
	Outfall 011 continued	Min Max	5.6 6.5	5.8 7.2	4.5 8.7	5.8 8.5	5.6 7.0	6.3 7.6	6.2 7.6
			Temperature (°C)						
		Min Max Avg	11 15 12	10 12 11	10 13 11	11 13 11	11 13 11	11 13 12	11 13 12
12	Outfall 012		pH (su) (hour of collection)						
		1	7.0 (0955)	6.5 (0805)	8.0 (0750)	7.9 (0755)	b	b	7.2 (0755)
		2	6.5 (1150)	7.0 (1020)	8.5 (0925)	7.7 (1005)	b	b	---
		Min Max	6.5 7.0	6.5 7.0	8.0 8.5	7.7 7.9	b b	b b	7.2 7.2
			Temperature (°C)						
		Min Max Avg	11 23 17	20 20 20	20 21 20	20 21 20	b b b	b b b	21 22 21
14	Outfall 014		pH (su) (hour of collection)						
		1	7.2 (1317)	6.7 (1325)	8.1 (1325)	10.5 (0915)	7.4 (0920)	7.0 (0920)	7.3 (0920)
			Temperature (°C)						
		1	11	11	12	11	12	11	12
15	Outfall 015		pH (su) (hour of collection)						
		1	7.1 (1350)	6.7 (1350)	5.8 (1335)	6.8 (0935)	7.5 (0935)	7.2 (0940)	8.0 (0940)
			Temperature (°C)						
		1	15	12	13	11	11	12	11
16	Outfall 016		pH (su) (hour of collection)						
		1	6.9 (1335)	7.2 (1350)	6.5 (1335)	7.7 (0935)	7.6 (0935)	7.3 (0940)	b
			Temperature (°C)						
		1	16	25	12	11	14	14	b

Table 25 (Cont'd.)
 INSTANTANEOUS pH AND TEMPERATURE DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Sta. No.	Description	Sequence No. ^a	Date: May 1979						
		or Time (hr)	8-9	9-10	10-11	11-12	12-13	13-14	14-15
New Jersey Zinc Wastewater Treatment Plant Influent			pH (su)						
	0900		2.2	3.1	2.5	3.2	3.0	4.0	
	1300		3.0	3.0	3.2	2.6	3.2	3.0	
	1700		2.3	2.8	2.5	2.8	4.0	3.4	
	2100		2.8	3.0	2.7	2.6	3.3	2.6	
	0100		3.0	3.1	2.8	2.5	4.0	3.0	
	0500		2.8	2.7	2.8	---	3.0	2.9	
	Min		2.2	2.7	2.5	2.5	3.0	2.6	
	Max		3.0	3.1	3.2	3.2	4.0	4.0	
			Temperature (°C)						
	Min		26	26	24	25	26	21	
	Max		33	30	31	30	29	27	
	Avg		30	28	29	28	27	25	
New Jersey Zinc Wastewater Treatment Plant Effluent			pH (su)						
	0900		11.0	11.3	12.0	11.5	11.3	12.0	
	1300		13.0	12.0	12.4	11.1	11.2	11.5	
	1700		12.1	12.0	11.9	11.0	11.5	11.8	
	2100		12.1	11.4	11.6	11.2	11.2	11.6	
	0100		12.0	11.1	11.4	11.3	11.3	11.6	
	0500		11.8	11.2	11.3	---	11.9	11.6	
	Min		11.0	11.1	11.3	11.0	11.2	11.5	
	Max		13.0	12.0	12.4	11.5	11.9	12.0	
			Temperature (°C)						
	Min		24	25	26	26	25	24	
	Max		31	30	31	28	28	26	
	Avg		28	27	28	27	27	25	

For automatic sampling stations (01, 04, 05, 07 and 08) a sequence number indicates the order of pH data collection; actual times are in parentheses. For manual sampling stations (02, 03, 06, and 14-18) the data were collected at regular intervals; the start time of each sampling run is listed.

b Negligible flow

Table 26
TOTAL SUSPENDED SOLIDS (TSS) DATA
New Jersey Zinc - East Plant Discharges
Palmerton, Pennsylvania
May 1-15, 1979

Station Number	Station Description (Background Station)	Date ^a May 1979	Flow		TSS Gross Values			TSS Net Values		
			m ³ /dayx10 ³	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
01	Outfall 001	2	15.9	4.21	9	140	310	2	32	71
	(Station 08 -	3	15.1	3.98	21	320	710	15	230	510
	Aquashicola Creek)	4	16.8	4.43	13	220	490	11	180	400
		5	15.3	4.04	23	350	770	21	320	710
		6	13.7	3.63	11	150	330	9	120	260
	5-day average ^b		15.4	4.06	16	240	530	12	180	400
		9	13.1	3.47	17	220	490	14	180	400
		10	14.5	3.82	11	160	350	9	130	290
		11	15.1	3.98	9	140	310	6	90	200
		12	14.9	3.94	5	74	160	1	15	33
		13	15.0	3.95	4	60	130	1	15	33
		14	14.9	3.93	6	90	200	3	45	100
		14 ^c	14.9	3.93	6	90	200	3	45	100
		15	14.3	3.77	6	86	190	2	29	64
	7-day average		14.5	3.84	8	120	260	5	70	150
	12-day average		14.9	3.93	11	170	370	8	120	260
02	Outfall 002	9	0.144	0.038	5	0.72	1.6	3	0.43	0.95
	(Station 09 -	10	0.110	0.029	4	0.44	0.97	0†	0†	0†
	Pohopoco Creek)	11	0.136	0.036	5	0.68	1.5	2	0.27	0.60
		12	0.095	0.025	7	0.66	1.5	1	0.10	0.22
		13	0.004	0.001	3	0.01	0.02	1	0.004	0.009
		14	0.019	0.005	7	0.13	0.29	4	0.08	0.18
		15	0.155	0.041	6	0.93	2.1	3	0.46	1.0
	7-day average		0.095	0.025	4	0.51	1.1	2	0.19	0.42
		8 ^d	0.44	0.117	4	1.8	4.0	2	0.88	1.9
		8 ^d	0.44	0.117	2	0.88	1.9	0†	0†	0†
		10 ^e	0.29	0.077	2	0.58	1.3	0†	0†	0†
		12 ^e	0.17	0.046	5	0.85	1.9	0†	0†	0†
		15 ^e	0.15	0.040	5	0.75	1.7	2	0.3	0.66
	3-day average ^f		0.20	0.054	4	0.73	1.6	<1	<0.10	<0.22
		9	3.26	0.86	3	9.8	22	1	3.3	7.3
04	Outfall 004	10	3.14	0.83	6	19	42	0†	0†	0†
	(Station 09 -	11	2.99	0.79	4	12	26	1	3.0	6.6
	Pohopoco Creek)	12	3.03	0.80	6	18	40	0	0	0
		13	2.99	0.79	4	12	26	2	6.0	13
		14	2.88	0.76	4	12	26	1	2.9	6.4
		15	2.88	0.76	5	14	31	2	5.8	13
	7-day average		3.03	0.80	5	14	31	1	3.0	6.6
		9	1.30	0.343	3	3.7	8.2			
	Characteristics as	10	1.08	0.286	2	2.2	4.9			
	Discharged	11	1.08	0.286	4	4.3	9.5			
	(gross values only)	12	1.08	0.286	11	12	26			
		13	1.08	0.286	2	2.2	4.9			
		14	1.14	0.302	4	4.6	10			
		15	1.08	0.286	3	3.2	7.1			
	7-day average		1.12	0.296	4	4.6	10			

Table 26 (Continued)
TOTAL SUSPENDED SOLIDS (TSS) DATA
New Jersey Zinc - East Plant Discharges
Palmerton, Pennsylvania
May 1-15, 1979

Station Number	Station Description (Background Station)	Date ^a May 1979 (collection time)	Flow		TSS Gross Values			TSS Net Values		
			m ³ /dayx10 ³	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
05	Outfall 005 Process Load Characteristics ^g (Stations 06, 07, 09)	9	0.46	0.121	0†	0†	0†	0†	0†	0†
		10	0.74	0.195	1	0.5	1.1	0†	0†	0†
		11	0.84	0.223	2	2.4	5.3	0†	0†	0†
		12	0.85	0.225	12	10	22	6	5.1	11
		13	0.89	0.234	2	1.4	3.1	0	0	0
		14	0.95	0.252	4	3.5	7.7	1	0.95	2.1
		15	0.92	0.244	3	2.4	5.3	0	0	0
		7-day average	0.81	0.213	4	2.9	6.4	1	0.86	1.9
10	Outfall 010 (Station 08 - Aquashicola Creek)	9	0.023	0.006	2	0.05	0.11	0†	0†	0†
		10	0.023	0.006	2	0.05	0.11	0	0	0
		11	0.023	0.006	4	0.09	0.20	1	0.02	0.04
		12	0.023	0.006	4	0.09	0.20	0	0	0
		13	0.026	0.007	3	0.08	0.18	0	0	0
		14	0.034	0.009	6	0.20	0.44	3	0.10	0.22
		15	0.019	0.005	4	0.08	0.18	0	0	0
		7-day average	0.023	0.006	4	0.09	0.20	1	0.02	0.04
11	Outfall 011 (no background - gross values only)	9	0.61	0.160	0	0	0			
		10	0.60	0.159	3	1.8	4.0			
		11	0.60	0.159	6	3.6	7.9			
		12	0.57	0.151	4	2.3	5.1			
		13	0.56	0.149	2	1.1	2.4			
		14	0.56	0.148	0	0	0			
		15	0.40	0.106	2	0.8	1.8			
		7-day average	0.56	0.147	2	1.4	3.1			
12	Outfall 012 ^h (Station 09 - Pohopoco Creek ⁱ)	8 (0955)	0.34	0.09	2	0.7	1.5	0†	0†	0†
		9 (0805)	0.45	0.12	0	0	0	0†	0†	0†
		9 (1020)	0.38	0.10	0	0	0	0†	0†	0†
		10 (0750)	0.49	0.13	2	1.0	2.2	0†	0†	0†
		10 (0925)	0.42	0.11	2	0.8	1.8	0†	0†	0†
		11 (0755)	0.42	0.11	6	2.5	5.5	0	0	0
		11 (1005)	0.42	0.11	3	1.3	2.9	0†	0†	0†
		14 (0755)	0.45	0.12	7	3.2	7.1	4	1.8	4.0
		14 (1005)	0.49	0.13	3	1.5	3.3	0	0	0
		Average	0.42	0.11	3	1.2	2.6	<1	0.2	0.4
14	Outfall 014 ^h (no background - gross values only)	8 (1317)	3.3 ^j	880 ^k	0	0	0			
		9 (1325)	7.2 ^j	1900 ^k	0	0	0			
		10 (1325)	5.7 ^j	1500 ^k	2	0.01	0.02			
		11 (0915)	4.9 ^j	1300 ^k	6	0.03	0.07			
		12 (0920)	3.0 ^j	780 ^k	3	0.01	0.02			
		13 (0920)	2.0 ^j	520 ^k	0	0	0			
		14 (0920)	1.5 ^j	390 ^k	0	0	0			
		7-day average	3.9 ^j	1000 ^k	3	0.01	0.02			
15	Outfall 015 ^h (no background - gross values only)	8 (1350)	0.30	0.079	0	0	0			
		9 (1350)	0.28	0.073	2	0.56	1.2			
		10 (1335)	0.25	0.067	0	0	0			
		11 (0935)	0.21	0.056	0	0	0			
		12 (0935)	0.17	0.046	0	0	0			
		13 (0940)	0.17	0.046	3	0.51	1.2			
		14 (0940)	0.16	0.041	0	0	0			
		7-day average	0.22	0.058	1	0.15	0.34			

Table 26 (Continued)
 TOTAL SUSPENDED SOLIDS (TSS) DATA
 New Jersey Zinc - East Plant Discharges
 Palmerton, Pennsylvania
 May 1-15, 1979

Station Number	Station Description (Background Station)	Date ^a May 1979 (collection time)	Flow		TSS Gross Values			TSS Net Values		
			m ³ /dayx10 ³	mgd	mg/l	kg/day	lb/day	mg/l	kg/day	lb/day
16	Outfall 016 ^h (no background - gross values only)	8 (1335)	0.045	0.012	21	1	2			
		9 (1350)	0.030	0.008	4	0.1	0.2			
		10 (1335)	<0.019	<0.005	7	<0.1	<0.2			
		11 (0935)	<0.019	<0.005	2	<0.04	<0.08			
		12 (0935)	<0.019	<0.005	8	<0.1	<0.2			
		13 (0940)	0.47	0.125	2	1	2			
		14 (0940)	0	0	---	---	---			
		7-day average	<0.08	<0.02		<0.3	<0.7			

a Date listed for composite samples is date composite period ended; grab samples for Stations 12, 14, 15, and 16) are listed by date and time of collection.

b average concentrations computed on flow-weighted basis by back-calculating from average flow and load data.

c duplicate sample - data not included in average.

d grab sample

e composite sample

f average of composite data

g Outfall 005 process load characteristics were computed by:

1. Subtracting the Station 06 and 07 flow and load contributions from Station 05 "as discharged" characteristics to obtain the gross process flows and loads,
2. Back-calculating the gross process concentration, and
3. Subtracting the Station 09 background concentration to obtain the net process values.

Background values (concentrations and/or loads) for Stations 06, 07, 08, and 09 are in Appendix ____.

h grab samples only

i TSS concentrations from Station 09 composite samples were used as background at Station 12.

j m³/day

k gal/day

† Values less than zero are presented and averaged as zero.

Table 27
OIL AND GREASE DATA^a
New Jersey Zinc - East Plant Discharges, Intakes, and Background Stations
Palmerton, Pennsylvania
May 8 - 14, 1979

NEIC Station Number	Station Description	Intake or Background Station	Gross Oil and Grease (all values in mg/l)														
			May 1979														
			8		9		10		11		12		13		14		Average
01	Outfall 001	08	ND ^b 0655*	ND 1920	ND 0655	210 ^c 1907	ND 0650	ND 1905	ND 0655	ND 1910	ND 0700	ND 1910	ND 0700	ND 1904	ND 0655	ND 1915	15
02	Outfall 002	09	ND 0950	ND 2028	ND 0800	ND 2002	ND 0745	d 1950	d 0750	ND 2000	ND 0745	ND 2000	ND 0750	ND 1950	ND 0747	11 1955	0.92
03	Outfall 003	09	ND 0825	ND 2015	ND 0745	ND 1953	e	e	d 0740	e	e	e	e	e	ND 0745	e	ND
04	Outfall 004	09	ND 1005	ND 2035	140 ^c 0820	56 ^c 2028	ND 0810	ND 2020	ND 0810	ND 2025	ND 0752	ND 2010	ND 0755	ND 2010	d 0805	ND 2006	15
05	Outfall 005	06,07,09	ND 0755	ND 1954	24 ^c 0830	8 1936	ND 0725	ND 1934	ND 0720	ND 1944	ND 0725	ND 1940	ND 0725	ND 1935	ND 0725	ND 1938	2.3
06	005 Background 1	NA ^f	ND 0722		ND 0725												
07	005 Background 2	NA	ND 0740	ND 1942	34 0715	ND 1930	ND 0715	9 1925	ND 0710	ND 1935	ND 0715	ND 1930	ND 0720	ND 1928	ND 0710	ND 1930	3
08	Aquashicola Creek Intake	NA	ND 0655	ND 1913	250 0655	12 1917	ND 0700	ND 1907	d 0700	ND 1909	ND 0705	ND 1910	ND 0700	ND 1905	ND 0655	ND 1914	20
09	Pohopoco Creek Intake	NA	ND 0805	160 1958	ND 0735	41 1944	8 0735	ND 1940	ND 0730	ND 1950	ND 0730	ND 1943	ND 0735	ND 1942	ND 0730	ND 1945	15

Time of sample collection is presented below each result.

All data based on grab samples.

ND means not detected (below detection limit of 7.5 mg/l).

These relatively high oil and grease concentrations were preceded by similarly high concentrations in the intake or background water source for these discharges. Thus the source of the oil and grease was probably the water source rather than the process.

Sample lost in laboratory accident.

Negligible flow; no sample.

Not applicable.

Table 28
 24-HOUR STATIC BIOASSAY SURVIVAL DATA
 NEW JERSEY ZINC - EAST PLANT
 PALMERTON, PENNSYLVANIA
 May, 1979

NEIC Station No.	Effluent Concentrations (%)				
	Control % Survival	100% % Survival	50% % Survival	25% % Survival	10% % Survival
01	100	100	90	100	100
02	100	100	100	100	100
03	100	100	100	100	100
04	100	100	100	100	100
05	100	90	100	100	100
11	100	0	0	0	0
12	100	100	100	100	100

24-Hour Static Bioassay
Physical Chemical Characteristics
New Jersey Zinc-East Plant
Palmerton, Pennsylvania
May, 1979

Station No.	Effluent Concentration (%)	D.O. mg/l		Parameter pH		Temperature C°		Total Alkalinity (mg/l CaCO ₃)	
		Initial	24-hour	Initial	24-hour	Initial	24-hour	Initial	24-hour
01	Control	9.0	6.5	7.5	7.2	16.0	16.2	22	
	100%	8.0	5.5	7.6	7.2	17.4	16.6	36	
	50%	8.5	5.5	7.4	7.1	17.2	16.6		
	25%	9.0	6.0	7.3	7.0	16.8	16.6		
	10%	9.0	6.0	7.3	7.0	17.7	16.4		
02	Control	8.5	7.0	7.2	7.0	16.5	16.4	22	
	100%	8.0	6.0	6.3	6.4	16.5	16.6	10	
	50%	9.0	7.0	6.8	6.8	14.5	16.2		
	25%	9.0	7.0	6.9	6.9	15.0	16.2		
	10%	9.5	7.0	7.0	7.0	15.0	16.3		
03	Control	9.0	7.5	7.2	7.3	16.0		22	
	100%	9.0	6.0	6.9	6.7	17.4		14	
	50%	8.5	6.5	7.0	6.9	16.3			
	25%	8.5	6.5	7.1	7.1	15.9			
	10%	9.0	6.5	7.2	7.1	15.6			
04	Control	8.5	7.0	7.2	7.0	16.5	16.4	22	
	100%	8.5	6.0	6.9	6.7	16.0	16.2	11	
	50%	8.5	7.0	6.9	6.9	14.0	15.6		
	25%	8.5	7.0	6.9	6.9	14.7	15.8		
	10%	9.0	7.0	6.9	6.9	15.0	16.0		
05	Control	8.5	7.0	7.2	7.0	16.5	16.4	22	
	100%	8.0	6.5	7.0	6.9	16.2	17.0	18	
	50%	8.5	7.0	7.0	6.8	14.4	16.0		
	25%	8.5	7.0	7.0	6.9	15.0	16.0		
	10%	8.5	7.0	7.0	6.8	15.0	16.2		
11	Control	9.0	6.5	7.5	7.2	16.0	16.2	22	
	100%	9.0		7.0		15.8		19	
	50%	9.0		7.3		15.8			
	25%	9.0		7.2		16.0			
	10%	9.0		7.3		16.8			
12	Control	9.0	6.5	7.5	7.2	16.0	16.2	22	
	100%	9.0	6.0	7.4	7.2	17.4	16.6	10	
	50%	9.0	6.0	7.5	7.3	17.4	16.4		
	25%	9.0	6.0	7.5	7.2	17.4	16.6		
	10%	9.0	6.0	7.5	7.2	17.8	16.6		

PROBABILITY	DOSE	95 PERCENT FIDUCIAL LIMITS	
		LOWER	UPPER
0.01	0.00073820	-0.00776382	0.00413811
0.02	0.00143839	-0.00555397	0.00503407
0.03	0.00209049	-0.00410912	0.00561486
0.04	0.00272203	-0.00313320	0.00605993
0.05	0.00333776	-0.00229694	0.00642923
0.06	0.00410413	-0.00159030	0.00674692
0.07	0.00443173	-0.000957524	0.00703086
0.08	0.00479293	-0.00042858	0.00723915
0.09	0.00507590	0.00006488	0.00752770
0.10	0.00536649	0.00051565	0.00775087
0.15	0.00641515	0.00233902	0.00871752
0.20	0.00727243	0.00372433	0.00954963
0.25	0.00800791	0.00485323	0.0102308
0.30	0.00853239	0.00581019	0.01107448
0.35	0.00923042	0.00664303	0.01182474
0.40	0.00993117	0.00738295	0.01252693
0.45	0.01042303	0.00805267	0.01317059
0.50	0.01097403	0.008637020	0.01418338
0.55	0.01152903	0.00925067	0.01505323
0.60	0.01209092	0.009800758	0.01592968
0.65	0.01257167	0.01035330	0.01688563
0.70	0.01320370	0.01090781	0.01791967
0.75	0.01394418	0.01147059	0.01906026
0.80	0.01457946	0.01207904	0.02035416
0.85	0.01553694	0.01270392	0.02188670
0.90	0.01651560	0.01359810	0.02354254
0.91	0.01687613	0.01379596	0.02431855
0.92	0.01715915	0.01400958	0.02483701
0.93	0.01747030	0.01424298	0.02540856
0.94	0.01781793	0.01450198	0.02604857
0.95	0.01821433	0.01479543	0.02678044
0.96	0.01868006	0.01513784	0.02764265
0.97	0.01925260	0.01555572	0.02870570
0.98	0.02001370	0.01610673	0.03012332
0.99	0.02121329	0.01696677	0.03236610

Table 30. Probit Analysis on Dose (% effluent). New Jersey Zinc-East Plant Outfall 011. Palmerton, Pennsylvania. May 1979.

PROBIT ANALYSIS ON DOSE

PROBABILITY	DOSE	95 PERCENT FIDUCIAL LIMITS	
		LOWER	UPPER
0.01	0.60403151	0.41018751	0.69336036
0.02	0.63595340	0.46244881	0.71769840
0.03	0.65620682	0.49539173	0.73335531
0.04	0.67144268	0.52003503	0.74527177
0.05	0.68383587	0.53997651	0.75506883
0.06	0.69438443	0.55686523	0.76349228
0.07	0.70363344	0.57160102	0.77095032
0.08	0.71191484	0.58473124	0.77769201
0.09	0.71944643	0.59661481	0.78333116
0.10	0.72637928	0.60750034	0.78963160
0.15	0.75508312	0.65191986	0.81408942
0.20	0.77789602	0.68627490	0.83447590
0.25	0.79746746	0.71486522	0.85284893
0.30	0.81504321	0.73967634	0.87021236
0.35	0.83132977	0.76180453	0.88716518
0.40	0.84678412	0.78193483	0.90411892
0.45	0.86173638	0.80054280	0.92139019
0.50	0.87645158	0.81799378	0.93924961
0.55	0.89116678	0.83459806	0.95795572
0.60	0.90611904	0.85064594	0.97778709
0.65	0.92157339	0.86643542	0.99908166
0.70	0.93785995	0.88230285	1.02229523
0.75	0.95543570	0.89867033	1.04810229
0.80	0.97500714	0.91613309	1.07759789
0.85	0.99782004	0.93570195	1.11277556
0.90	1.02652387	0.95940045	1.15795439
0.91	1.03345672	0.96500352	1.16898729
0.92	1.04098832	0.97104569	1.18101784
0.93	1.04926971	0.97764000	1.19429545
0.94	1.05851873	0.98494920	1.20918007
0.95	1.06906729	0.99322083	1.22622061
0.96	1.08146048	1.00286072	1.24631927
0.97	1.09669634	1.01461050	1.27112924
0.98	1.11694976	1.03008287	1.30425669
0.99	1.14887165	1.05419517	1.35674374

Table 31. Probit Analysis on Dose (% effluent). New Jersey Zinc-East Plant
Outfall 001, Palmerton, Pennsylvania. May 1979.

Table 32
 HEAVY METALS CONCENTRATION (mg/l)
 96-HOUR CONTINUAL FLOW BIOASSAY
 NEW JERSEY ZINC - EAST PLANT
 PALMERTON, PENNSYLVANIA
 May, 1979

	Fe		Mn		Zn		Pb		Cd		Cu		As	
	T *	D **	T	D	T	D	T	D	T	D	T	D	T	D
Outfall 001														
24 hour	0.32	0.03	0.22	0.19	1.3	0.89	0.05	Nd	0.13	0.14	Nd	Nd	Nd	Nd
48 hour	0.26	0.03	0.16	0.14	1.2	0.67	0.045	Nd	0.03	0.02	Nd	Nd	0.002	Nd
72 hour	0.19	0.05	0.14	0.12	1.0	0.61	0.043	Nd	0.03	0.03	Nd	Nd	0.002	Nd
96 hour	0.18	0.07	0.18	0.16	1.9	1.3	0.04	0.04	0.05	0.05	Nd	Nd	Nd	Nd
Outfall 011														
24 hour	Nd	Nd	0.27	0.26	64	60	Nd	Nd	0.73	0.70	Nd	Nd	Nd	Nd
48 hour	Nd	Nd	0.27	0.26	59	58	0.02	Nd	0.75	0.71	Nd	Nd	.007	Nd
72 hour	Nd	Nd	0.27	0.26	67	58	Nd	Nd	0.74	0.71	Nd	Nd	Nd	Nd
96 hour	Nd	Nd	0.27	0.26	64	60	0.01	Nd	0.74	0.71	Nd	Nd	Nd	Nd

* Total Metal

** Dissolved Metal

Table 33

Heavy Metals Concentrations mg/l*
 96-Hour Continual Flow Bioassay
 New Jersey Zinc-East Plant Outfall 001
 Palmerton, Pennsylvania
 May, 1979

		Effluent Concentration (%)											
Control		10		18		32		56		75		100	
T**	D***	T	D	T	D	T	D	T	D	T	D	T	D
24-hour													
Zn	Nd	0.13	0.09	0.23	0.16	0.42	0.28	0.73	0.50	0.98	0.67	1.3	.89
Cd	Nd	0.01	0.01	0.02	0.02	0.04	0.04	0.07	0.08	0.10	0.10	0.13	0.14
Pb												0.05	Nd
48-hour													
Zn	Nd	0.12	0.07	0.22	0.12	0.38	0.21	0.67	0.38	0.90	0.50	1.2	0.67
Cd	Nd	0.003	0.002	0.005	0.004	0.01	0.006	0.02	0.01	0.02	0.01	0.03	0.02
Pb												0.05	Nd
72-hour													
Zn	Nd	0.10	0.06	0.18	0.11	0.32	0.20	0.56	0.34	0.75	0.46	1.0	0.61
Cd	Nd	0.003	0.003	0.005	0.005	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03
Pb												0.04	Nd
96-hour													
Zn		0.19	0.13	0.34	0.23	0.61	0.42	1.1	0.73	1.4	0.98	1.9	1.3
Cd		0.005	0.005	0.009	0.009	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05
Pb												0.004	0.04

*Metals concentrations in the control and 100% effluent are analytical values; other values were extrapolated.

**Total Metal

***Dissolved Metal

Table 34
ACUTE TOXICITY OF ZINC AND CADMIUM
TO
RAINBOW TROUT*

96 hour LC ₅₀ mg/l	Lethal Threshold mg/l**	Water Hardness mg/l	Fish length mm
<u>Zinc</u>			
0.24	30% @ 0.11	22	70
0.56	10% @ 0.13	23	140
0.83	10% @ 0.34	30	179
<u>Cadmium</u>			
0.003	40% @ 0.0024	14	40
0.003	5% @ 0.0015	31	135

*Goettl and Davies, Fed. Aid Project
F-33-R-12, Water Pollution Studies
Colorado Division of Wildlife, 1977.

**Lowest concentration that killed fish during test.

Table 35
 96-HOUR CONTINUAL-FLOW BIOASSAY SURVIVAL DATA*
 NEW JERSEY ZINC - EAST PLANT OUTFALL 001
 PALMERTON, PENNSYLVANIA
 MAY, 1979

Time Period	Effluent Concentration (%)						
	Control (Aquashicola Creek Water)	10	18	32	56	75	100
24-hour	100	100	100	100	100	100	15
48-hour	100	100	100	100	100	95	15
72-hour	100	100	100	100	100	95	15
96-hour	100	95	100	100	100	85	15

*Expressed as percent.

Table 37
Heavy Metals Concentrations mg/l*
96-Hour Continual Flow Bioassay
New Jersey Zinc-East Plant Outfall 011
Palmerton, New Jersey
May, 1979

Effluent Concentration (%)																			
Control		0.32		0.56		1.0		1.8		2.4		3.2		5.6		7.5		10.0	
T **	D ***	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D	T	D
24-hour																			
ZN	Nd	0.16	0.14	0.28	0.25	0.50	0.44	0.90	0.79	1.2	1.1	1.6	1.4	2.8	2.5	3.8	3.3	5.0	4.4
Cd	Nd	0.002	0.002	0.003	0.004	0.006	0.008	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.06	0.06	0.08
48-hour																			
ZN	Nd	0.23	0.26	0.41	0.47	0.74	0.83	1.3	1.4	1.7	2.0	2.3	2.6						
Cd	Nd	0.003	0.003	0.005	0.006	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03						
72-hour																			
ZN	Nd	0.21	0.21	0.38	0.38	0.67	0.67	1.2	1.2	1.6	1.6	2.1	2.1						
Cd	Nd	0.003	0.003	0.005	0.005	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03						
96-hour																			
ZN		0.17	0.17	0.31	0.31	0.58	0.58	1.0	1.0	1.4	1.4	1.8	1.8						
Cd		0.003	0.002	0.005	0.004	0.01	0.006	0.02	0.01	0.02	0.02	0.03	0.02						

*Metals concentrations at 10% and 3.2% and the control are analytical values; other values were extrapolated.

**Total Metal

***Dissolved Metal

Table 38
 PHYSICAL-CHEMICAL CHARACTERISTICS
 96-HOUR CONTINUAL FLOW BIOASSAY
 NEW JERSEY ZINC - EAST PLANT OUTFALL 011
 PALMERTON, PENNSYLVANIA
 May, 1979

Parameter	Effluent Concentration (%)									
	Control (Aquashicola Creek Water)	0.32	0.56	1.0	1.8	2.4	3.2	5.6	7.5	10.0
<u>24-Hour</u>										
DO mg/l	8.5	8.0	8.0	8.0	8.5	7.5	8.5	8.5	8.5	8.0
pH	7.1	7.1	7.1	7.2	7.1	7.1	7.1	7.1	7.1	7.1
Temperature °C	16.8	16.2	16.1	16.8	16.6	16.2	16.8	16.6	16.8	16.8
Total Alkalinity *	24									20
<u>48-Hour</u>										
DO mg/l	8.0	8.5	8.5	8.0	7.5	8.5	7.5			
pH	7.1	7.5	7.5	7.1	7.1	7.5	7.1			
Temperature °C	16.1	16.2	16.0	16.2	16.1	16.0	16.3			
Total Alkalinity	22						24			
<u>72-Hour</u>										
DO mg/l	8.5	8.5	8.5	8.5	8.5	8.5	8.5			
pH	7.5	7.5	7.5	7.5	7.5	7.5	7.5			
Temperature °C	16.0	16.2	16.2	16.0	16.1	16.2	16.0			
Total Alkalinity	22						23			
<u>96-Hour</u>										
DO mg/l	8.5	8.5	8.5	8.5	8.5	8.0	8.5			
pH	7.5	7.5	7.5	7.5	7.5	7.5	7.5			
Temperature °C	16.2	16.3	16.2	16.2	16.2	16.4	16.2			
Total Alkalinity	22						22			

* mg/l CaCO₃

Table 39
 96-HOUR CONTINUAL-FLOW BIOASSAY SURVIVAL DATA*
 NEW JERSEY ZINC - EAST PLANT OUTFALL 011
 PALMERTON, PENNSYLVANIA
 May, 1979

Time Period	Effluent Concentration (%)									
	Control	0.32	0.56	1.0	1.8	2.4	3.2	5.6	7.5	10.0
24-hour	100	100	100	100	100	100	30	0	0	0
48-hour	100	100	100	95	80	65	10			
72-hour	100	100	95	80	60	10	5			
96-hour	100	100	80	65	5	0	0			

*Expressed as percent.

PROBABILITY	DOSE	95 PERCENT FIDUCIAL LIMITS	
		LOWER	UPPER
0.01	0.18651411	-0.19369107	0.35027110
0.02	0.25022564	-0.08498399	0.39753800
0.03	0.29064357	-0.01640895	0.42792345
0.04	0.32105716	0.03491256	0.45104606
0.05	0.34579221	0.07645311	0.47006006
0.06	0.36684562	0.11163844	0.48641616
0.07	0.38530534	0.14233788	0.50090847
0.08	0.40183381	0.16968854	0.51402164
0.09	0.41686580	0.19443584	0.52607458
0.10	0.43070277	0.21709598	0.53728911
0.15	0.48799153	0.30938200	0.58525328
0.20	0.53352282	0.38032736	0.62577433
0.25	0.57258461	0.43876878	0.66296117
0.30	0.60766330	0.48874246	0.69886461
0.35	0.64016894	0.53247529	0.73470975
0.40	0.67101361	0.57140321	0.77129352
0.45	0.70085619	0.60659704	0.80915813
0.50	0.73022562	0.63895076	0.84870454
0.55	0.75959506	0.66926200	0.89029344
0.60	0.78943763	0.69827094	0.93434293
0.65	0.82028231	0.72669568	0.98142990
0.70	0.85278794	0.75528641	1.03241712
0.75	0.88786664	0.78492100	1.08865966
0.80	0.92692843	0.81679127	1.15241764
0.85	0.97245971	0.85283089	1.22784444
0.90	1.02974847	0.89697075	1.32395476
0.91	1.04358544	0.90747848	1.34732171
0.92	1.05861743	0.91883790	1.37276252
0.93	1.07514591	0.93126720	1.40079704
0.94	1.09360563	0.94508060	1.43217540
0.95	1.11465904	0.96075627	1.46804117
0.96	1.13939408	0.97907858	1.51027341
0.97	1.16980267	1.00148190	1.56231421
0.98	1.21022560	1.03108779	1.63166881
0.99	1.27393714	1.07742500	1.74130559

TABLE 40. Probit Analysis on Dose (mg/l dissolved zinc). New Jersey Zinc-East Plant Outfall 001 and 011. Palmerton, Pennsylvania. May 1979.

Outfall is listed with the Outfall. Intake and background concentrations subtracted from the gross concentrations are in Appendix D. When subtraction of the background concentration from the gross concentration resulted in a zero or negative net value, this value was listed as zero. All average concentrations in Table 21 were computed on a flow-weighted basis by back-calculating from average load and flow data. Detection limits for the particular analyses are on the footnote page.

The data at Outfall 001, the main process discharge, show net metals concentration ranges of 0.2 to 4.0 mg/l for zinc, 0.01 to 0.10 mg/l for cadmium, 0.02 to 0.25 mg/l for lead; 0.03 to 0.52 mg/l for iron and 0 to 0.14 for manganese. The 12-day average net concentrations for the metals were 1.7 mg/l for zinc, 0.05 mg/l for cadmium, 0.11 mg/l for lead, 0.26 mg/l for iron and 0.03 mg/l for manganese.

The data show a marked difference in 001 effluent quality before and after the shutdown of the No. 3 roaster and the two Peabody scrubbers in the acid plant. Based on the averages of the before-shutdown and after-shutdown periods, the concentrations and loads for the five metals were reduced by 52 to 90% after the shutdown.

The data at Outfall 002, the discharge from four in-series oil separation tanks, show net concentration ranges of 0.11 to 0.42 mg/l for zinc, 0 to 0.002 mg/l for cadmium and 0 to 0.34 mg/l for iron. Average net concentrations for these three metals during the 7-day monitoring period were 0.32, 0.001, and 0.03 mg/l, respectively. Outfall 003, an intermittent discharge of induction furnace cooling water, contained net zinc concentrations of from 0.03 to 0.27 mg/l with an average of 0.10 mg/l, and net cadmium concentrations of from 0 to 0.002 mg/l with an average of 0.001 mg/l.

The data at Outfall 004, the Waelz kiln and sinter plant cooling water discharge, showed net concentration ranges of 0 to 0.44 mg/l for zinc, 0 to 0.008 mg/l for cadmium, 0 to 0.06 mg/l for iron and 0 to 0.04 mg/l for manganese. Seven-day average net concentrations for these respective metals were 0.13, 0.002, 0.01, and 0.01 mg/l.

The results from Outfall 005, which contains Blue Mountain and Cinder Bank runoff and Oxide East cooling water, are presented in two sets. First presented are the characteristics of the waste stream that is actually discharged to Aquashicola Creek ("characteristics as discharged"). The second set of data ("process load characteristics") have had the flow and load characteristics from the two runoff monitoring stations (06 and 07) subtracted from the "characteristics as discharged" to show only the gross and net contribution of the Oxide East department. It is the net process load characteristics that are limited by the NPDES permit. The net process concentration ranges were 0 to 4.7 mg/l for zinc, 0.006 to 0.070 mg/l for cadmium, 0 to 0.15 mg/l for lead and 0 to 0.03 mg/l for copper. Seven-day average net concentrations for the respective metals were 1.0, 0.024, 0.05 and 0.01 mg/l. The 7-day average flow and load data show that, during this study, the contributions from the two runoff stations was a minor portion of the 005 discharge, accounting for only 27% of the flow, 25% of the zinc, 19% of the cadmium and none of the lead or copper.

At Outfall 010, the discharge from the Field Station Facility the effluent data reflect the batch-type processes that are conducted there. The ranges of net metals concentrations were very wide: 0.9 to 78 mg/l of zinc, 0.021 to 0.171 mg/l of cadmium and 0 to 0.08 mg/l of lead. The respective 7-day average net concentrations were 27, 0.074 and 0.02 mg/l.

The data at Outfall 011, a surface runoff and groundwater discharge, show considerable amounts of zinc and cadmium being discharged. Zinc concentrations ranged from 50 to 78 mg/l and cadmium ranged from 0.72 and 0.77 mg/l for the seven days. The respective average concentrations were 66 and 0.75 mg/l. The load data for these two metals show that the only Outfall discharging more zinc and cadmium on a daily basis was Outfall 001 before the roaster shutdown.

The data from Outfall 012, an intermittent discharge from the slab casting and ball casting shops, show relatively low concentrations of zinc, cadmium, and lead. Net concentrations ranged from 0 to 0.42 mg/l for zinc, from 0 to 0.008 mg/l for lead, and were always 0 mg/l for cadmium. The respective average net concentrations were 0.12 and 0.002 and 0 mg/l.

The data from the surface runoff Outfalls 014, 015, and 016 indicate some zinc and cadmium contamination. Zinc concentrations at the three Outfalls ranged from 0.39 mg/l to 4.5 mg/l with most values greater than 1.6 mg/l. The respective 7-day averages were 4.5, 1.7, and 0.9 mg/l. Cadmium concentrations ranged from 0.01 to 0.03 mg/l and the 7-day average was 0.02 mg/l for all three Outfalls. However, the load data show that the zinc load never exceeded 0.5 kg/day and the cadmium load never exceeded 9 grams/day.

The results of six days of composite sampling of the influent to and effluent from the NJZ Waste Acid Treatment Plant are presented in Table 22. The data show an average of 98% or better removal efficiency* for zinc, cadmium, iron, manganese, and arsenic. The average removal for lead was 92%. The average removal for TSS and selenium were relatively low, 27 and 57%, respectively. Load data were not calculated at the treatment plant because no adequate flow device exists at the site.

* Based on concentration.

Table 23 presents a summary of metals load data from all East Plant discharges for the five days, May 10 to 14, on which a metals mass balance was performed on Aquashicola Creek. The data show that Outfalls 001 and 011 were the sources of the major part of zinc and cadmium contributions to Aquashicola Creek. Based on the 5-day averages, these two Outfalls combined to account for 93 and 90% of the zinc and cadmium loads, respectively. However, as was discussed previously, the total of all East Plant discharges accounted for only 18 and 8% of the zinc and cadmium contributions to Aquashicola Creek. The remainder is attributable to non-point sources.

Field Measurements

Table 24 presents data from twelve days of continuous pH recording at Outfall 001. The data show 89 excursions above 9.0 su* and 16 excursions below 6.0 su. Accumulated daily time at pH >9.0 ranged from 0 to 1096 min/day, with a 12-day total of 2,989 minutes; accumulated daily time at pH <6.0 ranged from 0 to 94 min/day, with a 12-day total of 282 minutes. These data indicate that the pH control system for the effluent from the Waste Acid Treatment Plant is totally inadequate.

Instantaneous pH and temperature data collected at all eleven Outfalls and their background stations are presented in Table 25. The pH data collected at the Outfalls are summarized below:

Outfall	No. pH Readings	Readings <6.0 su	Readings >9.0	Total No. Excursions	% Excursions
001	56	1	13	14	25
002	73	1	0	2	3
003	22	0	0	0	0
004	43	0	0	0	0
005	44	0	2	2	4
010	82	0	1	1	1
011	81	9	0	9	11
012	9	0	0	0	0
014	7	0	1	1	14
015	7	1	0	1	14
016	6	0	0	0	0

* 12 days at Outfall 001, 7 days at all other Outfalls.

The temperature data show that Outfalls 001 and 010 were the only two discharges with temperatures in excess of 25°C (77°F) and most temperatures were 20°C (68°F) or below.

TSS and Oil and Grease

Table 26 presents total suspended solids data composite and grab samples collected from the 11 East Plant discharges (Outfalls 001-005, 010-012, 014-016). The concentration data have all been corrected for analytical and sampler blanks. The background Stations are used to compute the net concentrations at each Outfall are listed with the Outfalls. All average concentrations were computed on a flow-weighted basis by back-calculating from average load and flow data. The Outfall 005 TSS data are presented similarly to the 005 metals data.

The data show that, except for four days at Outfall 001 and one day at Outfall 016, all net TSS concentrations were less than 10 mg/l. Average concentrations over the monitoring period* ranged from 1 to 8 mg/l. The Outfall 001 concentration and load data show the effect of the previously discussed process reductions. The average concentrations and loads were decreased by 58 and 61%, respectively, after the shutdown.

The oil and grease data in Table 27 show most measured concentrations as less than detectable (<7.5 mg/l) but several relatively high values on May 9. In all but one case, however, the high value at each Outfall was preceded by a similarly high value at the background water source(s) for the Outfall. The exception was for the last sample at Outfall 002 which contained 11 mg/l.

* 12 days at Outfall 001, 7 days at all other Outfalls.

Effluent Toxicity

The screening tests showed Outfall 011 to be acutely toxic to fish within a 24-hour exposure period [Table 28]. No mortality of test fish occurred at the 100% effluent concentration of Outfalls 001, 002, 003, 004, 005, and 012. No fish survived the screening test in Outfall 011 effluent at concentrations down to 10%. Vital physical and chemical characteristics (pH, temperature, and dissolved oxygen concentration) for test chambers were adequate for fish survival [Table 29].

The results of the continual flow bioassays of Outfall 001 and 011 showed both effluents to be acutely toxic to rainbow trout. The 96-hour LC_{50} for Outfall 011 was calculated to be a mixture of approximately 1% effluent and 99% Aquashicola Creek dilution water (95% fiducial limits 0.86% to 1.4% [Figure 20, Table 30]. The 96-hour LC_{50} for Outfall 001 was calculated to be a mixture of 88% effluent and 12% dilution water (95% fiducial limits 81.8% to 93%) [Figure 21, Table 31].

Outfalls 001 and 011 contained heavy metals in concentrations known to be potentially toxic to fish [Table 32]. The toxicity of individual heavy metals to fish varies greatly as does the toxicity of different chemical species of the same metal. However, some general characteristics of heavy metals toxicity are similar for the majority of metals. Studies indicate it is the ionic or labile species of heavy metals that are toxic to fish and not the total metal content of the water which may include insoluble chelated and precipitated forms⁸. The percentage of the total metal content of water in the toxic ionic state is dynamic and a function of various physical and chemical characteristics of the water which include pH,

* LC_{50} indicates the concentration (actual or interpolated) at which 50% of the organisms died or would be expected to die.

PROBABILITY

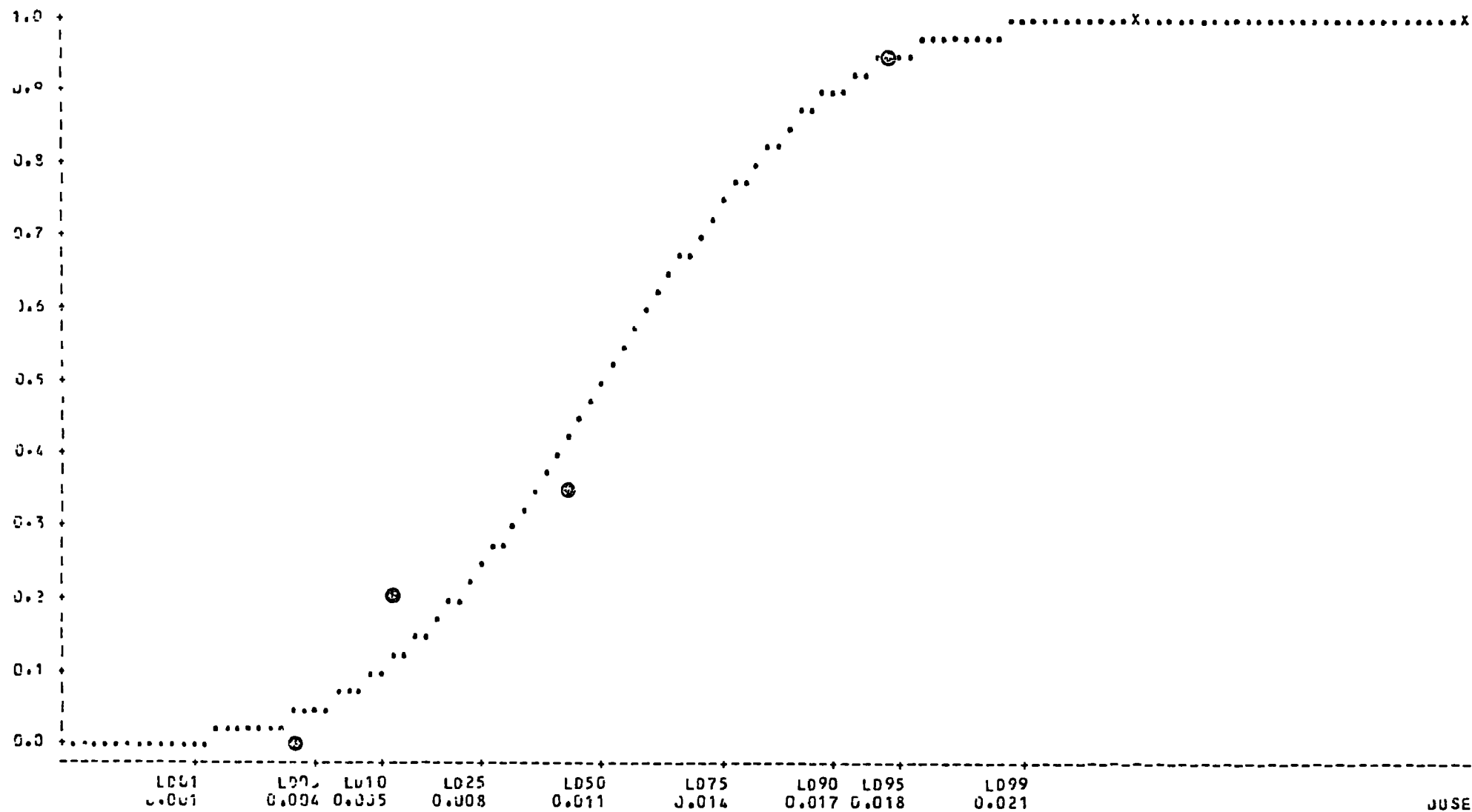


FIGURE 20. Probit Analysis on Dose. New Jersey Zinc-East Plant Outfall 011, Palmerton, Pennsylvania May, 1979

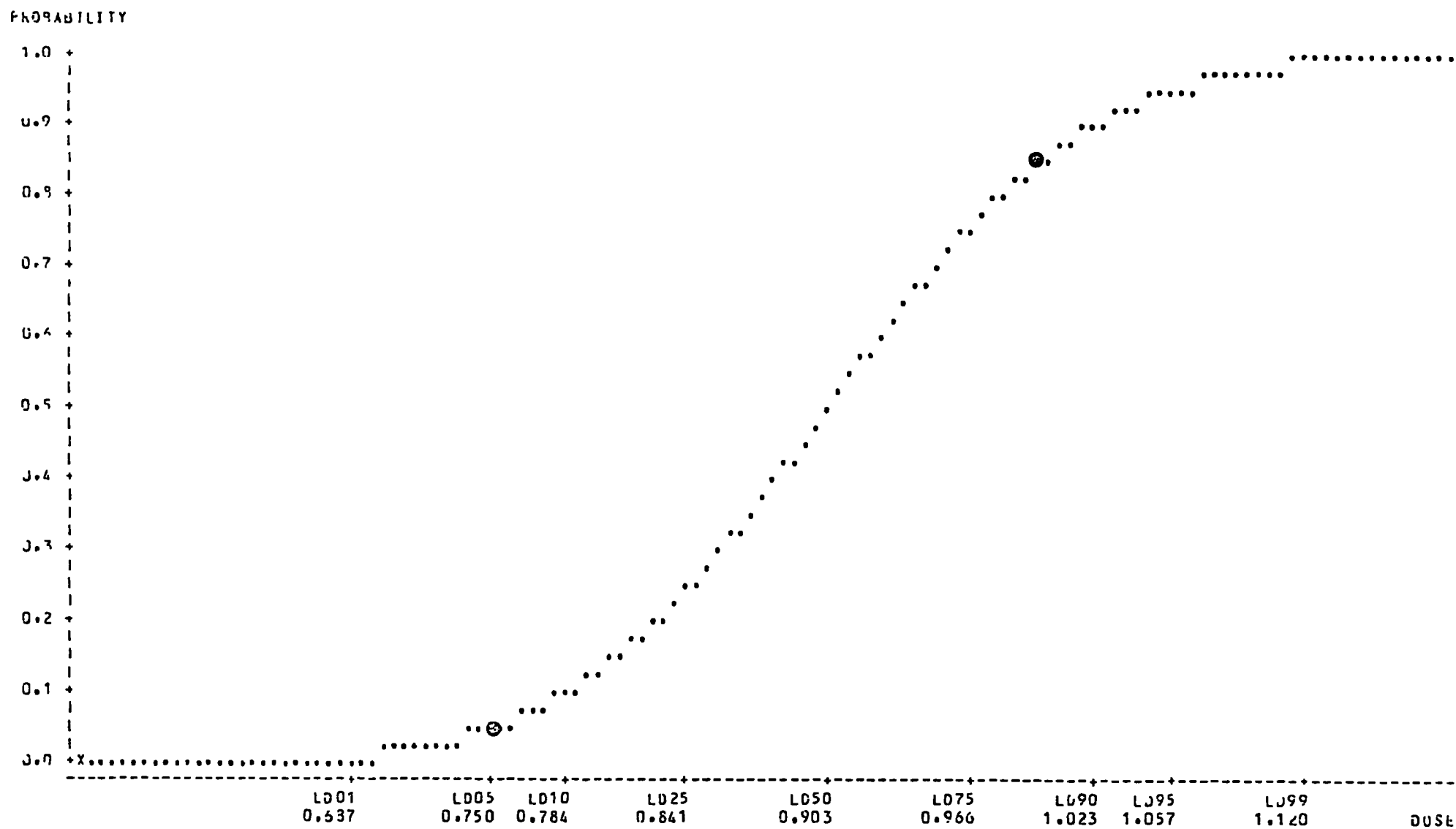


FIGURE 21. Probit Analysis on Dose. New Jersey Zinc-East Plant Outfall 001. Palmerton, Pennsylvania May, 1979

temperature, carbon dioxide levels and alkalinity⁹. This concept is significant in that an effluent containing heavy metals which is apparently not toxic at the point of discharge can become acutely toxic when introduced into a receiving water of different physical and chemical characteristics. In addition, where two or more heavy metals are combined in solution the toxicity of the resulting mixture is not always predictable and may be additive, synergistic or antagonistic.

The susceptibility of fish to heavy metals poisoning differs between species and individual groups within the same species. In general, younger and smaller or physically stressed fish have lower resistance to heavy metals poisoning. Conversely, fish acclimated to high sub-lethal concentrations of metals may show greater resistance to toxic levels of the same metals. Exposure of fish to toxic levels of heavy metals usually results in gill damage through precipitation of mucous and or cytological damage. The major physiological change preceding death appears to be tissue hypoxia which occurs once the gas exchange process at the gills is no longer sufficient to supply the oxygen requirements of the fish¹⁰.

Outfall 001 was mildly toxic to rainbow trout (96-hour LC_{50} = 88%). Chemical analyses of the 001 effluent revealed the presence of Fe, Mn, Zn, Pb, Cd, and As [Table 32]. Only dissolved zinc and cadmium, averaging 0.87 mg/l and 0.06 mg/l, respectively, were present in potentially toxic concentrations [Tables 33 and 34].

The initial 24-hour exposure resulted in 85% mortality of test fish in undiluted 001 effluent [Table 35]. No further mortalities were recorded at this concentration in the 96-hour test. A 15% kill occurred in the 75% effluent concentration between 48 and 96 hours. The initial rapid mortality in the undiluted effluent and subsequent survival of the remaining test fish indicated that some additional stress, other than heavy metals exposure, occurred during the first

24-hour test interval. Continuous flow pH data for Outfall 001 show that between approximately 1930 and 2100 on May 12, the pH exceeded 9.0 (maximum 11.1) for approximately 61 minutes [Table 24]. The total alkalinity of Outfall 001 averaged 39 mg/l as CaCO_3 during the 96-hour test [Table 36]. Water of such low alkalinity will generally have a poor buffering capacity. A laboratory test using soft water (approximately 35 mg/l CaCO_3) showed that addition of as little as 10% of pH 11 solution to dilution water of pH 6.7 resulted in a mixture pH of 8.9 [Figure 22]. A 15% addition resulted in a mixture of pH 9.5. The diluter system was calibrated to deliver approximately 15% additions to the test chambers every 18 minutes. Short exposure to pH 9.5 would probably not by itself be lethal to rainbow trout [Figure 22]. However, a rapid change of pH from 7 to 9.5 would induce stress on the fish making them more susceptible to other toxicants. The ultimate toxicity of Outfall 001 probably is due to heavy metals toxicity; however, the initial rapid kill probably resulted as a combination of metals toxicity and physical stress induced by excessive pH variation.

While the bioassay of Outfall 001 indicated this effluent is only moderately toxic, consideration must be given to the possibility that the toxicity tests were performed under atypical operating conditions. The 96-hour testing period for this Outfall occurred after a portion of the East Plant had been shut down. Samples taken before and after the shutdown showed the average concentration of metals in this effluent were reduced from 52 to 90% [Table 21]. Additionally, pH variation was also significantly reduced during the testing period. For instance: pH excursions greater than 9 averaged 406 minutes/24-hour period for the four days period prior to bioassay testing as compared for the first 72 hours after the test began [Table 24]. These factors indicate that Outfall 001 is considerably more toxic under normal operating conditions.

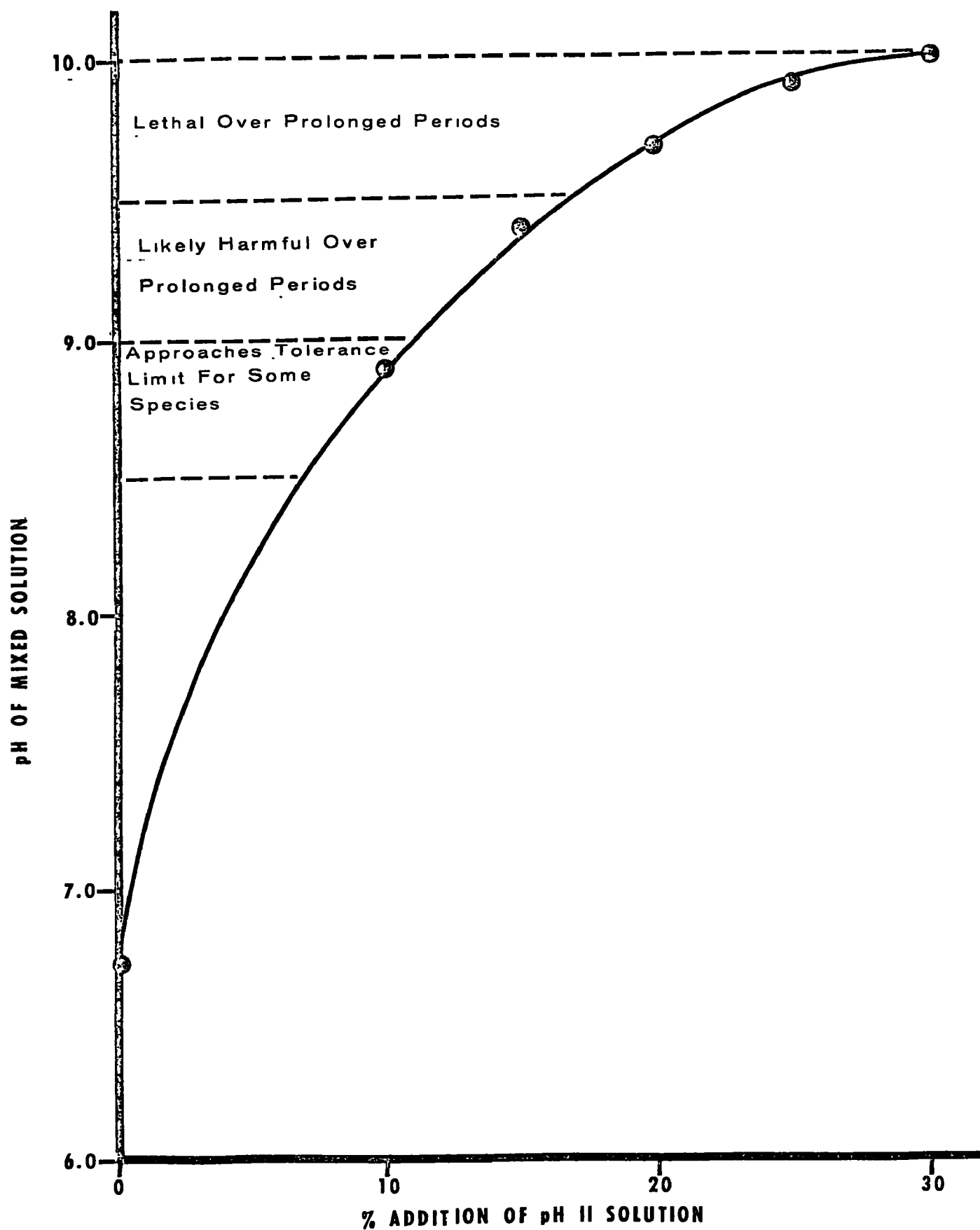


Figure 22. Effect of pH 11 Solution Addition on Reconstructed Soft Water
Total Alkalinity 35 mg/l Ca Co₃

Chemical analysis of Outfall 011 during the exposure period showed the effluent contained Mn, Zn, Pb, Cd, and As [Table 32]. As with Outfall 001, only dissolved zinc and cadmium were present at acutely toxic concentrations averaging 59 mg/l and 0.71, respectively, in the undiluted effluent [Table 32]. At the calculated LC_{50} concentrations of 1.1% effluent, these values extrapolated to 0.68 mg/l zinc and 0.008 mg/l cadmium [Table 37]. Both cadmium and zinc have been shown to be acutely toxic to rainbow trout in this range [Table 34]. Daily monitoring for pH, temperature, and dissolved oxygen concentration showed vital physical and chemical characteristics in all test chambers were adequate for fish survival [Table 38].

Fish mortalities at effluent concentrations greater than 3.2% were rapid, and no test fish survived 24-hours exposure. At effluent concentrations down to 0.56%, mortalities continued to occur throughout the 96-hour exposure decelerated rates [Table 39]. Regardless of the concentration, behavioral characteristics of stricken fish were similar. The initial response was general lethargy accompanied by slow swimming near the surface interrupted by brief periods of erratic swimming patterns. Preceding death, fish remained immobile at the bottom of the test chamber, exhibiting rapid gill movement. These symptoms are consistent with general anoxia of heavy metals poisoning. Although no mortalities were observed at the 0.32% effluent concentration, after 96-hours of exposure some test fish became lethargic indicating this effluent is probably toxic at 0.32% concentration for exposures greater than 96-hours.

In the toxicity tests of Outfalls 001 and 011 zinc and cadmium were identified at acutely toxic concentrations in both discharges [Tables 33 and 32]. Aside from a small variation in alkalinity [Tables 36 and 38], the physical and chemical characteristics at test dilutions were similar. It would, therefore, be expected that the toxic effect of zinc and cadmium would also be similar. To test this

hypothesis, the data from both bioassays were pooled and a linear regression done plotting percent mortality vs. mg/l dissolved zinc and cadmium. Results showed a correlation coefficient for mortality vs. zinc concentration to be 0.89 and for cadmium 0.12. This indicates a high probability exists for a relationship between dissolved zinc concentration and mortality, and virtually no correlation for dissolved cadmium. The data were then subjected to probit analysis for dissolved zinc concentration vs. mortality. The resulting 96-hour LC_{50} was calculated to be a dissolved zinc concentration of 0.73 mg/l [(95% fiducial limits 0.64 to 0.85 mg/l) Table 40, Figure 23]. The extrapolated zinc concentration for 001 and 011 at their respective 96-hour LC_{50} dilutions were 0.76 mg/l and 0.68 mg/l, well within the confidence limits of the pooled data. These calculations strongly indicate that zinc was the principle toxicant in Outfalls 001 and 011 and cadmium had little or no toxic influence. It also indicates that the combination of cadmium with zinc had no synergistic or additive effect on toxicity.

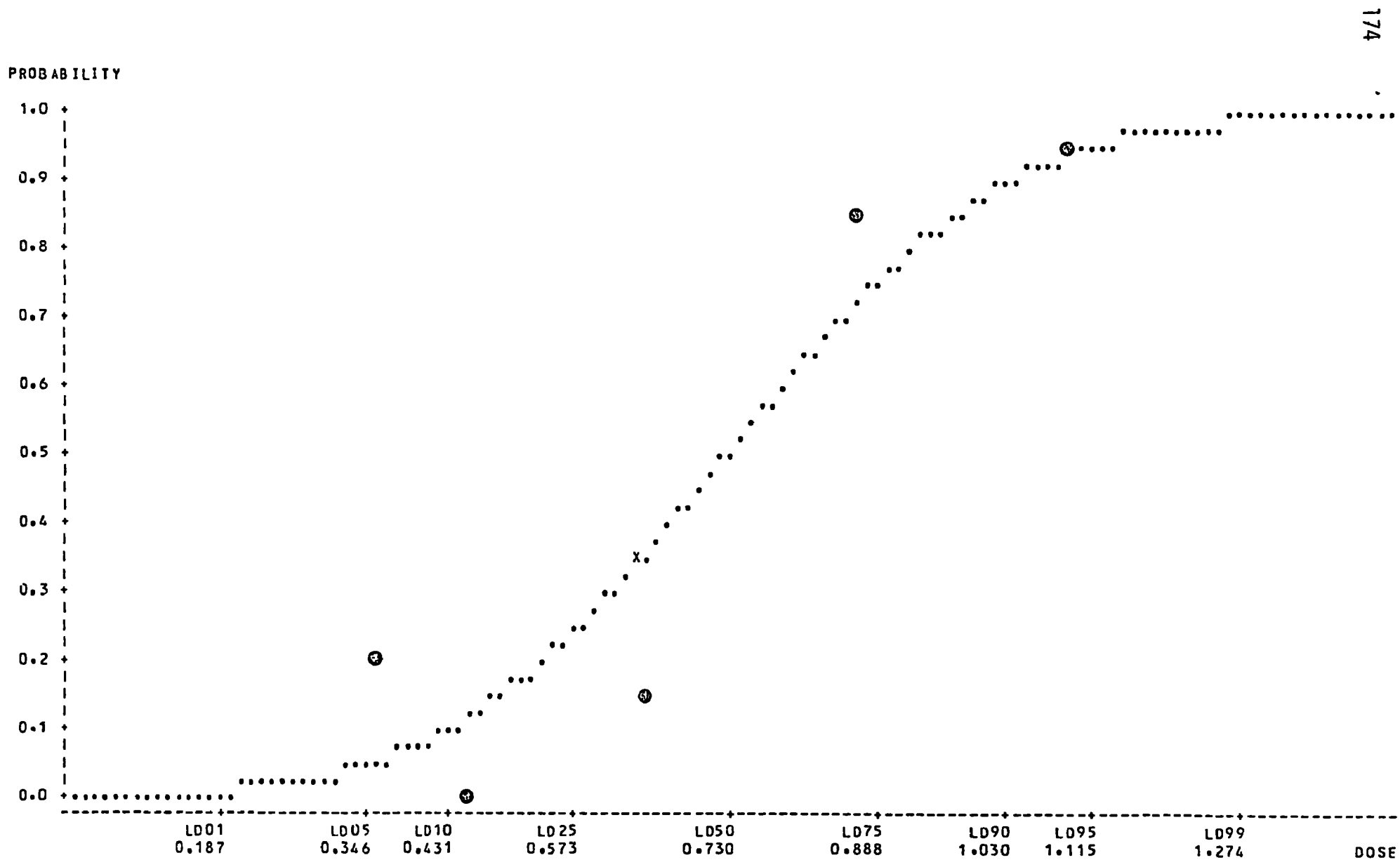


FIGURE 23. Probit Analysis on Dose. New Jersey Zinc-East Plant Outfall 001 and 011.
Palmerton, Pennsylvania, May, 1979.

VI. ASSESSMENT OF BEST MANAGEMENT PRACTICES

BEST MANAGEMENT PRACTICES DEFINED

The Environmental Protection Agency has been authorized by the Clean Water Act (CWA) of 1977 to develop Best Management Practices (BMP) for industrial facilities discharging wastewaters to the nation's receiving waters. Section 402(2)(1) of the CWA allows EPA to impose NPDES permit conditions considered necessary for compliance with provisions of the act. Four general ancillary industrial sources are identified in Section 304(3) as subject to BMPs: plant-site runoff, spills or leaks, sludge or waste disposal, and raw-material drainage. Through the inclusion of BMP for ancillary industrial sources in the NPDES permitting requirements, EPA can control the discharge of toxic and hazardous substances from the total plant-site as well as from discrete outfalls.¹

BMP is subdivided into two groups, base-line and advanced. The base-line BMP should be applicable to all ancillary sources of toxic chemicals for all industry groups. These require human commitments and procedural actions such as material inventory and compatability, employee training, spill reporting, preventive maintenance, good house-keeping and security.

The advanced BMPs have been related to five ancillary sources: material storage areas; in-plant transfer areas, process areas, and material handling areas; loading and unloading operations; plant site runoff; and sludge and hazardous waste disposal areas.

* "Best Management Practices for Control of Toxics and Hazardous Materials," Stowe, C.W., Cleary, J.G. and Thorn, H.M. Jr., Paper Presented at Purdue Industrial Waste Conference, May 8-10, 1979.

NEED FOR BMP AT PALMERTON

On January 12, 1977, the Administrator established effluent guidelines for six toxic pollutants, and on January 31, 1978 published the list of "65 toxic pollutants" recognized in NRDC V Train. Included in the list are cadmium and compounds, lead and compounds, and zinc and compounds. The data from the NEIC survey show that lead, zinc and cadmium are discharged to Aquashicola Creek and Lehigh River from refining processes, the Cinder Bank, Blue Mountain, raw material storage and handling areas, and the storage area for sludge from the wastewater treatment plant. The data also show that the majority of the toxic pollutants discharged to the Creek are from sources other than the NPDES regulated Outfalls.

The Company has been aware of the problems for many years, but has not pursued a comprehensive program to correct all of the problems. If the compounds were being discharged primarily from process Outfalls and emitted from the stacks, treatment systems could be installed to further reduce the pollutants. However, at Palmerton the reduction of the toxic materials requires total plant site control, therefore the inclusion of Best Management Practices is necessary.

Best Management Practices for Palmerton

The NEIC data show that the Aquashicola Creek is being degraded by the heavy metals from runoff, groundwater, and effluent discharges. The mortality of the fish exposed during the survey is attributed to the high zinc concentrations in the Creek water. Contamination of the shallow aquifer by zinc, cadmium and other metals was documented. Zinc was detected in the deep wells which might indicate that this aquifer is becoming contaminated. Corrective actions must be implemented to reduce the amount of contaminants released to the environment. The two most important actions to be implemented are control of runoff, and to reduce the amount of infiltration to the groundwater.

Runoff Control

The data show that about one-half of the zinc load in Aquashicola Creek originates between the Harris Bridge and Research Field Station Bridge. Approximately 90% of the cadmium and the remainder of the zinc load enters the creek downstream from the Research Field Station Bridge. The data also show that the Cinder Bank's seeps, and upstream of the Aggregates Bridge, contain high concentrations of zinc. Because there was no appreciable flow from seeps and springs between the Aggregates and Research Field Station Bridges, it was not determined if runoff was highly contaminated in this area. However, runoff contacting the raw material storage and handling areas, and the storage area for the sludge from the acid wastewater treatment plant, becomes highly contaminated with zinc. Therefore, all Cinder Bank runoff from precipitation, seeps, and springs east (upstream) of the Aggregates Bridge must be collected and conveyed to lined surface impoundments. The impounded runoff must be monitored; if the zinc and cadmium concentrations are greater than 5 and 0.5 mg/l, respectively, the impounded water must be treated to reduce the concentrations to these levels. (The zinc and cadmium concentrations are achievable by lime precipitation as specified in the Development Document and as demonstrated by the NJZ's wastewater treatment plant).

The two raw material storage areas and handling areas (east of the acid department and south of the railroad car unloading trestle) must either be lined to prevent infiltration and diked to contain contaminated runoff, or as an alternative, the raw materials may be stored inside a building. The area used for sludge storage must be lined and diked. Contaminated runoff inside the diked areas cannot be discharged unless the zinc and cadmium concentrations are 5.0 and 0.5 mg/l or less, respectively.

To treat the runoff, the Company must either expand the waste acid treatment plant or build another treatment facility. Because the waste acid treatment facility is currently overloaded, the system

should be expanded and sludge handling facilities incorporated to reduce volumes for disposal. The expansion of the facility should include capacity for the highly contaminated runoff. If an adequate settling and filtration system is installed, the treated water could be used in the plant to supplement the Aquashicola and Pohocopo Creek waters. According to Company personnel, the raw water supply systems are being used at maximum capacity.

Runoff from the plant site must be diverted around the raw material storage and handling areas and the sludge storage area. Diversion channels, ditches, and drains should be placed throughout the East Plant site to quickly remove runoff to the creek. All runoff should be monitored; if zinc and cadmium concentrations are greater than 5 and 0.5 mg/l, respectively, the runoff must be treated. In addition, the Company should re-evaluate the runoff drainage system and eliminate the sources of contamination. If, over a 3-month period, the monitoring shows that the zinc and cadmium concentrations are less than 5.0 and 0.5 mg/l, the Company should then request a relaxation of the monitoring requirements.

Control of the runoff from Blue Mountain can be achieved through two concurrent actions. First, all runoff must be isolated from the Cinder Bank by using channels, pipes, etc., to convey the water around the Cinder Bank to the Creek. Second, the amount of runoff can be reduced by restoring and maintaining the vegetation on Blue Mountain. Much of the water will be taken up by the vegetation, especially during the growing season. Water from seeps and springs should also be intercepted and monitored before being discharged to the Creek and before it contacts the Cinder Bank.

Infiltration Control

The amount of rainfall that enters the ground and penetrates to the groundwater table is influenced by many factors including permeability of the ground, turbidity of the water, nature of rainfall and

wetness of the soil, nature and growth of vegetation, geology of the area and slope. At Palmerton, the measure which can be implemented to reduce infiltration include vegetation, permeability, and slope modifications.

The raw material storage and handling areas are subject to heavy equipment movement. Impervious liners are required in these areas to prevent infiltration. Concrete pads or equivalent which can withstand heavy equipment may be constructed to prevent groundwater contamination; buildings could be constructed over the storage and handling areas as an alternative to collection and treatment of contaminated runoff.

The waste acid treatment plant sludge storage areas must be lined to prevent the water contained in the sludge from leaching into the groundwater. The contaminated water from the sludge contains high levels of zinc, cadmium, and other metals. Covering the area to prevent precipitation from reaching the sludge will not prevent the natural dewatering of the sludge. The storage area must be diked and all contained water treated.

The Cinder Bank contributes most of the contaminated flow to the groundwater. The Cinder Bank is permeable and covers a large area, it has unstable slopes which crack and allow channels into the groundwater; infiltration cannot be stopped. However, there are methods which can be used to reduce the amount of infiltration. The surface of the Cinder Bank is currently contoured in such a manner as to hold much of the rainfall. The Cinder Bank must be contoured to facilitate runoff and stabilize the area.

Hillside erosion is greater on the straight segments of slopes than on either convex or concave segments, therefore slopes of 4 to 1 with an S-shaped profile having as short a straight segment as possible, are preferred. The runoff should be collected in channels (which are

maintained) to remove the stormwater from the Cinder Bank to the surface impoundments. Water from seeps and springs should be conveyed to the runoff channels.

Ponding of water on top of the Cinder Bank must be eliminated to prevent the runoff from flowing down the face of the slope. This can be accomplished by constructing a dike or berm along the top edge and diverting the runoff to drainage channels.

Vegetation affects runoff and evapotranspiration of moisture from the surface, and the root zone. Obviously the effects are greatest during the growing season. The Company has initiated a revegetation program in inactive areas on Blue Mountain and the Cinder Bank, and proposes to test materials and procedures necessary to support the vegetation for the next five years. Revegetation of at least 20 acres will commence in 1981. The program should be accelerated and the amount of vegetation added annually should be increased. Revegetation of twenty acres/year will not solve the infiltration problem expeditiously. If the Company believes that five years will be required, then 1/5 of the Cinder Bank should be revegetated yearly. A compliance schedule should be included in the permit for the revegetation phase.

Revegetation of Blue Mountain and the Cinder Bank should not exceed 5 years. The areas can be seeded and planted to reduce contamination from the runoff infiltration and restore the natural beauty. The Company has been working with the Soil Conservation Service since 1976. Preliminary data indicate that there are grasses which will grow on Blue Mountain and Cinder Bank. The Company should be required to complete recontouring and revegetation by 1984.

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APPENDIX A

PENNSYLVANIA WATER QUALITY STANDARDS

PENNSYLVANIA WATER QUALITY STANDARDS

(Pennsylvania Code, Title 25 — Environmental Resources, Chapter 93 — Water Quality Standards; Adopted August 21, 1979; Effective October 8, 1979; Pending Approval by the U.S. Environmental Protection Agency)

§ 93.1. Definitions.

The following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise:

Ambient stream concentration — The range in concentration or level of a water quality parameter which would be expected to occur in the absence of human activities. The value is normally determined from quality measurements of waters that are not affected by waste discharges or other human activities.

Ambient temperature — The temperature of the water body upstream or outside of the influence of a heated waste discharge or waste discharge complex. The ambient temperature sampling point should be unaffected by any sources of waste heat.

Application factor — The ratio of the safe concentration to the 96-hour LC50 concentration which is assumed to be constant for related groups of chemicals and is multiplied by an LC50 value in order to produce the estimated safe concentration of a pollutant necessary to protect the balanced indigenous community in the receiving body of water.

Balanced community — A group of populations occupying a common area which consists of desirable species of fish, shellfish, and other wildlife, including the biota of other trophic levels which are necessary as part of the food chain or otherwise ecologically important to the maintenance of these populations.

Carcinogenic — Producing cancer.

Clean Streams Law — The Clean Streams Law (35 P. S. §§ 691.1-691.1001).

Clean Water Act — 33 U.S.C. §1251 *et seq.*

A-2 Cumulative pollutant — A pollutant which is measurably increased in concentration within aquatic organisms relative to concentrations in the receiving waters.

Daily average — The arithmetic average of all determinations made during a calendar month.

Daily determination — The arithmetic average of all determinations made during a 24-hour period.

Department — The Department of Environmental Resources of the Commonwealth.

Effluent limits — Any restriction established by the Department on quantities, rates, and concentrations of pollutants which are discharged into the waters of this Commonwealth.

Epilimnion — Warm upper layer of nearly uniform temperature in a stratified body of water, such as a lake or impoundment.

Existing potable water supply — A source of water supply which is presently being used by humans after conventional treatment for drinking, culinary and other purposes, such as inclusion in food products, after conventional treatment.

Existing sensitive industrial water supply — An existing industrial water supply use which would require installation of additional water treatment by the industrial user in the event that the total dissolved solids concentration instream exceeds 500 mg/l as a monthly average and 750 mg/l at any one time.

LC50 value — The concentration of a pollutant in test waters that is lethal to 50% of the test organisms during continuous exposure for a specified period of time.

Maximum allowable daily load (MDL) — The maximum amount of a pollutant from point and nonpoint sources which the receiving waters can assimilate at the accepted design stream flow without endangering the achievement of the water quality standards.

Mutagenic — Producing adverse changes in the genes.

Noncumulative pollutant — A pollutant which is not measurably increased in concentration within aquatic organisms relative to concentrations in the receiving waters.

Representative important species — Those species of aquatic life whose protection and propagation will assure the sustained presence of a balanced indigenous community. Such species are representative in the sense that maintenance of water quality criteria will assure both the natural completion of the species' life cycles and the overall protection and sustained propagation of the balanced indigenous community.

Safe concentration value — An estimated pollutant concentration as may be determined by the Department from relevant aquatic field studies, substantial available scientific literature, or bioassay tests tailored to the ambient quality of the receiving waters which will allow the survival of representative important species that have been chronically exposed to the concentration in the receiving waters.

State water plan — The reports, studies, inventories and plans prepared by the Department to guide the conservation, development, and administration of the Commonwealth's water and related land resources as authorized by 71 P. S. § 510-4.

Teratogenic — Producing monstrosities, malformations, or extreme deviations from the normal structure of life forms.

Test water — A receiving water directly upstream from a

waste discharge which is relatively unaffected by human activities, or a reconstituted water which approximates the ambient chemical characteristics of these receiving waters.

Total dissolved solids — The portion of the total residue of water capable of passing through a standard glass fiber filter — Reeve-Angel type 934A, 984H, Gelman Type A; or equivalent — and which remains after evaporation and drying to a constant weight at a temperature of 103°-105°C.

Water-quality-based effluent limitations — An effluent limitation based on the need to attain or maintain specific water quality criteria in order to assure protection of a designated use.

Water quality criteria — Levels of parameters or stream conditions that need to be maintained or attained to prevent or eliminate pollution.

Water quality standards — The combination of water uses to be protected and the water quality criteria necessary to protect those uses.

§ 93.2. Scope.

The provisions of this chapter set forth water quality standards for the waters of this Commonwealth. These standards are based upon water uses which are to be protected and shall be considered by the Department in its regulation of discharges.

§ 93.3. Protected water uses.

Water uses which shall be protected, and upon which the development of water quality criteria shall be based, are set forth, accompanied by their identifying symbols, in the following Table 1:

Table 1	
Symbol	Protected Use
Aquatic Life	
CWF	Cold Water Fishes — Maintenance and/or propagation of fish species including the family Salmonidae and additional flora and fauna which are indigenous to a cold water habitat.
WWF	Warm Water Fishes — Maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
MF	Migratory Fishes — Passage, maintenance and propagation of anadromous and catadromous fishes and other fishes which ascend to flowing waters to complete their life cycle.
TSF	Trout Stocking — Maintenance of stocked trout from February 15 to July 31 and maintenance and propagation of fish species and additional flora and fauna which are indigenous to a warm water habitat.
Water Supply	
PWS	Potable Water Supply — Use by humans after conventional treatment for drinking, culinary, and other purposes, such as inclusion into foods (either directly or indirectly).
IWS	Industrial Water Supply — Use by industry for inclusion into nonfood products, processing and cooling.
LWS	Livestock Water Supply — Use by livestock and poultry for drinking and cleansing.
AWS	Wildlife Water Supply — Use for waterfowl

	habitat and for drinking and cleansing by wild-life
IRS	<i>Irrigation</i> — Used to supplement precipitation for growing crops.
	<i>Recreation</i>
B	<i>Boating</i> — Use of the water for power boating, sail boating, canoeing, and rowing for recreational purposes when surface water flow or impoundment conditions allow.
F	<i>Fishing</i> — Use of the water for the legal taking of fish.
WC	<i>Water Contact Sports</i> — Use of the water for swimming and related activities.
E	<i>Esthetics</i> — Use of the water as an esthetic setting to recreational pursuits.
	<i>Special Protection</i>
HQ	<i>High Quality Waters</i> — A stream or watershed which has excellent quality waters and environmental or other features that require special water quality protection.
EV	<i>Exceptional Value Waters</i> — A stream or watershed which constitutes an outstanding national, state, regional or local resource, such as waters of national, state or county parks or forests, or waters which are used as a source of unfiltered potable water supply, or waters of wildlife refuges or state game lands, or waters which have been characterized by the Fish Commission as "Wilderness Trout Streams," and other waters of substantial recreational or ecological significance.
	<i>Other</i>
N	<i>Navigation</i> — Use of the water for the commercial transfer and transport of persons, animals and goods.

§ 93.4. Statewide water uses.

(a) Those uses set forth in the following Table 2 were considered in determining the water quality criteria applicable to the particular waters listed in section 93.9 of this title (relating to designated water uses and water quality criteria) except where otherwise indicated in such section.

Table 2

Symbol	Use
	<i>Aquatic Life</i>
WWF	Warm Water Fishes
	<i>Water Supply</i>
PWS	Potable Water Supply
IWS	Industrial Water Supply
LWS	Livestock Water Supply
AWS	Wildlife Water Supply
IRS	Irrigation
	<i>Recreation</i>
B	Boating
F	Fishing
WC	Water Contact Sports
E	Esthetics

(b) Less restrictive uses than those currently designated for particular waters listed in section 93.9 of this title (re-

lating to designated water uses and water quality criteria) may be adopted where it is demonstrated that:

(1) the existing designated use is not attainable because of natural background conditions,

(2) the existing designated use is not attainable because of irretrievable man-induced conditions; or

(3) application of effluent limitations for existing sources more stringent than those required pursuant to 33 U.S.C. § 1311, in order to attain the existing designated use, would result in substantial and widespread adverse economic and social impact.

§ 93.5. Application of water quality criteria to discharge of pollutants.

(a) The water quality criteria prescribed in this chapter for the various designated uses of the waters of this Commonwealth apply to receiving waters and are not to be necessarily deemed to constitute the effluent limit for a particular discharge, but rather one of the major factors to be considered in developing specific limitations on the discharge of pollutants. Where water quality criteria become the controlling factor in developing specific effluent limitations, the procedures set forth in section 95.3 of this title (relating to waste load allocations) will be employed.

(b) The accepted design stream flow, to which the water quality criteria as set forth in this chapter shall apply, is the actual or estimated lowest seven-consecutive-day average flow that occurs once in ten years for a stream with unregulated flow, or the estimated minimum flow for a stream with regulated flows, except where the Department determines that a more restrictive application is necessary to protect a particular designated or existing use. Where the lowest seven-consecutive-day average flow that occurs once in ten years is zero, the Department shall specify the design flow based on the identified or estimated flow at that point where a use identified in section 93.4 of this title (relating to statewide water uses) becomes possible.

(c) Where adopted water quality criteria as set forth in section 93.9 of this title (relating to designated water uses and water quality criteria) are more stringent than ambient stream concentrations of specific water quality indicators, such ambient stream concentrations shall be deemed to be the applicable criteria used to establish specific effluent limits.

(d) *(Reserved)*

(e) *(Reserved)*

§ 93.6. General water quality criteria.

(a) Water shall not contain substances attributable to point or nonpoint source waste discharges in concentration or amounts sufficient to be inimical or harmful to the water uses to be protected or to human, animal, plant or aquatic life.

(b) Specific substances to be controlled shall include, but shall not be limited to, floating debris, oil, grease, scum and other floating materials, toxic substances, pesticides, chlorinated hydrocarbons, carcinogenic, mutagenic and teratogenic materials, and substances which produce color, tastes, odors, turbidity, or settle to form deposits.

§ 93.7. Specific water quality criteria.

(a) Waters of this Commonwealth for which specific criteria have been established are listed in section 93.9 of this title (relating to designated water uses and water quality criteria).

(b) References to specific criteria in section 93.9 of this title (relating to designated water uses and water quality

criteria) shall be keyed to the list of specific criteria set forth in subsection (c) of this section and to the groups of criteria set forth in subsection (d) of this section.

quality criteria. Unless otherwise specified, the specific criteria concentration limits are for the total, rather than the dissolved, form of a substance

(c) The following Table 3 shall display the specific water

Table 3

<i>Parameter</i>	<i>Symbol</i>	<i>Criteria</i>
Aluminum	Al	Not to exceed 0.1 of the 96-hour LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters.
Alkalinity	Alk ₁	Equal to or greater than 20 mg/l as CaCO ₃ , except where natural conditions are less. Where discharges are to waters with 20 mg/l or less alkalinity, the discharge should not further reduce the alkalinity of the receiving waters.
	Alk ₂	Not less than 20 mg/l as CaCO ₃ .
	Alk ₃	Between 20 and 100 mg/l.
	Alk ₄	Between 20 and 120 mg/l.
Ammonia Nitrogen	Am ₁	Not more than 0.5 mg/l.
	Am ₂	Not more than 1.5 mg/l.
Arsenic	As	Not to exceed 0.05 mg/l.
Bacteria	Bac ₁	During the swimming season (May 1 through September 30), the fecal coliform level shall not exceed a geometric mean of 200 per 100 milliliters (ml) based on five consecutive samples each sample collected on different days; for the remainder of the year, the fecal coliform level shall not exceed a geometric mean of 2000 per 100 milliliters (ml) based on five consecutive samples collected on different days.
	Bac ₂	(Coliforms/100 ml) — Not more than 5,000/100 ml as a monthly average value, nor more than this number in more than 20% of the samples collected during any month, nor more than 20,000/100 ml in more than 5% of the samples.
	Bac ₃	(Coliforms/100 ml) — Not more than 5,000/100 ml as a monthly geometric mean.
	Bac ₄	(Fecal Coliforms/100 ml) — Maximum geometric mean of 770/100 ml; samples shall be taken at a frequency and location to permit valid interpretation.
	Bac ₅	The fecal coliform density in five consecutive samples shall not exceed a geometric mean of 200/100 ml.
Chloride	Ch ₁	Not more than 150 mg/l.
	Ch ₂	Not more than 250 mg/l.
	Ch ₃	Not more than 200 mg/l.
	Ch ₄	Maximum 15-day mean 50 mg/l.
Chromium	Cr	Not to exceed 0.05 mg/l as hexavalent chromium.
Color	Col ₁	Not more than 50 units on the platinum-cobalt scale; no other colors perceptible to the human eye.
	Col ₂	Not more than 75 units on the platinum-cobalt scale; no other colors perceptible to the human eye.
Copper	Cu ₁	Not to exceed 0.1 of the 96-hour LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters.
	Cu ₂	Not to exceed 0.1 mg/l.
Cyanide	CN	Not to exceed 0.005 mg/l as free cyanide (HCN + CN ⁻).
Dissolved Oxygen	DO ₁	Minimum daily average 6.0 mg/l; no value less than 5.0 mg/l. For lakes, ponds and impoundments only, no value less than 5.0 mg/l at any point.
	DO ₂	Minimum daily average 5.0 mg/l; no value less than 4.0 mg/l. For the epilimnion of lakes, ponds and impoundments, minimum daily average of 5.0 mg/l, no value less than 4.0 mg/l.
	DO ₃	Minimum daily average not less than 5.0 mg/l, during periods 4/1-6/15 and 9/16-12/31 not less than 6.5 mg/l as a seasonal average.
	DO ₄	Minimum daily average not less than 3.5 mg/l; during periods 4/1 - 6/15 and 9/16 - 12/31, not less than 6.5 mg/l as a seasonal average.
	DO ₅	For the period 2/15 to 7/31 of any year, minimum daily average of 6.0 mg/l, no value less than 5.0 mg/l. For the remainder of the year, minimum daily average of 5.0 mg/l, no value less than 4.0 mg/l.

	DO ₁	No value less than 7.0 mg/l.																										
Fluoride	F	Not to exceed 2.0 mg/l.																										
Hardness	Hd ₁	Maximum monthly mean 150 mg/l.																										
	Hd ₂	Maximum monthly mean 95 mg/l.																										
Iron	Fe	Not to exceed 1.5 mg/l as total iron; not to exceed 0.3 mg/l as dissolved iron.																										
Lead	Pb	Not to exceed the lesser of 0.05 mg/l or 0.01 of the 96-hour LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters.																										
Manganese	Mn	Not to exceed 1.0 mg/l.																										
Methylene Blue Active Substance	MBAS ₁	Not more than 0.5 mg/l.																										
	MBAS ₂	Not more than 1.0 mg/l.																										
Nickel	Ni	Not to exceed 0.01 of the 96-hour LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters.																										
Nitrite plus Nitrate pH	N	Not to exceed 10 mg/l as nitrogen.																										
	pH ₁	Not less than 6.0 and not more than 9.0.																										
	pH ₂	Not less than 6.5 and not more than 8.5.																										
	pH ₃	Not less than 7.0 and not more than 9.0.																										
	pH ₄	Not less than 6.0 and not more than 8.5.																										
Phenolics	Phen ₁	Not to exceed 0.005 mg/l.																										
	Phen ₂	Maximum 0.02 mg/l.																										
Phosphorus (Total Soluble as P)	P ₁	Not more than 0.03 mg/l.																										
	P ₂	Not more than 0.10 mg/l.																										
	P ₃	Not more than 0.13 mg/l.																										
Radioactivity	Rad	Alpha emitters, maximum 3 pc/l; beta emitters, maximum 1,000 pc/l.																										
Specific Conductance	SC	Not to exceed 3400 micromhos/cm at 25°C.																										
Sulfate	Sul	Not to exceed 250 mg/l.																										
Temperature	Temp ₁	No rise when ambient temperature is 58°F. or above; not more than 5°F. rise above ambient temperature until stream temperature reaches 58°F.; not to be changed by more than 2°F. during any one-hour period.																										
	Temp ₂	No rise when ambient temperature is 87°F. or above; not more than a 5°F. rise above ambient temperature until stream temperature reaches 87°F.; not to be changed by more than 2°F. during any one-hour period.																										
	Temp ₃	For the period 2/15 to 7/31, no rise when ambient temperature is 74°F. or above; not more than 5°F. rise above ambient temperature until stream temperature reaches 74°F.; not to be changed by more than 2°F. during any one-hour period; for the remainder of the year, no rise when ambient temperature is 87°F. or above; not more than a 5°F. rise above ambient temperature until stream temperature reaches 87°F.; not to be changed by more than 2°F. during any one-hour period.																										
	Temp ₄	Not to exceed the following temperatures in the month indicated:																										
		<table><tr><th>Month</th><th>Temperature, °F.</th></tr><tr><td>January</td><td>56</td></tr><tr><td>February</td><td>56</td></tr><tr><td>March</td><td>62</td></tr><tr><td>April</td><td>71</td></tr><tr><td>May</td><td>80</td></tr><tr><td>June</td><td>90</td></tr><tr><td>July</td><td>90</td></tr><tr><td>August</td><td>90</td></tr><tr><td>September</td><td>90</td></tr><tr><td>October</td><td>78</td></tr><tr><td>November</td><td>69</td></tr><tr><td>December</td><td>58</td></tr></table>	Month	Temperature, °F.	January	56	February	56	March	62	April	71	May	80	June	90	July	90	August	90	September	90	October	78	November	69	December	58
	Month	Temperature, °F.																										
	January	56																										
	February	56																										
	March	62																										
	April	71																										
May	80																											
June	90																											
July	90																											
August	90																											
September	90																											
October	78																											
November	69																											
December	58																											
Temp ₅	Not more than 5°F. above the average daily temperature during the 1961-66 period, which is shown below, or a maximum of 86°F., whichever is less.																											

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**Average Daily Temperature
1961-1966**
(Temperatures may be interpolated)

<i>Delaware Estuary, Head of Tide to River Mile 108.4 (about 1 mile below Pennypack Creek)</i>	<i>Delaware Estuary, River Mile 108.4 (about 1 mile below Pennypack Creek) to Big Timber Creek</i>	<i>Delaware Estuary, from Big Timber Creek to Pennsylvania Delaware State Line</i>
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Date	°F	°F	°F
January 1	37	41	42
February 1	35	35	36
March 1	38	38	40
April 1	46	46	47
May 1	58	58	58
June 1	71	71	72
July 1	79	79	80
August 1	81	81	81
September 1	78	79	78
September 15	76	77	76
October 1	70	70	70
November 1	59	61	60
December 1	46	50	50
December 15	40	45	45

Temp, Not more than 5°F. rise above the ambient temperatures until stream temperatures reach 50°F., nor more than 2°F. rise above ambient temperature when temperatures are between 50°F. and 58°F., nor shall temperatures exceed 58°F., whichever is less, except in designated heat dissipation areas.

Temp, As a guideline, the maximum length of heat dissipation areas shall not be longer than 3,500 feet measured from the point where the waste discharge enters the stream. The width of heat dissipation areas shall not exceed two-thirds the surface width measured from shore to shore at any stage of tide or the width encompassing one-fourth the cross-sectional area of the stream, whichever is less. Within any one heat dissipation area only one shore shall be used in determining the limits of the area. Where waste discharges are close to each other, additional limitations may be prescribed to protect stream uses. Controlling temperatures shall be measured outside the heat dissipation area. The rate of temperature change in the heat dissipation area shall not cause mortality of the fish.

Temp, As a guideline, the maximum length of heat dissipation areas shall not be longer than 3,500 feet or 20 times the average stream width, whichever is less, measured from the point where the waste discharge enters the stream. Heat dissipation areas shall not exceed one-half the surface stream width or the width encompassing one-half of the entire cross-sectional areas of the stream, whichever is less. Within any one heat dissipation area, only one shore shall be used in determining the limits of the area. Where waste discharges are close to each other, additional limitations may be prescribed to protect water uses. Controlling temperatures shall be measured outside the heat dissipation zone. The rate of temperature change in designated heat dissipation areas shall not cause mortality of the fish.

Temp, As a guideline, the maximum length of heat dissipation areas shall not be longer than 1,000 feet or 20 times the average width of the stream, whichever is less, measured from the points where the waste discharge enters the stream. Heat dissipation areas shall not exceed one-half the surface stream width or the width encompassing one-half of the entire cross-sectional area of the stream, whichever is less. Within any one heat dissipation area, only one shore shall be used in determining the limits of the area. Where waste discharges are close to each other, additional limitations may be prescribed to protect water uses. Controlling temperatures shall be measured outside the heat dissipation zone. The rate of temperature change in designated heat dissipation areas shall not cause mortality of the fish.

Threshold Odor Number	TON	Not more than 24 at 60°C.
Total Dissolved Solids	TDS,	Not more than 500 mg/l as a monthly average value; not more than 750 mg/l at any time.
	TDS,	Not more than 1,500 mg/l at any time.
	TDS,	Not to exceed 133% of ambient stream concentrations or 500 mg/l, whichever is less.
	TDS,	Not to exceed 133% of ambient stream concentration.
Turbidity	Tur,	Not more than 30 NTU during the period 5/30 — 9/15, nor more than a monthly mean of 40 NTU or a maximum of 150 NTU during the remainder of the year.
	Tur,	Maximum monthly mean 40 NTU, maximum value not more than 150 NTU.

Zinc	Tur,	Not more than 100 NTU.
	Tur,	For the period 5/15 — 9/15 of any year, not more than 40 NTU, for the period 9/16 — 5/14 of any year, not more than 100 NTU.
	Tur,	Maximum monthly mean of 10 NTU, maximum 150 NTU.
	Tur,	Maximum monthly mean of 20 NTU, maximum of 150 NTU.
	Tur,	Maximum monthly mean of 30 NTU, maximum of 150 NTU.
	Zn	Not to exceed 0.01 of the 96-hour LC50 for representative important species as determined through substantial available literature data or bioassay tests tailored to the ambient quality of the receiving waters.

(d) Unless otherwise specified in subsection (e) of this section and section 93.9 of this title (relating to designated water uses and water quality criteria), statewide specific criteria set forth in the following Table 4 shall apply to all surface waters of this Commonwealth:

Table 4

Symbol	Specific Water Quality Criteria
Al	Aluminum
Alk	Alkalinity,
As	Arsenic
Bac,	Bacteria,
Cr	Chromium
Cu,	Copper,
CN	Cyanide
F	Fluoride
Fe	Iron
Pb	Lead
Mn	Manganese
Ni	Nickel
N	Nitrite plus Nitrate
pH,	pH,
Phen,	Phenolics,
TDS,	Total Dissolved Solids,
Zn	Zinc

(e) The following Table 5 contains groups of specific water quality criteria based upon water uses to be protected. When the symbols listed below appear in the *Water Uses Protected* column in section 93.9 of this title (relating to designated water uses and water quality criteria), they have the meaning listed in the table below. Exceptions to these standardized groupings will be indicated on a stream-by-stream or segment-by-segment basis by the words "Add" or "Delete" followed by the appropriate symbols described elsewhere in this chapter.

Table 5

Symbol	Water Uses Included	Specific Criteria
WWF	Statewide list	Statewide list plus DO ₂ and Temp,
CWF	Statewide list plus Cold Water Fish	Statewide list plus DO ₂ and Temp,
TSF	Statewide list plus Trout Stocking	Statewide list plus DO ₂ and Temp,
HQ-WWF	Statewide list plus High Quality Waters	Statewide list plus DO ₂ and Temp,
HQ-CWF	Statewide list plus High Quality Waters and Cold Water Fish	Statewide list plus DO ₂ and Temp,
HQ-TSF	Statewide list plus High Quality Waters and Trout Stocking	Statewide list plus DO ₂ and Temp,
EV	Statewide list plus Exceptional Value Waters	Existing quality

(f) The list of specific water quality criteria does not include all possible substances that could cause pollution. For substances not listed, the general criterion that these substances shall not be inimical or injurious to the designated water uses applies. The best scientific information available will be used to adjudge the suitability of a given waste discharge where these substances are involved.

§ 93.8. Development of specific water quality criteria for the protection of aquatic life.

(a) When a specific water quality criterion has not been established for a pollutant in section 93.7(c), Table 3, or pursuant to section 93.7(f) of this title (relating to specific water quality criteria) and a discharge of a pollutant into waters of this Commonwealth designated to be protected for aquatic life in section 93.9 of this title (relating to designated water uses and water quality criteria) is proposed, a specific water quality criterion for such pollutant may be determined by the Department through establishment of a safe concentration value.

(b) Establishment of a safe concentration value shall be based upon data obtained from relevant aquatic field studies, standard continuous flow bioassay test data which exists in substantial available literature, or data obtained from specific tests utilizing one or more representative important species of aquatic life designated on a case-by-case basis by the Department and conducted in a water environment which is equal to or closely approximates that of the natural quality of the receiving waters.

(c) In those cases where it has been determined that there is insufficient available data to establish a safe concentration value for a pollutant, the safe concentration value shall be determined by applying the appropriate application factor to the 96-hour (or greater) LC50 value. Except where the Department determines, based upon substantial available data, that an experimentally derived application factor exists for a pollutant, the following application factors shall be used in the determination of safe concentration values:

(1) Concentrations of pollutants that are noncumulative shall not exceed 0.05 (1/20) of the 96-hour LC50.

(2) Concentrations of pollutants that are cumulative shall not exceed 0.01 (1/100) of the 96-hour LC50.

(3) Concentrations of pollutants with known synergistic or antagonistic effects with pollutants in the effluent or receiving water will be established on a case-by-case basis using the best available scientific data.

(d) Persons seeking issuance of a permit pursuant to the Clean Streams Law and 33 U.S.C. § 1342 authorizing the discharge of a pollutant for which a safe concentration value is to be established using specific bioassay tests pursuant to subsection (c) of this section shall perform such testing with the approval of the Department and shall submit the following in writing to the Department:

(1) A plan proposing the bioassay testing to be performed.

(2) Such periodic progress reports of the testing as may be required by the Department.

(3) A report of the completed results of such testing including, but not limited to, the following.

- (i) all data obtained during the course of testing, and
- (ii) all calculations made in the recording, collection, interpretation, and evaluation of such data.

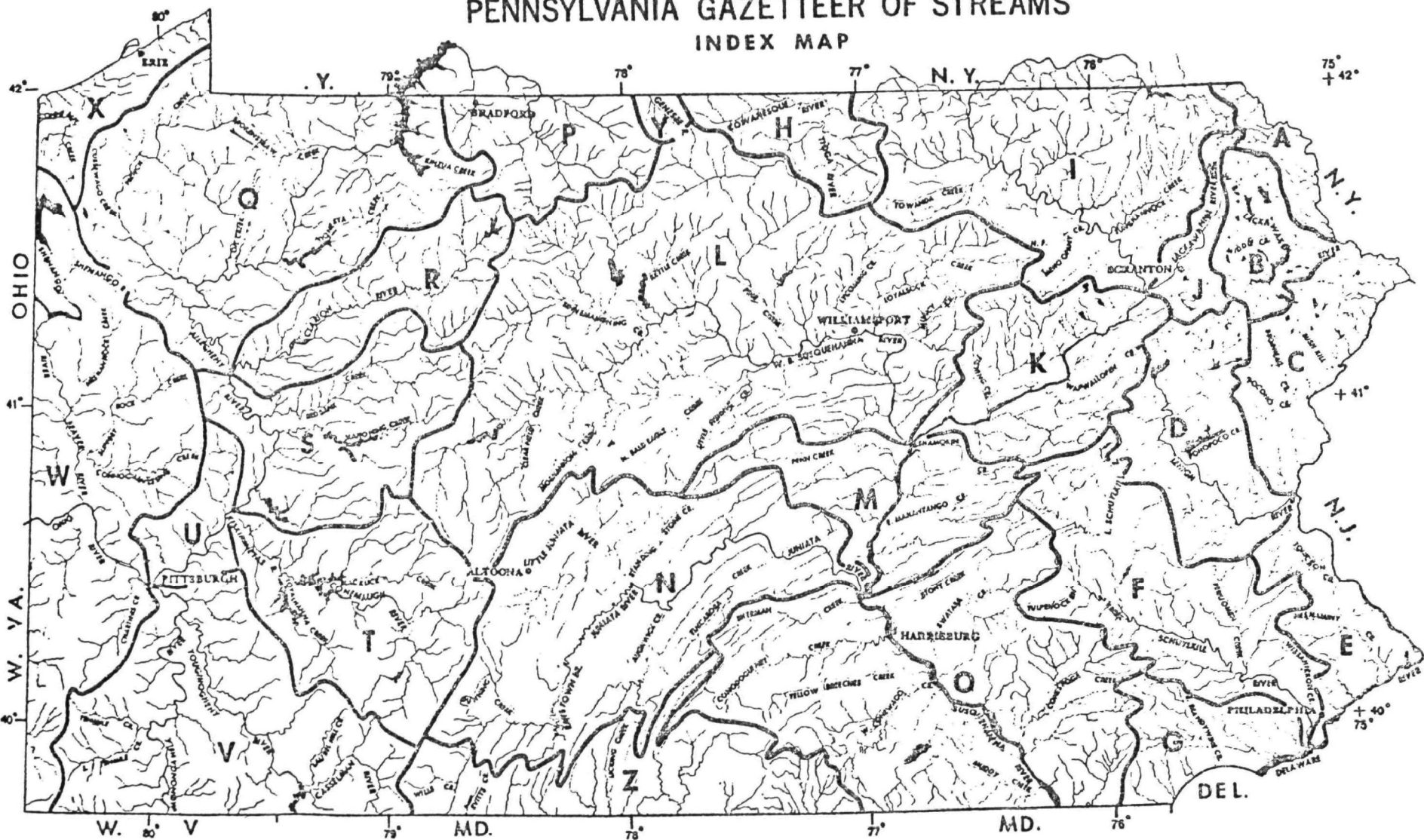
(e) Bioassay testing shall be conducted in accordance with the continuous flow methodologies outlined in EPA Ecological Research Series Publication, EPA-660/3/75-009, Methods of Acute Toxicity Tests with Fish, Macroinvertebrates, and Amphibians (April, 1975); Standard Methods for the Examination of Water and Wastewater (14th Edition); Standard Method of Test for ASTM D1345-59 (Reapproved 1970) and published in the 1975 Annual Book of

ASTM Standards — Part 31 — Water; or EPA Environmental Monitoring Series Publication, EPA-600/4-78-012, Methods for Measuring the Acute Toxicity of Effluents to Aquatic Organisms (January, 1978). Use of any other methodologies shall be subject to prior written approval by the Department. Test waters shall be reconstituted according to recommendations and methodologies specified in the previously cited references, or methodologies approved in writing by the Department.

§ 93.9. Designated water uses and water quality criteria.

The following tables shall display designated water uses and water quality criteria. The County column in Drainage Lists A through Z indicates the county in which the mouth of the stream is located.

PENNSYLVANIA GAZETTEER OF STREAMS INDEX MAP



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LIST D - CONTINUED

Stream	Town	County	Water Uses Protected	Exceptions To Specific Criteria
Delaware River				
Lehigh River				
Mud Run	Basin	Carbon	HQ-CWF	None
Buck Mountain Creek	Basin	Carbon	HQ-CWF	None
Drakes Creek	Basin	Carbon	HQ-CWF	None
Stony Creek	Basin	Carbon	EV	None
Penn Springs	Basin	Carbon	HQ-CWF	None
Black Creek	Basin, Source to Beaver Creek	Carbon	HQ-CWF	None
Black Creek	Main Stem from Beaver Creek to Lehigh River	Carbon	CWF	None
Unnamed Tributaries of Black Creek	Basins from Beaver Creek to Lehigh River	Carbon	HQ-CWF	None
Beaver Creek	Basin	Carbon	CWF	None
Quakake Creek	Basin, Source to Wetzel Creek	Carbon	HQ-CWF	None
Quakake Creek	Basin from and including Wetzel Creek to Black Creek	Carbon	CWF	None
Maple Hollow	Basin	Carbon	HQ-CWF	None
Bear Creek	Basin	Carbon	HQ-CWF	None
Nesquehoning Creek	Basin, Source to Lake Greenwood	Schuylkill, Carbon	HQ-CWF	None
Nesquehoning Creek	Main Stem from and including Lake Greenwood, Lake Hauto, and to and including Tibbetts Pond	Carbon	HQ-WWF	None
Unnamed Tributaries of Nesquehoning Creek	Basins, those Tributaries to Lake Greenwood, Lake Hauto and Tibbetts Pond	Schuylkill, Carbon	HQ-CWF	None
Swartz Run	Basin	Carbon	HQ-CWF	None
Grassy Meadow Run	Basin	Carbon	HQ-CWF	None
Bear Creek	Basin	Carbon	HQ-CWF	None
Nesquehoning Creek	Main Stem from Tibbetts Pond Dam to Lehigh River	Carbon	CWF	None
Unnamed Tributaries of Nesquehoning Creek	Basins from Tibbetts Pond Dam to Lehigh River	Carbon	HQ-CWF	None
Dennison Run	Basin	Carbon	HQ-CWF	None
Broad Run	Basin	Carbon	HQ-CWF	None
Deep Run	Basin	Carbon	EV	None
First Hollow Run	Basin	Carbon	EV	None
Jeans Run	Basin	Carbon	HQ-CWF	None
Robertson Run	Basin	Lehigh	HQ-CWF	None
Lehigh River	Main Stem from Route 903 Bridge at Jim Thorpe to Allentown Dam	Carbon, Lehigh	TSF	None

LIST D - CONTINUED

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Stream	Zone	County	Water Uses Protected	Exceptions To Specific Criteria
Delaware River Lehigh River				
Unnamed Tributaries of the Lehigh River	Basins from Route 903 Bridge at Jim Thorpe to Allen- town Dam	Carbon, Lehigh	CWF	None
Silkmill Run	Basin	Carbon	CWF	None
Mauch Chunk Creek	Main Stem, Source to Lehigh River	Carbon	CWF	None
Unnamed Tributaries of Mauch Chunk Creek	Basins, Source to Lehigh River	Carbon	CWF	None
White Bear Creek	Basin, Source to Route 902 Bridge	Carbon	EV	None
White Bear Creek	Basin from Route 902 Bridge to Mauch Chunk Creek	Carbon	CWF	None
Beaverdam Run	Basin	Carbon	CWF	None
Long Run	Basin	Carbon	CWF	None
Mahoning Creek	Basin	Carbon	CWF	None
Pohopoco Creek	Basin, Source to Wild Creek	Monroe, Carbon	CWF	None
Wild Creek	Basin	Carbon	EV	None
Pohopoco Creek	Basin from Wild Creek to Mouth	Carbon	CWF	None
Fireline Creek	Basin	Carbon	CWF	None
Lizard Creek	Basin	Carbon	TSF	None
Aquashicola Creek	Basin, Source to and including Buckwa Creek	Carbon	CWF	None
Aquashicola Creek	Main Stem from Buckwa Creek to Mouth	Carbon	TSF	None

APPENDIX B

ANALYTICAL METHODS

CHEMICAL ANALYSIS

Chemical analyses were performed employing methods approved by the EPA for the NPDES program (40 CFR 136, Federal Register, Dec. 1, 1976). Some metal analyses were performed utilizing Inductively Coupled Argon Plasma Atomic Emission Spectroscopy (ICAP-AES). Although the ICAP-Argon method is not as yet approved for the NPDES program, the analysis did adhere to the proposed EPA method. When ICAP-AES data was reported, comparability to the NPDES methods was proven. The references to the methods for each parameter are listed below.

Parameter	Technique	Reference*
Oil and Grease	Separatory Funnel Extraction	A, Method 413.1
TSS	Glass-Fiber Filter Filtration	A, Method 160.2
Aqueous Metals	Flame Atomic Absorption Spectroscopy	A, Methods, 200.0 213.1, 220.1, 236.1, 239.1 243.1, 289.1
	Flameless Atomic Absorption Spectroscopy	A, Methods, 200.0 206.2, 213.2, 220.2, 239.2, 245/1. 270.2, 282.2
	Inductively Coupled Argon Plasma-Atomic Emission Spectroscopy	B
Sediment Metals	Inductively Coupled Argon Plasma-Atomic Emission Spectroscopy	B, C

* A = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, 1979.

B = Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes Interim, U.S. EPA, EMSL, Cincinnati, OH, 1979.

C = "Digestion of Environmental Materials for Analysis by Inductively Coupled Plasma-Atomic Emission Spectrometry", N.R. McQuaker, D.F. Brown, and P.D. Kluckner, Anal. Chem. 51, 1082, 1979.

APPENDIX C

NJZ LABORATORY EVALUATION

Evaluation of New Jersey Zinc Laboratory, Palmerton, Pennsylvania

The subject laboratory was visited on November 29, 1978, to evaluate the procedures used to comply with the Plant's NPDES permit. Sample preservation and handling methods, laboratory facilities, equipment type and condition, analytical methods, quality control, record keeping procedures, consistency of laboratory records and Daily Monitoring Reports (DMR) data were evaluated. The laboraotry was requested to analyze reference samples to determine its ability to accurately perform the analyses required by its permit.

Mr. Cliff Brown is the laboratory supervisor, Cindy Hoch, Gene Able, Karen Everett and John Hunter perform the laboratory testing.

Summary of Findings and Conclusions

The lab was adequately equipped and organized; lab personnel were well trained and consciencious about their work. However, significant deviations from prescribed procedures were noted for the permitted parameters, i.e. pH, metals, TSS, cyanide and oil and grease. The quality control program at the New Jersey Zinc Lab was found to be minimal. Previously reported results should be viewed with respect to the findings of this inspection.

Findings

- 1) Sample Preservation and Containers - Recommended containers are being used. However, recommended holding times are not. Cyanide samples after preservation with NaOH are held up to 2 weeks before analysis even though the recommended holding time is 24 hours. As a result, previously reported cyanide values may be low. Also, oil and grease and TSS samples are not held at 40C prior to analysis in accordance with recommended procedures.
- 2) Laboratory Facility and Equipment - The laboratory equipment is adequate to perform the required testing with one possible exception: a low-temperature hot plate is used to evaporate the extract for the oil and grease procedure. It could not be determined within the time constraints of the inspection, whether this hot plate could provide adequate temperature control. The laboratory facility itself appears to be adequate. It does, however, have a potential dust problem during warmer months when windows to the outside are opened. Such a problem could have a profound effect on metals samples which are exposed to laboratory air for a period of time during concentration procedures.
- 3) Procedures - Procedures for the permitted parameters are acceptable with the following exceptions:
 - a. Reagent grade petroleum ether is used in the oil and grease procedure as opposed to 1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113). Filter paper was used but it should be rinsed at the end of the filtration step with small amounts of solvent or some of the oil and grease will be lost. Each sample volume

was measured with a graduated beaker; a more precise measuring device such as a graduated cylinder must be used in order to provide sufficiently accurate measurements.

- b. The distillation step has been omitted from the total cyanide procedure. The lab sites historically poor recovery for the method when distillation is included. The method usually is less than 100% efficient, however, distillation unless shown otherwise must be included to remove interferences.
- c. The pre-washing of filters is being omitted from the TSS procedure. Sample aliquots are measured in a beaker rather than a volumetric device of higher accuracy such as a graduated cylinder. Whatman GF/B filters are used in the determination; results may be slightly higher due to greater retentiveness of this filter media. The temperature of the drying oven at the time of inspection was 110°C while the procedure specifies 103 - 105°C; this can produce low results. Also, the drying time used was 1/2 hour as opposed to the required minimum of 1 hour; this could produce high results.
- d. There is an error in the trace metals determinations. Some of the metals samples were prepared by adding 5 ml of HNO₃ to 100 ml of sample and heating just to the point of boiling. Since the resulting sample is compared directly to standards made up to exact volumetric concentration, there is a resultant error of approximately 5% in the subsequent determination by direct aqueous aspiration into an atomic absorption spectrophotometer.
- e. pH measurements are performed using a HACH* wet method rather than an approved electrometric method.

4) Records - The laboratory record keeping system includes date and time of sampling but does not include the time of analysis. Also, the name of the analyst performing the tests is not always recorded.

Selected analyses were traced through various levels of laboratory documentation. In all cases, numerical values were found to be consistent.

5) Quality Control - The laboratory quality control program is minimal. Laboratory personnel stated that duplicate samples were analyzed only occasionally for metals parameters; blanks were analyzed each time analyses were performed, however; there was no record of either. Duplicates and blanks were not being analyzed for TSS. Mr. Brown is currently instituting a program whereby "blind" samples will be analyzed by the various analysts.

*HACH Chemical, Loveland, Colorado.

The balance used for TSS was last serviced in June, 1978, however, daily calibration checks are not being performed. The thermometer used in TSS determinations to monitor oven temperature was stated to have been calibrated at some time several years in the past, but no record was available.

Check Samples

The performance check sample results were within acceptable limits.

Check Sample Results

<u>Parameter</u>	<u>True Value</u>	<u>Reported Value</u>
Cd	10 ug/l	13 ug/l
Cd	70 "	78 "
Fe	50 "	62 "
Fe	900 "	960 "
Mn	55 "	55 "
Mn	500 "	545 "
Pb	80 "	84 "
Pb	400 "	416 "
Zn	60 "	55 "
Zn	400 "	383 "
Oil and Grease	28 mg/bottle	25 mg/bottle
TSS	70 mg/l	72 mg/l

Required Changes*

- a. Freon 113 must be used as the extracting solvent for the oil and grease procedure. Further, for this procedure a steam bath or more precisely controlled hot plate, and more accurate sample measurement devices must be used in the procedure.

*Note, where discrepancies exist, the lab must either modify its present practice to conform with 40 CFR 136 or obtain formal approval for alternate methods.

- b. Cyanide samples must be distilled before the determination. Further, they must be analyzed as soon as possible after collection to insure reliable results.
- c. TSS sample aliquots must be more accurately measured than was being done at the time of inspection. The temperature of the drying oven must be maintained at 103 - 105°C and samples must be dried for a minimum of 1 hour. Constant weight checks as referenced in Standard Methods, 14th ed. (1), must be performed.
- d. Metal samples and standards must be prepared equivalently so that volumetric concentrations are comparable.
- e. An electrometric method must be used to determine pH.
- f. Records must include date and time of sampling, time of analyses, and the identification of the analyst.

Recommended Changes

- a. The laboratory should verify that the excessive holding times used for cyanide samples do not lower results.
- b. Some means should be instituted to protect samples from dust during times when this is a problem in the laboratory.
- c. The quality control program should be upgraded to include the routine use of blanks, duplicates and standard additions with all parameters where applicable. The calibration of the analytical balance should be checked daily. The calibration of the thermometer should be re-verified. All quality control data should be documented.
- d. The DI system should be monitored to show that reagent water is of satisfactory quality for the testing.

References

- 1) Standard Methods for the Examination of Water and Wastewater, 14th ed., APHA-AWWA-WPCF.

APPENDIX D

BACKGROUND DATA

Table D-1
 INTAKE WATER QUALITY DATA^a
 NEW JERSEY ZINC COMPANY - EAST PLANT
 Palmerton, Pennsylvania
 May 1 - 15, 1979

Date May	Total Zinc	Total Cadmium	Total Lead	Total Iron	Total Manganese	Total Copper	TSS
Station 08 - Aquashicola Creek Intake							
2	1.2	0.031	0.01	0.14	0.20		7
3	1.4	0.02	0.02	0.21	0.23		6
4	1.2	0.015	ND	0.11	0.26		2
5	1.3	0.02	ND	0.18	0.21		2
6	0.95	0.015	0.01	0.14	0.24		2
9	0.88	0.02	0.01	0.20	0.20	ND	3
10	0.91	0.015	0.005	0.17	0.23	0.02	2
11	0.96	0.02	0.005	0.30	0.25	ND	3
12	0.78	0.015	0.02	0.20	0.21	ND	4
13	0.76	0.02	0.01	ND	0.21	ND	3
14	0.72	0.015	0.005	0.1	0.24	ND	3
15	0.67	0.01	0.01	0.23	0.17	ND	4
Station 09 - Pohopoco Creek Intake							
9	0.10 ^b	0.003 ^b	ND	0.18	0.06	ND	2
10	0.13	0.007	ND	0.46	0.19	ND	7
11	0.27	0.007	0.01	0.26	0.08	ND	3
12	0.12	ND	0.02	0.32	0.12	ND	2
13	0.10 ^c	0.003 ^c	0.03	0.19	0.07	ND	2
14	ND	ND	ND	0.17	0.05	ND	3
15	ND	ND	0.01	0.18	0.08	ND	3
Station 26 - Rolling Mill Industrial Water							
15	ND	ND	0.01	ND	0.08		

a All data corrected for sampler and analytical blanks.

b Samples collected on May 9 and 13 contained zinc and cadmium concentrations ten to fifty times greater than the concentrations on all other days. These values were judged invalid and were replaced with the average of the values from the other five days.

Table D-2
 OUTFALL 005 BACKGROUND WATER QUALITY DATA
 NEW JERSEY ZINC COMPANY - EAST PLANT
 Palmerton, Pennsylvania
 May 1 - 15, 1979

Parameter	Date May '79 → Sta. No. →	9			10	11	12	13	14	15
		06	07	Total	07	07	07	07	07	07
Flow m ³ /day NO ³ mgd		0.003	0.78	0.78	0.34	0.24	0.23	0.20	0.19	0.16
		0.0008	0.21	0.21	0.09	0.06	0.06	0.05	0.05	0.04
Total Zinc mg/l kg/day lb/day		3.4	1.2		1.0	1.1	1.1	1.0	1.1	1.1
		0.01	0.94	0.95	0.34	0.26	0.25	0.20	0.21	0.18
		0.02	2.1	2.1	0.75	0.57	0.55	0.44	0.46	0.40
Total Cadmium mg/l kg/day lb/day		0.066	0.015		0.016	0.006	0.016	0.015	0.007	0.015
		0.0002	0.012	0.012	0.0054	0.0014	0.0037	0.0030	0.0013	0.0024
		0.0004	0.026	0.026	0.012	0.003	0.008	0.007	0.003	0.005
Total Lead mg/d kg/day lb/day		0.01	ND		0.07	ND	0.01	ND	ND	ND
		0.03 ^b	0	0.03 ^b	0.024	0	0.002	0	0	0
		0.001 ^c	0	0.001 ^c	0.053	0	0.004	0	0	0
Total Copper mg/l kg/day lb/day		0.02	ND		ND	ND	ND	ND	ND	ND
		0.06 ^b	0	0.06 ^b	0	0	0	0	0	0
		0.002 ^c	0	0.002 ^c	0	0	0	0	0	0
TSS mg/l kg/day lb/day		ND	5		5	8	7	4	6	5
		0	3.9	3.9	1.7	1.9	1.6	0.8	1.1	0.8
		0	8.6	8.6	3.7	4.2	3.5	1.8	2.4	1.8

a Flow at Stations 06 for one day only.

b grams/day

c ounces/day

Table D-3
MERCURY AND TIN SAMPLING DATA
NEW JERSEY ZINC - EAST PLANT
(Aquashicola Creek, Mill Creek and Lehigh River)
Palmerton, Pennsylvania

Station and Description		May ^a 1979	Mercury (mg/l) ^b	Tin (mg/l) ^c
01	Outfall 001	5/2 ^d	ND ^e	ND
02	Outfall 002	5/9 ^d	ND	ND
03	Outfall 003	5/8 ^f	ND	ND
04	Outfall 004	5/9 ^d	ND	ND
05	Outfall 005	5/9 ^d	ND	ND
06	005 Background 1	5/9 ^d	ND	ND
07	005 Background 2	5/9 ^d	ND	ND
08	Aquashicola Creek Intake	5/2 ^d	ND	ND
09	Pohopoco Creek Intake	5/9 ^d	ND	ND
10	Outfall 010	5/9 ^d	ND	ND
11	Outfall 011	5/9 ^d	ND	ND
12	Outfall 012	5/8 ^f	ND	ND
14	Outfall 014	5/8 ^f	ND	ND
15	Outfall 015	5/8 ^f	ND	ND
16	Outfall 017	5/8 ^f	ND	0.018
17	WWTP Influent	5/10 ^d	0.23	0.074
		5/12 ^d	0.16	-
		5/15 ^d	0.22	-
18	WWTP Effluent	5/10 ^d	ND	ND
19	Mill Creek	5/8 ^f	ND	ND
20	Aquashicola Creek at Tatra Inn Bridge	5/8 ^f	ND	ND
21	Aquashicola Creek at 6th Street Bridge	5/10 ^f	ND	ND
24	Aquashicola Creek at Field Station Bridge	5/8 ^f	ND	ND
25	Aquashicola Creek at Aggregates Bridge	5/9 ^f	ND	ND
27	Aquashicola Creek at Harris Bridge	5/8 ^f	ND	ND
28	Lehigh River below Aquashicola Creek	5/8 ^f	ND	ND
29	Lehigh River upstream of Aquashicola Creek	5/8 ^f	ND	ND
30	Lehigh River upstream of West Plant	5/8 ^f	ND	ND

a Dates for composite samples are dates on which the composite period ended; for grab samples, the dates are the sample collection dates.

b Mercury analyses by flame atomic absorption; detection limit is 0.005 mg/l.

c Tin analyses by flameless atomic absorption; detection limit is 0.001 mg/l.

d Indicates composite sample.

e ND means less than the detection limit.

f Indicates grab sample.