WATER POLLUTION CONTROL PRACTICES AT SEVEN MAJOR INDUSTRIAL PLANTS IN THE KANAWHA RIVER VALLEY OF WEST VIRGINIA

NATIONAL FIELD INVESTIGATIONS CENTER - CINCINNATI
AND
REGION III - PHILADELPHIA
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
JUNE 1974

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FOREWORD

Because the water quality of the Kanawha River in West Virginia drops dramatically during the course of its 97-mile flow, the U.S. Environmental Protection Agency conducted a series of investigations during the period January-March 1972 to identify the causative factors.

The major area of the investigations extended from the Kanawha's point of origin, the New and Gauley Rivers, to the Winfield Dam, about 32 miles from the Kanawha's juncture with the Ohio River (Figure 1). The Ohio was also sampled a few miles upstream and downstream from the mouth of the Kanawha to determine whether the water quality of the Ohio was being degraded by the Kanawha.

Since evidence indicated that the poor water quality of the Kanawha was attributable more to industrial waste discharges into it than to domestic wastes and surface water runoff, the investigators visited 40 plants that were discharging directly into the Kanawha. Their objective was threefold: (1) to find out if the plants were treating their wastewater before releasing it into the river; (2) if treatment was being provided, to determine the degree of pollutional reduction each industry achieved; (3) to establish what each plant needed to do so that their collective efforts would allow the dissolved oxygen in the Kanawha to meet the 4.0 mg/l level at the river's low flow of 1,930 cubic feet per second.

The Director of NFIC-Cincinnati wrote the plant managers before the survey started and asked that they help carry it out. He also requested that they provide information about the pollution abatement programs they had in effect and advised them that the data collected could be used in a Federal enforcement conference. During the investigations, NFIC-C personnel employed a "split" wastewater sampling procedure at each plant to provide a check on Federal, State, and company data. Each manager was subsequently given a draft copy of the investigators' report on his plant and was asked to comment on it.

The original objective of the survey was to produce a report that could be used as a basic document in an enforcement conference proceedings. However, with the passage of time and the Federal Water Pollution Control Act (PL 92-500) October 18, 1972, the focus of EPA's water pollution control activities shifted from calling

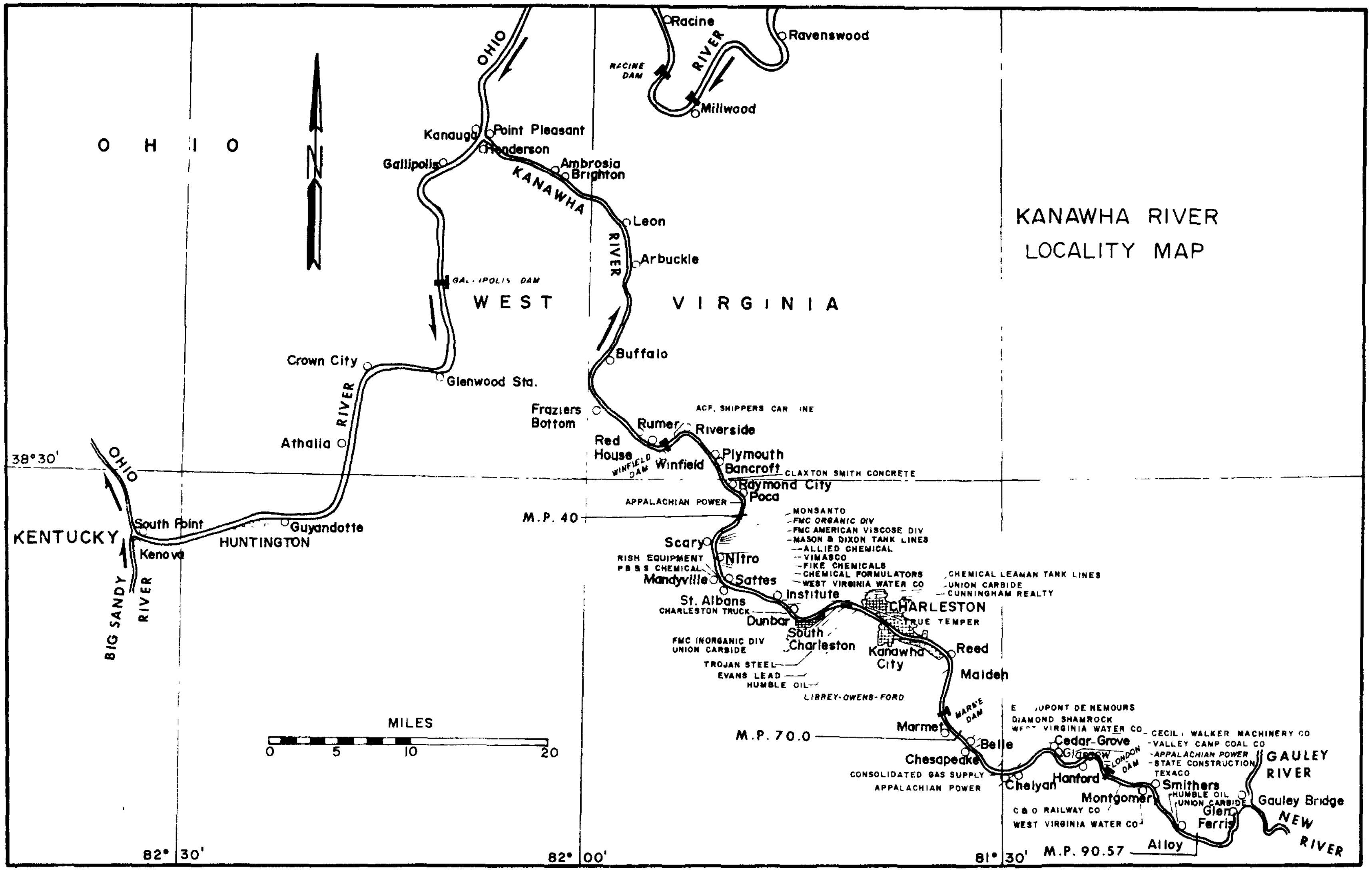

KANAWHA RIVER
LOCALITY MAP
OHIO
WEST VIRGINIA
KENTUCKY
OHIO
RIVER
KANAWHA
RIVER
BIG SANDY
RIVER
GAULEY
RIVER
NEW
RIVER
Racine
RACINE DAM
Millwood
Ravenswood
Kanauga
Point Pleasant
Henderson
Gallipolis
Ambrosia
Brighton
Leon
Arbuckle
GALLIPOLIS DAM
Buffalo
Crown City
Glenwood Sta.
Athalia
Fraziers Bottom
ACF, SHIPPERS CAR LINE
Rumer
Riverside
Red House
WINFIELD DAM
Winfield
Plymouth
Bancroft
CLAXTON SMITH CONCRETE
Raymond City
Poca
APPALACHIAN POWER
M.P. 40
South Point
Kenova
HUNTINGTON
Guyandotte
MONSANTO
FMC ORGANIC DIV
FMC AMERICAN VISCOSE DIV
MASON & DIXON TANK LINES
ALLIED CHEMICAL
VIMASCO
FIKE CHEMICALS
CHEMICAL FORMULATORS
WEST VIRGINIA WATER CO
Scary
Nitro
Sattes
Mandyville
St. Albans
Institute
CHARLESTON TRUCK
Dunbar
South Charleston
FMC INORGANIC DIV
UNION CARBIDE
TROJAN STEEL
EVANS LEAD
HUMBLE OIL
LIBBEY-OWENS-FORD
CHEMICAL LEAMAN TANK LINES
UNION CARBIDE
CUNNINGHAM REALTY
CHARLESTON
TRUE TEMPER
Kanawha City
Reed
Malden
MARMET DAM
Marmet
M.P. 70.0
Belle
Chesapeake
CONSOLIDATED GAS SUPPLY
APPALACHIAN POWER
DIAMOND SHAMROCK
Cedar Grove
Glasgow
LONDON DAM
Chelyan
Hanford
Montgomery
C & O RAILWAY CO
WEST VIRGINIA WATER CO
CECIL I. WALKER MACHINERY CO
VALLEY CAMP COAL CO
APPALACHIAN POWER
STATE CONSTRUCTION
TEXACO
Smithers
HUMBLE OIL
UNION CARBIDE
Glen Ferris
Gauley Bridge
Alloy
M.P. 90.57
MILES
0
5
10
20
38°30'
82° 30'
82° 00'
81° 30'

FIGURE I

enforcement conferences to establishing effluent guidelines and issuing individual discharge permit limitations. The report on these plants has not, therefore, been used in any enforcement conferences, but because of the basic information it contains, it has definite value in the permit program to help establish specific effluent limitations.

This volume presents data on and recommendations about the following seven major plants out of the total of 40 facilities visited:

E. I. du Pont de Nemours and Company at Belle
Union Carbide Corporation at South Charleston
Union Carbide Corporation at Institute
FMC Corporation, Inorganic Chemicals Division, at South Charleston
FMC Corporation, American Viscose Division, at Nitro
FMC Corporation, Organic Chemicals Division, at Nitro
Monsanto Company at Nitro

It should be noted that these field surveys represented only one phase of an information-gathering program that continued after the surveys had been completed. As a result, these reports contain information that updates certain situations that existed in early 1972. In these instances, the newer information appears in parentheses to separate it from the observations made or data recorded during the surveys.

The recommendations presented regarding effluent limitations for each plant are based on the information available at the time of each survey. Should Federal, State, or local regulations require a higher level of pollutional reduction, the recommendations presented shall not be used to avoid compliance with such requirements.

The State of West Virginia's Division of Water Resources participated in the investigations to the fullest extent possible, and its assistance is gratefully acknowledged.

INDEX

E. I. DUPONT DE NEMOURS AND COMPANY, INCORPORATED
BIOCHEMICALS DEPARTMENT
BELLE PLANT
BELLE, WEST VIRGINIA

General Plant Description

The plant is located on the right bank of the Kanawha River (facing downstream) about 10 miles southeast of Charleston at river mile point 68.5. The property stretches along the shore for just under one mile and covers approximately 104 acres (Figure A-1).

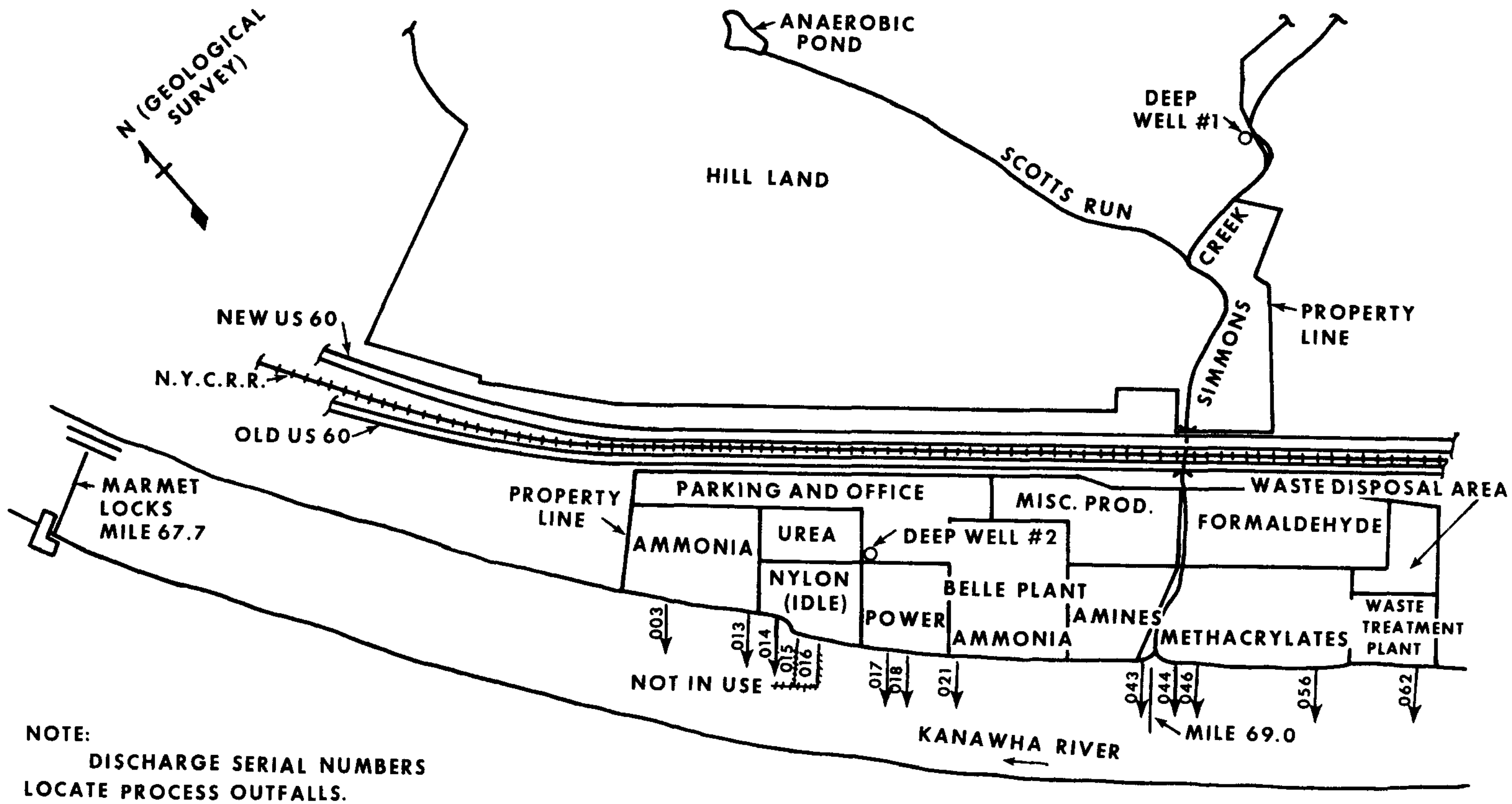
The plant went operational in 1926 and made one product - ammonia. In 1933, employment stood at 600 and at about 5,000 in the late 1940's. At the time of the survey, employees numbered approximately 1,700, and more than 30 chemicals were being manufactured, including ammonia, urea, ethylene glycol, methylamines, formaldehyde, and methacrylates. The plant was being operated 24 hours a day, seven days a week, and plant officials said that production varied little from season to season. The principal raw materials being used were natural gas, coal, air and water.

Water Usage

The plant was withdrawing about 175 million gallons a day (mgd) of water from the Kanawha and returning 98% of it untreated after using most of it as "non-contact" cooling water (Table A-1). Approximately 2.41 mgd were returned to the river after being processed in the wastewater treatment plant. Water usage had declined steadily from 95.4 billion gallons in 1967 to 61.1 in 1971.

Wastewater Discharges and Waste Sources

Wastewater was discharged into the Kanawha through 62 outfalls. Plant officials said that 49 handled cooling water, condensate, pump backflushes, and surface runoff, 10 discharged combined process wastes and cooling water, one was connected to the wastewater treatment plant, and two were inactive. Information on the 11 major outfalls is shown in Figure A-2, and the sources of process wastes sent to the wastewater treatment plant are listed in Figure A-3.



NOTE:
DISCHARGE SERIAL NUMBERS LOCATE PROCESS OUTFALLS.

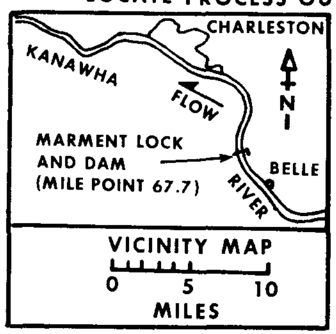


FIGURE A-1
GENERAL PHYSICAL LAYOUT
AND BELLE PLANT OUTFALL LOCATIONS

E.I. du Pont de Nemours & Co.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA
DECEMBER 4 1972

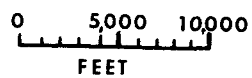


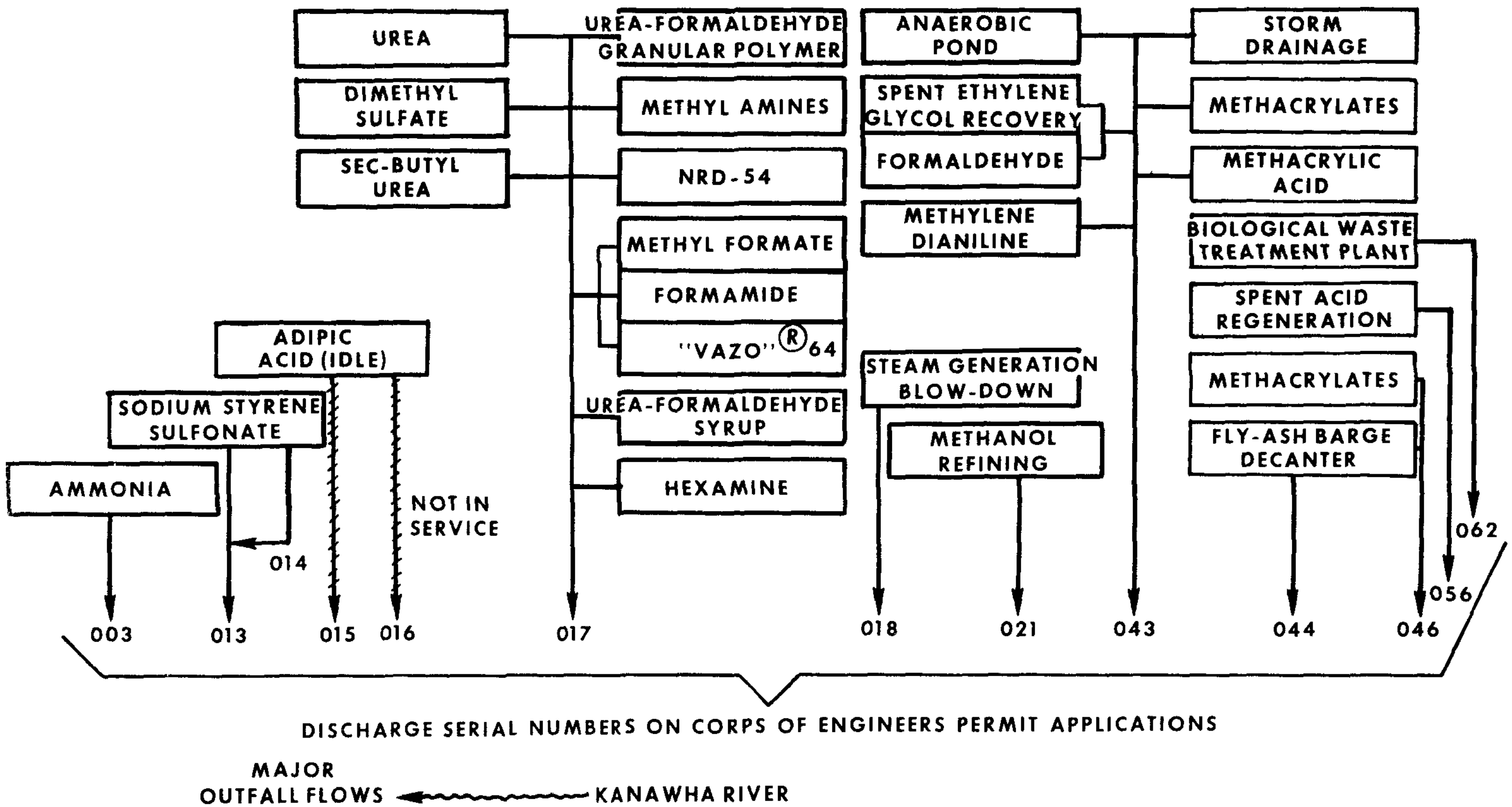
Table A-1

WATER USE AND DISPOSAL METHOD

E. I. duPont de Nemours and Company

Belle, West Virginia

Inlet Water Uses	Water Use (MGD)	Disposal Method				Process Mfgr. (MGD)
		River (MGD)	Treat (MGD)	Well (MGD)	Barge (MGD)	
Non-Contact Cooling	167	167				
Contact Cooling	.55		.55			
Boiler Feed	3.0	2.2				.8
Process	1.64		.55	.22	.03	.84
Fume Scrubbing	.22		.22			
Cleanup	.055		.055			
Fly Ash Sluicing	.055	.055				
Pump Backwash	1.92	1.92				
Sanitary	1.04		1.04			
TOTALS	175.3	171.0	2.41	.22	.03	1.64



MAJOR OUTFALL FLOWS

OUTFALL	FLOWS
003	47.95 mgd
013	1.30 mgd
014	0.29 mgd
017	58.75 mgd
018	0.01 mgd
021	2.05 mgd
043	21.02 mgd
044	0.05 mgd
046	1.08 mgd
056	9.94 mgd
062	2.39 mgd
TOTAL	144.83 mgd

E.I. du Pont de Nemours & Co.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.

FIGURE A-2
MAJOR DISCHARGE OUTFALLS TO KANAWHA RIVER

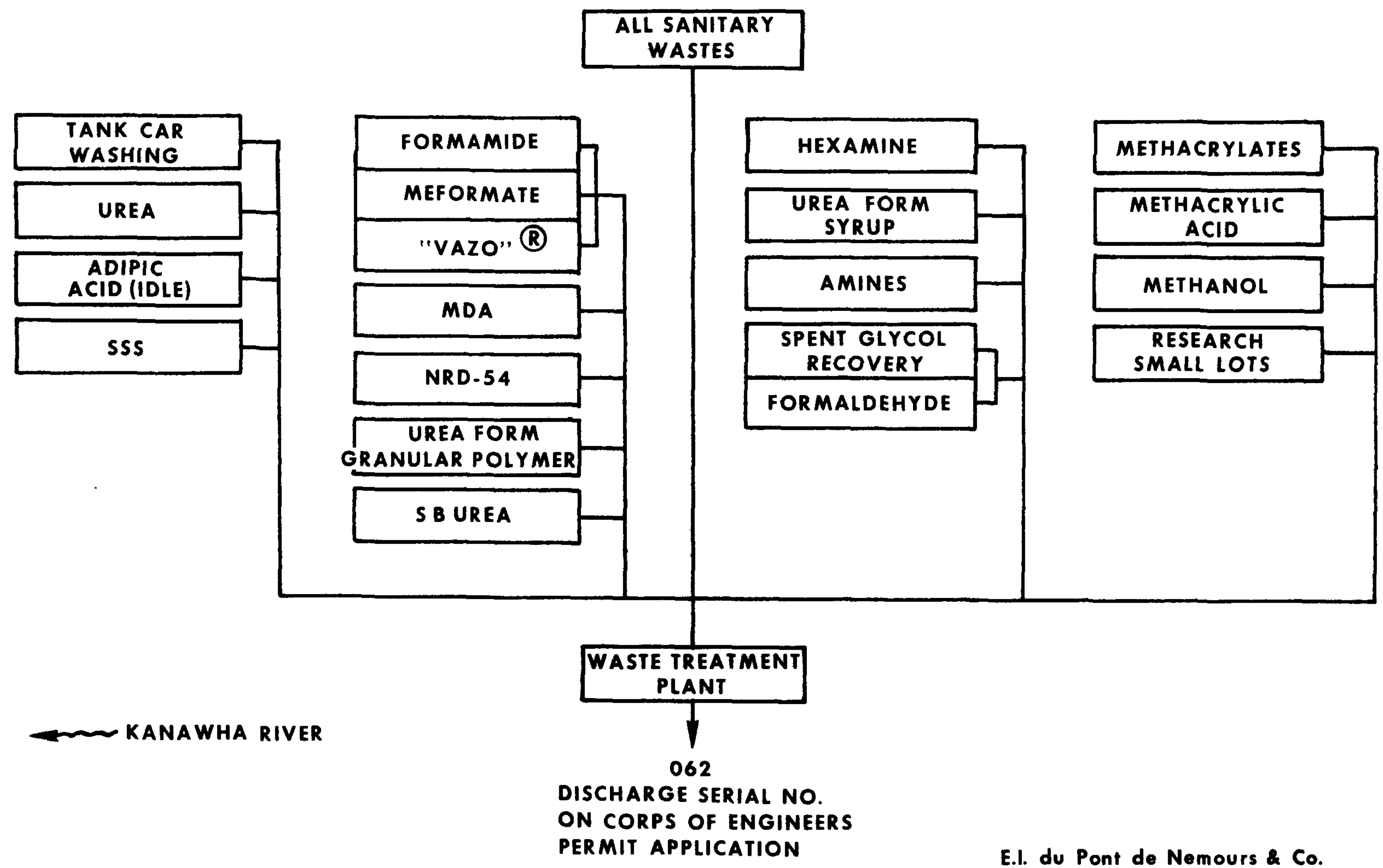


FIGURE A-3
PROCESS AND SANITARY
WASTE COLLECTION SYSTEM

E.I. du Pont de Nemours & Co.
BELLE PLANT
BELLE, KANAWHA COUNTY, W. VA.
FEBRUARY 25, 1972

Wastewater Treatment Program

Historical Development

DuPont began a waste-reduction program at the plant in 1945. Between then and 1972, the summertime five-day biochemical oxygen demand (BOD(5)) load discharged into the river was reduced from 350,000 pounds per day to less than 21,000. The wintertime load throughout the period was always higher than the summer load; at the time of the survey, it was about 40,000 pounds per day.

The waste-reduction program has covered four periods: 1945-1958; 1959-1964 (Phase I of the State's program); 1965-1972 (Phase II); and 1972 to present.

During the period 1945-1958, no waste treatment was provided, but the following pollution-control measures were implemented:

1. Calandrias were installed on open-bottom steam stills.

2. Refrigerated condensers were employed ahead of some vacuum jets.

3. Intermediate process steps were redesigned.

4. An ammonium sulphate recovery plant was built, and waste oil was incinerated.

5. Condensed organic vapors were oxidized catalytically.

6. Fly ash was collected and flushed to a pond.

7. Fly ash was removed by barges, and the fly ash pond was converted into a facility where organic wastes were digested anaerobically.

8. Liquid waste was incinerated.

9. Continuously operating automatic samplers were provided.

10. Wastes were impounded during summer and discharged into the river during high winter flows.

11. Natural gas rather than coal was used to process process gases.

12. A unit was installed in which volatile materials were decomposed thermally.

DuPont claims that by 1958 the summer BOD(5) load to the river had been reduced to 50,000 pounds per day as a monthly average.

The period 1959-1964 was dominated by the implementation of a pollution-control project to meet the State's Phase I program. In this phase, DuPont was directed to reduce the monthly BOD(5) average to 35,000 pounds per day. Company officials say that this requirement was met after the aerobic waste treatment plant went operational in 1961 and stricter process controls were initiated.

Early in the period 1964-1972, the discharge permit issued under the State's Phase II program stipulated that summer BOD(5) loads and total oxidizable nitrogen (TKN) could not exceed 21,000 and 28,000 pounds per day, respectively. The impounding of wastes for winter release to the river was to be discontinued.

DuPont says it complied with these conditions by:

1. Expanding the aerobic wastewater treatment plant.

2. Building a new ammonia production plant.

3. Replacing the ammonium sulphate facility with a spent-acid regeneration system that incorporates recovery and recycling.

4. Modifying powerhouse boilers so that they could burn liquid organic wastes.

5. Shipping salt brines to the Gulf of Mexico in barges.

6. Using deep wells, making process changes, and shutting down certain production facilities to eliminate impounding activities.

7. Phasing out nylon intermediate production and shutting down the thermal decomposition unit.

8. Discontinuing use of the catalytic oxidation unit after some production facilities were closed down.

9. Incorporating waste-control devices and procedures when new units were designed.

The company's loading data presented in Table A-2 indicate that the plant was generally meeting its Phase II permit conditions. The company attributed the higher BOD(5) and TKN values recorded during the winter to several factors:

1. The anaerobic and aerobic biological treatment facilities operate less efficiently at lower temperatures.

2. Maintenance of waste treatment equipment, hydrostatic testing of pressure vessels, and cleaning of equipment were performed during this period.

3. At times, some liquid had to be pumped out of the anaerobic pond because infiltrating ground water had raised the level too high.

In the fourth period, the company was to meet the requirements of the State's Phase III program, which was scheduled to be completed on December 31, 1972. The State advised the company of the general requirements in December 1969. One called for "85 percent and 65 percent reduction of the first and second-stage BOD(20), respectively," presumably of loads existing at that time. (In May 1972, the State advised DuPont that the daily BOD(5) and TKN loads could not exceed 15,000 and 18,000 pounds as monthly averages. An adjustment was being negotiated to allow higher values during cold weather. A compliance schedule was to be submitted to the State after all requirements were specified. The company expected that the aerobic waste treatment plant would have to be expanded to achieve compliance.)

Wastewater Handling System

(The wastewater handling devices and practices in use as of July 1972 were: (1) an aerobic wastewater treatment plant; (2) an anaerobic pond; (3) incineration; (4) powerhouse burning of liquid organic wastes; (5) fly ash barged to local landfill; (6) salt brine barged to the Gulf of Mexico; (7) deep-well disposal; (8) process modifications and operational controls; (9) daily monitoring.)

Deep-Well Disposal and Barging to Sea

Two deep wells were being operated under State permits. The first was issued in 1966 and authorized the drilling of a well to a depth of 1,500 feet. The second permit was obtained in 1967 for a well drilled to 5,400 feet; most of the liquid injected did not flow below 4,300 feet. Organics and brines incompatible with other

Table A-2

TOTAL COMBINED

DU PONT BELLE PLANT EFFLUENT LOADINGS - 1971
(COMPANY DATA)

	MONTHLY AVERAGE DISCHARGE - NET POUNDS/DAY			
MONTH	BOD_5	COD	NH_3N (as N)	TKN-N (as N)
JANUARY	27,200	90,300	23,000	32,000
FEBRUARY	20,900	90,400	21,800	33,000
MARCH	29,500	74,100	19,200	34,600
APRIL	40,000	66,200	21,500	27,300
MAY	30,800	52,000	15,700	23,200
JUNE	20,400	45,300	15,200	15,600
JULY	17,300	66,500	14,100	22,900
AUGUST	11,700	61,100	9,100	13,000
SEPTEMBER	19,900	37,200	11,600	21,000
OCTOBER	13,400	40,800	7,150	13,400
NOVEMBER	17,500	58,400	11,700	14,600
DECEMBER	20,400	49,800	9,750	14,600
Average	22,400	61,000	15,000	22,100

treatment systems were being discharged into the wells at a rate of about 220,000 gallons per day, according to the company (Table A-1). This would represent a BOD(5) load of 12,000 pounds.

Approximately 30,000 gallons of salt brine were collected each day, and the accumulations were periodically taken by barge to the Gulf of Mexico and discharged into at least 100 fathoms of water about 100 miles off the coast.

Wastewater Treatment System

The activated-sludge waste treatment plant had an efficiency of approximately 85% in summer and 75% in winter. A flow diagram appears as Figure A-4. The plant was designed to accept 30,000 pounds of BOD(5) per day but during peak loads handled up to 40,000.

About 6,000 pounds (dry weight) of sludge were pumped each day from the waste treatment plant to a seven-acre anaerobic digestion pond to be stabilized (Figure A-5). A 300,000-gallon reservoir was used to store and blend the wastes and adjust the pH. The desired quantities of phosphorous compounds were added as nutrients, and the wastes were fed to the pond at a controlled, continuous rate. The BOD(5) removal efficiency of this facility was approximately 80% in summer and 40% in winter. (The effluent was to be routed to the aerobic treatment plant beginning in 1972.)

Cooling Water

Non-contact cooling water (which could have contained pollutants) was discharged directly into the Kanawha at a rate of about 167 mgd. Approximately 550,000 gallons of contact cooling water were directed to the aerobic treatment plant each day.

Monitoring

The analyses conducted at the plant are listed in Figure A-6. An asterisk indicates characteristics reported to the State monthly or annually; abnormal discharges were also reported.

Efficiency

The total raw waste loads generated were not determined precisely, therefore the efficiencies presented in Table A-3 are estimates based on company data and values determined during the survey.

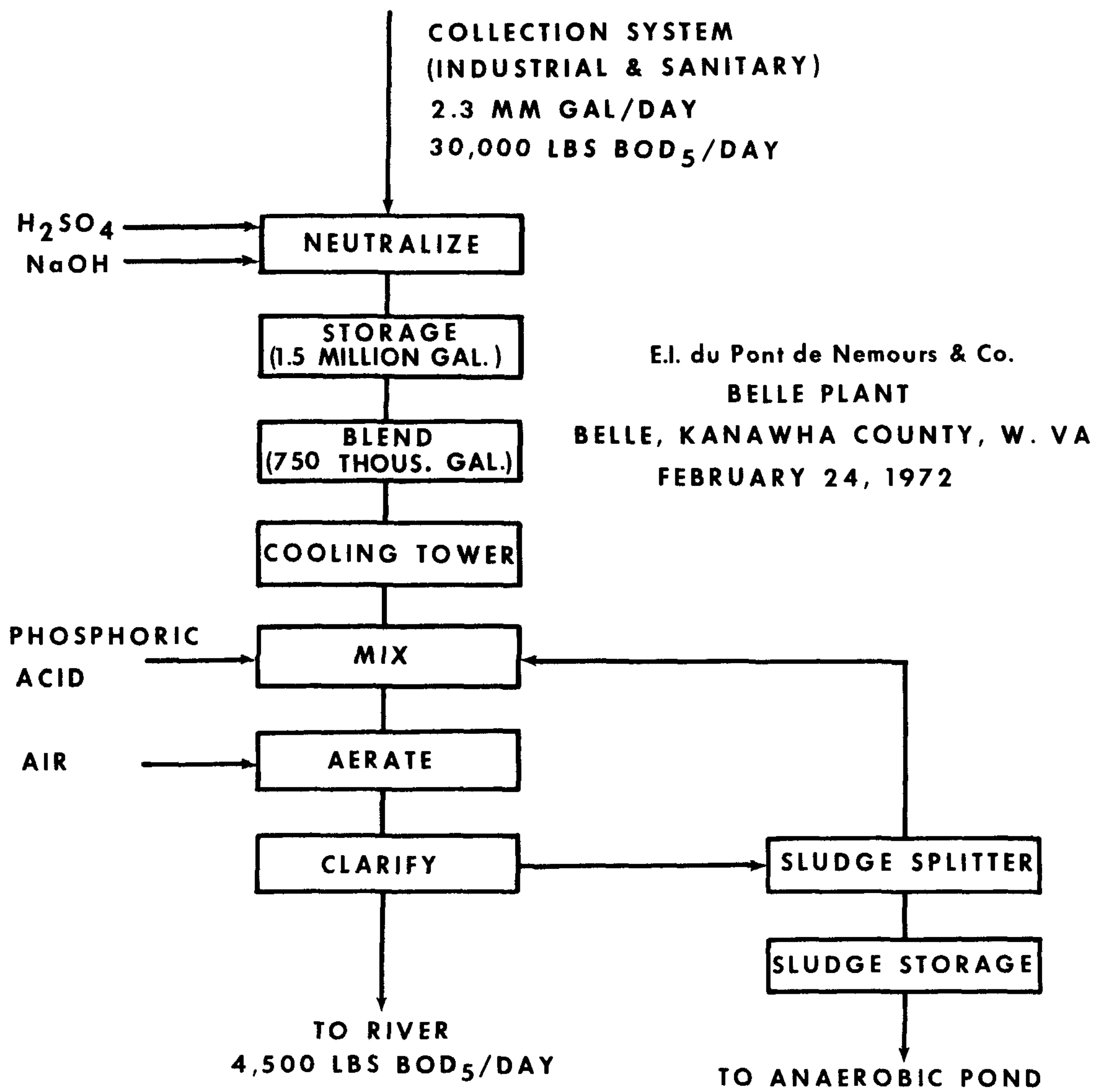


FIGURE A-4
**ACTIVATED SLUDGE
WASTE TREATMENT PLANT**

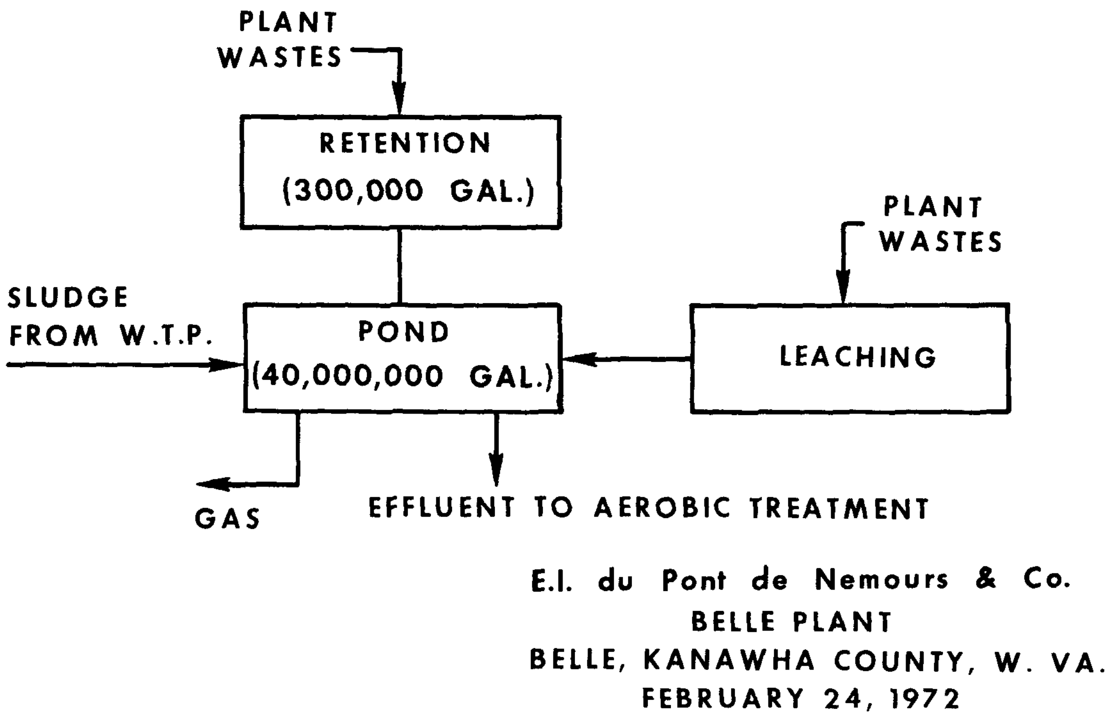


FIGURE A-5
ANAEROBIC POND

RIVER OUTFALLS	COD(AUTO)	COD(TITRATION)	BOD5	NH3-N(AUTO)	TOT. KJEL. N	NH3-N	ORGANIC-N	NO3	NO2	pH	SUSP. SOLIDS	TOT. SOLIDS	TOT. CARBON	ODOR	CHLORIDE	UREA	CYANIDE	HARDNESS	ACIDITY	COPPER	ALKALINITY	SULFATE
003	D	W	W	D						C			W									
013	D	W	W							C			W C									
014	D	W	W										W C									
017	D	W	W	D									W			D						
021	D	W	W	D									W									
043	D	W	W	D						C			W C									
046	C	W	W	D									W									
056										W									W	W		
062	D	W	W	D	W								W									
EFFLUENT COMPOSITE		W	W*		W M*	M*	M*	M*	M*	W M*	M*	M*	W	W M	A*		A*	A*			A*	A*
INFLUENT RAW H_2O COMPOSITE	D	W	W*	D	W M*	M*	M*	M*	M*	W M* C	M*	M*	W	W M	A*		A*	A*			A*	A*
IN-PLANT BRANCH SEWERS																						
7 LOCATIONS	D			D																		
5 LOCATIONS	C									C			C									
3 LOCATIONS	D			D											D							
5 RAW WATER LOCATIONS	D			D																		

ANALYSIS FREQUENCY

C - CONTINUOUSLY
D - DAILY
W - WEEKLY (COMPOSITE)
M - MONTHLY (COMPOSITE)
A - ANNUALLY
* REPORTED TO STATE

FIGURE A-6
BELLE PLANT - POLLUTION CONTROL ANALYSES
E.I. du Pont de Nemours & Co., Incorporated

	COD(AUTO)	BOD5	pH	ODOR	CHLORIDE	TOT. KJEL. N	NH3–N	DISS. O2	INERT SOLIDS	SUSP. SOLIDS	TOT. CARBON	TEMPERATURE	ALKALINITY	AMM. SALTS	VOL. ACIDS	PO4	UREA	SETTLEABILITY
WASTE TREATMENT																		
• INFLUENT	C	W	C				D				W	C					D	
• EFFLUENT	3/D	W				W	W				W							
• AERATORS			C					12/D		3/D		C						12/D
• RET. SLUDGE									W	W								
ANAEROBIC POND																		
• POND	W	W	W			W	W						W	W	W	AR		
• EFFLUENT	W	W	W			W	W						W	W	W			
• RETENTION POND	AR	AR	AR															
KANAWHA RIVER																		
• CHELYAN			2/W*	2/W*	2/W*	W*	W*	2/W*				2/W*						
• KANAWHA CITY			2/W*	2/W*	2/W*	W*	W*	2/W*				2/W*						
• BELLE PLANT			C									C						

ANALYSIS FREQUENCY

C - CONTINUOUSLY

D - DAILY

W - WEEKLY

AR - AS REQUESTED - (NOT SCHEDULED)

* - REPORTED TO STATE

FIGURE A-6 (continued)

BELLE PLANT - POLLUTION CONTROL ANALYSES

E.I. du Pont de Nemours and Company, Incorporated

TABLE A-3
ESTIMATED BOD(5) REMOVAL EFFICIENCIES ACHIEVED IN 1971
AT DUPONT'S BELLE, WEST VIRGINIA PLANT
(lb/day)

Receiving facility	Raw load	Effluent load	Removal efficiency
Aerobic treatment plant	36,500	4,000	89
Anaerobic pond	12,900*	7,700**	40
Deep wells	12,000	0	--
Cooling water outfalls	10,800	10,800	0
	72,200	22,500	69

*Derived by multiplying value in next column by 1.67 to reflect a 40% winter removal efficiency.
** Value determined during survey.

Spill Potential

Between 1960 and 1972, oil had spilled into the river on three occasions; the total consisted of 200 gallons of lubricating oil and 550 of coconut oil. Refractory organics had leaked out of barges in three instances, and seven spills of ammonia or ammonia-urea solutions had taken place, but the quantities involved are unknown. On two occasions, spills are known to have killed fish in the river.

NFIC-Cincinnati Survey

Sampling

To confirm the effluent loadings reported by DuPont and to gather more data on other discharged constituents and the treatment plant's efficiency, the EPA conducted a 24-hour survey on February 23 and 24, 1972. Samples collected were split with DuPont and the State's Division of Water Resources.

Analytical Results

The analytical results (converted to pounds per day) are listed in Table A-4. In most cases, the company's results are higher than NFIC's.

TABLE A-4

EFFLUENT SAMPLING RESULTS - lbs/day

E. I. DuPont de Nemours & Co.
Belle Plant

Field Data Calculations of Net Loads

OUTFALL NUMBER	FLOW AVERAGES	BOD_5	BOD_{20}	COD	TOTAL SOLIDS	SUSPENDED SOLIDS	AMMONIA N	TOTAL K N	$NO_2 + NO_3$ N	T.O.C.	SULFATE	CHLORIDE	OIL & GREASE	
003	20,900 gpm 20.2 MGD 251X10^6 lbs/day			2,000 9,790	36,600 40,900	11,500 13,800	1,830 1,910	2,360 2,080	201 133	2,260 2,920	5,270 3,360			EPA Du Pont
013	916 gpm 1.32 MGD 11.0X10^6 lbs/day			363 250	7,740 1,730		7.7 9	17.6 15	8.8 5	99 44	198 107	110 76		EPA Du Pont
014	250 gpm .36 MGD 3.0X10^6 lbs/day			84 150	486 450	156 160				30 18	117 46	30 28		EPA Du Pont
017	30,000 gpm 43.2 MGD 360X10^6 lbs/day	4,464 7,200		18,000 36,000	60,500 68,000		6,120 5,800	15,500 13,600	432 389	8,280 7,200	7,200 4,460	4,320 4,000	720 8,680	EPA Du Pont
018	10 gpm .014 MGD .12X10^6 lbs/day			8.3 16	268 290				1.9 2	2.5 3				EPA Du Pont
021	1,420 gpm 2.0 MGD 17.0X10^6 lbs/day	71 153		306 390	2,480 2,160	884 950	20.4 27	28.9 27	17 12	136 68			170 231	EPA Du Pont
043	19,083 gpm 27.46 MGD 229X10^6 lbs/day	7,832 8,470 6,870	19,602 58,170 10,305	11,221 16,720	84,272 91,370 84,960	 48,500	595 760 779	847 760 1,210	573 609 2,480	4,580 4,580 -	5,950 5,180 -	4,580 4,300 -	3,660 4,830 -	EPA Du Pont State
044	17.4 gpm .025 MGD 0.21X10^6 lbs/day			22 2	345 415	60 105				5 0.4	220 73			EPA Du Pont
046	750 gpm 1.1 MGD 9.0X10^6 lbs/day	24 100		99 180	1,260 1,630	576 610				63 27	162 116		108 172	EPA Du Pont
056	6,245 gpm 8.99 MGD 75.0X10^6 lbs/day	120		750 750	13,800 12,000	4,200 5,180				450 150	4,650 2,230	600 585		EPA Du Pont
062	1,582 gpm 2.28 MGD 19X10^6 lbs/day	5,090 13,200 5,260	8,820 20,900 8,340	5,760 6,990	17,380 19,000 18,700	2,430 1,180 1,750	2,470 2,300 3,250	3,800 3,700 3,700	11 3 15	2,850 2,200			38 260	EPA Du Pont State
Major Outfalls Total Discharge		17,600 29,400	28,400 79,000	38,600 71,200	225,000 238,000	19,900 22,000	11,000 10,900	22,500 20,300	1,250 1,150	18,800 17,200	23,800 15,600	9,640 8,990	4,700 14,200	EPA Du Pont
Raw Water Intake Quantities		1,460 1,940	 7,790	7,790 11,700	132,000 128,000	55,000 41,900	487 292	974 292	779 584	6,820 2,920			0 12,600	EPA Du Pont
Net Total Discharge	lbs/day	16,100 27,400 21,300	 71,300	30,800 59,600 -	92,500 110,000 84,000	0 0 26,700	10,600 10,600 12,100	21,600 20,000 25,000	466 569 2,770	11,900 14,300			4,700 1,510 -	EPA Net lbs/day Du Pont Net lbs/day State Net lbs/day

The data in Tables A-2 and A-4 indicate that the plant discharged large quantities of BOD, both carbonaceous and nitrogenous, COD, organic carbon (TOC), total solids, and oil and grease. The aerobic treatment plant was removing about 80% of the influent BOD, 80% of the COD, and essentially none of the nitrogen at the time of the survey.

The company appeared to be meeting the State's Phase II requirement for BOD (15,000 pounds per day) and TKN (18,000 pounds per day) during the summer months.

Major Sources and Loads

The data in Table A-4 show that there were three outfalls of significance: the general plant outfall (No. 017), Simmons Creek (No. 043 containing effluent from the anaerobic pond), and the aerobic waste treatment plant (No. 062).

About 25% of the BOD load entered the river from the general plant outfall, which was also discharging about 25% of the total solids and 75% of the nitrogen loads during the survey.

Toxicity of Effluents

Static bioassay tests, using fathead minnows, were made on the effluent from the aerobic waste treatment plant in March 1972. During the tests, the dissolved oxygen in the effluent ranged from 6.9 to 8.0 mg/1, the pH was 6.5, and temperature was between 23 and 27 degrees C. The median tolerance limit (TL50) of the wastewater was 24% at the end of 24, 48, and 96 hours. (The TL50 is the percentage of a wastewater by volume which will kill 50% of the test organisms in a specified time; the lower the TL50, the the higher the toxicity of the effluent.) Other effluents from the plant were not tested for toxicity.

Summary and Conclusions

The major pollutional loads were:

1. The anaerobic pond, which had a biological efficiency removal that ranged from 40% in winter to 80% in summer.

2. The main plant outfall; in 1971, it had discharged an average of approximately 8,000 pounds of ammonia-N and 5,000 pounds of organic nitrogen per day.

3. The aerobic wastewater treatment plant; in 1971, its efficiency had ranged from 69.5% in winter to 92.3% in summer. BOD(5) removal efficiency during the survey was 80.7%.

4. Contaminated cooling water.

Recommendations

It is recommended that:

1. The company take further precautions against the possibility of spills entering the river, particularly with respect to ammonia, since large quantities are manufactured and stored on site.

2. Cooling water be segregated from process wastes so that it does not become contaminated.

3. The maximum amount of nitrogen be removed from waste streams using the best technology currently available.

4. The toxicity of effluents be reduced at least to the point that no discharge exceeds 1/20 of the 96-hour TL50.

5. BOD(5) discharge loads be reduced to at least 2,600 pounds per day based on water quality standards.

6. Monitoring be increased at the major outfalls (003, 013, 014, 017, 021, 043, 044, 046, 056, and 062).

UNION CARBIDE CORPORATION
CHEMICALS AND PLASTICS DIVISION
SOUTH CHARLESTON PLANT
SOUTH CHARLESTON, WEST VIRGINIA

General Plant Description

The plant occupied all of Blaine Island, which is about 1.25 miles long, and 1.1 miles of the south bank of the Kanawha River (left shore facing downstream). In addition, two storage facilities were located on 0.5 mile of the north shore (Figure B-1).

The wastewater treatment facility used was a joint venture between Union Carbide and the City of South Charleston; it occupied about 0.14 mile of the south shore, just upstream from the main plant.

The plant, which is acknowledged to be the nation's first petrochemical facility, began operations in 1925. Peak employment has been 4,200, but in March 1972 it had approximately 2,100. The principal buildings included numerous chemical production facilities, two power plants, a large automated warehouse, a laboratory, and a 10-story office building.

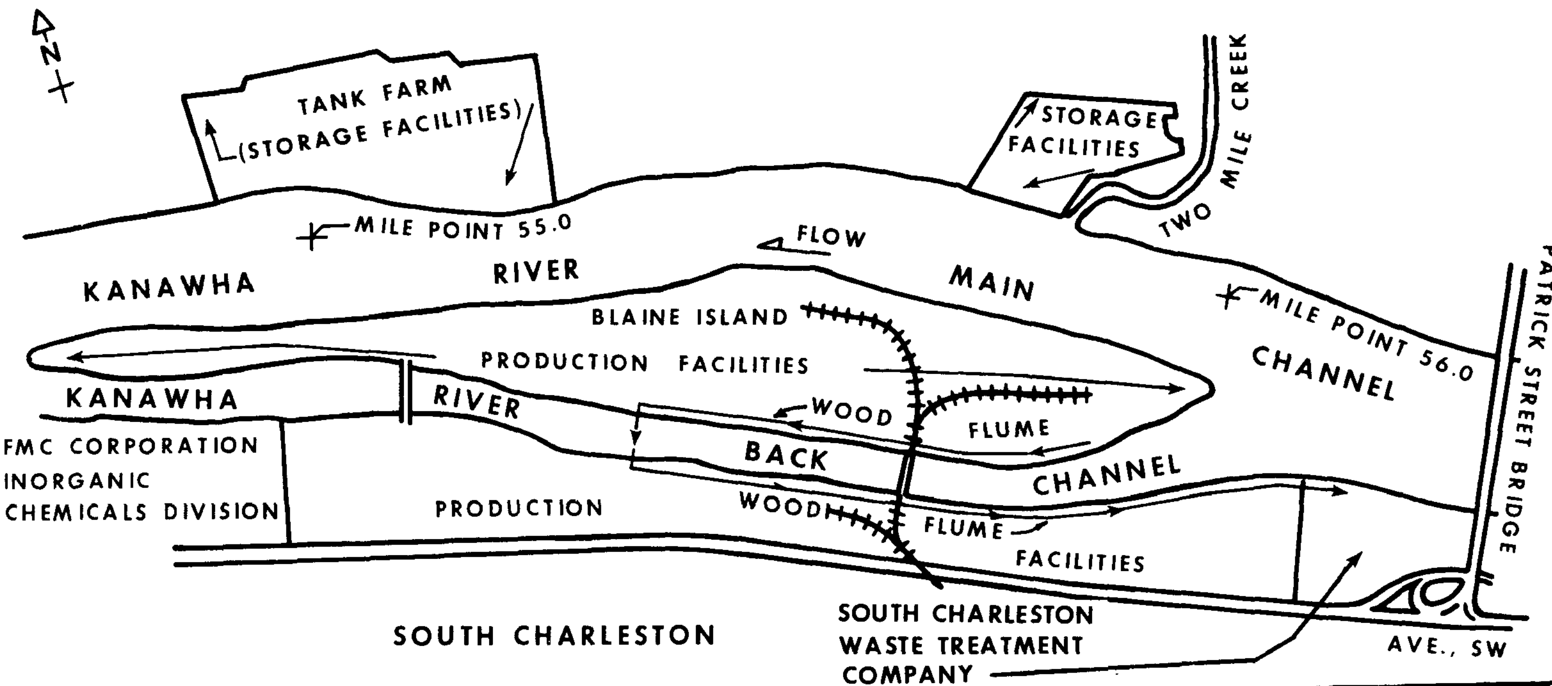
Representative organic chemical products were acids, alcohols, aldehydes, esters, ethers, plasticizers, glycols, monomers, polyols, and surfactants. Discontinued products included ethylene oxide, propylene oxide, polyethylene, and crotonaldehyde.

Principal raw materials used were natural and refinery gases were cracked to produce ethylene, propylene, acetylene, and hydrogen. Subsequent processing involved mixing with other raw materials, such as air, water, and chlorine.

More than 400 chemicals were being manufactured around the clock, 365 days per year; some of them are listed in Table B-1. No figures were available on total quantity and value of specific products shipped out.

Water Usage

Of the average 222 millions of gallons a day (mgd) of water withdrawn from the river in 1971, 208 mgd were used for cooling purposes and were returned to the Kanawha without being treated.



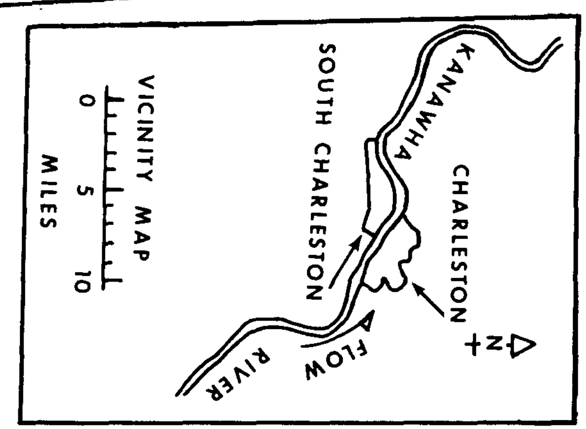


FIGURE B-1
GENERAL PLAN - PLANT FACILITIES

UNION CARBIDE CORPORATION
SOUTH CHARLESTON PLANT
JULY 1972

Table B-1

SOME PRODUCTS HANDLED BY
THE UNION CARBIDE SOUTH CHARLESTON PLANT

Products	Examples	Uses	UCC Brand Names
Acids	Acetic, valeric, iso-pentanoic	Intermediates for esters, anhydrides, amides, peroxides, metallic salts, and as a solvent.	NIACET
Alcohols	Butanol, isobutanol, methyl amyl alcohol	Solvents, intermediates for aldehydes, ketones, acids, esters, plasticizers, lubricants, surfactants, and oil additives.	SYNASOL, ANHYDROL
Aldehydes	2-ethylhexaldehyde, hexaldehyde, pentaldehyde, isobutyraldehyde	Intermediates for acids, alcohols, amines, pharmaceuticals, rubber accelerators, resins, and dyes.	
Esters	Butyl acetate, ethyl acetate	Lacquer solvents, emulsion paints, intermediates for dyes, pharmaceuticals, insecticides, plasticizers, and as synthetic lubricants.	
Ethers	Butyl ether, isopropyl ether, vinyl ethyl ether	Extractants, solvents, & couplers.	
Plasticizers	FLEXOL Plasticizer TOF, FLEXOL Plasticizer 3 GH	Used with resins, lacquers, rubbers, to impart special properties.	FLEXOL
Glycol ethers	Butyl CELLSOLVE, Butyl CARBITOL, CELLOSOLVE	Solvents for lacquers, varnishes, dyes, paints, oils, insecticides, and soaps.	CELLOSOLVE

Table B-1 (Cont.)

SOME PRODUCTS HANDLED BY
THE UNION CARBIDE SOUTH CHARLESTON PLANT

Products	Examples	Uses	UCC Brand Names
Glycols	Ethylene glycol, diethylene glycol, propylene glycol	Solvents, antifreeze, deicing fluids, gas dehydration, humectants, air purification, and intermediates	PRESTONE SENTRY KROMFAX
Ketones	Methyl ethyl, methyl isoamyl	Solvents for resins, lacquers, pharmaceuticals, dewaxing compounds, and flotation agents	
Monomers	Vinyl acetate, vinyl chloride	To form polymers and copolymers for fibers, plastics, rubbers, paints, textile finishes, floor and shoe polishes, paper coatings, adhesives	BAKELITE NIACET
Nitrogen Compounds	Monoethanolamine, diethanolamine, isopropylamine, morpholine	Intermediates for soaps and dyes, emulsifying agents, corrosion inhibitors, insecticides, pharmaceuticals, fungicides, petroleum additives, wash and wear textile finishing resins, catalysts, detergents, cosmetics, shampoos, soluble oils, and fibers.	
Polyols	Polymer polyols NIAX LHT 34, Straight polyol LG-56	Production of flexible, semirigid and rigid urethane foams, elastomers, coatings, and adhesives.	NIAX
Surfactants	TERGITOLS Aerosol MA	Emulsifiers, detergents, and wetting agents	TERGITOL
Mixtures	Brake fluids, hydrolubes, antileak compounds	Solvents, curing agents, compounds, hydrolubes, brake fluids, corrosion inhibitors, de-icing fluids, insecticides,	CARBOSEAL, UCON, UGAR, MORLEX STABILENE, MYLONE

About 8.4 mgd were processed in the wastewater treatment works (Figure B-2). The balance consisted of water used in the boilers and at the Technical Center, contained in products, and lost to evaporation. An estimated 150-160 mgd were being used in March 1972.

Wastewater Discharges and Waste Sources

Process wastewaters were routed through a redwood flume to the treatment plant, and the effluent was discharged into the Kanawha at Mile Point 56.2. In 1971, the City's portion had averaged 2.3 mgd and the plant's 8.4 mgd. Over a period of years, the municipal flow had increased while the industrial and total flows had decreased.

Untreated cooling water discharges described in Union Carbide's Refuse Act permit applications are listed in Table B-2. Most of the discharges were classified as cooling water by the company, but they also contained process wastewaters to some degree. The outfalls were located on the Kanawha's Back Channel between Mile Points 55.0 and 56.0 and at Mile Point 53.3 (Ward Hollow).

The principal waste sources were the production units listed below (with building numbers) and their support activities, such as the steam plants:

Amines, glycol esters, miscellaneous distillation, glycol (077); chlorhydrin (124); oxide adducts (167); polyols (106); hydrogenation (066); specialty chemicals (115); plasticizers (122, 125); esters, CELLOSOLVE (121) (070); aldehyde, butanol, ketene (061) (063) (108); ethanol (045); latex (087); vinyl specialty resins (082); vinyl solvent resins (083); vinyl dispersion resins (085); DYNEL resins, fiber, staple (078) (098) (152-252); bulk handling (585).

Wastewater Treatment Program

Historical Development

Pollution abatement and waste treatment efforts at the plant began in 1952-1953 when cooling waters were separated from sanitary and process wastes.

The West Virginia Department of Natural Resources and the Kanawha River Industrial Advisory Committee initiated Phase I of the Kanawha cleanup program in 1958 when they required that all industrial and domestic wastes be given primary treatment and that industrial wastes undergo partial secondary treatment. The 1958 base BOD(5) (5-day biochemical oxygen demand) load for the South Charleston plant was established at 167,000 pounds per day. Phase I required that Union Carbide reduce the load to 100,000 pounds per day.

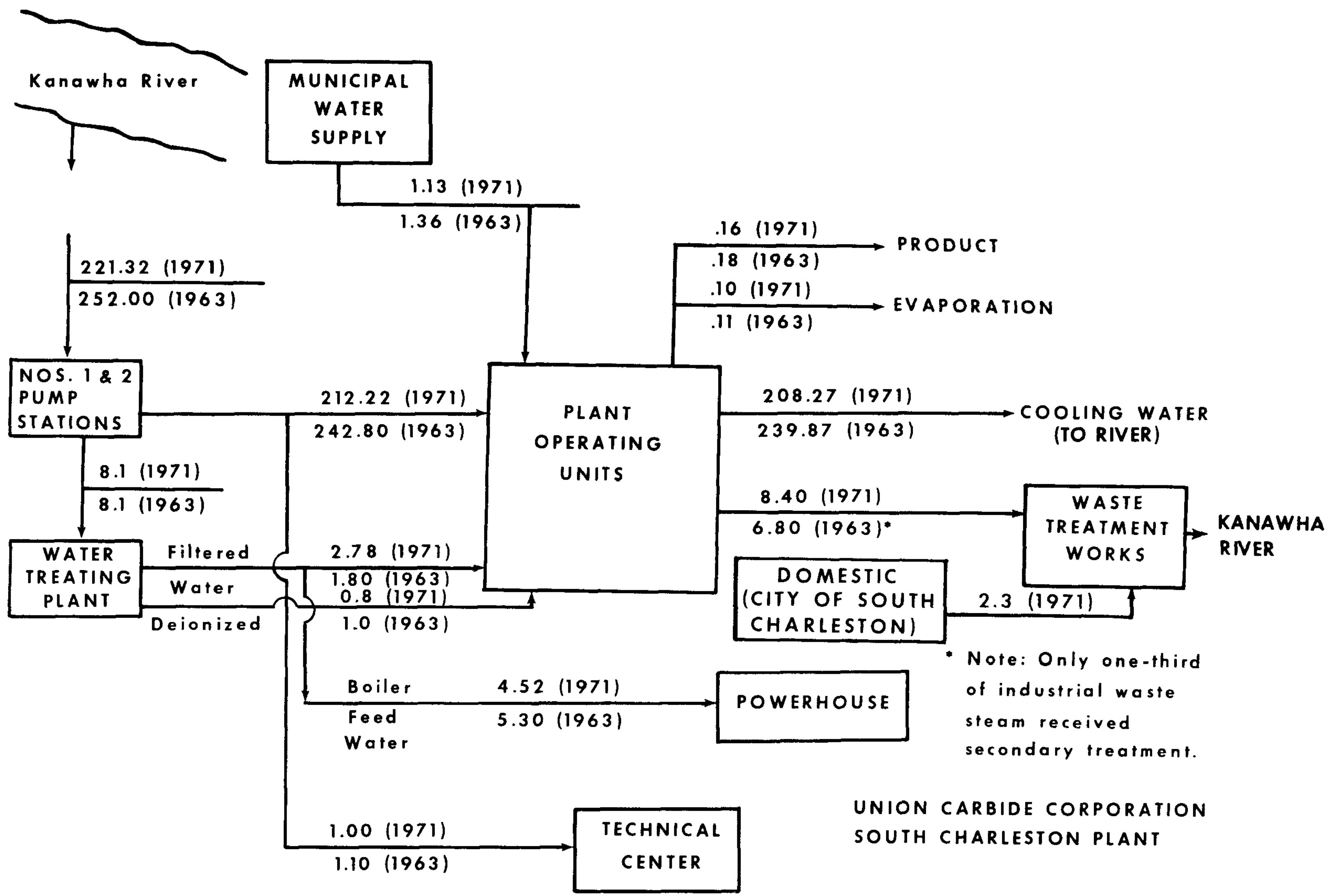


FIGURE B-2
WATER USE DIAGRAM - MGD (1963 and 1971)

TABLE B-2

DISCHARGES, SOURCES AND FLOWS
Union Carbide Corporation - South Charleston Plant
(South Charleston Waste Treatment Plant Discharge Not Included)

Refuse Act Permit Application No.	Source Area	Flow - MGD Permit Application	Flow - MGD During Survey
001 thru 008, 012, 018, 020 thru 022, 026, 029, 030, 034, 041, 043 thru 046, 049, 052, 055 thru 058, 066 thru 070, 073, 082 thru 090 (total 44 outfalls)	Surface runoff	normally dry	
019 and 077	Waste collection stations	no discharge	
009	Water treatment backwash	0.4	0.34
011	Pumphouse-flushing traveling screen	-	
013		0.05	
014	Misc. distillation - polyol processing	6.5	8.62
015	" "	2.2	1.98
016		0.6	
017	Liquid phase hydrogenation	7.1	2.47
023	Fine chemicals and vinylite	25.5	13.4
024	No. 2 CELLOSOLVE unit	4.7	3.55
025	Vinyl resins and plasticizers	27.4	17.83
027		0.7	
028		0.04	
031	Acetic esters	8.1	4.58
032	Aldehyde and powerhouse	2.3	2.77
033	No. 1 Pumphouse screen flushing	-	

TABLE B-2 (Cont.)

DISCHARGES, SOURCES AND FLOWS

Union Carbide Corporation - South Charleston Plant
(South Charleston Waste Treatment Plant Discharge Not Included)

Refuse Act Permit Application No.		Source Area	Flow - MGD Permit Application	Flow - MGD During Survey
035		Aldehyde	2.7	2.65
036		Merrill furnaces - aldehyde	4.0	0.93
037[1]		Crotonaldehyde	1.8	
038		Aldehyde	2.7	2.49
039		Acetaldehyde	7.5	6.14
040		Butanol	14.0	10.55
042		Butanol	4.1	5.42
047	Polyethylene process shut down Spring 1972		0.10	
048			1.4	
050		Gas separation	22.3	0.52
051			1.4	
053		Gas separation	4.7	0.52
054			6.5	
059			0.5	
060			1.6	
061		Polyethylene	2.3	
062			0.1	
063			0.7	
064			0.07	
065			0.5	
071			0.1	
072		Dynel	0.7	
074		Miscellaneous Chemicals	18.6	17.15
075		Oxide Adducts and Powerhouse	6.1	1.34
076		" " "	8.5	6.51

TABLE B-2 (Cont.)

DISCHARGES, SOURCES AND FLOWS

Union Carbide Corporation - South Charleston Plant
(South Charleston Waste Treatment Plant Discharge Not Included)

Refuse Act Permit Application No.	Source Area	Flow - MGD Permit Application	Flow - MGD During Survey
078		0.1	
079	Oxide adducts & powerhouse	7.5	4.13
080 (1)	Composite drains	3.5	2.73
081		0.6	
091	Ward Hollow (includes fly ash disposal)	4.0	3.45

(1) Closed down by mid-1972.

The South Charleston Sanitary Board and Union Carbide formed the South Charleston Waste Treatment Company in 1959. The design of the combined domestic and industrial waste treatment works for Phase I was completed that year, and construction was completed in 1963.

When Phase I ended in June 1963, the Kanawha River still did not meet the minimum criteria and Phase II was launched; the final implementation date was June 30, 1966, but the State later extended it to June 30, 1968. The plant's new BOD(5) load limitation was 50,000 pounds per day.

Expansion of the South Charleston Waste Treatment Plant was completed, after many delays, in mid-1968. The plant, affected by start-up difficulties, generally met the BOD(5) load limitation by mid-1969.

Phase II still did not achieve the water quality standards DO criteria and a Phase III program was initiated by the State in 1969 with an implementation date of December 31, 1972. The Phase III BOD(5) limit for the South Charleston plant was established as 85 percent reduction of the 1958 BOD(5) load (a limit of 24,900 pounds per day total discharge) and a maximum practicable reduction of nitrogen loadings. The BOD(5) limitation was met in 1971 by a higher treatment plant efficiency, tighter process control and the shutdown of certain production units. (Additional pollution control improvements were under construction and will result in a lower BOD discharge level as facilities are completed in 1973-74.)

The total waste load disposition for the year 1971 is shown in Table B-3. (The Phase III limit of 24,900 pounds per day BOD(5) discharge to the Kanawha River was achieved well ahead of the December 31, 1972, compliance date.)

TABLE B-3

DISPOSITION OF THE TOTAL WASTE LOAD
UNION CARBIDE'S SOUTH CHARLESTON PLANT IN 1971

Lb BOD(5)/Day Raw Load	Disposal/Treatment	Lb BOD(5)/Day Discharged to the River
149,400	Plant's steam boilers	0
15,000	Chemical landfill	0
53,000	Sewage treatment plant	6,700
7,500	Cooling water (untreated)	7,500
10,700	Ward Hollow (untreated)	10,700
235,600 Total	Total	24,900

Waste Disposal Facilities

About 150,000 pounds per day BOD(5) were burned in the plant steam boilers. Solid chemical wastes with a BOD(5) of 15,000 pounds per day were transported to the Goff Mountain Landfill, operated by the Union Carbide Institute plant. Inert solid wastes were landfilled in the "Fillmont" area north of the Union Carbide Technical Center and south of FMC Inorganic Chemicals Division's "Beaver Pond."

Fly ash and wastewater treatment plant industrial sludge were pumped to the Ward Hollow disposal pond south of the Technical Center. The overflow from the pond, which included other wastewaters, was discharged to Davis Creek. (Beginning in late 1972 it was routed to the South Charleston Waste Treatment Plant.)

Wastewater Treatment System

Certain process wastewaters from the plant were routed to the treatment plant, which also handled the wastes from the City of South Charleston.

The general layout and a flow diagram of the treatment plant are shown in Figure B-3. The municipal wastes and industrial wastes

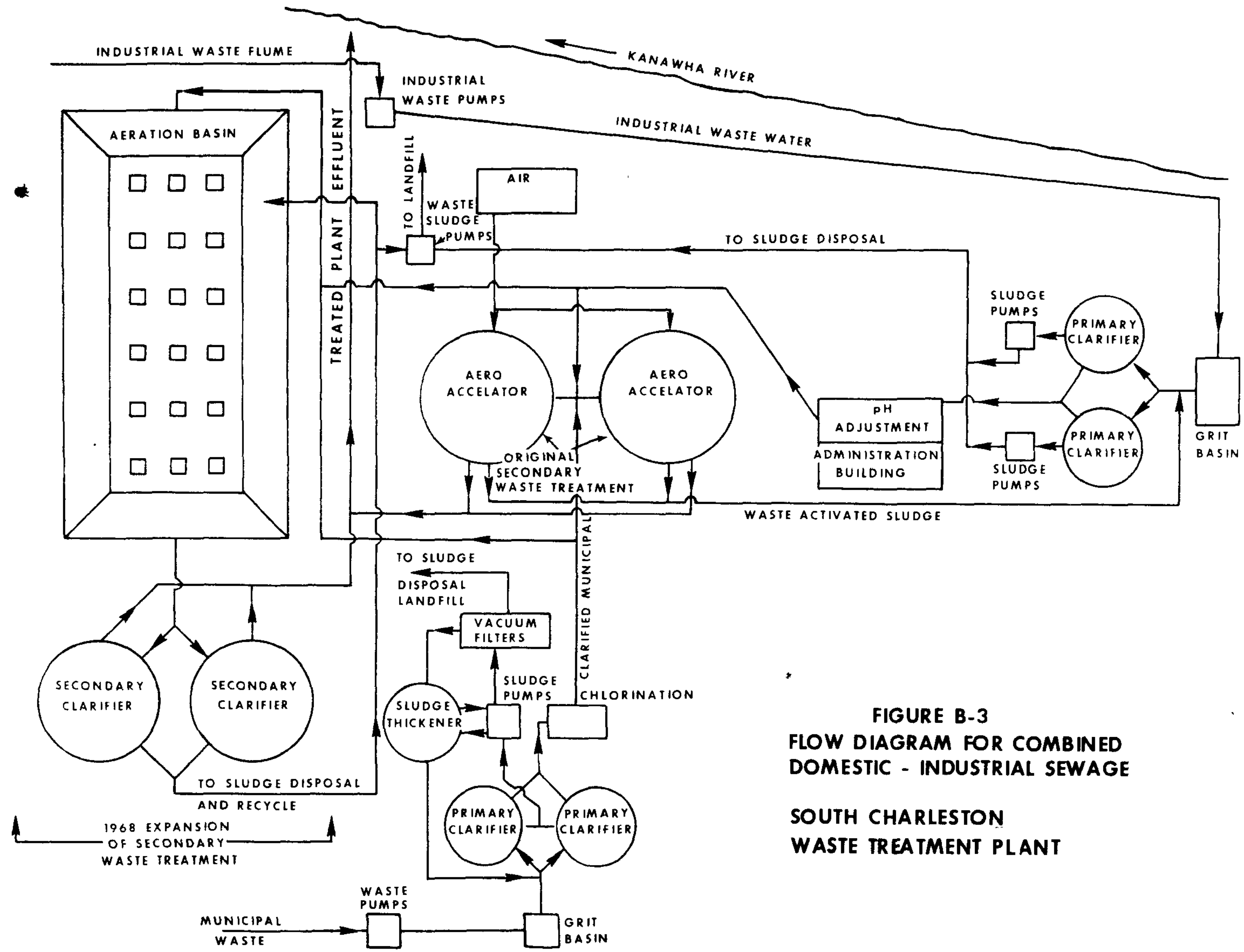


FIGURE B-3
FLOW DIAGRAM FOR COMBINED DOMESTIC - INDUSTRIAL SEWAGE

SOUTH CHARLESTON WASTE TREATMENT PLANT

received primary treatment in the plant before being combined for further treatment.

The domestic system was designed to handle an ultimate city population of 42,500 and an average domestic flow of 5.8 million gallons per day. When the sewage entered the plant, it was first pumped through mechanical cutters to a flow-measuring flume and then into a 12,000-gallon grit basin where coarse material was removed.

Settleable solids were then removed in the two 61-foot diameter municipal primary clarifiers. The solids were further concentrated in a 45-foot diameter sludge thickener. The thickened sludge was filtered on two eight-foot diameter by 12-foot long rotary vacuum filters. The filter cake was buried in a landfill. The overflow from the primary clarifiers was chlorinated before being sent to the secondary treatment system.

The industrial process wastewater was collected in redwood flumes on Blaine Island and along the river-bank on the mainland section of the plant (Figure B-1). Wastewater from the Blaine Island flume entered a sump, was pumped to the mainland flume, and flowed to the treatment plant. As it entered the plant, it was pumped to a grit basin for removal of coarse solids.

The industrial system was designed to handle 11.5 million gallons per day of flow. The two industrial primary clarifiers were the same size as the domestic clarifiers. The industrial sludge was pumped unthickened to a disposal pond where it was mixed with fly ash.

Clarified wastewater from the industrial stream flowed to a three-basin pH control system. A computer controlled the flow of additives so that the emerging pH was maintained close to 8.0.

Approximately one-third of the combined industrial and municipal wastewater flowed to the original secondary treatment system which consisted of two Aero-Accelators. Each Aero-Accelator was 90 feet in diameter and over 24 feet deep and could hold about 1,130,000 gallons of liquid. A 150-horsepower motor-driven agitator in each Accelator stirred the mixture of wastewater and biological growth. Three compressors provided oxygen for biological growth. The air was pumped into the bottom of the Aero-Accelators through sparger pipes mounted under the agitators. The flow was proportioned so that the wastewater would remain for an average of 7 1/2 hours in the aeration zone and an average of 2 1/2 hours in the recirculation and sedimentation zones.

The remaining two-thirds of primary clarified wastewater was pumped to the aeration basin which has been added to the secondary treatment system in 1968. The basin measured 202 feet wide by 347 feet long at the top and had sloping sides to a depth of 18 feet. Total volume was 6,450,000 gallons, sufficient to provide an average of about 10 hours of aeration time for biodegradation of the waste. The sides and bottom were lined with a layer of cement-fly ash mixture to keep the circulating liquid from eroding them. Agitation and aeration were provided by 18 pier-mounted units. Each unit was driven by a 100-horsepower motor. The treated flow from the new basin passed to two final clarifiers where the sludge was collected by a revolving tubular mechanism. Both secondary clarifiers were 95 feet in diameter, 12 feet deep; their size allowed approximately two hours for separation of the sludge. The majority of the sludge was returned to the basin to maintain biological activity, but part was withdrawn and pumped to the Ward Hollow fly-ash lagoon. The treated effluent from the secondary clarifiers was combined with the Aero-Accelator effluent and discharged to the river through the outfall structure.

Cooling Water

At the time of the survey there were 45 active outfalls. (In early 1973, the number had been reduced to 29 as a result of closing down certain production units and routing additional wastewater streams to the treatment plant.) There were 45 "dry outfalls" at the time of the survey, mainly surface water drains. (This number has been increased by unit shutdowns since the survey.)

All of the discharges, except that from the wastewater treatment plant, were classified by the company as cooling water outfalls. Most of them received either intermittent or continuous wastes from spills, leaks, upsets, etc., of the chemical processes. The untreated cooling water discharges represented 32 percent of the total BOD(5) load imposed on the Kanawha River in 1971.

Monitoring and Control Practices

All waste treatment plant influent streams and the plant effluent stream were being sampled regularly, as were various intermediate points (Table B-4). Analyses were performed in the laboratory at the treatment works. Data reported to the State included analyses of raw wastewaters from domestic and industrial sources, primary treated domestic and industrial wastes, combined influent wastes to the Aero-Accelators, influent to the surface aeration basin, combined effluent from the Aero-Accelators, combined effluent from the secondary clarifiers and total plant outfall. Threshold odor was measured routinely on certain treatment works streams at the plant's laboratory.

Untreated wastewater (cooling water) streams flowed continuously and each was equipped with a composite sampler which collected a

TABLE B-4

SOUTH CHARLESTON SEWAGE TREATMENT CO.
LABORATORY ANALYSIS SCHEDULE

	BOD_{20}	BOD_5	COD	TOTAL SOLIDS	SUSP. SOLIDS	SETTLE. SOLIDS	TOTAL NITROGEN	AMMONIA NITROGEN	PO_4	CHLORIDE	OXYGEN UPTAKE	COLIFORM	MICRO-SCOPIC EXAM	pH	DO	TEMP.	FLOW	TOTAL CARBON
I. INDUSTRIAL INFLUENT	M,Th	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	--	-------	------	--------	-----	CRR*	--	CRR*	CRR*	CRR*
II. INDUSTRIAL CLARIFIED	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	------	--------	--	-------	------	--------	-----	---		--	---	---
III. DOMESTIC INFLUENT	----	M,W.	M,W.	M,W.	M,W	M,W.	Th	Th.	Th.	-------	------	--------	-----	CRR*	--	CRR*	CRR*	---
IV. DOMESTIC CLARIFIED		M,W.	M,W.	M,W.	M,W.	M,W.	------	--------	--	-------	------	--------	-----	---	--	---	---	---
V. FEED TO ACCELATORS	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	-----	-----	-----	------	--------	M,T,W, Th,F.	-------	------	--------	-----	S,M,T, W,Th,F,S.	--	---	---	---
VI. FEED TO BIG BASIN	----	S,M,T,W, Th,F,S	S,M,T,W, Th,F,S.	-----	-----	-----	------	--------	M,T,W, Th,F.	-------	------	--------	-----	---	--	---	---	---
VII. EAST ACCELATOR MIXED LIQUOR	----	-------	-------	-----	M,T,W,Th, F.	M,T,W,Th. F.	------	--------	--	-------	M,T,W,Th, F.	--------	M,W,F.	CRR*	CRR*	Log Sheets	---	---
VIII. WEST ACCELATOR MIXED LIQUOR	----	-------	-------	-----	M,T,W,Th, F.	M,T,W,Th, F.	------	--------	--	-------	M,T,W,Th, F	--------	M,W,F	CRR*	CRR*	Log Sheets	---	---
IX. BIG BASIN MIXED LIQUOR	----	-------	-------	-----	M,T,W,Th, F.	M,T,W,Th, F.	------	--------	--	-------	M,T,W,Th, F	--------	M,W,F.	CRR*	CRR*	Log Sheets	---	---
X. EAST ACCELATOR EFFLUENT	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	------	M,T,W,Th, F.	M,T,W, Th,F	-------	------	--------	-----	---	--	---	---	---
XI. WEST ACCELATOR EFFLUENT	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	Th,F,S,S, M,T,W.	Th,F,S,S, M,T,W.	------	M,T,W,Th, F.	M,T,W, Th,F.	-------	------	--------	-----	---	--	---	---	---
XII. FINAL CLARIFIED EFFLUENT	----	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	------	M,T,W,Th, F.	M,T,W, Th,F	-------	------	--------	-----	---	--	---	---	---
XIII. OUTFALL	M,Th.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	S,M,T,W, Th,F,S.	Th.	------	F.	-----	---	--	---	---	---
XIV. RECYCLE SLUDGE	----	------	-------	-----	M,T,W,Th. F.	-----	------	-------	--	-------	------	-------	-----	---	--	---	---	---
XV. FILTER CAKE			% Solids - Tuesday and Thursday.															
XVI. PRIMARY IND. SLUDGE																		
XVII. PRIMARY DOM. SLUDGE																		
XVIII. THICKENED SLUDGE			Suspended Solids - Tuesday and Thursday.															

* Control Room Recorder

representative sample of the discharge over a 24-hour period. The waste treatment works discharge monitoring system was also provided with a 24-hour composite sampler. The Ward Hollow discharge was sampled in a similar manner.

The cooling water samples were analyzed daily for total carbon. BOD(5), suspended solids, total solids, and chloride were determined on the basis of weekly composites. If the quality of sewered cooling water was below the standards established by the company's Environmental Protection Department, the responsible production unit was directed to take corrective action. Gas chromatograph analyses were made of any samples above the standard total carbon values in an effort to pinpoint the source of the leak, spill, etc. Three outfalls were monitored by foam detection instruments. Continuously operating total carbon analyzer monitoring sampling stations were located at the waste treatment works discharge point and at the industrial wastewater flume.

Union Carbide's monthly Waste Load Report to the State included data on average daily loads of BOD(5), suspended solids, and total solids. The loads were reported in pounds per day for total cooling water outfalls (not for individual outfalls), treatment plant, and overall plant total.

Control practices at the treatment works were as follows: The Aero-Accelator mixed liquor suspended solids (MLSS) was ordinarily maintained in the range of 5,500 to 7,500 mg/l, and averaged 6,000 mg/l. The Aero-Accelator mixed liquor volatile suspended solids (MLVSS) was usually 85 to 90 percent of the MLSS.

The surface aeration basin MLSS was generally maintained in the range of 5,000 to 7,000 mg/l, and the percent volatile in the range of 82 to 88 percent.

Since the Aero-Accelators were internally clarified, activated-sludge basins, the sludge recycle rate was not measured. It normally varies with the aeration zone port openings and the aeration rate. The ports were operated about three-fourths open.

The recycle rate in the surface aeration basin was usually in the range of 3,500 to 4,200 gpm and was generally maintained at 80 to 100 percent.

The MLSS concentration of samples of circulating sludge taken from the bottom of the Aero-Accelator peripheral zone was slightly higher than in the aeration zone, but seldom by more than ten percent. The solids concentration of the return sludge from the final clarifiers to the surface aeration basin was ordinarily 9,000 to 12,000 mg/l.

The air supplied to each Aero-Accelator varied with the organic loading, but averaged 3,700 standard cubic feet per minute (scfm). The mixed liquor dissolved oxygen near the top of the aeration zone was maintained in the range of 1.0 to 2.5 mg/l. Each Aero-Accelator could provide 4,500 scfm if the organic loading required it.

The dissolved oxygen (DO) level in the surface aeration basin was controlled by starting and stopping the 100-horsepower surface aerators. At the prevailing loadings, 12 to 16 aerators were usually in use. The five 75-horsepower bottom mixers helped keep the solids suspended, so the number of aerators on line was governed primarily by the DO level in the basin. The DO in the upper three feet of mixed liquor was generally held in the 3.0 to 5.0 mg/l range. Tests have shown this provides at least 0.5 mg/l at the lower depths.

The Sludge Volume Index (SVI) of the Aero-Accelator and surface aeration basin mixed liquors generally fell in the range of 50 to 120. The laboratory data on mixed liquors for the month of December, 1971, indicated an average of 95.

Depth of the sludge blanket in the surface aeration basin final clarifiers was not regularly measured. Occasional measurements with a photocell device showed the blanket was generally seven to 10 feet below the surface. The depth of the blanket in the peripheral zone of the Aero-Accelators was regularly measured and was generally five to seven feet below the surface.

Removal Efficiency

The overall raw and discharged BOD(5) loads for the plant and the city are shown in Figure B-4. The total load discharged into the river included the municipal load, which was very small compared with the industrial load; it had generally ranged between 200 and 1,000 pounds per day during the previous three years. During 1971, the monthly averages ranged between 170 and 620 pounds per day, less than five percent of the total wastewater treatment plant load to the river.

A summary of raw and discharged BOD(5) loads for 1969, 1970, and 1971 is shown in Table B-5.

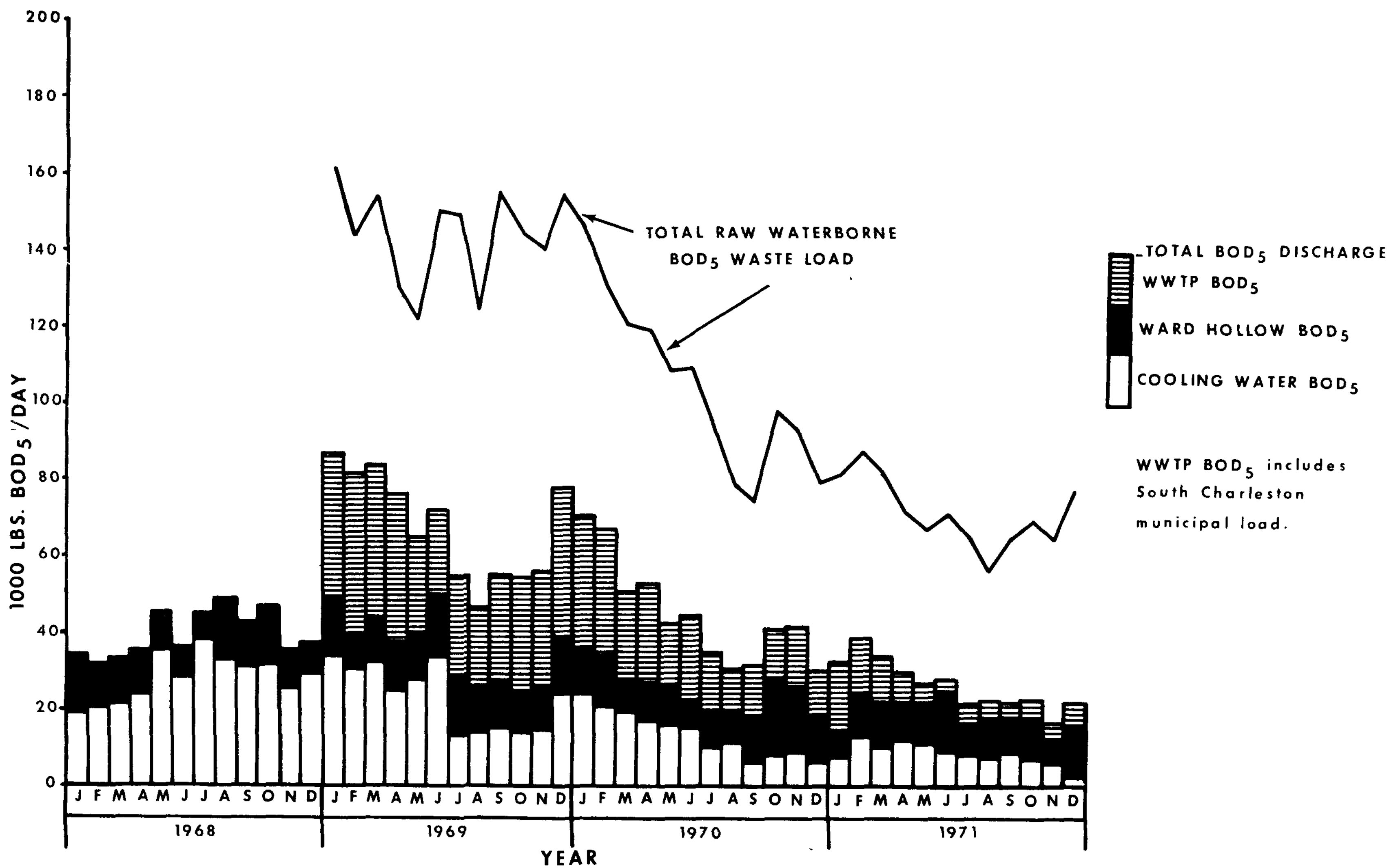


FIGURE B-4
BOD_5 WASTE LOADS

UNION CARBIDE CORPORATION
SOUTH CHARLESTON PLANT
SOUTH CHARLESTON
WASTE WATER TREATMENT PLANT (WWTP)

TABLE B-5
SUMMARY OF BOD(5) DATA AT UNION CARBIDE PLANT
AT SOUTH CHARLESTON, WEST VIRGINIA
1969-1971
(1000 lb/day)

Stream	1969	1970	1971
Waste treatment facility			
Influent	108	78	53
Effluent	31	19	7
Cooling water			
Influent	23	13	8
Effluent	23	13	8
Ward Hollow			
Influent	13	12	10
Effluent	13	12	10
Total			
Influent	144	103	71
Effluent	67	44	25
BOD(5) removed (percent)			
Waste treatment facility	71	76	85
Total system	53	57	65

The total raw waterborne BOD(5) load generated at the plant decreased by more than 50 percent during the period, and BOD(5) removal efficiency increased. In 1971, the total plant waterborne BOD(5) removal was 65 percent while the efficiency of the treatment plant was 87 percent. Treatment plant efficiencies were lower in winter and higher in summer. During 1971, they ranged from 74 percent in January to 93 percent in June.

(With the routing of the Ward Hollow discharge to the treatment plant in 1972, an additional reduction in the Union Carbide-South Charleston BOD(5) load to the river 8700 pounds per day was expected.)

Future Plans

Problem	Solution
Flooding of industrial raw wastewater flume.	Replacement of the island wastewater flume at a five-foot higher elevation was scheduled for completion by the end of 1973. It was estimated that the revised collection system would reduce flooding occurrences to an average of 26 hours per year.
Shutdown requirements for maintenance at industrial wastewater neutralization system.	A by-pass around the neutralization system was scheduled for completion by June, 1973.
Marked fluctuation in industrial influent loading and lack of storage facilities for industrial waste.	Three 1,000,000 gallon surge tanks had been installed adjacent to the waste treatment plant to reduce the peak fluctuations in influent BOD. These tanks will also be of value in avoiding discharges to the river if a power outage occurs or critical equipment breaks down. (The tanks were being used in a startup phase in May 1973.) An experimental bio-monitor device was to be installed to provide information on the need for total or partial diversion of industrial wastewater to storage tanks because of its toxicity to activated sludge.

High suspended solids in the final clarifier effluent and foaming in the secondary system's aeration tanks.	(Installation of the following faciities was completed in early 1973: (1) clarifier spray system; (2) clarifier scum baffles; (3) submerged outlet for surface aeration basin; (4) improved flow divider to distribute surface aeration basin effluent between the two final clarifiers; and (5) bulk antifoam storage and feed system for better foam control in the surface aeration basin. An intensive investigation was being made of sources of foam producers within the chemical plant. An on-line foam detector had been developed and was being used in this investigation.)
Excessive stormwater flows which had periodically resulted in by-passing of the chlorinated domestic primary effluent to the Kanawha.	The South Charleston Sanitary Board had been advised that considerable stormwater was entering the sanitary sewer system and the infiltration was being investigated.
Equipment outages caused by electrical problems.	An improved electrical distribution system was scheduled for completion by June 1973.

Spill Potential

The waste inlet system utilized an open top flume which was flooded periodically by high river waters. Flooding of the flume had occurred frequently at the waste treatment works and the industrial waste inlet under certain high water conditions.

Occurrence of Flume Flooding

1961 12/19, 12/20, 2/26, 2/27, 2/28, 3/1

1962 1/8, 2/27, 2/28, 3/1, 3/22, 3/23

1963 3/12, 3/13, 3/16, 3/17, 3/18, 3/19, 3/20, 3/21, 3/26

1964 3/4, 3/5, 3/6, 3/7, 3/8, 3/9, 3/10, 3/16

1965 4/12, 3/26, 3/27, 3/28, 2/9

1966 5/1, 5/2, 5/3, 5/4

1967 3/7, 3/8, 3/14, 3/15, 3/16, 5/15, 5/16

1968 3/13

1969 12/30, 12/31, 8/21

1970 1/1, 1/3, 1/4, 2/16

1971 None

1972 2/24, 2/25, 2/26, 2/27, 2/28, 2/29, 3/1, 3/2, 3/3, 3/4

The average number of days per year during which the flooding had occurred was approximately five. Ten consecutive days of flooding occurred in 1972. During these periods, the raw waste load was, in effect, discharged directly into the river. (Installation of a new covered flume at a five-foot higher elevation was completed in late 1973, and this was expected to reduce the flooding occurrence to an average of 26 hours per year.)

The potential for pollution through spills in the manufacturing areas had been reduced by:

1. Installing 24-hour composite samplers at all continuously flowing outfalls.

2. Making weekly checks that dike valves were closed.

3. Having the Utilities Foreman on each shift visually inspect all outfalls.

4. Diverting certain pollution sources in the cooling water system to the wastewater treatment system.

Data on spill frequencies, quantities, etc., were not compiled under this study, but it is known that in 1971 one incident which occurred resulted in the company being cited and fined $500. The U. S. Coast Guard had detected a 40-gallon spill of Estanol during barge operations. Some of the surface water drains were connected to controlled dike areas from which contaminated water could be directed to the wastewater treatment plant.

The potential for the receiving water to be polluted by actual spills in the manufacturing and storage areas was judged to be moderate on the basis of the record and the presence of dikes around the tanks holding toxic materials.

NFIC-CINCINNATI FIELD SURVEY

Sampling

In order to confirm and/or ascertain the magnitude of loadings to the river, source areas, and effectiveness of the treatment system, the EPA conducted a 24-hour sampling survey of the plant's intake water, the waste treatment plant's influent and effluent, the principal cooling water outfalls, and the effluent from Ward Hollow on March 13, 14, and 15, 1972. Two-hour grab samples were composited over a period of 24-hours for each outfall and were split with the company and the State's Division of Water Resources.

Selection of the outfall sample points listed in Table B-6 was generally on the basis of high flow rates, those listed in Refuse Act Permit Applications as being greater than 1 mgd. Approximately 90 percent of the total flow from all outfalls was monitored by sampling at the points selected.

Toxicity checks were performed on the effluent from the waste treatment plant and two untreated discharges to the river, those from the vinylite area and the acetylene and miscellaneous chemicals area.

Analytical Results

The results of the NFIC-Cincinnati survey, converted to pounds per day, are listed in Table B-6. Results by concentrations are listed in Table B-7. State and Union Carbide results are also included if analyses were performed.

Figure B-4 is based on the data Union Carbide had reported monthly to the State. The survey results (Table B-6) show a total of 13,843 pounds per day BOD(5) was discharged into the river, as compared with an average of about 21,000 pounds per day for the last half of 1971 and an average of 26,000 pounds per day for all of 1971. As mentioned earlier, the load to the river had been decreasing due to improved waste treatment efficiency, other abatement efforts by the company, and the shutdown of production facilities in several areas. Additional reductions were expected for 1972 and the indicated trend was supported by the data collected during the survey.

Toxicity of Effluents

The static bioassays conducted used fathead minnows.

Table B-6

RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 13, 14, and 15, 1972

Analyses and Flows Converted to Net Loads in lbs/day

Outfall RAPP No.	Flow MGD	BOD_5			BOD_{20}			COD			TOC			Total Solids			Susp. Solids			TKN			NH_3-N			Phenol			Oil & Grease		
		Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA
004	0.34	-	-	-	-	-	-	-	-	57	-	-	20	-	-	613	-	-	417	-	-	1.7	-	-	-	-	-	-	-	-	-
014	8.62	-	-	160	-	-	-	-	-	575	-	-	216	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
015	1.98	-	-	150	-	-	-	-	-	1100	-	-	231	-	-	660	-	-	-	-	-	3.3	-	-	-	-	-	-	-	-	-
017	2.47	-	-	42	-	-	-	-	-	21	-	-	-	-	-	-	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-
023	13.4	-	-	340	-	-	-	-	-	336	-	-	112	-	-	-	-	-	-	-	-	67.	-	-	-	-	-	-	-	-	-
024	3.55	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
025	17.83	-	-	470	-	-	-	-	-	1340	-	-	149	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
031	4.58	-	-	57	-	-	-	-	-	38	-	-	38	-	-	-	-	-	-	-	-	7.6	-	-	-	-	-	0.7	-	-	-
032	2.77	-	-	180	-	-	-	-	-	2380	-	-	139	-	-	3230	-	-	2010	-	-	4.6	-	-	-	-	-	-	-	-	-
035	2.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2	-	-	-	-	-	-	-	-	-
036	0.93	-	-	6	-	-	-	-	-	8	-	-	8	-	-	-	-	-	8	-	-	0.8	-	-	-	-	-	-	-	-	-
038	2.49	-	-	46	-	-	-	-	-	21	-	-	62	-	-	208	-	-	-	-	-	2.1	-	-	-	-	-	-	-	-	-
039	6.14	-	-	600	-	-	-	-	-	-	-	-	102	-	-	1840	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
040	10.55	-	-	100	-	-	-	-	-	-	-	-	-	-	-	176	-	-	-	-	-	8.8	-	-	-	-	-	-	-	-	-
042	5.42	-	-	36	-	-	-	-	-	-	-	-	45	-	-	452	-	-	-	-	-	9.0	-	-	-	-	-	-	-	-	-
050	0.37	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
053	0.52	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
074	17.15	-	-	1000	-	-	-	-	-	3580	-	-	1000	-	-	-	-	-	572	-	-	57.	-	-	-	-	-	-	-	-	-
075	1.34	-	-	6	-	-	-	-	-	45	-	-	11	-	-	1030	-	-	213	-	-	-	-	-	-	-	-	-	-	-	-
076	6.51	-	-	-	-	-	-	-	-	163	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
079	4.13	-	-	13	-	-	-	-	-	241	-	-	34	-	-	206	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
080	2.73	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
091	3.45	9707	9701	6400	-	-	-	-	-	63100	-	-	5470		767000	871000	-	8860	1760	-	190	210	-	49	140	-	290	0.3	-	-	-
Dunel Plant (to 072)	0.72	-	-	200	-	-	-	-	-	114	-	-	30	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subtotal		-	-	9800	-	-	-	-	-	73100	-	-	7670	-	-	879000	-	-	4980	-	-	400	-	-	140	-	-	1.0	-	-	-
WWTP Influent		-	-	59000	-	-	-	-	-	187000	-	-	31900	-	-	85100	-	-	19200	-	-	4600	-	-	2700	-	-	-	-	-	4850
WWTP Mun. Influent		-	-	4800	-	-	-	-	-	9280			1820	-	-	14000	-	-	4960	-	-	530	-	-	260	-	-	-	-	-	-
Total WWTP Influent		-	-	64000	-	-	-	-	-	197000	-	-	33800	-	-	99100	-	-	24200	-	-	5100	-	-	3000	-	-	-	-	-	-
WWTP Effluent		-	-	4000	-	-	10800	-	-	45800	-	-	12700	-	-	178000	-	-	13500	-	-	3000	-	-	1500	-	-	-	-	-	3000

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972

Process or Area		Waste Treatment			Misc. Dist. & Polyol			Misc. Dist. & Polyol.			Hydrogenation		
Union Carbide/RAPP No.		11/009			16/014			17/015			19/017		
NFIC-C Sample Point No.		UCSC - 1			UCSC - 2			UCSC - 3			UCSC - 4		
		EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.
Flow	mgd		0.34			8.62			1.08			2.47	
BOD_5	mg/l				3.48			10.1			3.22		
BOD_{20}	mg/l												
COD	mg/l	29			17			77			10		
TOC	mg/l	12			8			19			4		
pH		8.1			6.9			3.3			7.4		
Tot. Solids	mg/l	362			82			186			92		
Sus. Solids	mg/l	168			8			18			20		
Vol. Solids	mg/l	118			10			22			8		
TKN	mg/l	1.2			0.6			0.8			0.7		
NH_3-N	mg/l	<0.5			<0.5			<0.5			<0.5		
Nitrite & Nitrate	mg/l	1.0			0.8			0.9			0.9		
Tot. Phosphorus	mg/l	0.2			0.1			<0.1			<0.1		
Oil & Grease	mg/l												
Phenols	mg/l				<.01			<.01			<.01		
Cyanide	mg/l				.01			.02			.01		
Mercury	μg/l (1)												
Arsenic	μg/l (1)												
Lead (2)	mg/l												
Zinc (2)	mg/l												
Aluminum (2)	mg/l												
Cadmium (2)	mg/l												
Chromium (2)	mg/l												
Copper (2)	mg/l												
Iron (2)	mg/l												
Magnesium (2)	mg/l												
Manganese (2)	mg/l												
Nickel (2)	mg/l												

NOTES: (1) No mercury or arsenic analyses were run by NFIC-C
(2) Metals analyses results below detectable or normal reporting limits except as shown.

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972

Process Area		Fine Chemicals & Vinylite			No. 2 Cellosolve			Vinyl Resins & Plasticizers			Acetic Esters		
Union Carbide/RAPP No.		22/023			37/024			23/025			27/031		
NFIC-C Sample Point No.		UCSC - 5			UCSC - 6			UCSC - 7			UCSC - 8		
		EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.
Flow	mgd		13.40			3.55			17.83			4.58	
BOD_5	mg/l	4.24			1.86			4.36			2.68		
BOD_{20}	mg/l												
COD	mg/l	12			9			18			10		
TOC	mg/l	6			5			6			6		
pH		4.3			7.6			4.3			7.3		
Tot. Solids	mg/l	146			102			124			110		
Sus. Solids	mg/l	10			6			6			12		
Vol. Solids	mg/l	30			14			8			25		
TKN	mg/l	1.2			0.6			0.6			0.8		
NH_3-N	mg/l	<0.5			<0.5			<0.5			<0.5		
Nitrite & Nitrate	mg/l	0.9			0.9			0.9			0.9		
Tot. Phosphorus	mg/l	<0.1			<0.1			<0.1			<0.1		
Oil and Grease	mg/l												
Phenols	mg/l												
Cyanide	mg/l												
Mercury (1)	µg/l												
Arsenic (1)	µg/l												
Lead (2)	mg/l												
Zinc (2)	mg/l												
Aluminum (2)	mg/l												
Cadmium (2)	mg/l												
Chromium (2)	mg/l												
Copper (2)	mg/l	0.12											
Iron (2)	mg/l												
Magnesium (2)	mg/l												
Manganese (2)	mg/l												
Nickel (2)	mg/l												
Bioassay TL_m	24 hr							14% (3)					
	48 hr							10%					
	96 hr							9.2%					

NOTES: (1) No mercury or arsenic analyses were run by NFIC-C
(2) Metals analyses showed values below detectable or normal reporting limits except as shown.
(3) Death immediate in 100% solution.

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972 (Cont.)

Process Area		Aldehyde & Power House			No. 1 Intake			Aldehyde			Aldehyde		
Union Carbide/RAPP No.		28/032			28N/033			29A/035			29/036		
NFIC-C Sample Point No.		UCSC - 9			UCSC - 10			UCSC - 11			UCSC - 12		
		EPA	UC	W.Va.	EPA	UC	W. Va.	EPA	UC	W.Va.	EPA	UC	W.Va.
Flow	mgd		2.77			--			2.65			0.93	
BOD_5	mg/l	8.82			3.30	1.6		.30			1.97		
BOD_{20}	mg/l												
COD	mg/l	112			8			7			10		
TOC	mg/l	37			5			5			6		
pH		8.7			7.3			7.5			7.5		
Tot. Solids	mg/l	286			104			98			140		
Sus. Solids	mg/l	108			6			18			22		
Vol. Solids	mg/l	52			14			32			40		
TKN	mg/l	0.8			0.7			0.7			0.7		
NH_3-N	mg/l	0.5			<0.5			<0.5			<0.5		
Nitrite & Nitrate	mg/l	1.2			0.9			0.8			0.9		
Tot. Phosphorus	mg/l	0.1			1.3			<0.1			<0.1		
Oil & Grease	mg/l												
Phenols	mg/l	0.03			<.01			<.01			<.01		
Cyanide	mg/l	<.01			<.01			.01			.01		
Mercury (1)	µg/l												
Arsenic (1)	µg/l												
Lead (2)	mg/l												
Zinc (2)	mg/l												
Aluminum (2)	mg/l												
Cadmium (2)	mg/l	0.19											
Chromium (2)	mg/l												
Copper (2)	mg/l												
Iron (2)	mg/l												
Magnesium (2)	mg/l												
Manganese (2)	mg/l												
Nickel (2)	mg/l												

Notes: (1) No mercury or arsenic analyses were run by NFIC-C
(2) Metalsanalyses results below detectable or normal reporting limits except as shown.

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972 (Cont.)

Process Area Union Carbide/RAPP No. NFIC-C Sample Point No.		Aldehyde 30/038 UCSC - 13			Acetaldehyde 31/039 UCSC - 14			Butanol 32/040 UCSC - 15			Butanol 33/042 UCSC - 16		
		EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.
Flow	mgd		2.49			6.14			10.55			5.42	
BOD_5	mg/l	3.41			12.9			2.38			2.0		
BOD_{20}	mg/l												
COD	mg/l	10											
TOC	mg/l	8			7			5			6		
pH		7.6			7.5			7.6			7.4		
Tot. Solids	mg/l	156			182			148			156		
Sus. Solids	mg/l	14			13			10			7		
Vol. Solids	mg/l	26			38			48			44		
TKN	mg/l	0.7			0.6			0.7			0.8		
NH_3-N	mg/l	<0.5			<0.5			<0.5			<0.5		
Nitrite & Nitrate	mg/l	0.9			0.9			0.8			0.9		
Tot. Phosphorus	mg/l	<0.1			<0.1			0.1			<0.1		
Oil & Grease	mg/l												
Phenols	mg/l	<.01			<.01			<.01			<.01		
Cyanide	mg/l	<.01			<.01			.01			.02		
Mercury (1)	µg/l												
Arsenic (1)	µg/l												
Lead (2)	mg/l												
Zinc (2)	mg/l												
Aluminum (2)	mg/l												
Cadmium (2)	mg/l												
Chromium (2)	mg/l												
Copper (2)	mg/l												
Iron (2)	mg/l												
Magnesium (2)	mg/l												
Manganese (2)	mg/l												
Nickel (2)	mg/l												

Notes: (1) No mercury or arsenic analyses were run by NFIC-C.
(2) Metals analyses results below detectable or normal reporting limits except as shown.

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972 (Cont.)

Process Area		Gas Separation			Gas Separation			Raw River Water		
Union Carbide/RAPP No.		53/050			55/053			72/072		
NFIC-C Sample Point No.		UCSC -17			UCSC - 18			UCSC - 20		
		EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.
Flow	mgd		0.37			0.52			0.72	
BOD_5	mg/l	2.29			2.32			1.20	1.6	0.8
BOD_{20}	mg/l									
COD	mg/l	8			8			9		
TOC	mg/l	5			5			5		
pH		7.5			7.3					6.8
Tot. Solids	mg/l	130			128			146		111
Sus. Solids	mg/l	9			7			21		16
Vol. Solids	mg/l	16			20					
TKN	mg/l	0.6			0.6			0.6		0.49
NH_3-N	mg/l	<0.5			<0.5			<0.5		0.14
Nitrite & Nitrate	mg/l	0.9			0.9			0.9		4.8
Tot. Phosphorus	mg/l	0.3			<0.1			<0.1		
Oil & Grease	mg/l	1			1			<1		
Phenols	mg/l	<.01			<.01			<.01		<.01
Cyanide	mg/l	.02			.04			.02		
Mercury (1)	µg/l									0.8
Arsenic (1)	µg/l									<10
Lead (2)	mg/l									<.01
Zinc (2)	mg/l									0.02
Aluminum (2)	mg/l									0.4
Cadmium (2)	mg/l									
Chromium (2)	mg/l									<.05
Copper (2)	mg/l									.14
Iron (2)	mg/l									0.5
Magnesium (2)	mg/l									4.8
Manganese (2)	mg/l									0.1
Nickel (2)	mg/l									<.05

NOTES: (1) No mercury or arsenic analyses were run by NFIC-C
(2) Metals analyses results below detectable or normal reporting limits except as shown.

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972 (Cont.)

Process Area		Misc. Chemicals		Oxide Adducts & Power House		Oxide Adducts & Power House		Oxide Adducts & Power House		
Union Carbide/RAPP No.		74/074		75/075		80/076		79/079		
NFIC-C Sample Point No.		UCSC - 21		UCSC - 22		UCSC - 23		UCSC - 24		
		EPA	UC	EPA	UC	EPA	UC	EPA	UC	W.Va.
Flow	mgd		17.15		1.34		6.51		4.13	
BOD_5	mg/l	8.29		1.77		1		1.58		
BOD_{20}	mg/l									
COD	mg/l	34		13		12		16		
TOC	mg/l	12		6		5		6		
pH		7.4		10.1		7.3		8.2		
Tot. Solids	mg/l	135		238		126		152		
Sus. Solids	mg/l	25		40		18		17		
Vol. Solids	mg/l	34		46		10		28		
TKN	mg/l	1.0		0.6		0.5		0.6		
NH_3-N	mg/l	<0.5		<0.5		<0.5		<0.5		
Nitrite & Nitrate	mg/l	0.8		1.3		0.9		0.9		
Tot. Phosphorus	mg/l	<0.1		<0.1		<0.1		2.1		
Oil & Grease	mg/l									
Phenols	mg/l	<.01		<.01		<.01		<.01		
Cyanide	mg/l	.06		.09		.03		<.01		
Mercury(1)	µg/l									
Arsenic(1)	µg/l									
Lead(2)	mg/l									
Zinc(2)	mg/l									
Aluminum(2)	mg/l									
Cadmium(2)	mg/l									
Chromium(2)	mg/l									
Copper(2)	mg/l									
Iron(2)	mg/l									
Magnesium(2)	mg/l									
Manganese(2)	mg/l									
Nickel(2)	mg/l									
Bioassay TL_m	24 hr	X(3)								
	48 hr	X								
	96 hr	X								

NOTES: (1) No mercury or arsenic analyses were run by NFIC-C.
(2) Metals analyses results below detectable or normal reporting limits except as shown.
(3) Less than 50% mortality in 100% wastewater solution tested.

TABLE B-7 RESULTS OF UNION CARBIDE SOUTH CHARLESTON PLANT SAMPLING MARCH 14 AND 15, 1972 (Contd.)

Process Area		Compressor Drains			Ward Hollow			Dynel		
Union Carbide/RAPP No.		81/080			/081			-		
CFIC Sample Point No.		UCSC - 25			UCSC - 26			UCSC - 27		
		EPA	UC	W.Va.	EPA	UC	W.Va.	EPA	UC	W.Va.
Flow	mgd		2.73			3.45			0.72	
BOD_5	mg/l		1.06		224	339	338	35.6		
BOD_{20}	mg/l									
COD	mg/l	9			2200			28		
TOC	mg/l	5			195			10		
pH		7.4			11.9		11.3	7.3		
Tot. Solids	mg/l	132			30400		26761	134		
Sus. Solids	mg/l	12			82		324	15		
Vol. Solids	mg/l	28			4080			4		
TKN	mg/l	0.6			7.9		7.1	<0.5		
NH_3-N	mg/l	<.05			5.5		1.8	<0.5		
Nitrite & Nitrate	mg/l	0.9			0.7			0.7		
Tot. Phosphorus	mg/l	<0.1			<0.1			<0.1		
Oil & Grease	mg/l				11			1		
Phenols	mg/l	< .01			.01		10	<.01		
Cyanide	mg/l	.06			.01			<.01		
Mercury(1)	µg/l						<0.2			
Arsenic(1)	µg/l						<10			
Lead(2)	mg/l						0.01			
Zinc(2)	mg/l						.06			
Aluminum(2)	mg/l						0.3			
Cadmium(2)	mg/l				.09		.004			
Chromium(2)	mg/l				.11		.17			
Copper(2)	mg/l				.28		.21			
Iron(2)	mg/l						.76			
Magnesium(2)	mg/l						2.4			
Manganese(2)	mg/l						0.43			
Nickel(2)	mg/l				.05		0.4			

NOTES: (1) No mercury or arsenic analyses were run by NFIC-C.
(2) Metals analyses results below detectable or normal reporting limits except as shown.

The effluent from the waste treatment plant had a dissolved oxygen range of 4.8 to 7.2 mg/l, a pH of 6.7 to 6.9, and a temperature of 23 to 27 degrees C. The median tolerance limit (TL 50) was 34 percent at 24 hours, 30 percent at 48 hours, and 26 percent at 96 hours. (The TL50 is the concentration of effluent that would be lethal to 50 percent of the fish held in it for the specified time period, i.e., 24, 48, or 96 hours. Thus, the lower the TL50, the higher the toxicity of the effluent.) The indicated toxicity of this nominal 10 mgd discharge was higher than would be expected of a treated effluent.

The 17.83 mgd flow from outfall No. 025 (the vinyl resins and plasticizers area) and the 17.15 mgd discharge from outfall No. 074 (the miscellaenous chemicals area) were also tested for toxicity by means of static bioassays. Test conditions were: dissolved oxygen 4.9 to 6.8 mg/l, pH 3.3 to 6.0, and temperature 23 to 27 degrees C. The TL50 for outfall No. 025 was 14 percent at 24 hours, 10 percent at 48 hours, and 9.2 percent at 96 hours. The test fish died immediately in a 100 percent discharge solution. There was less than 50 percent mortality in 100 percent wastewater shown in the 24-hour exploratory bioassay of the wastewater stream from outfall No. 074. Further bioassays are undertaken only when the mortality rate in undiluted effluent exceeds 50 percent.

It should be noted that these two outfalls represented only 29 percent of the total untreated wastewater flow from the plant.

Summary and Conclusions

1. Pollution abatement programs which have been undertaken have markedly reduced the plant's pollutional loads to the Kanawha River.

2. To meet established future use criteria for the Kanawha River, additional improvements will be required in waste treatment and other abatement efforts.

3. The wastewater treatment facilities had been operated with good efficiency but the need for a higher level of sustained efficiency is evident. Better biological treatment suspended solids removal, and minimizing the effects of peaks in organic loadings are areas for improvement.

4. The largest sources of pollutional loads to the Kanawha at the time of the survey were the Ward Hollow stream -- 6,400 pounds per day of BOD(5), the waste treatment plant -- 4,000 pounds per day, and the so-called cooling waters -- 3,200 pounds per day. (Since the Ward Hollow stream was routed to the waste treatment plant beginning in late 1972, future abatement efforts must be directed at the waste treatment plant and the untreated cooling water sources.)

5. A number of the plant's outfalls had been properly classified as cooling water streams on the basis of the analytical results of this study.

6. The time lag for the detection and correction of spills or similar upsets in cooling waters was excessive. Daily analyses of composite samples from each cooling water discharge provided the only routine checks.

7. The flume replacement scheduled for completion by late 1973 will bring a needed reduction in discharge of untreated industrial wastewater caused by river flooding, but discharges will still occur during certain extreme conditions.

8. Toxicity levels were high in two of the three outfalls selected for bioassay checks. The possibility exists that the other untested discharges were also toxic.

Recommendations

General

It is recommended that:

1. The combined total Union Carbide-South Charleston Waste Treatment Plant BOD(5) load to the river be reduced to no more than 3,500 pounds per day and the total nitrogen load to no more than 1,400 pounds per day. These numbers are based on the maintenance of 4 mg/l DO at the Kanawha River sag point at a seven-day, once-in-10-year low flow of 1930 cfs at Charleston.

2. The toxicity of effluents be reduced at least to the point that no discharge exceeds 1/20 of the 96-hour TL50.

Waste Treatment Works

It is recommended that:

1. Coagulants be added to the wastewater or that other physical-chemical treatment methods be developed and applied to maintain the primary industrial effluent suspended solids concentration below 30 mg/l.

2. Tests of advanced methods be undertaken to reduce and smooth out organic loadings in the primary system and to improve organic removal in the secondary system.

Union Carbide Plant

It is recommended that:

1. Separation of process wastes from cooling waters be effected, priority efforts being directed toward identification of the pollutants, determination of the sources, and abatement of pollution in the following untreated wastewater discharges:

Outfall	Process Area	Flow
074	Miscellaneous chemicals	17.15
039	Acetaldehyde	6.14
025	Vinyl resins and plasticizers	17.83
023	Fine chemicals and vinylite	13.40
032	Aldehyde and power house	2.77

The above are listed in the recommended order of priority based on the calculated pollutional loads discharged to the Kanawha River. The sum of the BOD(5) loads from these sources is approximately 2,600 pounds per day, over three-fourths of the total load from the 21 cooling water discharges sampled.

2. The untreated wastewater discharge be routed from the Dynel Tow area to the industrial wastewater flume, then to the waste treatment plant.

3. Engineering studies be undertaken to determine the best method for improving the monitoring of untreated wastewater streams and that an improved monitoring system be implemented. The possible use of on-line total carbon analyzers programmed to selectively sample wastewaters from various sources on a timed cycle is suggested.

4. Plant personnel be required to keep an accurate and detailed log of raw wastewater discharged from the flume into the river and to report same to regulatory authorities.

UNION CARBIDE CORPORATION
CHEMICALS AND PLASTICS DIVISION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

General Plant Description

Union Carbide's plant at Institute, West Virginia is located at Mile Point 48.9 on the Kanawha River, about six miles downstream from Charleston on the right side of the river (facing downstream). It occupies just over one mile of shoreline in two stretches, one of which fronts the chemical plant and the other the wastewater treatment plant (Figure C-1).

The plant is bounded on the southeast by West Virginia State College and on the northwest and northeast by largely undeveloped land. The company owns 775 acres, of which 550 had been developed.

The plant was originally built for the United States Government during World War II to produce butadiene and styrene, materials needed to manufacture Buna-S rubber. In April, 1943 styrene production began, and the entire plant was practically complete and in full production.

In 1947, Union Carbide purchased the plant from the Government, not to produce butadiene but other chemicals, such as acetone and butanol. Gas-producing operation began in December 1950, and other additions followed -- the SEVIN complex, the fluorocarbons and CELLOSIZE units, another steam and power plant, and an expanded laboratory.

In early 1970, Union Carbide acquired the West Virginia properties of Ameripol, Inc., a subsidiary of the B. F. Goodrich Company. The principal property consisted of a 36.2-acre parcel of land, including buildings and storage facilities, surrounded on three sides by the Union Carbide plant.

From an initial staff of 147 employees, employment rose to almost 3,000. In February 1972, it stood at about 1,900. The plant was operating 24 hours a day, 365 days a year.

Annual production was about 1.5 million tons of basic and intermediate materials. The products included chemical additives for gasoline, jet fuels, waterbased paints, cheese, baked goods, and other foods. Over 100 chemicals were made for the textile finish industry and over 90 for pharmaceutical companies. The insecticide SEVIN was one of several agricultural chemicals being produced. Products being manufactured in February 1972 and their general uses

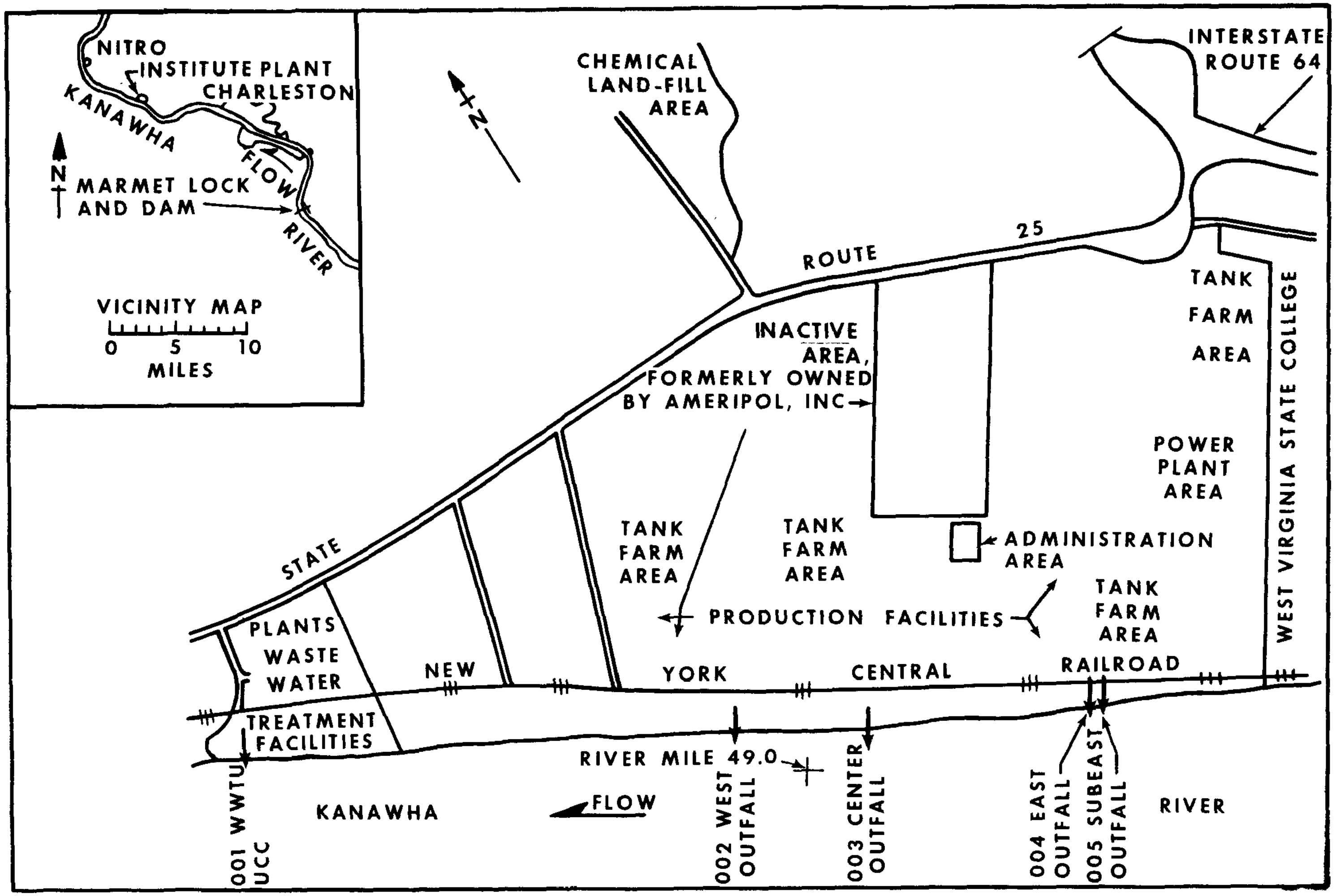


FIGURE C-1
UNION CARBIDE CORPORATION
INSTITUTE PLANT
GENERAL PLAN - PLANT FACILITIES
JULY 1972

are listed in Table C-1. Production units and associated products are listed in Table C-2.

The principal raw material used by the Institute Plant was natural gas. (With the closing of the olefins units in mid-1972, the plant was to import ethylene and propylene.) Other major raw materials included chlorine and caustic, napthalene, isopropanol, ethanol, ammonia, and air.

Water Usage

The plant purchased an average of 1.7 million gallons a day (mgd) of water from the Nitro municipal system and withdrew an average of 300 mgd from the Kanawha River. The latter figure ranged from 240 mgd in winter to 350 mgd in summer.

The average amounts of water used within the plant were:

Cooling water	288.0 mgd
Process water	5.6 mgd
Sanitary system	1.7 mgd
Other	0.7 mgd
Fly ash disposal	2.9 mgd
Evaporation	0.4 mgd

The plant processed about 6.0 mgd through its two in-house raw water treatment plants complete with Zeolite exchange. Water purchased from the City of Nitro was used for in-plant domestic purposes and in some process applications.

The volume of cooling water used had been reduced about 47 percent during the period 1962-1972; (it dropped further when the olefins complex was shut down in mid-1972.) Other water uses had not changed materially in recent years. An average of 5.6 mgd of wastewater, including process and sanitary wastes, was treated at the company's wastewater treatment plant. It was discharged into the Kanawha River.

Wastewater Discharges and Waste Sources

The plant had five major outfalls on the Kanawha River; one was connected to the waste treatment plant, and four discharged cooling water. The plant also discharged wastes to Goff Branch, a small stream to the southeast, which drained into the Kanawha. Figure C-2

TABLE C-1

PRODUCTS MANUFACTURED AT THE UNION CARBIDE INSTITUTE PLANT

Products	Uses	UCC Brand Name
Aldehydes	Intermediates for acids, alcohols, amines	
Ketones	Solvents for lacquers, pharmaceuticals	
Alcohols	Solvents; intermediates for aldehydes, ketones	
Glycols	Solvents; automobile anti-freeze	PRESTONE
Phthalate esters	Plasticizers	FLEXOL
Alkylbenzene	Soft detergents	UCANE
Ethylene oxide adducts	Detergents, surfactants	TERGITOL
Anhydride	Intermediates	
Fluorocarbons	Propellants for aerosols, refrigerants	UCON
Polyethylene glycol	Pharmaceuticals, cosmetics	CARBOWAX
Esters	Solvents	
Acrylates	Plastics	
Polyols	Urethane foams for upholstery mattresses	NIAX
Ethylene oxide polymers	Water thickener, water soluble extruded and molded shapes	POLYOX
Isocyanates	Rigid foams	NIAX
Polymers	Oil additives	UCAR
Fibers	Synthetic yarn	
Hydroxyethyl cellulose	Paint thickener	CELLOSIZE
Glutaraldehyde	Tanning agent for leather, makes leather washable	UCAR
Mixed oxide adducts	Brake fluids, lubricants	UCON
Aryls	Intermediates, dye carriers	
Ethers	Extractants	
Pyridines	Pharmaceutical intermediates	
Oxides	Sterilizers, fumigents, intermediates	
Carbamates	Insecticides, pesticides	SEVIN

TABLE C-2

PRODUCTION UNITS AND ASSOCIATED PRODUCTS

Union Carbide - Institute Plant

Units	Product or Use
Olefins[1]	Ethylene, propylene, acetylene, butadiene, dripolene - from natural gas
High pressure hydrogenation	Intermediate for weather resistant rubber
Alkylbenzene	Intermediate for biodegradable detergents
Ketones	Isopropanol, miscellaneous ketones
Misc. recovery	Miscellaneous chemicals processing
Butanol	Butanol and intermediates for other alcohols
UCAR improvers	Oil additives
CELLOSIZE	Hydroxyethyl cellulose
Catalyst	Miscellaneous catalysts
Plasticizers	Phthalate esters - plasticizers
Ethylene oxidation	Pyridines pharmaceutical intermediates
Ethylene glycol[2]	Ethylene oxide, ethylene glycol
Air separation	Nitrogen, oxygen
Acrolein derivatives	Acrolein derivatives, glutaraldehyde
Fluorocarbons	Fluorocarbons
SEVIN	SEVIN insecticide
SPANDEX[3]	SPANDEX - yarn for elastic wearing apparel
POLYOX[4]	POLYOX
Oxide derivatives[5]	TERGITOL, TEMIK, CARBOWAX, acrylates
Rigid polyols	Polyalcohols for urethane foams
Isocyanates	TDI- foam insulation ingredient
DNT	DNT - an intermediate
Phthalic anhydride	Phthalic anhydride, FLEXOL DOP

1 - The operation of the Olefins Unit discontinued in 1972.

2 - The production of ethylene oxide discontinued in 1972.

3 - The production of SPANDEX was discontinued in 1972.

4 - The POLYOX Unit is operated a maximum of six months per year.

5 - The production of TEMIK discontinued in 1972.

is a flow diagram of the sources of cooling water, and Figure C-3 shows the wastewaters directed to the wastewater treatment plant.

The wastewater treatment outfall (001) was submerged and usually created a surface roil in the river. Three cooling water outfalls (002, 003, 004) were above water, while the fourth (005) was submerged and also created a surface roil.

Even though the discharges from outfalls 002, 003, 004, and 005 were primarily cooling waters, they contained significant quantities of pollutants. Company officials stated that they separated as much as possible all direct, continuous, and intermittent process discharges to the cooling water sewers.

Direct discharges into the river occurred from traveling screen backwashes at the three raw water intake pumphouses. Some accidental discharges into Goff Branch had occurred in the past from production areas and a hydrochloric acid neutralization process.

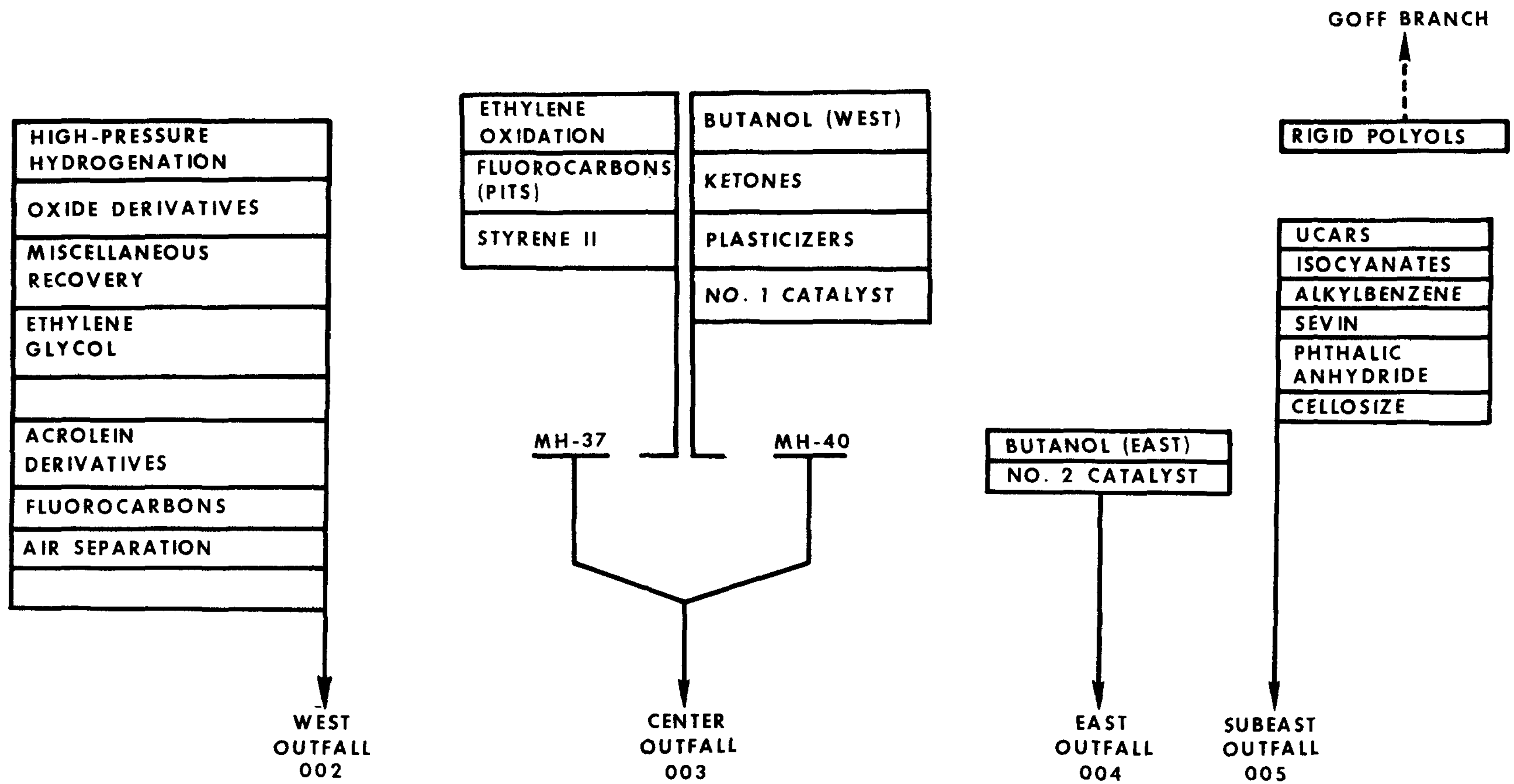
Waste Treatment Program

Historical Development

Information on waste control efforts prior to the initiation in 1958 of the State's phased program was not obtained from the company. At the beginning of the phased cleanup program, the plant was apportioned about 130,000 pounds per day of BOD(5) as its average contribution to the Kanawha. Figure C-4 is a company graph of raw BOD(5) loads, permit limits, and loads discharged from 1958 through 1971. Thirty to 40 percent of the BOD(5) load imposed on the river had been discharged into it via cooling waters, which had been increasing while the total load had been increasing.

The State's Phase I program required that the 1958 BOD(5) load be reduced by 40 percent to 78,000 pounds per day by mid-1963. As the final step in meeting the Phase I requirements, the company constructed an aerated stabilization facility capable of removing 50,000 pounds per day. The facility came on line in 1963. Preliminary work to reduce the wasteload to the waste treatment plant included source eliminations, tighter housekeeping practices, and incineration in the powerhouse.

When Phase I ended in mid-1972 and the State's water quality objectives for the river had not been met, it launched Phase II. The plant was required to achieve a 70 percent reduction of the 1958 BOD(5) load by mid-1966. This limit of 39,000 pounds per day was attained by converting an aerated lagoon into an activated sludge system, improving source controls, and installing an elaborate in-



NOTE:
1. DNT Unit has recycle cooling water system.

FIGURE C-2
COOLING WATER UNIT SOURCES
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

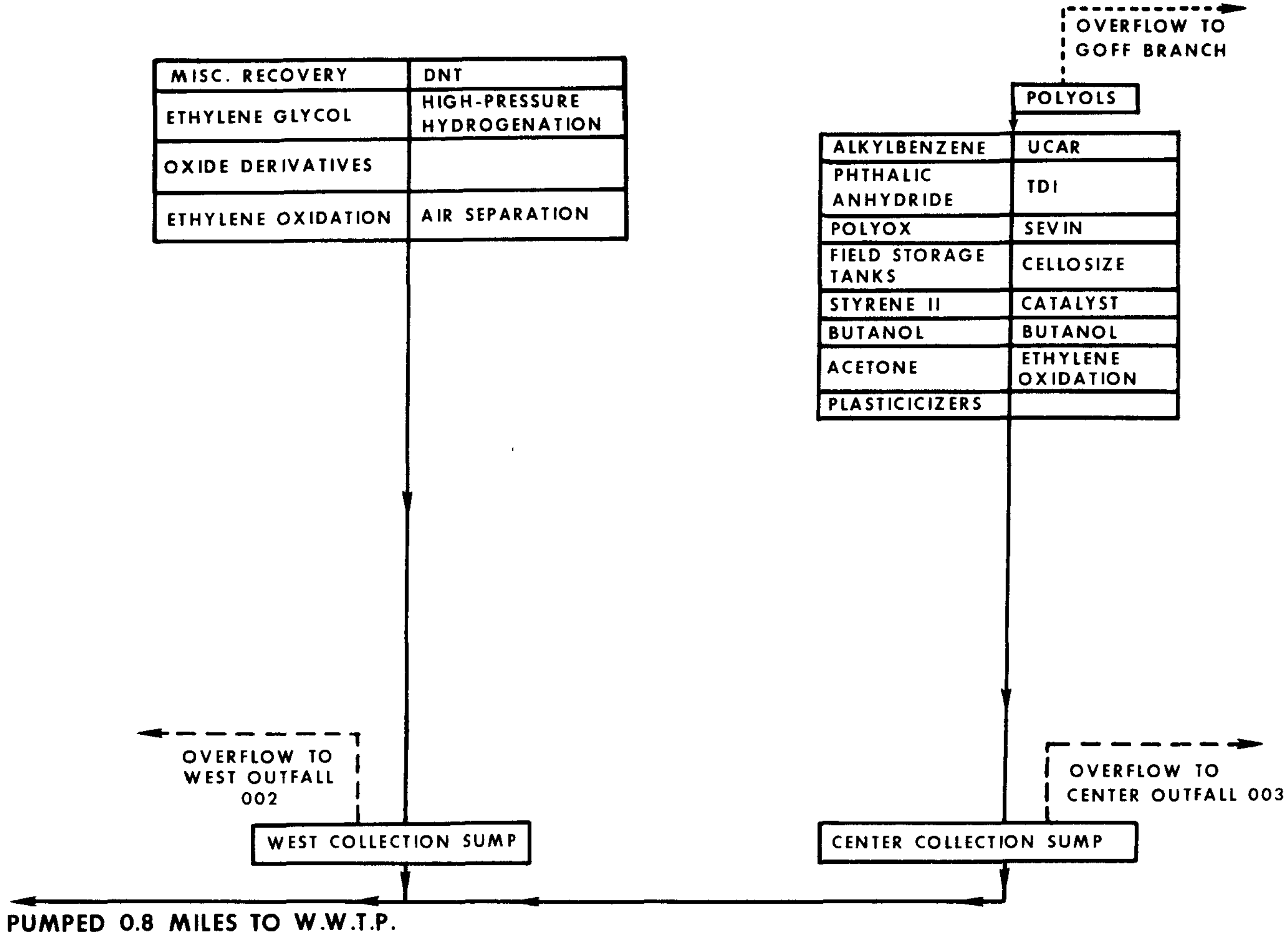


FIGURE C-3

UNIT SOURCES OF WASTEWATERS DIRECTED TO THE WASTEWATER TREATMENT PLANT

UNION CARBIDE CORPORATION

INSTITUTE PLANT

INSTITUTE, WEST VIRGINIA

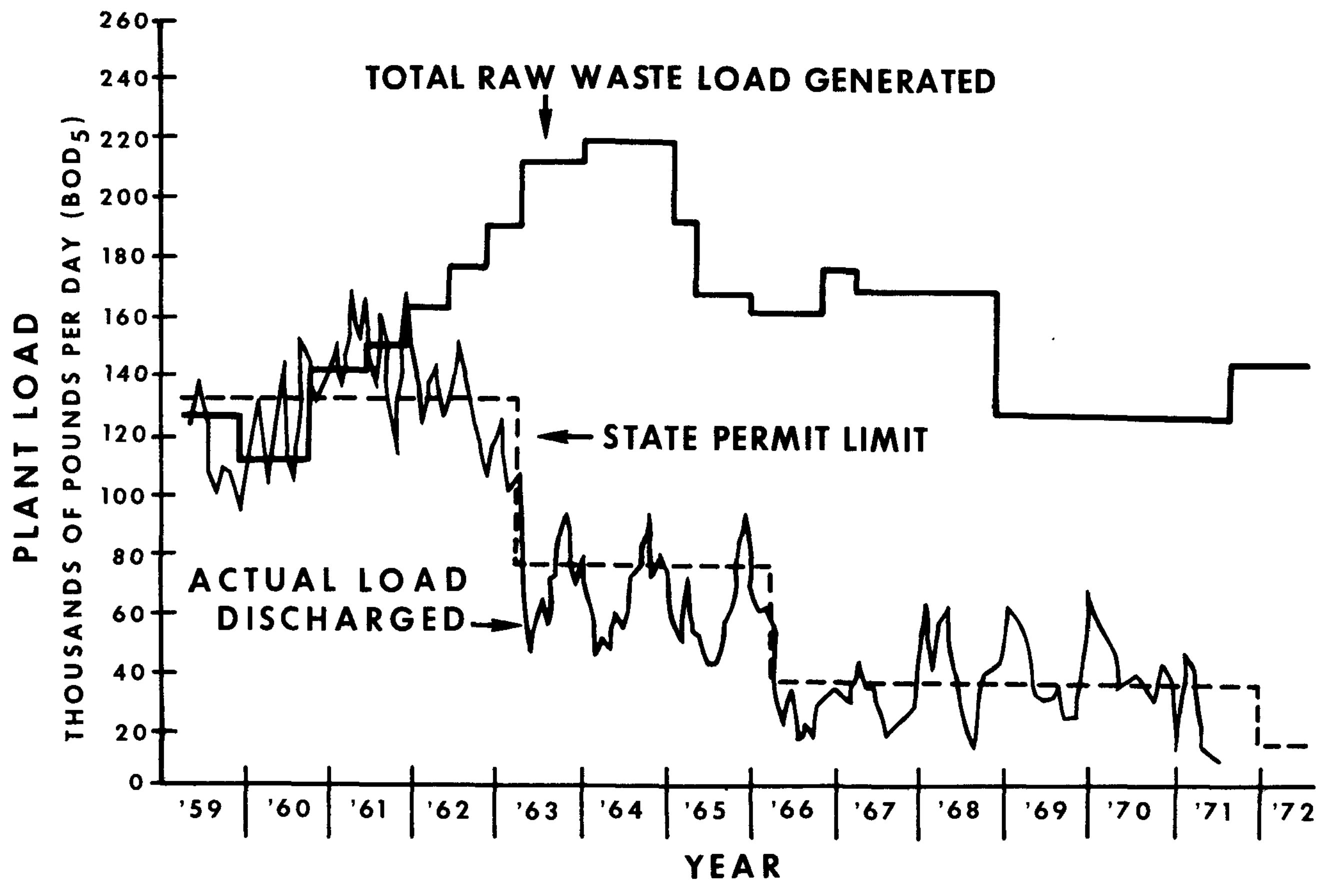


FIGURE C-4
TOTAL RAW LOAD GENERATED, PERMIT LIMITS, AND LOAD DISCHARGED.
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

plant monitoring and control system. These improvements were completed in 1966.

The dissolved oxygen (DO) level in the Kanawha was still below 3.0 mg/l at the sag point when Phase II ended, therefore the State initiated Phase III in 1969. The plant was then required to achieve an 85 percent reduction in the 1958 BOD(5) load and as large a reduction of its nitrogenous load as practical by the end of 1972. The allowable BOD(5) discharge was reduced to 19,500 pounds per day.

To attain these reductions, six additional 100-horsepower aerators were installed. This increased the BOD(5) reduction capacity of the biological system to about 97,000 pounds per day. Source control measures included stripping, decanting, and incineration. Additional low-flow waste streams were diverted from the cooling water sewer system to the wastewater treatment plant. Production unit shutdowns also lowered waste discharge loadings. The retirement of the acrylic esters unit resulted in 65 percent reduction in the oxidizable nitrogen load and a drop of 15,000 pounds per day in the BOD(5) load sent to the biological system.

The company indicated the improved operation of the final clarifiers and the removal of TERGITOL detergents had resulted in a 75 percent reduction of suspended solids and a decrease of 6,000 pounds per day BOD(5) discharge to the river from the wastewater treatment plant. Expansion of the cooling water monitoring system and installation of carbon analyzers on the major outfalls had minimized the duration of accidental spills, condenser leaks, etc. The company;s records indicated that the Phase III BOD(5) goal was attained during only eight months on 1971. The Phase III program was scheduled to end in December 1972.

Waste Disposal Facilities

One of two powerhouses had been modified to burn liquid organic wastes, and in 1971, the average amount incinerated was the equivalent of 600,000 pounds of BOD(5) per day. An average of 2.9 mgd of fly ash slurry was handled by a private contractor and pumped to its landfill about 1.5 miles east of the plant. The overflow from the site discharged into Finney Creek, which in turn empties into the Kanawha.

The plant's Environmental Department operated a State-licensed chemical landfill (Goff Mountain Landfill) in a 40-acre mountain valley site just north of the plant. About seven acres were being utilized. Solid organic chemical wastes consisting of filter cakes, rejected products, etc,. were handled in a managed disposal pattern. The solid materials were retained by a leaky earth dam. Liquid runoff was directed through the dam, collected, and sent through the wastewater treatment plant.

A 15-acre site west of the wastewater treatment plant was used to dispose of inert (non-chemical) materials.

Wastewater Treatment Plant

Process and sanitary waterborne wastes, drainage from tank truck loading racks and runoff from the Goff Mountain landfill were sent to the wastewater treatment plant. The BOD(5) loading to the plant averaged about 110,000 pounds per day. The figure varied by 30 to 40 percent, principally because wastes from the CELLOSIZE unit were either burned or routed to the treatment plant.

The wastewater treatment plant was located on a 15-acre site 0.8 mile downstream from the production site; there was room for expansion.

The wastewater treatment plant included:

1. A collection and pumping system

Process wastes from the plant were collected in two sump areas (Figure C-3). One sump collected wastewater from the eastern and nearby western plant areas, and the other did so from the far western plant area wastes. An operator in the control room at the treatment plant mormally monitored the pH of the intake and requested that acid or base from various production units be added.

The wastes were transferred approximately one mile to the wastewater treatment plant via a 20-inch diameter fiberglass-reinforced polyester pipe.

2. Primary System - Equalization Basin (Figure C-5)

Wastewater from the transfer line entered a 1 million-gallon equalization basin which had a 4-hour retention time at the normal waste flow of 5.6 mgd. The resulting sludge was transferred to the adjacent sludge storage basin, and floating organic chemicals and solids were removed by mechanical means. Automated measurements of flow, pH, temperature, total carbon, and specific organic chemicals were recorded for the effluent (the influent to the aeration basins.)

3. Secondary System - Biological Aeration Basins (Figure C-5)

This system consisted of three 5 million-gallon, one-acre aeration basins which contained a total of fifteen 75-horsepower and

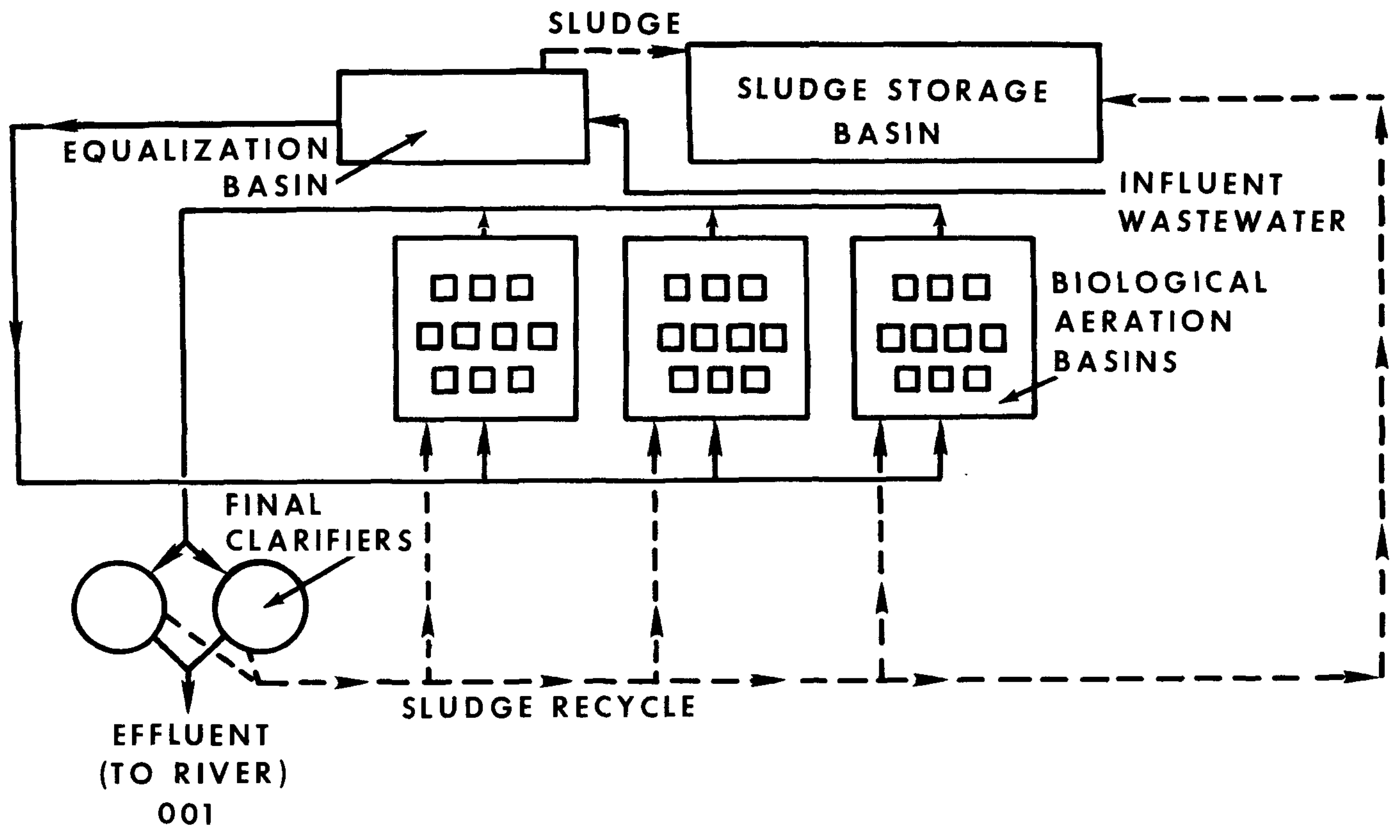


FIGURE C-5
INSTITUTE PLANT'S WASTE WATER TREATMENT UNIT
UNION CARBIDE CORPORATION
INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

fifteen 100 horsepower aerators and two 316,000-gallon final clarifiers.

During non-recycling periods, the aeration basins and the final clarifiers had retention times of 62 and 2.5 hours, respectively, at the average plant wastewater flow of 5.6 mgd. When return sludge flow was underway, retention time was reduced to 40 hours. The three aeration basins had been designed so they could be operated in parallel or in series.

The effluent from the aeration basins was transported to the two final clarifiers where the liquid overflow was discharged into the river through the submerged outfall No. 001. Two sludge pumps moved the settled materials from the bottom of the clarifiers to be recycled to the aeration basin or wasted to the 12 million-gallon sludge-holding basin. Sludge was pumped from the holding basin to nearby sludge-drying beds. The dried sludge was landfilled at the adjacent site.

Cooling Water

On an average, 275 mgd of water were needed for cooling purposes in summer and 238 mgd in winter. The summer average discharge quantity (in mgd) for each outfall was:

002, 90; 003, 105; 004, 15; and 005, 65.

Monitoring

An extensive monitoring program was followed at the plant, including in-plant process waters, cooling waters, river water, outfalls, and wastewater treatment unit evaluations. The sewer sampling schedule for the plant is illustrated in Table C-3, and the on-stream analyzers or monitors are listed in Table C-4. In all, 26 in-plant process wastewater samplers and 43 cooling water samplers were utilized daily.

Efficiency of Waste Treatment

Prior to 1963, few waterborne waste loads were treated, and any load reductions achieved resulted primarily from increased process control. Figure C-6, however, illustrates how progress in treatment after 1963 reduced the BOD(5) loads imposed on the river; the table is based on data provided by plant officials. In the table, the difference between the total raw load and the amount discharged into the river represents the quantity removed in the wastewater treatment plant.

TABLE C-3

SEWER SAMPLING SCHEDULE

Union Carbide Corporation - Institute Plant
Chemicals and Plastics Environmental Protection Dept.

	Inlet Water No. 2 Pumphouse	River Water St. Albans Bridge	WWTP Influent	Center Collection Sump	West Collection Sump	WWTP Effluent (001)	Cooling Water Composite	Cooling Water West Outfall (002)	Cooling Water Center Outfall (003) MH-40 Branch	Cooling Water Center Outfall (003) MH-37 Branch	Cooling Water East Outfall (004)	Cooling Water Subeast Outfall (005)	Goff Branch	Contractors Flyash Pond Effluent	Unit Process Sewers 26 Samples Max.	Unit Cooling Water Sewers 43 Samples Max.	Each of 3 Biobasins*
Dissolved Oxygen	-	-	-	-	-	-	-	-	-				-	-	-	-	3/D
Biobasin Oxygen Uptake	-	-	-	-	-	-	-	-	-				-	-	-	-	3/D
Temperature	-	2/W	-	-	-	-	-	-	-				-	-	-	-	2/D
Carbonate Carbon	5/W	-	1/W	5/W	5/W	1/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	As needed		-
Organic Carbon	5/W	-	1/D	5/W	5/W	1/D	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	5/W	-
BOD_5	2/W	-	2/W	-	-	2/W	2/W	-	-	-	-	-	1/W	-	-	-	-
BOD_{20}	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Gas Chromatography	-	-	1/W	5/W	5/W	1/W	-	5/W	5/W	5/W	5/W	5/W	-	1/W	As Requested		-
Acidity	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Alkalinity	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
COD	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Chlorides	1/W	2/W	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Color	1/W	-	-	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
pH	2/W	2/W	2/W	5/W	5/W	2/W	2/W	-	-	-	-	-	5/W	5/W	-	-	2/D
Ortho Phosphate	-	-	5/W	-	-	5/W	-	-	-	-	-	-	-	-	-	-	-
Total Phosphorus	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	
Phenolics	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Ammonia Nitrogen	1/W	1/W	1/W	5/W	5/W	2/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Kjeldahl Nitrogen	1/W	1/W	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Nitrate Nitrogen	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Total Volatile Solids	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Suspended Solids	1/W	-	1/W	-	-	1/D	1/W	-	-	-	-	-	1/W	5/W	-	-	5/W*
Soluble Solids	1/W	-	1/W	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Fecal Coliform	1/W	-	-	-	-	1/W	1/W	-	-	-	-	-	1/W	-	-	-	-
Total Coliform	1/M	-	--	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Fecal Strep	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Oil & Grease	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Specific Conductivity	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Sulfide	1/M	-	--	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Sulfite	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-
Surfactants	1/M	-	-	-	-	-	1/M	-	-	-	-	-	-	-	-	-	-
Turbidity	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	-	-	-	-	-
Sulfates	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	-	-	-	-	-
Total Hardness	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	-	-	-	-	-
Metals	1/M	-	-	-	-	1/M	1/M	-	-	-	-	-	1/M	-	-	-	-

* Composite of all 3 Biobasins.

NOTE: W - Week; M - Month; D - Day.

TABLE C-4

ON-STREAM ANALYZERS OR MONITORS

Union Carbide Corporation - Institute Plant
Chemicals and Plastics Environmental Protection Dept.

	River Water	Cooling Water			Outfalls		Wastewater Treatment Unit			
	No. 2 Pumphouse	West 002	Center 003 MH-40	Center 003 Mh-37	East 004	Subeast 005	Influent	Each of 3 Biobasins	Each of 2 Clarifiers	Effluent 001
Total Carbon	X	X	X	X			X			
Gas Chromatography			X			X	X			
Dissolved Oxygen								X		
pH							X	X		
Flow							X	X		
Solids Level									X	

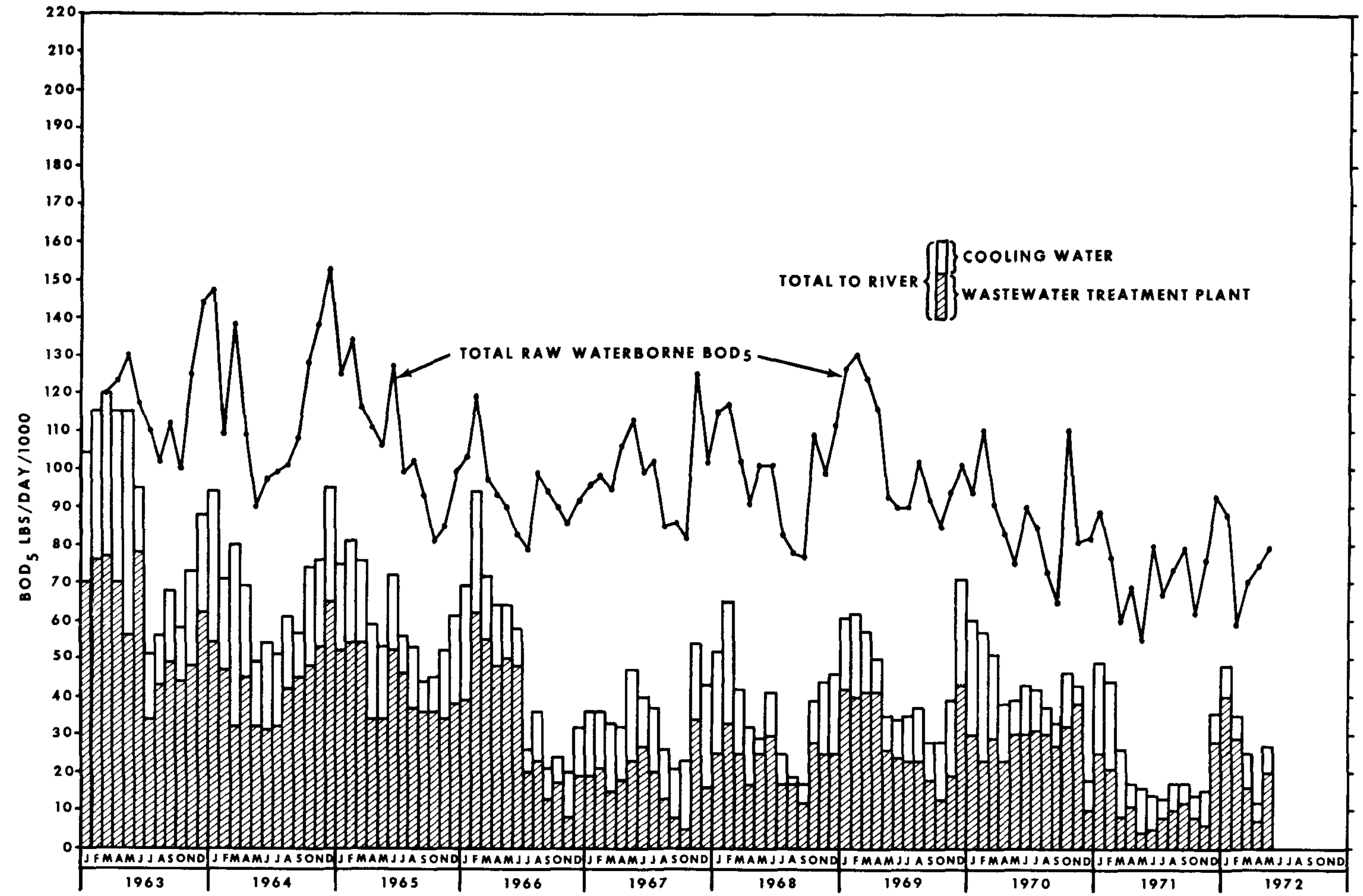


FIGURE C-6
WATERBORNE BOD5 LOADS - RAW AND DISCHARGED
(PLANT DATA)
UNION CARBIDE CORPORATION, INSTITUTE PLANT
INSTITUTE, WEST VIRGINIA

During Phase I, the initial wastewater treatment plant's BOD(5) removal efficiency ranged between 50 and 60 percent. After it was expanded in 1966, efficiency increased to 70 percent until the end of 1967. Since then, the level has varied widely -- from 40 percent in December 1969 to more than 90 percent in mid-1971. The average for the entire year of 1969 was about 60 percent.

The BOD(5) loading data for cooling water and the wastewater treatment unit discharges from the plant since 1963 are summarized in Table C-5. There was a continuous reduction in cooling water BOD(5) loads until 1966; they then leveled off until 1970 and dropped again in 1971. In 1971, the cooling water BOD(5) load averaged 39.2 percent of the 1963 load. Treatment plant influent BOD(5) loadings were erratic until 1970 when an 18.6 percent reduction occurred. In 1971, the influent load was 72.2 percent of that for 1963.

The waste treatment plant's ability to remove BOD(5) increased steadily from 1963 through 1966, then rose sharply after it was expanded in 1966. The average annual efficiency level dropped, however, in 1969 and 1970. In 1971, the annual efficiency reached 80 percent, the highest level observed. Efficiency fell off badly in the winter of 1971-72. Company officials said that an imbalance in pH control killed organisms in the aeration basins. (Sludge from the south Charleston treatment plant was used to reseed the activated sludge but recovery took several months.)

Kjeldahl nitrogen loads from the wastewater treatment plant varied widely from 1968 through 1970, but the average load dropped from 30,000 pounds per day in 1968 to 25,000 pounds per day in 1970. The average decreased to about 5,000 pounds per day in early 1971 (and has remained there), primarily as a result of source control; the treatment plant itself does not remove nitrogen effectively. The large decrease in early 1971 resulted from the closedown of the acrylic esters unit.

Future Plans

	Project	Purposes
1.	Tie east field storage tanks to process sewer.	Divert surface drainage wastes from cooling water.
2.	Install specific organic chemical analyzer on outfall 005.	Rapid identification and correction at source of spills.
3.	Install new pump and modify two others at center sumps; modify control instrumentation.	Increased reliability; eliminate overflow to cooling water.

TABLE C-5

SUMMARY OF BOD_5 LOADINGS - UNION CARBIDE INSTITUTE PLANT
COOLING WATER AND TREATMENT PLANT

	Cooling Water		Treatment Plant			Total Load
	lbs/day/1000	% of load to river	Influent lbs/day/1000	Effluent lbs/day/1000	% Removal	lbs/day/1000
1963	27.6	32	87.6	58.9	33	86.5
1964	23.5	34	92.7	45.7	51	69.2
1965	19.9	33	88.1	40.7	54	60.6
1966	15.0	31	78.8	33.2	58	48.2
1967	16.2	45	82.7	19.5	77	35.7
1968	14.4	39	83.2	23.0	72	37.4
1969	14.3	32	88.7	30.4	66	44.7
1970	14.5	34	72.2	27.7	61	42.2
1971	10.8	47	63.3	12.4	80	23.2

4. Install a parallel transfer line from plant to wastewater treatment facility.	Insurance against break.
5. Add two new sludge recycle pumps at treatment facility.	Provide reliability and increase sludge recycling capacity.
6. Lay a second line to transfer effluent from biobasins to the secondary clarifiers.	Prevent backup of flow in biobasins.
7. Reduce BOD load to cooling water by 2,200 pounds per day.	Collect and recover or burn wastes.
8. Install interceptor process sewer.	Serve plant river bank-dock area.
9. Install sludge drying basin and mix dried sludge with soil.	The mix will be used as the blending agent at the Goff chemical landfill.

Spill Potential

The plant had an inherent design weakness in that the old cooling water drainage system was so positioned that spillages drained into it unless they were pumped directly to the process waste line. This situation resulted in the direct discharge of most production unit upsets, pond drainage, leaky glands, and spills resulting from negligence and mechanical failure.

Recent notable spills included one that occurred when a barge was overfilled and 46,000 gallons of methyl iosbutyl ketone (MIBK) were lost on January 20, 1972. Thirty six hundred gallons of dicyclopentadiene were discharged through a spill into a cooling water sewer on February 15, 1972.

Based on experience, the potential for significant chemical spills is relatively high. Plant personnel recognized this problem and had installed a monitoring system to detect spills to cooling water.

NFIC-Cincinnati Field Survey

Sampling

To confirm and/or ascertain the magnitude of wastewater discharge loadings and sources, NFIC-C conducted a 24-hour sampling survey of the plant's intake water, waste treatment plant influent and effluent, the four main cooling water outfalls, and Goff Branch on February 23 and 24, 1972. Two-hour grab samples were composited for each outfall and were split with the company and West Virginia's Division of Water Resources. The analytical results, converted to pounds per day net loadings, are listed in Table C-6.

Analytical Results

Based on the company's data, the treatment plant's BOD(5) removal efficiency was only 55 percent during the survey, but an upset condition existed in the facility at the time of sampling.

About half the BOD(5) discharged into the river entered it from the wastewater treatment plant outfall (001). The remainder was present in cooling water discharges, mainly those from outfalls 002 and 003. The company's COD and TOC values were correlatable with those for BOD(5) during the survey. Over one million pounds per day of dissolved solids (related to chlorides) were discharged, particularly from the treatment plant.

Over 100 pounds per day of phenols entered the river from the wastewater treatment plant and 40 pounds were present in cooling water discharges. The high load from the treatment facility reflects the upset condition prevailing in its biological system. Under favorable biological growth conditions, the activated sludge system is capable of removing over 99 percent of phenols. Oil and grease concentrations from the treatment plant were measured at 38 mg/l by EPA and at 19 mg/l by the company.

Metals analyses by the State indicated that cadmium, aluminum, magnesium, calcium, and sodium were contained in the effluent from the wastewater treatment plant. Cadmium was measured at 330 pounds per day (over 6 mg/l).

Toxicity of Effluents

Static bioassay tests, using fathead minnows, were made in March 1972 on the effluent from outfalls 001, 003, and 005. The effluent had a dissolved oxygen range of 4.0 to 5.8 mg/l, a pH of 6.6 to 6.9, and a temperature of 23 to 27 degree C. Toxicity was shown only in the effluent from the waste treatment plant outfall (001). The median tolerance limit (TL50) wastewater percentage at 24 hours was 24 percent, at 48 hours 9 percent, and at 96 hours 9 percent. All of the fish that died did so within 48 hours. (The TL50 is the percentage of wastewater by volume which will kill 50 percent of the test organisms in the specified time.) The toxic agent was suspected to be cadmium.

TABLE C-6

UNION CARBIDE INSTITUTE PLANT

NET LOADS LBS/DAY

EPA SURVEY 2/23-2/24/72

	Wastewater Treatment Plant - Influent			Wastewater Treatment Plant-Effluent (001)			West Outfall (002)			Center Outfall (003)			East Outfall (004)			Subeast Outfall (005)			Goff Branch			Total to River	
	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	State	EPA	Co.	EPA
Flow	5.8			5.8			74.9			54.1			11.2			55.3			2.9				
BOD_5	45,100		26,500	25,400	28,000	25,300	9,500		9,300	7,900		8,840	2,230		3,040	484	2,170	2,170	370	430	270	50,200	48,900
BOD_{20}					36,600	47,700											2,350			670			
COD	107,500		106,600	93,900		87,700	23,100		0	18,900		0	4,480		2,150	11,100		14,300	0		1,350	151,500	105,500
TOC	55,900		23,300	37,000		22,800	8,740		0	7,220		900	1,680		750	3,230	0	700		220		57,900	25,100
Total Solids	37,200		370,000	338,000	337,000	337,000	52,500		32,500	718,000		109,000	5,140		6,720	458,000	342,000	385,000	17,800	17,900	17,900	1,589,000	888,000
Susp. Solids	2,610		3,530	1,980	5,760	1,890	9,990		17,500	35,600		0	3,360		1,400	54,900	57,600	52,600	9,070	9,290	8,970	114,900	82,400
Vol. Solids	42,300			53,900			31,200			69,500			190			107,000			3,120			264,900	
Chloride	201,000		203,000	182,000	200,000		0			307,000		35,200	0			151,000	144,000	153,000	2,660	3,310	3,450	642,700	
NH_3-N	720			850	1,980	2,270	37		0	22		0	4		0	14	100	46	4	0	14	930	2,330
TKN	2,860			3,850	3,650	3,290	510		125	580		45	110		100	280	190	140	66	17	26	5,400	3,730
NO_3-N	250			14	410		56			0			83			0	0		12	22		165	
NO_2-N	1			5			0			4			9			0			0			18	
Phenols	180		100	120	54	100	9		12	13		13	2		2	15	11	9	7	5	6	166	142
Acidity	1,210			1,210			6,250			0			0			13,800			0			21,260	
Alkalinity	26,100			18,600			9,370			2,250			0			9,220			1,450			40,900	
Oil & Grease	2,320		9,670	920		1,890	0		0	450		900	180		0	0		0	0		0	1,550	2,790
Sulfates	3,050			9,040			0			0			180			0		0	1,160			10,380	
HCN	0		0	0		0	0		6	0		0	0		0	0		50	0		0	0	56
Aluminum					500												230			100			
Arsenic					0												0			0			
Magnesium					43												1,750			240			
Manganese					1												5			7	4		
Iron					0												230			210			
Calcium					72												75,400			1,130			
Cadmium					330												0			0			
Nickel					5												0			0			
Lead					0.5												7			0			
Copper			6		12												0			0			
Zinc					14												0			2			
Sodium					128,000												39,000			4,700			
Potassium					330												0			65			
Chromium			5		5												0			0			
pH	7.1			7.6	7.5		9.8			6.8			7.8			10.4	9.9		7.9	7.2			
TO No.					1,000												50			50			

Summary and Conclusions

1. The plant was in compliance with the State's pollution control program.

2. In-plant, wastewater treatment, unit, and effluent monitoring programs were extensive.

3. Toxicity was a definite problem in the wastewater treatment system.

4. The diversion of contaminated streams from cooling water systems which served the plant was critical to the effectiveness of future abatement programs.

5. Additional removal of contaminants from cooling waters was required so that the company could meet any reasonably imposed discharge criteria in the future.

6. Landfill leachate containing toxic elements could cause problems in the wastewater treatment system.

Recommendations

It is recommended that:

1. The toxicity of the effluent be reduced so that no discharge exceed 1/20 of the 96-hour TL50.

2. An effluent pH range of 6.0 to 8.5 be maintained.

3. Waste streams which add BOD, COD, TOC, phenols, oil and grease, and suspended solids to cooling waters be separated and treated.

4. Total phenol discharges be reduced to the State-imposed limit of four pounds per day.

5. The total BOD(5) and TKN discharges to the river be lowered to on or more than 2,800 and 1,300 pounds per day, respectively, in order for the Kanawha to meet the DO criterion of 4.0 mg/l at the proposed flow of 1,930 cfs.

6. By using process control and recycling, reduce to an absolute minimum the load of dissolved solids discharged into the river.

7. The spill potential of organic chemicals into cooling waters be decreased by complete separation and containment wherever possible

so that the wastes can be diverted to the process sewer system or the recovery system.

8. The cadmium source be isolated and that wastewaters be treated at the source to reduce the pollutional effects on the treatment plant and the river.

FMC CORPORATION
INDUSTRIAL CHEMICAL DIVISION
SOUTH CHARLESTON PLANT
SOUTH CHARLESTON, WEST VIRGINIA

General Plant Description

The plant is located on the left bank of the Kanawha River (facing downstream) and occupies 3,150 feet of the river shoreline in three separate sections (Figure D-1) between Mile Points 54 and 55. At the time of the survey, it was called the Inorganic Chemicals Division. The plant areas along shore were: (1) the original plant site that housed the chlorine and related production units; (2) the process development and quality control laboratory; (3) the downstream site where chlorinated dry bleach production units were located. A fourth area was inland and housed administrative offices, hydrogen peroxide production units, and a fly ash lagoon.

The plant had changed a great deal since it became operational in 1915. Three production units had been shut down for economic reasons, the hydrogen peroxide and dry bleach production units had been added, and most other units had been altered to increase their efficiency and capabilities. Employment had been stable at about 1,000 persons. The plant was being operated 24 hours per day, 365 days a year.

The plant manufactured the following products: hydrogen peroxide, liquid anhydrous ammonia, caustic sodas, chlorine gas, chlorine liquid, and chlorinated dry bleach. The amount of production was not ascertained. Raw materials used included salt brine, coal, urea, sulfur, and methane (natural gas). The brine was brought in by barge from a concentrated supply at Ben's Run, West Virginia.

Water Usage

Plant officials had reported in their Refuse Act permit application that it used 3.15 million gallons a day (mgd) of city water and 180.9 mgd of river water. The total amount was used as follows: 176.4 mgd for cooling purposes, 1.54 mgd for boiler feed, 6.05 mgd for process water, and 0.06 mgd for the plant's sanitary system. The usage contained in the application is not compatible with the Company's reported total discharge, 91 mgd. The amount used as cooling water probably represented the potential available rather than that actually used. The company stated that its water use had been stable, both seasonally and historically.

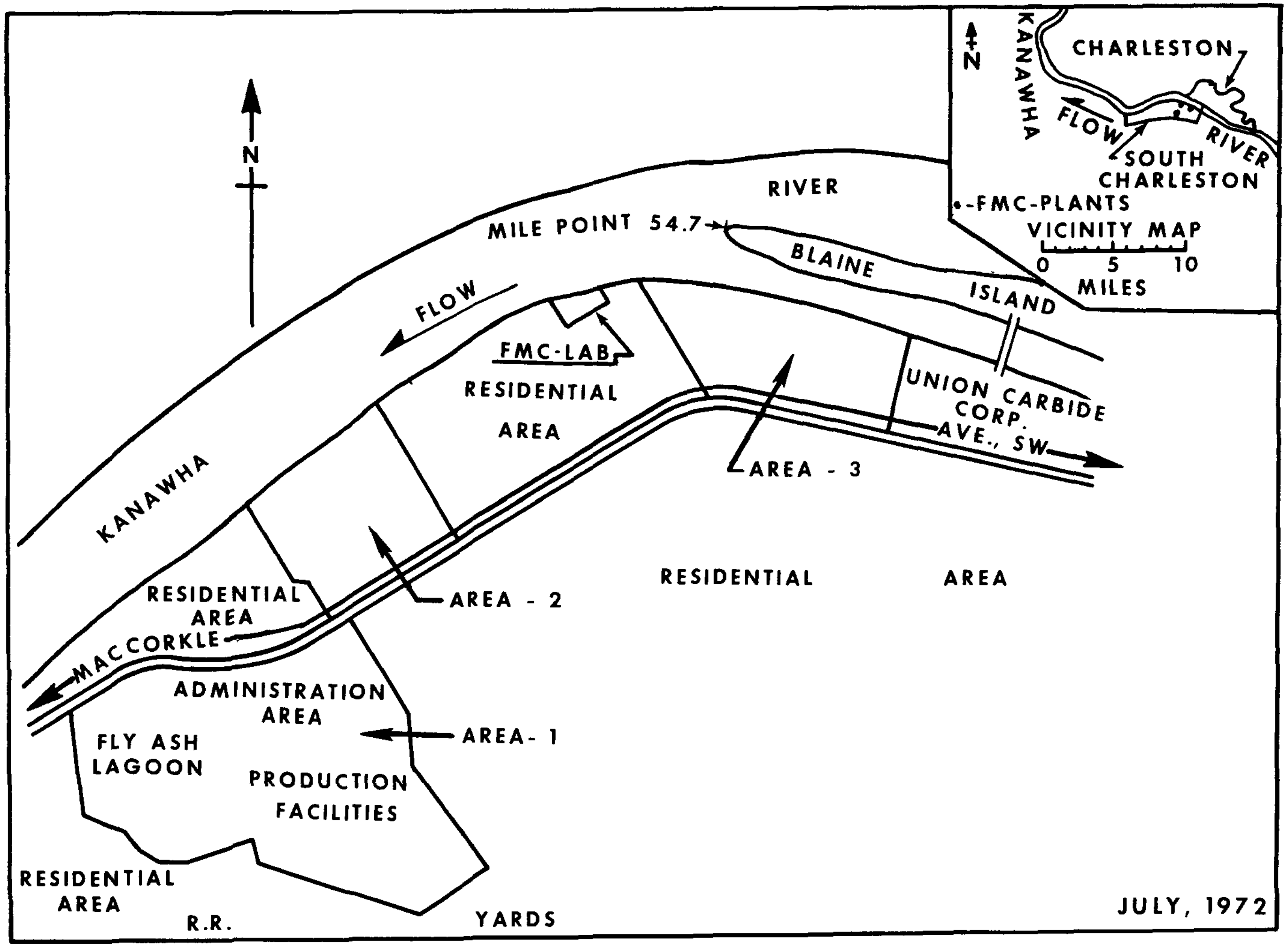


FIGURE D-1

FMC CORPORATION INORGANIC CHEMICALS DIVISION
SOUTH CHARLESTON PLANT
GENERAL PLAN - PLANT FACILITIES

Wastewater Discharges and Waste Sources

Sanitary wastes were sent to the South Charleston municipal wastewater treatment system. Approximately 0.75 mgd was lost to evaporation and 0.01 mgd was consumed in chemical processes. The remainder (91.1 mgd) was discharged to surface waters.

In its permit application, the company listed 29 outfalls, 28 of which discharged directly into the Kanawha and one into Davis Creek, a tributary of the Kanawha (Figure D-2). The outfalls are listed in Table D-1 by the numbers shown on the permit application.

Except for the fly ash pond (outfall 029), there was no formal treatment facility at the plant. Outfalls 003 through 015 lay within a stretch of 200 feet. Outfall 003 (from the turbine condensers, rectifiers, steam processing, brine treatment, and boiler water treatment) had a discharge of 26.2 mgd. Outfall 018 (from the chlorine and caustic diaphragm cells and sulfur recovery system) had a 38.9 mgd discharge. These two outfalls accounted for over 71.5 percent of the average daily effluent flow.

Wastewater Treatment Program

Historical Development

According to the company, several waste control projects were under way before the State began its phased pollution control program in 1958. These projects had been designed to reduce production losses.

To meet the State's Phase I requirements by 1963, the company:

1. Purchased land for a fly ash lagoon, and a 29-acre settling basin was constructed to hold boiler fly ash.

2. Built a collection system in Area 3 and a mile-long waste transfer pipeline.

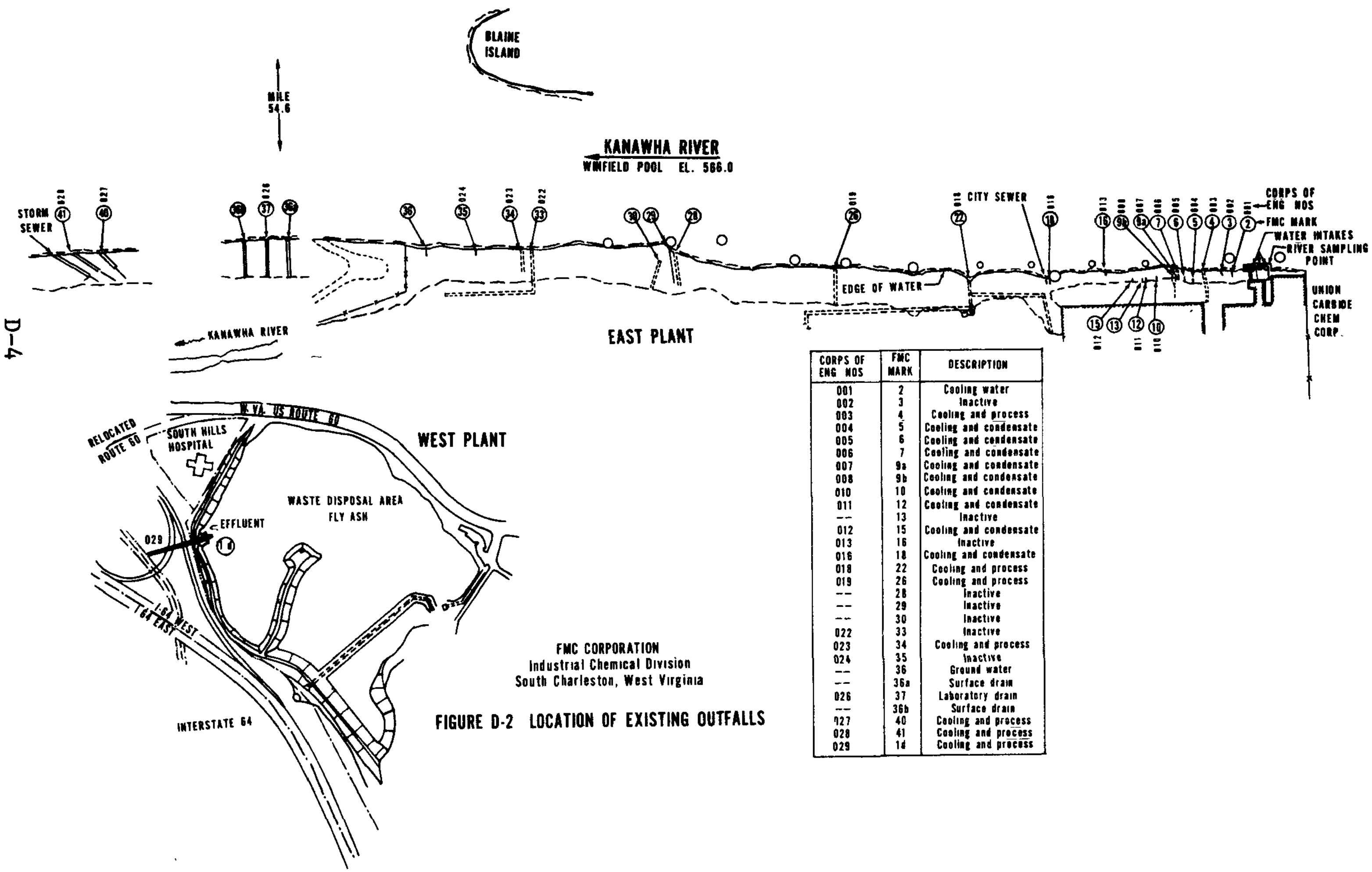
3. Segregated and pumped all sanitary wastes to the South Charleston municipal treatment plant.

4. Established a spill alert system.

To meet the Phase II requirements by 1969, the company:

1. Submerged the largest outfall to eliminate foaming.

2. Eliminated high magnesium and chloride wastes by obtaining a new brine source at Ben's Run.



FMC CORPORATION
Industrial Chemical Division
South Charleston, West Virginia

FIGURE D-2 LOCATION OF EXISTING OUTFALLS

CORPS OF ENG NOS	FMC MARK	DESCRIPTION
001	2	Cooling water
002	3	Inactive
003	4	Cooling and process
004	5	Cooling and condensate
005	6	Cooling and condensate
006	7	Cooling and condensate
007	9a	Cooling and condensate
008	9b	Cooling and condensate
010	10	Cooling and condensate
011	12	Cooling and condensate
--	13	Inactive
012	15	Cooling and condensate
013	16	Inactive
016	18	Cooling and condensate
018	22	Cooling and process
019	26	Cooling and process
--	28	Inactive
--	29	Inactive
--	30	Inactive
022	33	Inactive
023	34	Cooling and process
024	35	Inactive
--	36	Ground water
--	36a	Surface drain
026	37	Laboratory drain
--	36b	Surface drain
027	40	Cooling and process
028	41	Cooling and process
029	14	Cooling and process

TABLE D-1

WASTEWATER DISCHARGES SOURCES AND VOLUME

FMC Inorganic Chemicals Division

Outfall No.	Source Area	Discharge Volume (mgd)
001	Raw water intake	0.091
002	Steam condensate drain	0.22
003*	Turbine condensers, rectifiers, steam processing, brine treatment, boiler water treatment	26.2
004	Barometric condenser	1.01
005	" "	1.64
006	" "	0.50
007	" "	0.44
008	" "	0.44
009	Inactive	0.0
010	Barometric condenser	3.85
011	" "	2.09
012	" "	0.61
013	Vacuum seal for vacuum filters	0.43
014	Inactive	0.0
015	"	0.0
016*	Barometric condenser	1.14
017*	Caustic and chlorine coolers	4.1
018*	Chlorine and caustic diaphragm cells, sulfur recovery	38.9
019*	Carbon tetrachloride unit	3.3
020	Inactive	0.0
021	Inactive	0.0
022*	Ammonia production unit	0.5
023*	Carbon bisulfide unit	3.6
024	Ammonia production unit-vent scrubber	0.11
025	Air conditioning units	-
026	Laboratories	0.01
027*	Chlorinated cyanurate unit	0.50
028*	" " "	0.60
029*	Fly ash lagoon, hydrogen peroxide unit	0.9
	Total average effluent flow	91.181

* Effluents sampled by EPA March 1-2, 1972

3. Installed a sulfate purge system to reduce chloride wastes.

4. Made process changes to recover waste salt and caustic soda.

5. Installed an oil and solvent recovery system.

To meet the Phase III requirements by 1972, the company had to:

1. Eliminate all visual pollution, including foams and scum.

2. Reduce the BOD(5) load to a maximum of 1,000 pounds per day.

3. Decrease the oxidizable nitrogen load by 65 percent.

4. Neutralize all wastes to comply with water quality criteria for the Kanawha River.

5. Reduce all taste-and odor-producing materials to meet water quality criteria for the Kanawha.

Waste Disposal Facilities

The company operated a landfill and used a 29-acre pond as waste disposal facilities. Bottom ash, waste asbestos, and other plant solid wastes were placed in the landfill. Boiler fly ash, insoluble wastes from water and brine treatment, oil separator effluent, and the effluent from the hydrogen peroxide plant were sent to the pond. Although not confirmed by EPA or State analyses, the company claimed this procedure was effective in removing organics. On an average, the effluent discharged into Davis Creek from this facility amounted to 0.9 mgd; this represented less than one percent of the plant's total discharge.

Cooling Water

The cooling water discharges totaled over 90 mgd from the 28 outfalls on the Kanawha. The exact portion contributed by leaks and miscellaneous process wastewaters was not ascertained.

The non-contact cooling water volume was estimated at 70 mgd, and an additional 20 mgd were contaminated by spills, leaks, contact cooling, and process wastes.

Monitoring

The monitoring program consisted of compositing 2-hour grab samples over a 24-hour period once a month at each outfall. Special samples were also collected periodically at major outfalls.

Efficiency of Waste Treatment

The one wastewater stream that was treated before being discharged from one of the 29 outfalls was the one that entered Beaver Pond. The influent to the pond contained an average of 25,000 mg/l of suspended solids and the effluent contained an average of 5 mg/l. The removal efficiency for other constitutents was not known.

Future Plans

The most significant waterborne waste problem of the FMC Inorganic Chemicals plant was ammonia-bearing wastes. In the manufacture of dry bleach, much off gas was produced in the calcining of urea. This was the source of two-thirds of the water-borne ammonia waste, and presently a pilot operation was under way to burn the gas and, destroy the ammonia. (If successful, this method will satisfy the 65 percent reduction requirement of the Phase III program.)

Spill Potential

The spill potential of the three areas of the South Charleston Plant was great. If a spill occurred at any of the three plant production areas, there was no provision to capture and retain any liquid lost. According to plant personnel, the plant had had six spills to the river, but the character and amount were unspecified. They claimed, however, that the spills had been given immediate attention and treated as emergencies. The effects on the Kanawha were not ascertained. A formal spill alert system was established in 1963.

NFIC-Cincinnati Field Survey

Sampling

To ascertain the magnitude of waste constitutent discharge loadings, the EPA conducted a 24-hour sampling survey of selected effluents (Table D-1) on March 1 - 2, 1972. Two-hour grab samples were composited and split with the company.

Analytical Results

The analytical results, converted to pounds per day, are listed in Table D-2. The analytical results indicate that the samples from outfalls 027 and 028 could have been interchanged. The discharge volumes for these outfalls were 0.54 mgd and 0.67 mgd, respectively. Since these volumes are nearly equal and less than 1.0 mgd, the total difference in net loadings should be considered negligible when compared to the total plant discharge of over 90 mgd.

TABLE D-2

NET LOADINGS - LBS/DAY

FMC and EPA DATA

COE Number	Flow (mgd)	SOLIDS Total	SOLIDS Suspended	COD	TOC	TKN	NH_3	Cl^-	OIL & GREASE
(003)	(18.0)	17,700 (17,300)	3,150 (4,050)	2,160 (1,800)	ND (150)	NA	NA	7,300 (7,900)	NA
(016)	(1.1)	NA	NA	132 (46)	NA	NA	NA	10 (18)	NA
(017)	(3.2)	111,000 (109,000)	-80 (187)	310 (3,310)	NA	NA	NA	43,900 (43,600)	ND (27)
(018)	(39.4)	160,000 (145,000)	5,250 (6,250)	7,550 (8,870)	NA	NA	NA	58,800 (63,400)	ND (329)
(019)	(3.8)	3,100 (2,200)	- 348 (127)	NA	ND (1,590)	NA	NA	1,700 (1,460)	NA
(022)	(.26)	2,700 (7,800)	- 119 (2)	7 (2)	NA	32.9 (33.6)	31.9 (27.1)	25 (45)	NA
(023)	(1.9)	4,630 (4,280)	- 10 (48)	1,420 (1,510)	NA	-3 (1.6)	NA	- 11 (1,840)	ND (32)
(027)	(.54)	55,200 (48,800)	2,250 (2,000)	157 (315)	4,800 (5,500)	952 (15,300)	0 (7,200)	27,200 (162)	ND (22)
(028)	(.67)	64,600 (78,400)	NA	189 (1,340)	8,700 (5,540)	18,400 (1,230)	8,550 (38)	1,550 (29,200)	ND (50)
(029)	(1.2)	39,400 (37,700)	NA	834 (1,480)	12 (30)	2.5 (4.0)	NA	22,900 (28,600)	ND (0)

Note: EPA data in parentheses; ND = not detectable.
NA = not analyzed.

Total plant loadings are in line with data submitted to the State in 1971 (Table D-3).

Major Sources and Loads

The plant discharged large quantities of dissolved solids, COD, total organic carbon, ammonia, Kjeldahl nitrogen, and chlorides. The largest sources of solids and COD were the caustic and chlorine units (outfalls 017 and 018), the dry bleach units (027 and 028), and "Beaver Pond " (029).

The largest source of COD and chloride was the chlorine and caustic plant (No. 018). Chloride was also high from the chlorinated dry bleach (No. 027) plant and "Beaver Pond". Large quantities of total organic carbon and nitrogen originated in the dry bleach unit (027 and 028).

Oil and grease discharges appeared to be well under control at the plant.

Plant data reported to the State in 1971 indicated that an average of 1,900 pounds of BOD(5) was discharged into the river per day. The Refuse Act permit application indicated that 1,400 pounds were discharged from the chlorine caustic plant via outfall No. 018, which is reflected by the high COD.

Metals analyses of the effluent from the pond showed that it contained 16 pounds per day of chromium and 0.5 pounds per day of arsenic which were assumed to be associated with the fly ash.

Toxicity of Effluents

The only static bioassay tests conducted were made on the effluent from outfall No. 018 from the chlorine and caustic plant. The tests which used fathead minnows, were made of effluent which had a dissolved oxygen range of 5.1 to 5.9 mg/l, a pH 2.9 to 6.4, and a temperature between 23 and 27 degrees C. The median tolerance limit, TL50 of the wastewater at 24 hours was 78 percent, at 48 hours, 60 percent, and at 96 hours, 56 percent. (The TL50 is the percentage of wastewater by volume which will kill 50 percent of the test organisms in the specified time.)

Conclusions

Six discharges contained high levels of dissolved solids (003, 017, 018, 027, 028, 029). The discharge from 028 contained the major portion of the nitrogen load. The plant appeared to be meeting the State's Phase III requirements. The spill prevention program did not seem to be adequate to retain or to recover any liquids lost.

TABLE D-3

PLANT EFFLUENT - NET LOADS (POUNDS/DAY)

FMC CORPORATION - INORGANIC CHEMICALS DIVISION
South Charleston, West Virginia

Parameter	NFIC-C	March 1972 FMC	State	FMC Report to State 1971 (9 Months)
Total Solids	449,830	458,100	478,800	366,100
Susp. Solids	12,660	10,100	1,000	8,514
Chlorides	176,250	163,400	209,000	163,270
COD	18,670	12,770	NA	
TOC	12,775	13,565	NA	
TKN	16,560	19,440	21,840	
NH(3)	7,260	8,590	5,420	
Oil & Grease	460	ND	NA	
Chlorine	NA		7,940	5,575
Sulfide	76.0			
Mercury	.017			
Chromium	16.5			21.4
BOD(5)				1,877

NOTE: NA = not analyzed
ND = not detected.

Recommendations

It is recommended that:

1. The plant take immediate steps to separate and dispose of suspended solids, COD, and TOC wastes from the wastewater streams, particularly those discharged via outfalls 003, 018, 023, and 027.

2. Nitrogenous loads be reduced to 3,600 pounds per day and the BOD(5) discharge loads not to exceed 150 pounds per day in order to meet the DO criterion of 4 mg/l at the existing 7-day, once-in-ten-year low flow.

3. The toxicity of effluents be reduced at least to the point that no discharge exceeds 1/20 of the 96-hour TL50.

4. The company use less cooling water and reduce the contaminants introduced into it.

5. The spill program be up-dated so that all hazardous and toxic materials which have spill potential can be contained or recovered.

6. Monitoring be increased at the major outfalls which contain the largest sources of pollutants. Flow measurements must be more precise and continuously recorded for outfalls 003, 018, 019, 022, 023, 027, 028 and 029.

7. The dissolved solids load discharged into the river be decreased by in-plant recovery of salt, caustic sludge reduction, and acid reuse.

8. Wastes from raw water treatment be removed from the discharge of outfall 003, chromate be removed from outfalls 022, 023, 028, and 029, and lead be reduced in the discharge from outfall 018.

FMC CORPORATION
AMERICAN VISCOSE DIVISION PLANT
NITRO, WEST VIRGINIA

General Plant Description

This plant was located on the Kanawha River at Nitro, 12 miles downstream from Charleston at Mile Point 42.7. The plant was on the right side of the river (facing downstream) and occupied 120 acres which included about 2,200 feet of shoreline (Figure E-1). Adjacent installations were the Allied Chemical Company (upstream) and FMC's Industrial Chemical Division.

The plant, which became operational in 1938, had been modified and expanded over the years, but there had been no change in the basic manufacturing process of the principal product, rayon staple.

Employment had fluctuated between 850 and 1,150 and totaled 1,100 in March 1972. The plant operated 24 hours a day, 365 days per year at an average of about 80 percent of its rated capacity of rayon staple. A significant by-product was sodium sulfate.

Basic raw materials used included highly refined cellulose sheet pulp, caustic soda, carbon bisulfide, sulfuric acid and zinc sulfate. Sulfuric acid was supplied through a pipeline by the Allied Chemical Company.

Water Usage

The plant purchased an average of 20,000 gallons per day of water from the City of Nitro for domestic and process purposes. The plant pumped an average of 35 million gallons of water a day (mgd) from the Kanawha. Approximately 25 to 30 percent of this water was treated by standard precipitation, settling, filtration, and chlorination for use as process water. Ten to 15 percent was softened for process and boiler feed purposes.

The Company's Refuse Act permit application indicated that the plant used 26 mgd as cooling water, 1 mgd for boiler feed, 6.5 mgd as process water, 0.06 mgd in its sanitary system, and 1.46 mgd for other purposes. The application also indicated that 0.4 mgd was lost to evaporation and the rest was discharged into the river.

Wastewater Discharges and Waste Sources

The plant discharged all of its wastewaters, both industrial and sanitary, into the Kanawha through one sewer. The sewer led to a sump on the river bank which had two outfalls, one above water called

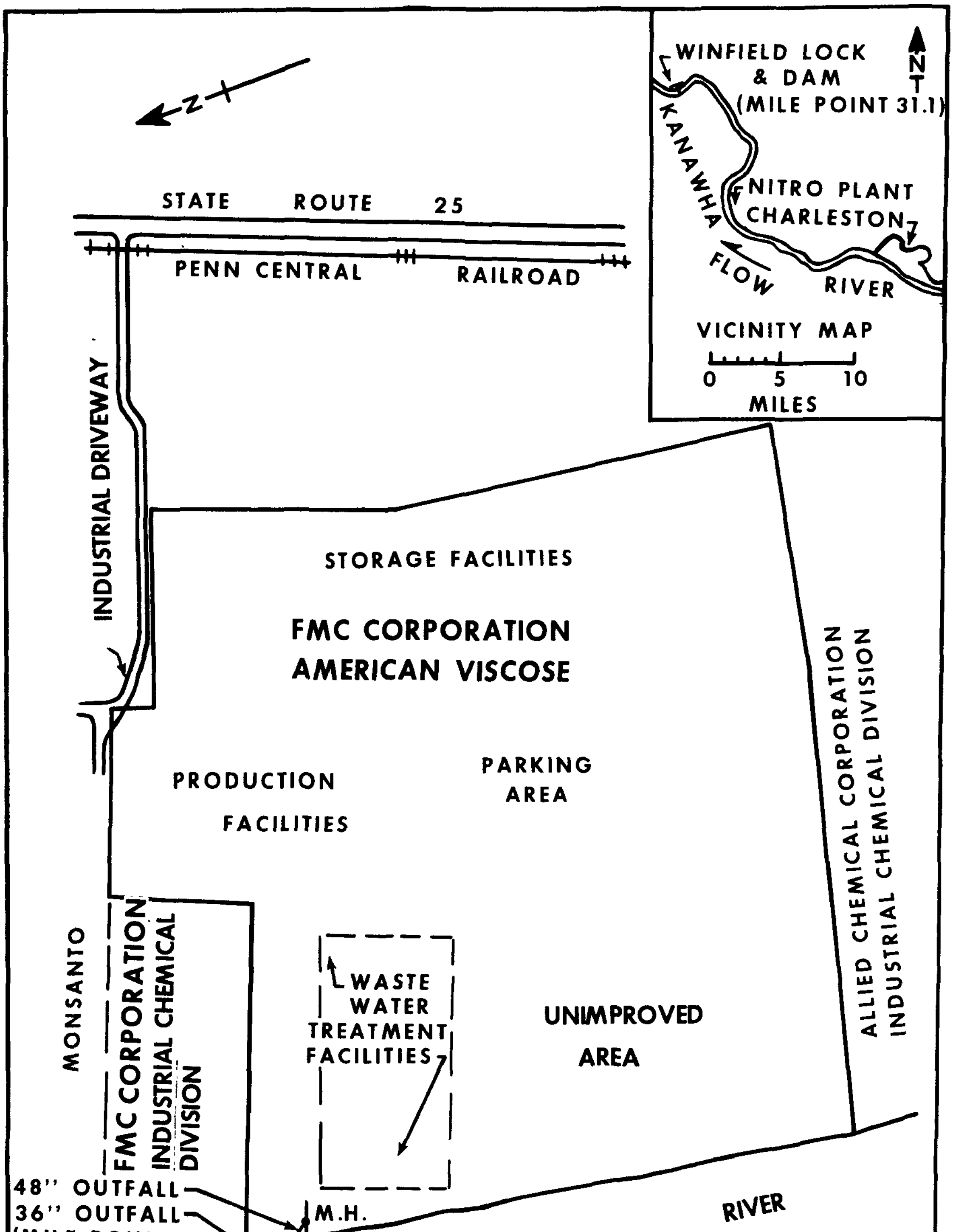


FIGURE E-1
FMC CORPORATION
AMERICAN VISCOSE DIVISION
GENERAL PLAN - PLANT FACILITIES
JULY 1972

the "secondary outfall" and a submerged 36-inch pipe extending 100 feet into the river called the "primary outfall". Under normal operating conditions, all wastewaters were discharged via the submerged outfall; a surface roil usually existed over its outlet. At the time of the investigation, none of the discharge (26 mgd of cooling water and 9 mgd of process water) was treated.

Information regarding specific unit sources of wastes was not provided by the company.

Wastewater Treatment Program

Historical Development

Company officials said that a program had existed for several years whereby process and cooling water wastes were separated. An aeration lagoon was constructed in which about one mgd of selected process and sanitary wastes were provided partial secondary treatment. The lagoon had been abandoned prior to NFIC-C's field survey and all waterborne production and sanitary wastes were being discharged untreated.

The history of waste treatment at the plant had been one of non-compliance with requirements of the State's phased program.

Under the principal requirements of Phase I and Phase II, the plant was to reduce the BOD(5) loading to the Kanawha from 9,300 pounds per day to 2,800 pounds per day by June 30, 1966. This date was later extended by the State for all Kanawha industries to June 30, 1967. The American Viscose plant did not meet the loading limitations. West Virginia Pollution Control Permit No. 4384 was issued to the plant on February 7, 1972, and included Phase III requirements. The BOD(5) limitation was set at 2,000 pounds per day and acidity was not to exceed 80,000 pounds per day by December 31, 1972.

The company agreed in a letter to the State in July 1971 to meet the Phase III requirements by December 1972 by constructing a secondary biological treatment facility. (In 1973 the company had completed and was operating a wastewater treatment facility that incorporated the following components:

1. Two primary clarifiers (each at two-thirds of total design requirement) for zinc removal.

2. Two rotary vacuum filters for dewatering zinc hydroxide sludge, which is disposed of in the landfill.

3. Pumping equipment to direct blowdown from acid reclaim cooling tower to waste treatment from No. 2 lift station.

4. A thickener installed ahead of the aerobic digestion chamber.

5. Three lift stations.

6. A final clarifier.)

The company's projected removal efficiencies are listed in Table E-1.

TABLE E-1

PROJECTED QUALITY OF TREATED EFFLUENT
(based on design flow of 9.3 mgd)

Constituent	mg/l	lb/day	Removal Efficiency Percent
BOD(5)	30	2,340	80
COD	243	18,954	60
Suspended Solids	30	2,340	84
Dissolved Solids	10,000	780,000	0
Zinc	5	390	95
pH	6.0 - 8.5 units	-	-

Solid Waste Disposal

The company reported that a portion of its property was used for solid waste disposal. The area had a small pond, which presumably received leachate from the disposed material and overflowed into an outfall of the Fike Chemical Company. The pH of the effluent was 13.

Spill Potential

The FMC American Viscose Division stated that spills had been insignificant due to good housekeeping and the nature of the process and chemicals used. Any rejected batches of alkali cellulose crumbs or viscose solution were placed on the company landfill. Tanks holding caustic and sulfuric acid were not diked, but were a long distance from the river. Materials such as carbon disulfide (CS_2) and the amine-phenol mixture were handled in well-designed equipment with good safeguards to minimize spill dangers.

NFIC-C Cincinnati Field Survey

Sampling

In order to ascertain and/or confirm the magnitude of waste constitutent discharge loadings, the EPA conducted a 24-hour sampling survey of the single discharge and the plant's raw water intake on March 21 - 22, 1972. Two-hour grab samples were composited and split with the company and the State Division of Water Resources.

It was anticipated that, as in all other plants visited, the facilities could be toured to become familiar with the plant layout. Due to a problem in the production area, this request was not allowed at the time of this visit. It was agreed, however, that sampling could be performed on a day to be mutually selected and this would encompass the discharge and the raw water intake.

Analytical Results

The analytical results, converted to pounds per day net loadings, are listed in Table E-2. For comparison average loadings of constituents reported to the State for the first 10 months of 1971 are included.

Major Waste Sources and Loads

Since the loadings shown in Table E-2 were untreated, they represented raw discharges into the river. The company was discharging loads of BOD, dissolved solids, zinc, COD, total organic carbon that were in excess of Phase I, II and III limit requirements for BOD and acidity.

Toxicity of Effluent

Static bioassay tests, using fathead minnows, were made on the plant's effluent in March 1972. The tests were made in a dissolved oxygen range of 5.3 to 6.2 mg/l, pH 2.6 to 5.8, and a temperature between 23 and 27 degrees C. The median tolerance limit (TL50) of the wastewater at 24, 48, and 96 hours was 7.6 percent for each time period. All of the fish that died did so within the first 24 hours. The TL50 is the percentage of wastewater by volume which will kill 50 percent of the test organisms in the specified time. In the case of this effluent, the toxic influence could have been the low pH of the initial sample.

TABLE E-2

TOTAL WATERBORNE WASTES

AMERICAN VISCOSE PLANT
Nitro, West Virginia

Net Loads - Pounds/Day

Parameter	NFIC Survey March 1972 EPA	NFIC Survey March 1972 STATE	NFIC Survey March 1972 VISCOSE	Viscose Report to State 1971 (10 Months)
BOD_5	7,570	7,920	13,450	11,287
BOD_{20}	18,915	16,920	25,900	NA
Total Solids	354,100	501,000	429,100	419,500
Susp. Solids	NA	13,500	3,950	14,300
Chloride	NA	36,300	26,800	13,450
Zinc	8,710	9,890	8,120	7,940
COD	31,200	NA	31,300	
TOC	9,610	NA	11,000	
TKN	360	609	550	
NH_3	0	405	NA	
Acidity	121,000	NA	103,210	
Phosphate	30	63	51	
Oil & Grease	270	-	282	
Phenol	3.0	3.4	0	
Cyanide	0	NA	0	
pH	2.2	2.2	2.5	

NA = Not analyzed.

Conclusions

1. The history of wastewater treatment at the plant had been one of non-compliance with the requirements of the State's phased program.

2. The wastewater discharged into the Kanawha was toxic.

3. The pH of the wastewater discharge was 2.2, and it contained over 400,000 pounds per day of dissolved solids and more than 8,000 pounds of zinc.

4. The spill prevention program was adequate in the carbon disulfide facilities but not in the caustic and acid areas.

5. Contaminates were not kept completely segregated from cooling waters.

Recommendations

1. All waste stream that contain BOD, COD, organic carbon, oil and grease, nitrogenous materials, and suspended solids should be segregated from cooling waters and routed to a treatment system.

2. The toxicity of the effluent should be reduced at least to the point that no discharge exceeds 1/20 of the 96-hour TL50.

3. The acid load to the river should be neutralized or otherwise treated so that the pH of the discharge is maintained within the range of 6.0 to 8.5.

4. The oxygen demand should be reduced to not more than 300 pounds of BOD(5) per day and 100 pounds of TKN per day. The zinc concentration in process wastewater should be limited to 1.0 mg/l.

5. The spill prevention program should be expanded to include the caustic and acid areas.

6. Monitoring should be carried out more frequently and the number of pollutants analyzed should be increased. Consideration should be given to performing bioassays and BOD(20), TKN, COD, and TOC analyses.

FMC CORPORATION
ORGANIC CHEMICALS DIVISION
NITRO, WEST VIRGINIA

General Plant Description

The plant is located on the right bank facing downstream of the Kanawha River in the Nitro, West Virginia area (Figure F-1). Detailed information on the plant area, buildings, etc., was not made available by the company for this survey. Since 1960, employment had ranged from approximately 475 to 150; at the time of the survey, it was about 170. The plant was operated 24 hours a day, 365 days a year.

Production quantities and sales are confidential. In 1970, the major products were plasticizers and phosphorus chemicals, and the principal raw materials were phosphorus, chlorine, caustic, phenol, cresylic acids, glycol ethers, organic alcohols, and propylene. Production had varied and many product has been added and deleted. Tributyl phosphate and tributoxyethyl phosphate were added in 1960, phosphorus tri and oxychlorides in 1962, methyldiphenyl phosphate in 1964, and isopropylphenol phosphates in 1969. Aluminum chloride and allyic esters production have been eliminated.

The eight main production areas and sources of wastewater as shown in the company's Refuse Act Permit Application were: (1) Isopropyl phenol; (2) Kronitex reaction - distillation; (3) Kronitex refining; (4) Tributoxyethyl phosphate - tributyl phosphate; (5) Methyl diphenyl phosphate; (6) Butyl cellosolve adipate; (7) Phosphorus trichloride; (8) Phosphorus Oxychloride.

Raw materials, intermediates, and products manufactured are shown in Figure F-2.

Water Usage

The following water use data (in millions of gallons a day, mgd) are taken from the company's Refuse Act Permit Discharge Application:

1. Source: Municipal system, 0.33; Kanawha River, 3.98.

2. Use: Cooling water, 4.01; boiler feed water, 0.09; process water, 0.21; sanitary system, 0.003.

The sanitary system discharged to the municipal treatment plant, and all other wastewaters were discharged into the Kanawha.

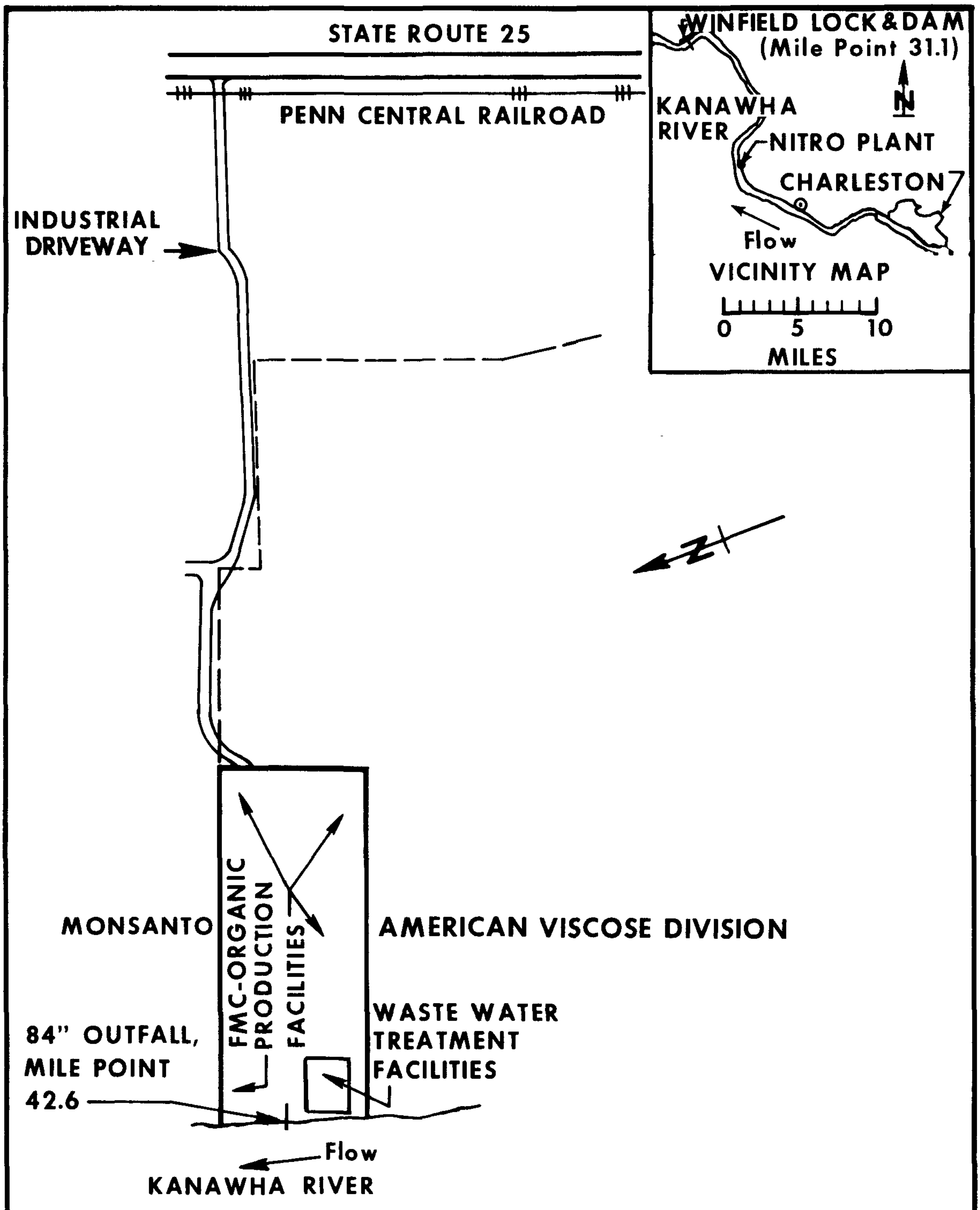
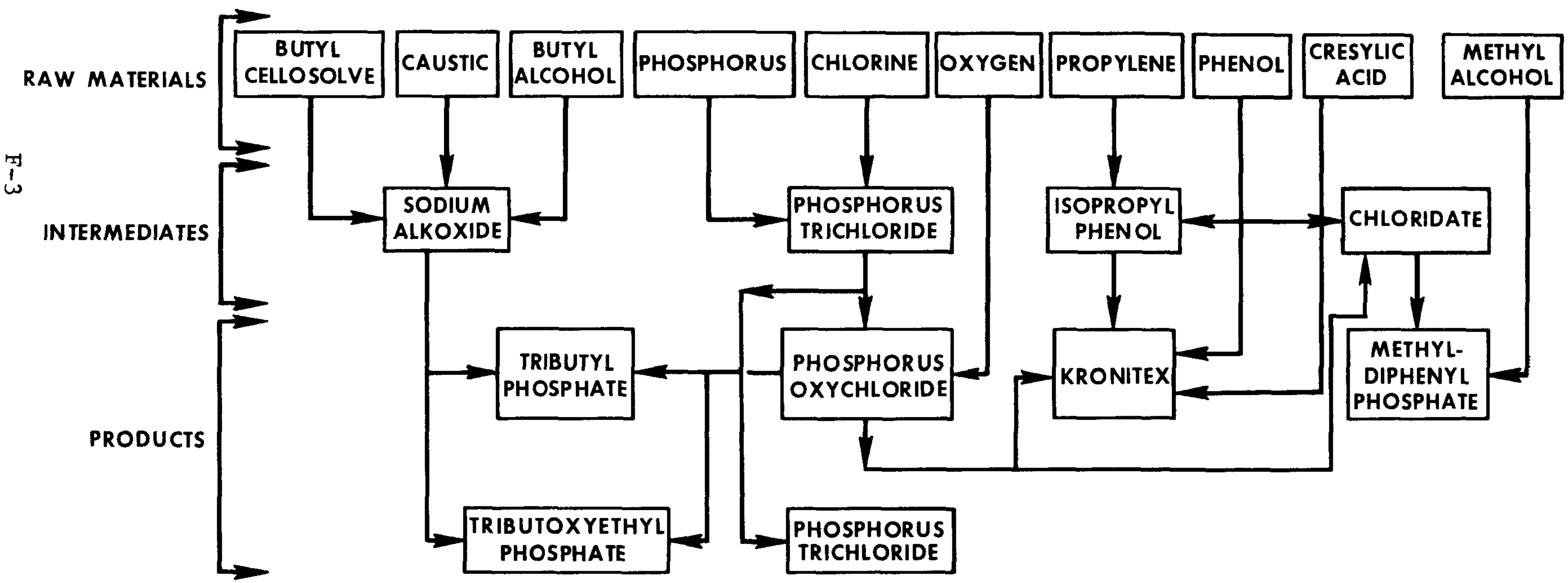


FIGURE F-1 FMC CORPORATION
ORGANIC CHEMICALS DIVISION NITRO, WEST VIRGINIA
GENERAL PLAN-PLANT FACILITIES

FIGURE F-2

FMC CORPORATION - ORGANIC CHEMICALS DIVISION - NITRO PLANT, NITRO, WEST VIRGINIA
BUDGETED 1972 MATERIALS



The discharge flows on which this EPA study was based were:

	mgd
Waste treatment plant	0.060
Cooling water	3.615
Total	3.675

(Flows were estimated from water intake values.)

Waste Treatment Program

Historical Development

West Virginia's phased program requirements for the Nitro Plant are shown in Table F-1. The base load to the Kanawha was established at 7,000 pounds BOD(5) per day in 1958.

TABLE F-1
WEST VIRGINIA'S PHASED PROGRAM FOR
FMC'S ORGANIC PLANT AT NITRO

	% Reduction from Base	BOD(5) Limit lb/day	Phenol Limit lb/day	Acidity Limit(1) lb/day	Compliance Date
Phase I	40	4,200	900	35,000	6/30/63
Phase II	70	2,100	16	10,300	6/30/66
Phase III	86	1,700	16	(2)	12/31/72

(1) As $CaCO_3$
(2) Neutralized sufficiently to comply with applicable water quality criteria for the Kanawha.

Under Phase I, the following projects were completed:

1. Sanitary wastes were segregated from plant wastes and piped to the municipal treatment plant.

2. An alcohol recovery-distillation recovery unit was installed to remove organics from the "drown" water.

Under Phase II, the following equipment was installed:

1. A collection, neutralization, extended-aeration, and clarifier system;

2. Another alcohol recovery-distillation system;

3. A hydrochloric acid adsorption and purification system;

4. Condensers to remove organics from reactor vent streams.

Plans for Phase III compliance are discussed later.

Waste Disposal Facilities

The company, in response to an NFIC-Cincinnati inquiry, reported that some waste materials were incinerated off-site. Incineration was the original method planned for meeting Phase II requirements but the system was not satisfactory. No information was provided on any landfill disposal activity.

Wastewater Treatment

The wastewater treatment plant consisted of a neutralization tank, an aeration lagoon, and a settling basin. The aeration basin, which was installed in 1968, had a capacity of about 500,000 gallons.

During 1969 and the first half of 1970, mechanical and other operational problems were experienced with the new lagoon. At that time the characterization and segregation of all waste streams were incomplete. (This was completed by mid-1972).

Company officials stated that their abatement efforts had resulted in a large reduction in the plant waste load in spite of rising production rates. The monthly averages of BOD(5) and phenol loads, as reported to the State by FMC are shown in Figures F-3 and F-4. The upset periods and overall decrease in loads imposed on the river are evident. The phenol problem had not been abated as Figure F-4 shows.

As to reducing inorganic loadings, officials reported that chlorides had been lowered by 30 percent and acidity by approximately 40 percent.

They said that the following work was undertaken to meet the Phase III requirements:

1. An experimental, high-rate trickling filter was being tested in the plant to provide greater BOD and phenolic reductions.

FIGURE F-3

FMC ORGANIC - NITRO, W.VA., PLANT

BOD_5 LOADS TO KANAWHA RIVER

1968-1972

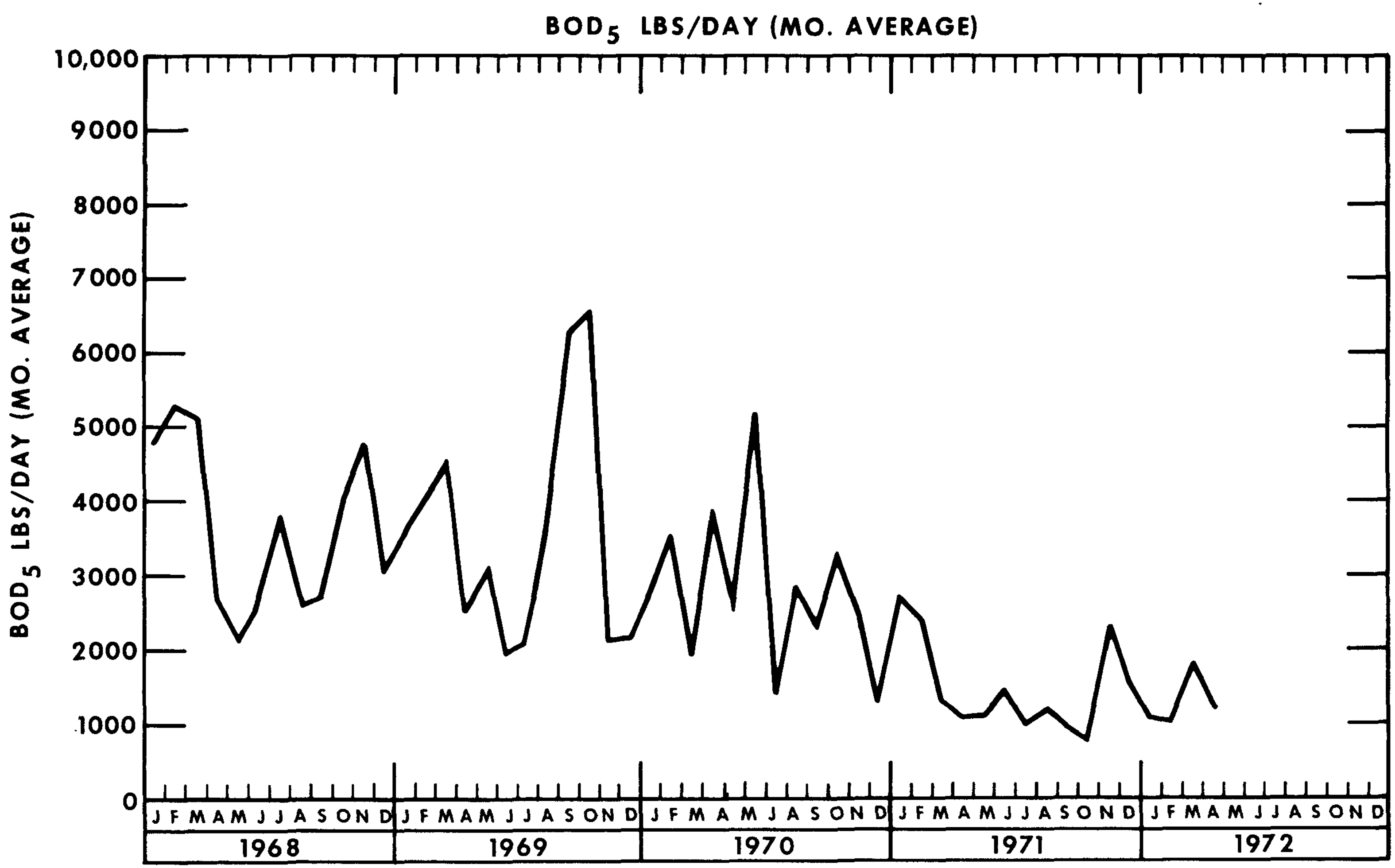
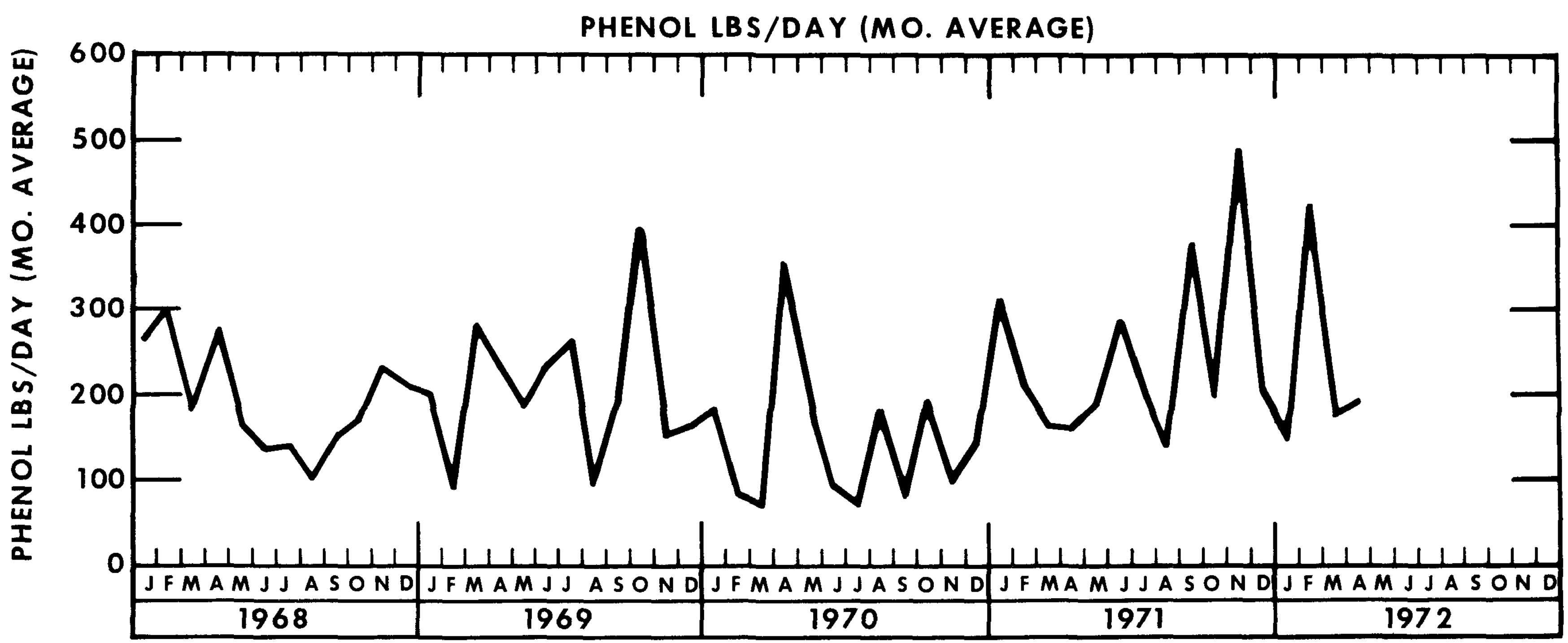


FIGURE F-4

FMC ORGANIC - NITRO,W.VA., PLANT
PHENOL LOADS TO KANAWHA RIVER
1968-1972



2. Installation of in-plant improvements to concentrate phenolic and BOD-bearing wastes for treatment.

3. Installation of a floating boom at the outfall to retain scum or oils which might accidentally enter the sewer system.

4. Investigation of chemical and biological treatment of wastewater streams in combination with sludge-handling studies necessary to meet future requirements.

(Final design on planned improvements was not completed in mid-1972 and it was evident that the construction schedule for Phase III would extend to 1973.) Costs of the new treatment works were estimated at $250,000 for 1972 and $150,000 for 1973.

Cooling Water

Cooling water was pumped from the Kanawha at a flow rate which had ranged from approximately 3.1 to 4.9 during a 10-year period ending in 1972. Recent measurements had indicated a temperature increase of about 6°C. General plant cooling water contained no inhibitors other than chlorine. Cooling water was screened and intermittently treated with chlorine to prevent slime growths; this method had not changed in recent years. There were two small cooling towers which operated as closed systems with very little loss or blowdown.

A significant portion of the total BOD(5) load discharged into the river was carried by the cooling water stream during the survey. Available records did not indicate what portion of the total load was typically carried by the cooling water.

Monitoring

The company reported that 24-hour composites of the lagoon and main sewer streams were analyzed and that any corrective action needed was taken accordingly. Details on the analytical parameters monitored were not provided.

Efficiency

Data on removal efficiencies were not available, but company officials stated that they ranged from 50 percent to 90 percent. Efficiency dropped sharply in cold weather.

Future Plans

As they did with regard to sales and production information, company officials treated any plans for expansion or reduction in operations as confidential. Judging from the general knowledge that production had been increasing, the production future of the plant appeared to be good.

Spill Potential

Spills of materials were treated as a plant emergency, and formal notification procedure had been established with the State. There had been no recent spills in which it was necessary to notify the State under the notification procedure. No spills into the river of oil, refractory organics, ammonia, or high dissolved solids materials had been recorded.

From observations during the limited study period, NFIC-Cincinnati personnel judged that the potential for spills was moderate and that pollution from spills generally would be evident in the cooling water stream. The results of the plant survey indicated that the bulk of the BOD(5) load to the river was in the untreated cooling water stream; high total load values might, therefore, reflect a spill or leakage in plant equipment during the sampling period.

NFIC-Cincinnati Field Survey

Sampling

A composite was made of samples collected every two hours during a 24-hour period on February 16 and 17, 1972. NFIC-Cincinnati also took samples for the State, but corporation personnel took their own samples on the same schedule. Sample points were:

1. Wastewater treatment plant inlet;

2. Wastewater treatment plant outlet;

3. Outfall (combined flow from treatment plant and cooling water).

4. Raw river water.

The outfall was the only active discharge point into the river. The plant's sanitary waste was not sampled because it was discharged into the municipal sewer system. Sampling for bioassay tests was limited to the discharge at the outfall.

Analytical Results

The analytical results in concentrations are shown in Table F-2 which gives the values determined by EPA, State, and company

Table F-2

FMC ORGANIC - NITRO, WEST VIRGINIA, PLANT
Analytical Results - 2/16/72 - 24-hr. Composite Samples

Sample Point[1]		1 WTP Inlet			2 WTP Discharge			3 Total Waste Outfall			5 Raw River Water		
		EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.
Flow	MGD						0.06			3.6			
BOD_5	mg/l	2790	1890	698	2930	1650	975	164	113	93	16.5	3.1	1.
BOD_{20}	"	-		1575	-		1325	224		123	-		-
COD	"	5480	6072	7000	5360	5565	4640	277	275	304	13	< 4	16
TOC	"	1140	2000		1290		1775	29		45	8		9
pH		-	6.9	6.8	-	7.7	6.8	-	2.4	2.2	-	7.2	7.1
Tot. Solids	mg/l	10600	10988	10757	9670	9204	9126	764	457	418	408	156	-
Sus. Solids	"	113	287	210	224	673	680	66	34	68	32	36	30
TKN	"	88	6.7		62	99		-	1.8		-	0.33	
NH_3-N	"	2.1	1.1		100	79		<0.5	1.2		< 0.5	< 0.06	
Nitrite & Nitrate	"	0.6		0.46	0.7		0.17	0.4		0.36	0.3		0.46
Tot. Phosphorus	"	74			63			2.6			< 0.1		
Chloride	"	-	6000	5319	-	5600	4219	340	400	425	315	19	30
Sulfate	"	-			-			-			-		
Oil & Grease	"	980	758	386	560	1323	410	21	45	2.0	< 1	3.2	19.2
Phenols	"	660	5309	780	630	5563	750	14	98.9	14	0.05	612	0.008
Cyanide	"	<0.01	< 0.26	0.0066	< 0.01	< 0.26	< 0.001	< .01	< 0.26	< 0.001	< 0.01	< 0.26	0.006
Arsenic[2]	µg/l	-	< 0.02		-	0.03		-	< 0.02		-	< 0.02	
Lead[3]	mg/l	-	0.10	< 0.02	-	0.18	0.02	-	0.010	< 0.02	-	0.025	< 0.02
Zinc[3]	"	-	0.31	0.34	-	0.39	0.39	-	0.20	0.21	-	0.15	0.14
Aluminum[3]	"	-	1.8	4.0	-	5.1	6.88	-	1.8	1.40	-	0.4	1.28
Cadmium[3]	"	-	1.4	< 0.005	-	2.4	< 0.005	-	4.2	0.007	-	1.4	< 0.005
Chromium[3]	"	0.18	0.2	0.153	0.19	0.1	0.190	0.06	< 0.1	0.064	-	< 0.1	0.009
Copper[3]	"	0.13	0.12	0.032	0.13	0.12	0.063	-	< 0.1	0.013	-	0.1	0.01
Iron[3]	"	-	0.15	0.25	-	1.6	1.84	-	1.1	2.07	-	0.9	1.91
Magnesium[3]	"	-	2.9	2.46	-	3.6	3.03	-	4.9	4.68	-	4.3	4.68
Manganese[3]	"	-	0.16	0.18	-	0.33	0.35	-	0.12	0.11	-	0.10	0.10
Nickel[3]	"	-	< 0.1	0.055	-	0.1	0.104	-	< 0.1	0.025	-	< 0.1	0.012
Bioassay TL_m	24-hr	-			-			13			-		
	48-hr							13					
	96-hr.							13					

(1) Sample point No. 4, Nitro City Water, was cancelled because it was sampled under the Monsanto investigation in Nitro.

(2) Arsenic analysis not run by NFIC-Cinti.

(3) NFIC metals analyses results are below detectable or normal reporting limits except as shown.

laboratories. The data for selected parameters are converted to net pollutant loads in pounds per day in Table F-3.

The results of the survey did not generally confirm the data the company had reported to the State by FMC-Organic, as a comparison of the values presented in Table F-3 and Figure F-3 for BOD(5) will show. The reason for the significantly higher BOD(5) during the survey has not been determined. The 419-pound-per-day value for phenol is higher than that usually reported monthly; the company reported 420 pounds per day average for February 1973.

Toxicity of Effluents

Fish bioassays on the plant's combined wastewater were performed at pH range of 2.6 - 5.8, the DO was 4.5 - 9.3 mg/l, and the temperature was 23 °- 27°C. The results indicated a TL50 of 13 percent at 24, 48, and 96 hours. The flow of 0.060 from the treatment plant was mixed with 3.6 of cooling water, a 60 to 1 dilution. The 13 percent TL50 was measured in the combined effluent stream and indicates that the plant's liquid wastes were a strongly toxic source.

Summary and Conclusions

1. High phenol discharges continued to be a problem at this plant. The State's Phase II and III requirements were a maximum of 16 pounds per day, but recent levels had averaged more than 10 times that amount.

2. The pH of the discharged wastewater was too low, reflecting inadequate acid recovery efforts by the company. The pH ranged from 2.0 to 2.4 in 1972, which was not a significant improvement over the few previous years.

3. Performance of waste treatment could not be appraised on the basis of the 24-hour sample because of the extended time wastewater was retained in the lagoon.

4. Pollution abatement efforts over the previous five years had significantly reduced overall BOD(5) loads to the river. Other than the required reduction of phenols and the low pH of the discharge, the company appeared to be meeting State requirements on an average basis.

5. Phase II use criteria for the Kanawha River would require reductions in pollutants.

6. The high toxicity of the outfall was of considerable concern. The impact of this toxicity on the receiving water and the

TABLE F-3

NET

POLLUTANT LOADINGS

FMC Organic Chemicals Division

LOAD IN POUNDS PER DAY

Outfall/ Location	Flow MGD	EPA	WVA	CO	EPA	WVA	CO
		BOD_5			BOD_{20}		
WWTP Inlet	0.06	1389	945	349	-	-	789
WWTP Disch.	0.06	1459	825	488	-	-	663
Total Waste Outfall	3.6	4431	3301	2764	6729	-	3695
		COD			TOC		
WWTP Inlet		2737	3040	3479	567	977	-
WWTP Disch.		2677	2786	2315	642	-	884
Total Waste Outfall		7931	8261	8652	631	-	1081
		TS			SS		
WWTP Inlet		5103	5424	5182	41	126	90
WWTP Disch.		4538	4530	4570	96	319	325
Total Waste Outfall		10694	9042	12557	1021	60	1142
		TKN			NH_3-N		
WWTP Inlet		44	3.2	-	1.1	0.55	-
WWTP Disch.		31	49	-	50	40	-
Total Waste Outfall		-	44	-	-	36	-
		PHENOL			OIL & GREASE		
WWTP Inlet		330	2352	391	491	378	184
WWTP Disch.		315	2479	376	280	661	196
Total Waste Outfall		418	-	420	631	1256	-

possible effect on waste treatment performance were definitely problems that needed to be solved.

Recommendations

It is recommended that:

1. A BOD(5) discharge limit of 240 pounds per day be achieved by December 31, 1975. This is based on the approved future use criteria requiring a dissolved oxygen level for the Kanawha River of 4.0 mg/l DO at 25°C and a seven-day once-in-10-year low flow of 1930 cfs.

2. The toxicity of the effluent be reduced at least to the point that it does not exceed 1/20 of the 96-hour TL50 for standard test organisms.

3. Extended and higher priority efforts be made to meet the 16 pound-per-day State limit for phenol; additional reductions will be required in the future.

4. Facilities and processes be provided to adequately neutralize the acid wastewaters and the pH of the discharge should be in the 6.0 to 8.5 range to meet anticipated effluent criteria.

5. FMC should determine what portion of its loads to the river is from untreated wastewaters, and report the findings to regulatory authorities. Further efforts to segregate wastes and route them to the treatment plant are desirable.

6. Monitoring frequency should be increased at the outfall and wastewater treatment plant. Flow measurement must be more precise and be continuously recorded for all wastewater discharged into the main sewer system.

MONSANTO COMPANY
ORGANIC CHEMICALS DIVISION
NITRO, WEST VIRGINIA

General Plant Description

The plant is located on the right side (facing downstream) of the Kanawha River at Mile Point 42.3 about a mile downstream from Nitro and about 15 miles northwest of Charleston. The property fronts on the river for about a mile, of which approximately 1,700 feet are occupied by the plant. The total plant area is 224 acres. Some 70 acres were used for production facilities, 35 for the waste treatment plant, and another 35 for a landfill (Figure G-1). The remaining land may be used for expansion.

Operation of the plant was initiated by its first owner, Rubber Services Laboratories, in 1922. Monsanto purchased the plant in 1929 and employed 240 persons during the first year of operations. About 650 persons were employed in February 1972.

The plant produced approximately 318 million pounds of organic chemicals in 1971, the highest in its history. The proprietary names of the chemicals produced are listed in Table G-1. Represented are rubber chemicals (accelerators, antitoxidants, intermediates, and vulcanizing agents), agricultural chemicals, oil additives, plasticizers, and paper chemicals. These organic chemicals were manufactured in 25 production units, many of which manufactured more than one product. With one exception, the process units were of the batch type. Twenty of the units were likely to be operating at any given time.

Production operations included distillation, drying, mixing, extracting, absorption, crystallization, adsorption, sizing, filtration, evaporation, and many others. The plant operated continuously and operations were not significantly affected by seasonal changes. There were, however, variations in product demand and raw material supply. The more than 100 raw materials used at the plant are listed in Table G-2.

Water Usage

Data on water usage in 1971 are presented in Table G-3. The company indicated there had not been any definite trend for the previous 10 years.

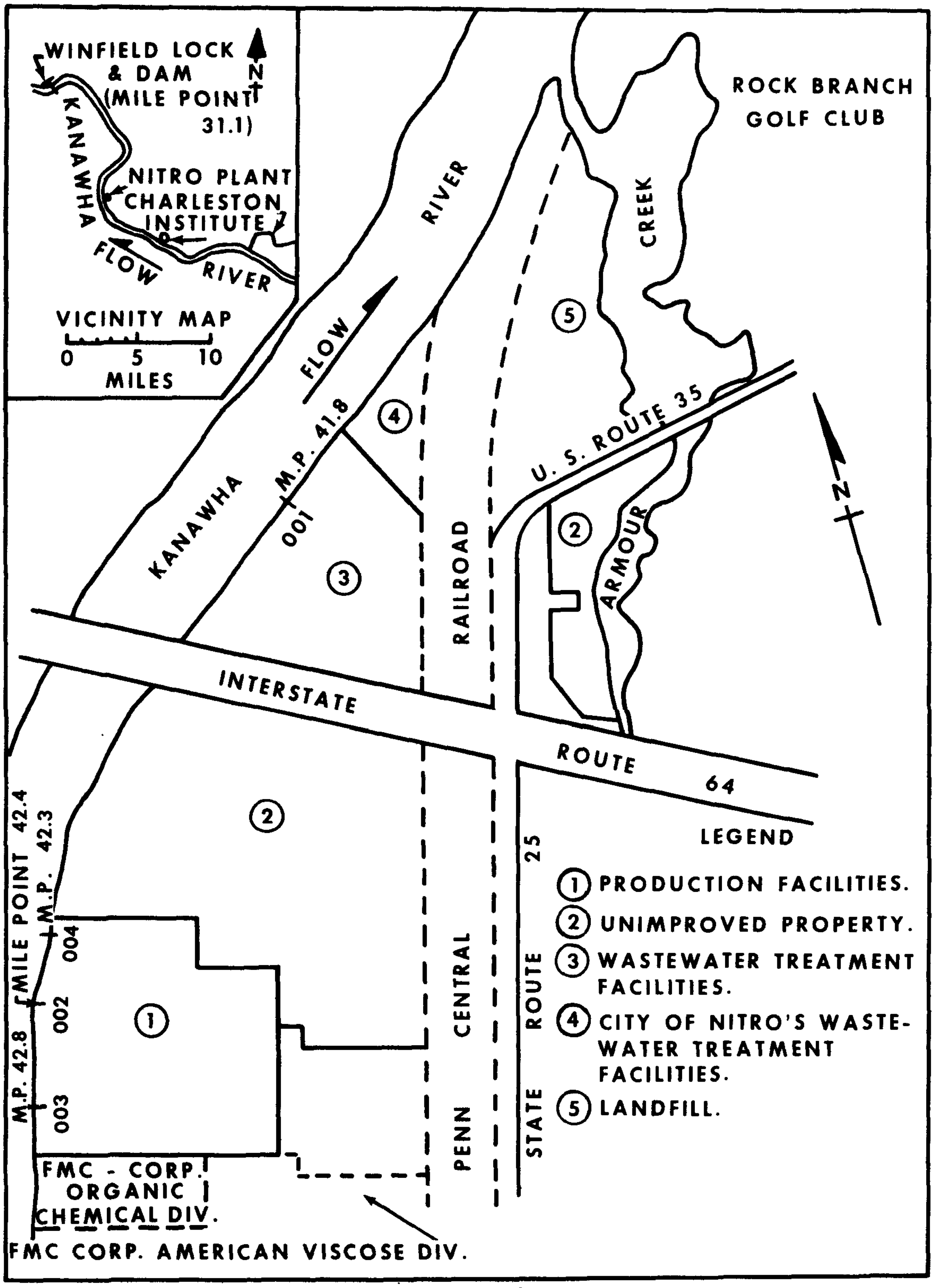


FIGURE G-1
MONSANTO - NITRO PLANT
GENERAL PLAN - FACILITIES AND OUTFALLS
JULY, 1972

TABLE G-1

PRODUCTS OF THE MONSANTO NITRO, WEST VIRGINIA, PLANT

A-32	Mersize-603-A	Santopoid 23 RIA
A-100	RT-28-A	Santopoid 33
Avadex BW Tech	RT-52-A	Santopoid 35
Avadex BW-UK	RT-53-A	Santopoid 39 MI
Avadex BW-US & Fargo	FT-64-A	Santopoid S
Avadex Tech	RT-252	Santopoid SJ
Avadex UK	Santocure 26	Santopoid SL
Avadex US	Santocure MOR	Santoquin
Calcium MHA	Santocure MOR-90	Santosize 70
DTO HV	Santocure NS-Pellets	Santosize 70T
DTO SHV	Santocure NS-Powder	Santovar A
EL-Sixty	Santocure Pellets	Santovar AX
EM-Tall 906	Santocure Powder	Santowhite Crystals
EM-Tall 926	Santoflex 503A	Santowhite Powder
Flectol H	Santoflex A-85	Santowhite MK
M-530	Santoflex AW	SFA
MBT	Santoflex DD	Sodium MBT-22%
Mersize 70 TFL	Santoflex DDS	Sodium MBT-50%
Mersize 77T	Santogard	Stabilized Vegadex Tech
Mersize 77 TFL	Santolene	
Mersize 80 TFL	Santolene C	Sulfasan R
Mersize 100 TFL	Santolene CM	Tetra
MHA Acid	Santolene CP	Thimore
NS-PVI	Santolene CX	Thiofide
PA-1260	Santolube 70	Thitax AP
PC-1244	Santolube 70-A	TORA
PC-1344	Santonox R	UFA Bleached
Rosin	Santopoid 22 RI	Vegadex
RD-18-500	Santopoid 22 RIA	Vegadex Tech
Mersize 603	Santopoid RI	

TABLE G-2

Principal Raw Materials of the Monsanto Nitro, West Virginia, Plant

Acetaldehyde	Dichloro Propene	Rosin
Acetic Acid, Glacial	Diethylamine	Crude Tall Oil
Acrolein	Diisobutylene	Soda Ash
Acrylate, 2-Ethyl Hexyl	Diisopropylamine	Sodium Bicarbonate
Agrimul A-100	Diphenylamine	Sodium Chloride
Agrimul N-100	Dowtherm	Skellysolve C
Alcohol, Butyl	Dimer Acid	Stearic Acid
Alcohol, Ethyl SDA-2B Anhyd	Cellosolve	Sterox SK
Alcohol, Isobutyl	Ethylene Dichloride	Molten Sulfur
Alcohol, Isopropyl	Ethylene Glycol	Sulfur Monochloride
Alcohol, Oleyl. & Cetyl (Ocenol)	Dicalite 4200	Sulfuric Acid 93%
Alkane 56	Hydrogen Cyanide	Sulfuric Acid 100%
Aluminum Chloride	Hydrogen Peroxide	Tertiary Amylene
Ammonia, Anhydrous	Hydroquinone	Toluene
Ammonia, Aqua	Kerosene	1,2,3 Trichloro 1-Propene
Ammonium, Thiocyanate	Lime	Trichloroethylene
Aniline Oil	Malic Acid Tech	Triethylene Tetramine
Benzene	Methyl Mercaptan	Urea
Butyraldehyde	Monochlorobenzene	Xylene
Butyric Acid	Morpholine	Tricresyl Phosphate
Calcium Chloride	Muriatic Acid 20 deg	Toluene Sulfonic Acid
Microcel E	Muriatic Acid 22 deg	Fumaric Acid
Carbon Bisulfide	Naptha Hy Arom	Benzol
Carbon Black No. 100	Nitrogen	Santobrite
Caustic Soda, Flake	Oil, Creosote	Cyclohexylamine
Caustic Soda, Liquid 50%	Fuel Oil No. 2	Dodecyl Aniline
Caustic Soda, Liquid 72%	Oil, Process	Para Phenetidine
Chlorine	Oil, White	Caustic Potash
Clay, Attapulgus	Oleic Acid	Sodium Sulfite
Clay, Super Filtrol	Paraformaldehyde	Acetone
Clenzolene	75% Phosphoric Acid	Methanol
Decyl Benzene	Phthalic Anhydride	50% Formalin
Dibutyl Para Cresol	Potassium Chloride	Disodium Phosphate
Dichloro Ethyl Ether	Pyridine, Refined	Sterox CD
Santocel C	Liquid Crystal Wax	Varsol 27

TABLE G-3

WATER USAGE BY MONSANTO IN 1971

Source and Use	Amount mgd
Kanawha River Water	
Tall oil barometric condenser water	6.55
Cooling water	2.9
Total river water	9.45
Nitro City Water	
Boiler feed	0.690
Cooling (make up)	0.147
Sanitary	0.060
Process	1.250
Total purchased water	2.147

Wastewater Discharges and Waste Sources

The Company had two active outfalls on the Kanawha. One was from the treatment plant and the other was the combined tall oil process wastewater and cooling water. All other wastewater from the plant, including storm sewer water, flowed to a lift station and was pumped to the wastewater treatment plant which was located approximately 0.5 mile downstream from the plant. A tabulation of discharges and waste sources is shown in Table G-4.

TABLE G-4

MONSANTO WASTEWATER DISCHARGES - 1971

Number	Description of Outfall	Milepoint	Flow
001	Treatment plant	41.8	2.15
002	Tall oil process and cooling water	42.5	9.45

Wastewater Treatment Program

Historical Development

According to Monsanto, the plant began extensive pollution abatement work in 1958 when Phase I of the State's Department of Natural Resources started its phased program for cleaning up the Kanawha. The pollution control requirements for Monsanto, starting with a base load of 16,420 pounds of BOD(5) per day to the river, are shown in Table G-5.

TABLE G-5

WEST VIRGINIA PHASED PROGRAM FOR MONTSANTO PLANT AT NITRO

	% Reduction from Base	BOD(5) Discharge Limit	Compliance Date
Phase I	40	9,850 pounds per day	6/30/62
Phase II	70	5,000 pounds per day	6/30/66
Phase III	86	2,500 pounds per day	12/31/72

The Phase II limits applied for the period of this study. Pollution control improvement was evident from a check of Monsanto's self-reporting data to the State and calculations from monthly averages. There had been difficulty, however, in meeting the BOD(5) limit:

1968: 5,900 pounds per day average
Averages exceeded 5,000 pounds per day limit for 8 months

1969: 5,600 pounds per day average
Averages exceeded 5,000 pounds per day limit for 6 months

1970: 5,900 pounds per day average
Averages exceeded 5,000 pounds per day limit for 7 months

1971: 3,600 pounds per day average
Averages exceeded 5,000 pounds per day limit for 2 months

1972: 4,088 pounds per day average
Averages exceeded 5,000 pounds per day limit for 1 month
(5 months)

Development of the wastewater treatment system started in the early 1960's, when flow meters and samplers were installed on all outfalls. Large-scale pilot plants were constructed to check out standard biological treatment processes and certain variations of them. Activated sludge did not perform well because of settling problems. The aerated lagoon system showed promise, was checked further, and selected for the full-scale plant. An outline of the construction schedule follows:

Primary lagoon and interceptor completed	June 1963
Neutralization pit and first aerated lagoon completed	October 1963
Second aerated lagoon completed	May 1966
Aeration capacity doubled	April 1970

Process wasteloads were also reduced by in-plant methods. The BOD(5), BOD(20), and total Kjeldahl nitrogen (TKN) loads per day for recent years are shown in Figures G-2, G-3, and G-4. The decline in BOD loadings was broken for a period of several months starting in October of 1971. According to the Company, an upset in the wastewater treatment plant was caused by a minor change made to improve efficiency in a manufacturing process. This change had an unexpected side reaction which produced a member of the sulfa drug family in trace quantities, but sufficient for the antibiotic to cause a major upset in the biological treatment system. The problem had been corrected and low loadings were being achieved even during times of marked increases in production. This contrast in production levels and effluent loads and the declining effluent loading per unit of production are shown in Figures G-5 and G-6, provided by the company.

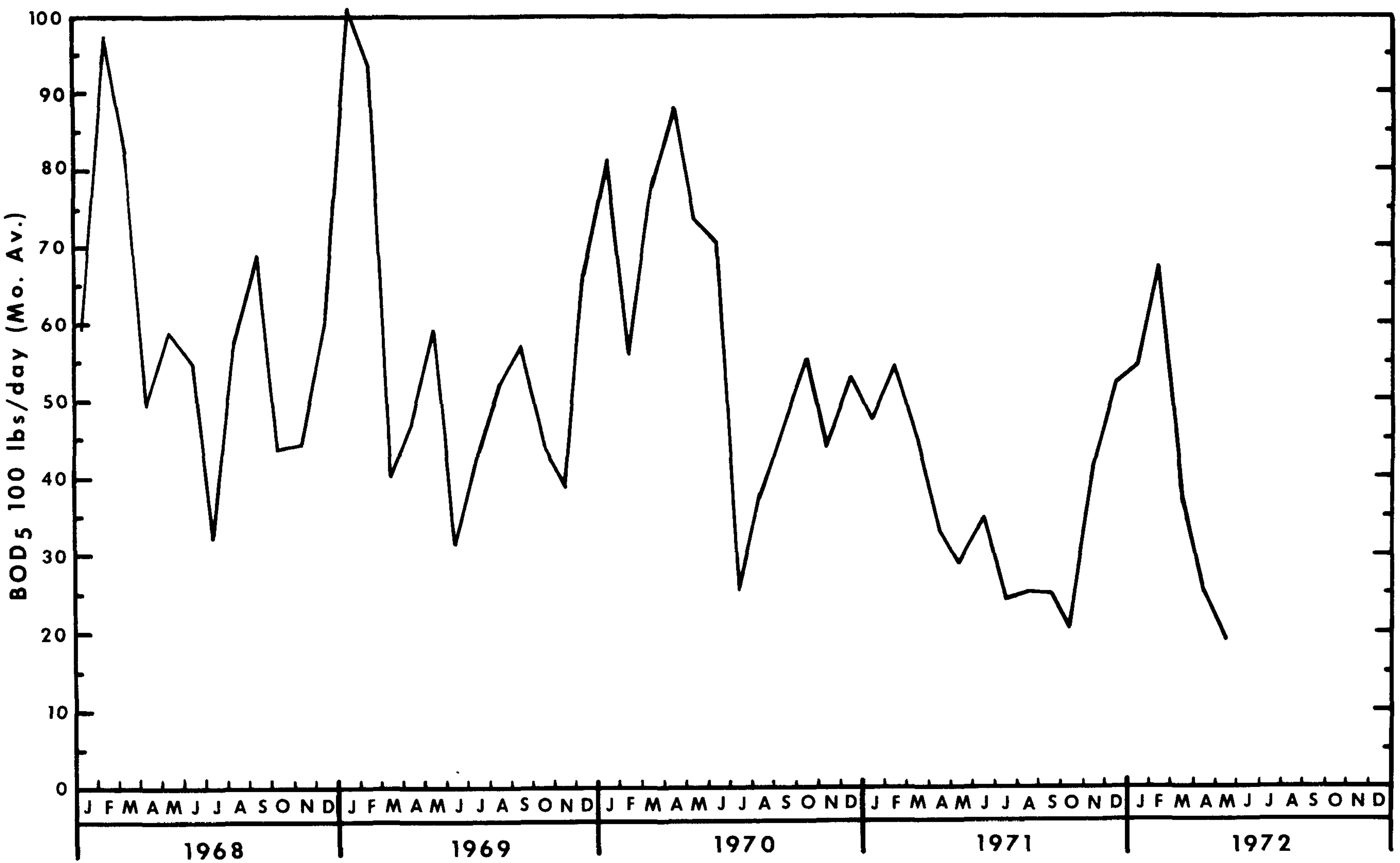


FIGURE G-2

MONSANTO NITRO, W. VA. PLANT TOTAL BOD_5 LOAD PER DAY TO KANAWHA RIVER

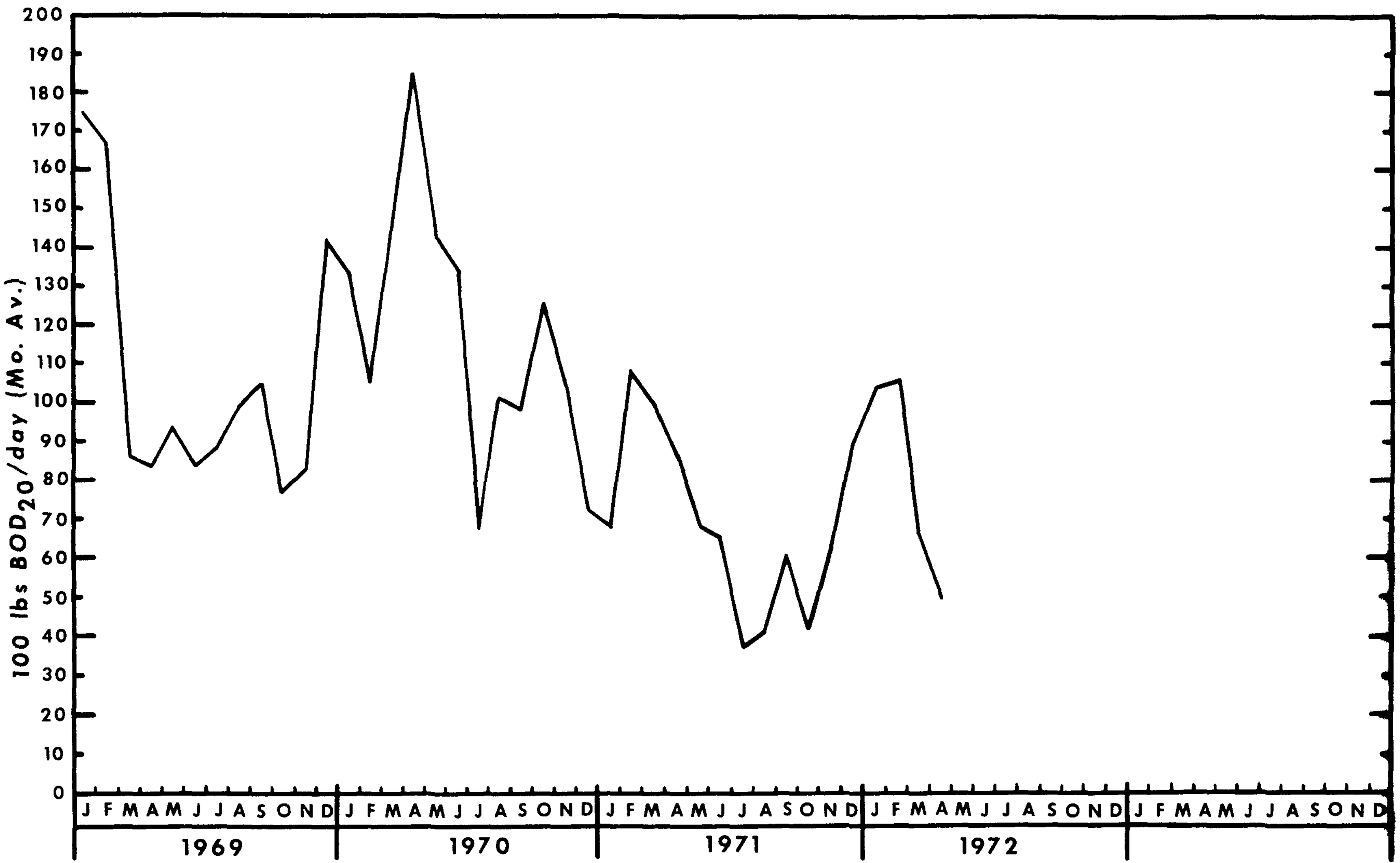


FIGURE G-3

MONSANTO NITRO, W. VA. PLANT TOTAL BOD_{20} LOAD PER DAY TO KANAWHA RIVER

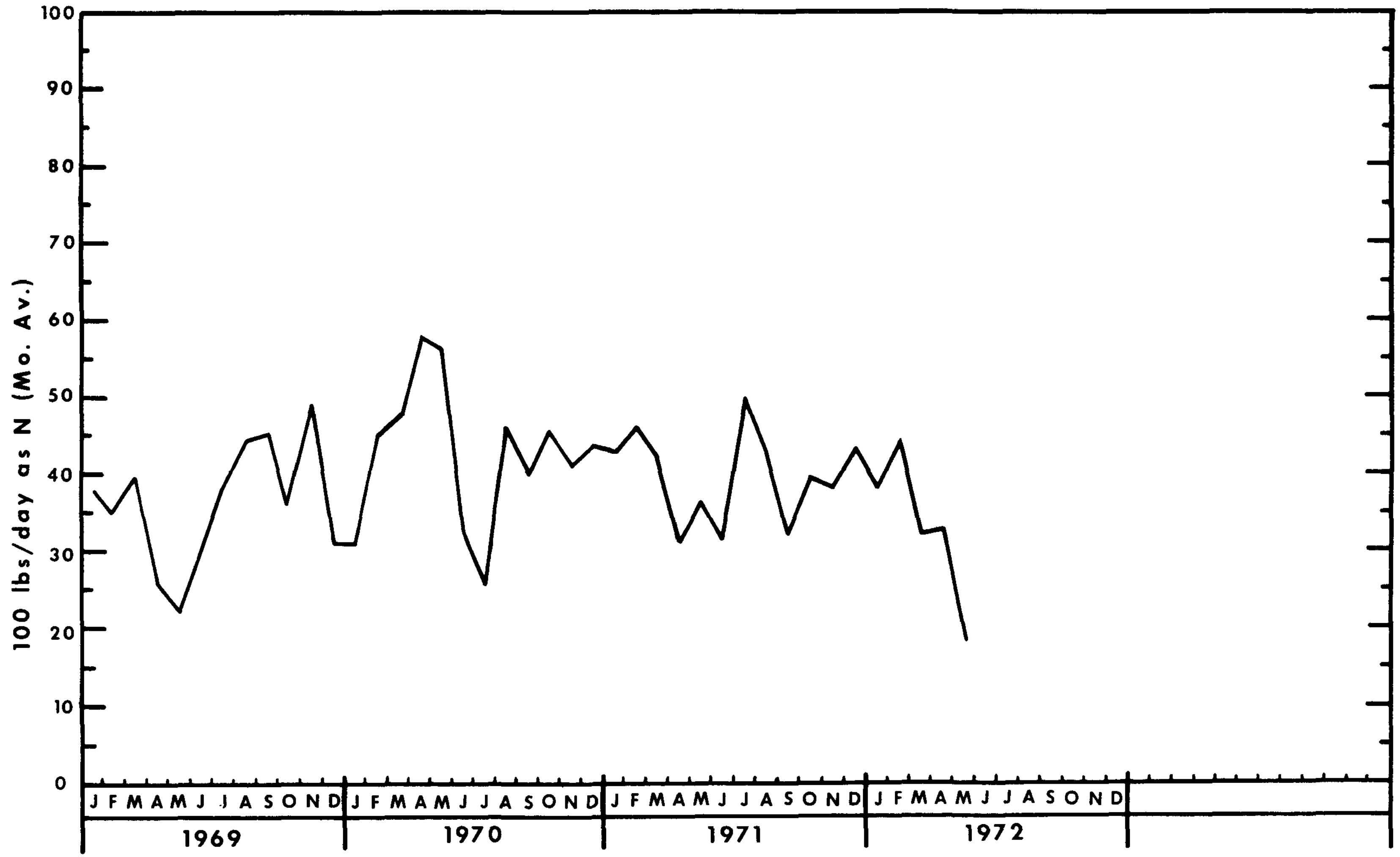


FIGURE G-4

MONSANTO NITRO, W. VA.

PLANT TOTAL KJELDAHL NITROGEN LOAD PER DAY TO KANAWHA RIVER

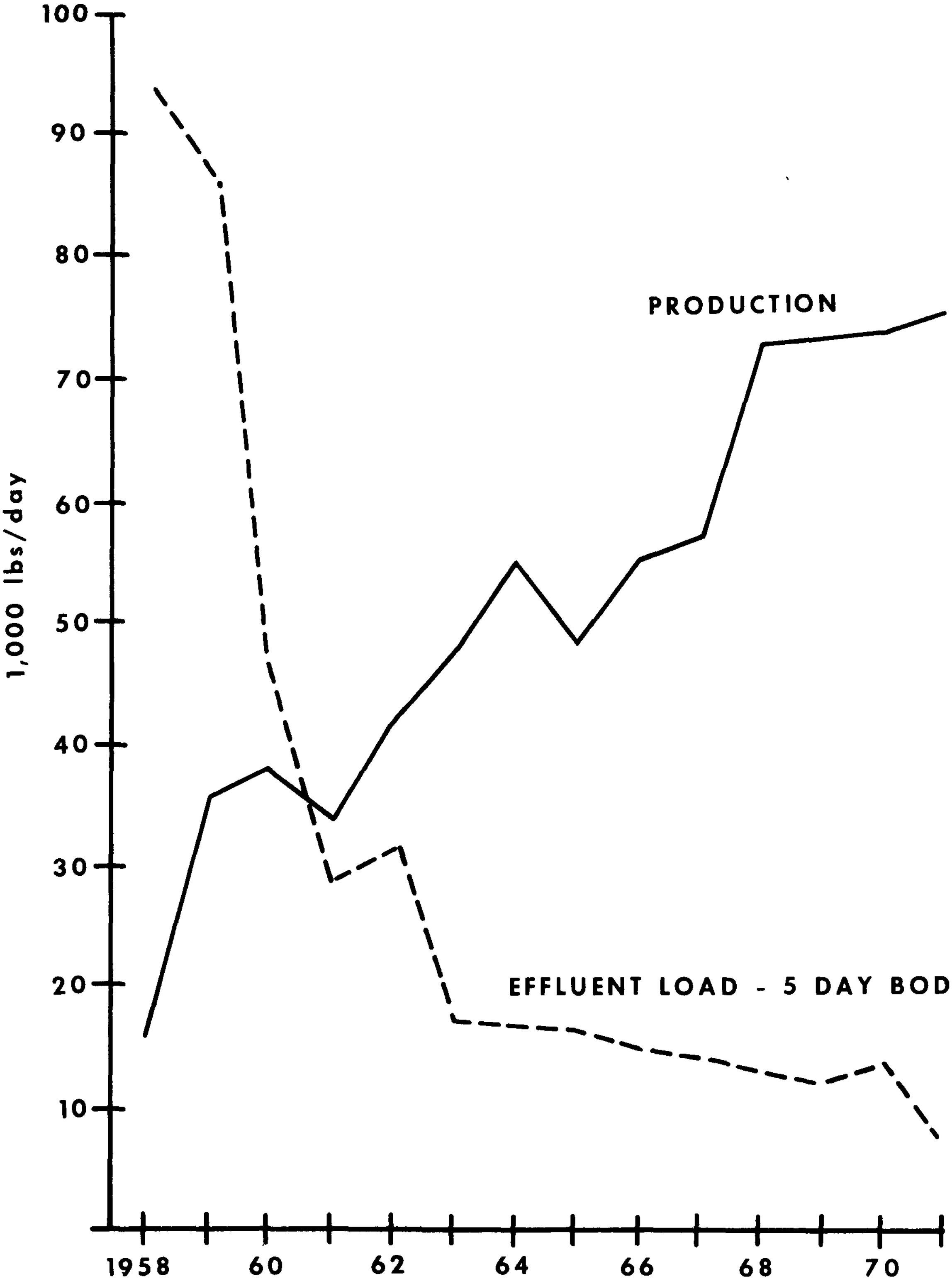


FIGURE G-5
EFFLUENT LOAD REDUCTION AND PRODUCTION INCREASE
MONSANTO NITRO, WEST VIRGINIA PLANT

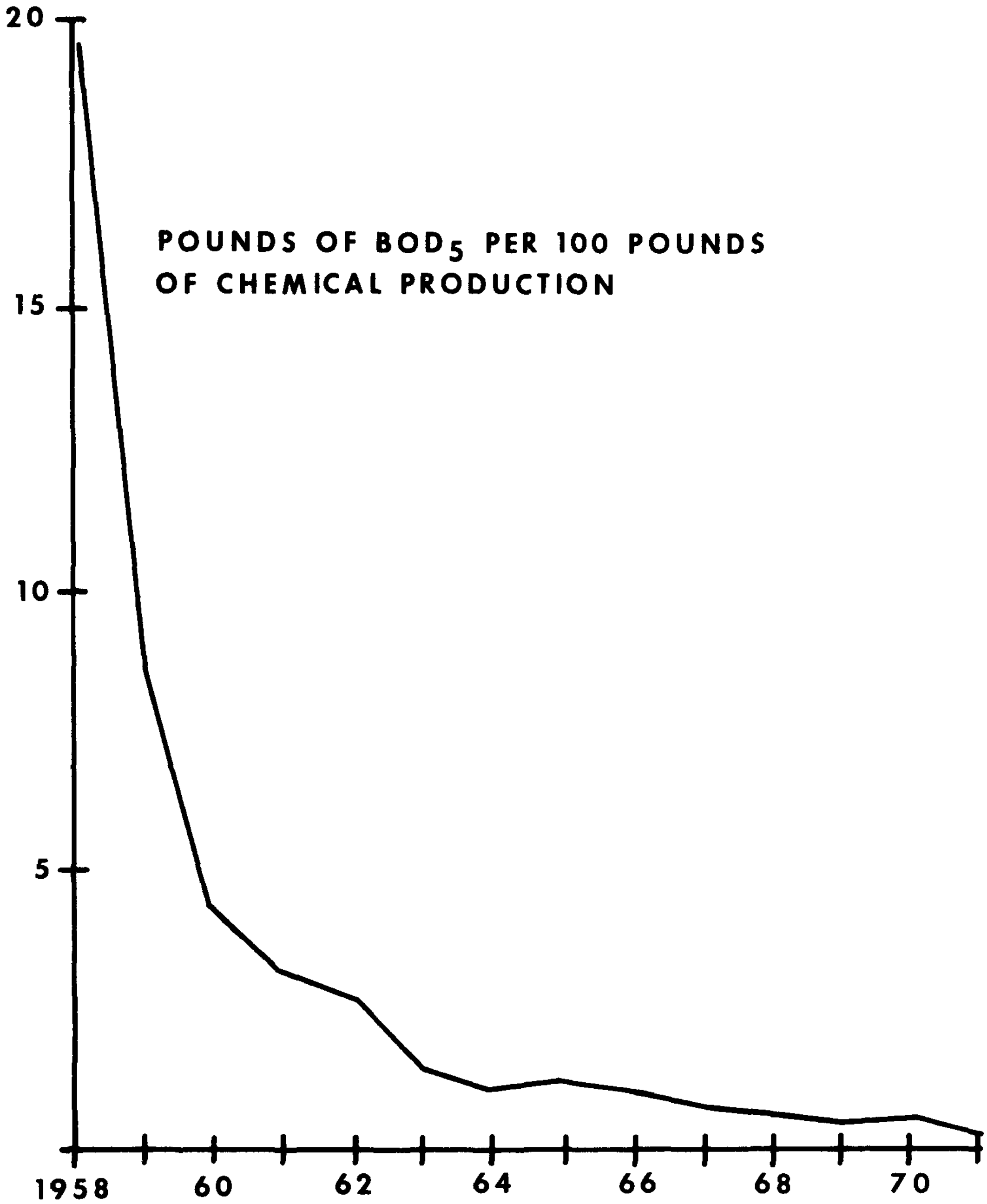


FIGURE G-6

DISCHARGED BOD_5 AS A FUNCTION OF PRODUCTION RATES
MONSANTO NITRO, WEST VIRGINIA PLANT

Waste Disposal Facilities

Monsanto reported that in 1971 it had disposed of 8,782 pounds per day of TOC by landfill and 18,940 pounds per day by incineration. On the basis of all waste loads reported as TOC, landfill and incineration represented approximately 57 percent of the total. Table G-6 contains data reported by the company except that its numbers for by-product sale, waste load reductions through monitoring, etc., and material recycled to process have been deleted as inappropriate in a reckoning of the actual total plant waste load.

TABLE G-6

DISPOSITION OF THE TOTAL WASTE LOAD
MONSANTO PLANT - 1971

Disposal Method	Total Organic Carbon (lb/day)
Material landfilled	8,782
Material burned	18,940
Material to disposal pond	9,372
Material to treatment plant (value low because sampling missed solids and oils)	8,102
Tall oil barometric condenser uncontrolled load (1962 level)	3,207
	48,403

Wastewater Disposal

For the tall oil process barometric condenser wastewater, which was discharged along with a cooling water stream, all wastes entered sewers and were processed through the treatment plant (Figure G-7).

Primary treatment was provided in three large lagoons. The first served as a pump sump after the gravity interceptor from the production area. The second and third (four- to five- and two-day retention times, respectively) removed settleable solids and floating material and provided equalization and storage capacity. A spill or upset could be segregated in the largest lagoon and slowly blended into the main flow. pH adjustment was provided by passing the flow

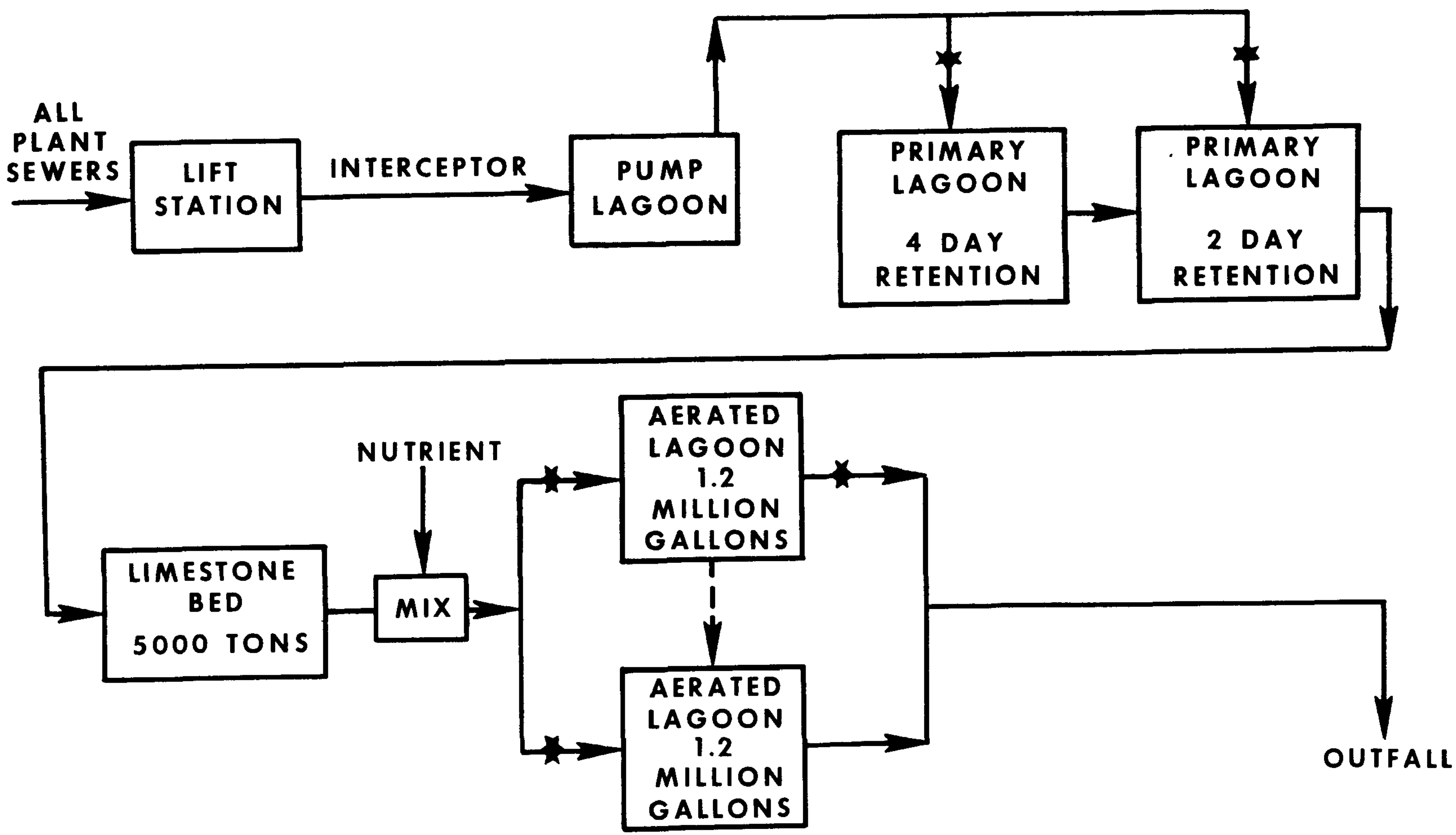


FIGURE G-7
WASTE TREATMENT PLANT
MONSANTO NITRO, W. VA. PLANT
MARCH 1972

through a 5,000-ton crushed limestone bed. This provided, the company said, reliable control without the problems of instrumentation and metering pumps.

Secondary treatment was provided by two aerated lagoons, each having a capacity of 1.2 million gallons. Aeration was provided by one fixed Infilco 50-hoursepower turbine aerator (rated capacity 5,000 pounds per day oxygen transfer) and three Lightnin floating aerators (rated capacity of each was 3,900 pounds per day oxygen transfer). The aerated lagoons were originally designed to be operated in parallel, but had been operated experimentally in series-parallel (all flow from one lagoon discharging into the second, both lagoons receiving equal amounts of primary effluent) to obtain increased efficiency.

The capacity of the treatment plant was:

1. Primary treatment-visual pollution removal: above 5.8 mgd.

2. Primary treatment-solids and oil removal plus full equalization: 4.5 mgd.

3. Limestone bed and biological treatment: 2.6 mgd maximum.

Cooling Water

All plant cooling water was discharged through outfall No. 002. This stream also contained the tall oil process barometric condenser wastewater. The discharge from outfall No. 002 represented a significant portion of the total BOD(5) load discharged into the river. The stream was untreated at the time of the survey. (A new skimming pond to remove fatty acids was completed in August 1972.) Appraisal of thermal loadings was not a part of this study and cooling water temperatures were not measured.

Monitoring

In-plant monitoring was provided by means of continuous sampling at the manufacturing plant, the wastewater lift stations, and the tall oil intake and discharge points. TOC analyses, supplemented by gas chromatographic analyses, were performed daily. In addition, continuous hot-wire instrument coupled with an alarm and recorder was used to detect volatile solvents in the sewer line to the lift station.

At the treatment plant, flow was measured and recorded by magnetic flow meters. Effluent TOC and pH were analyzed daily, and other parameters weekly -- BOD(5), BOD(20), total solids, suspended solids, Kjeldahl nitrogen, acidity, and chloride.

Removal Efficiency

Company officials reported that only a limited amount of data had been collected on overall treatment plant efficiency. Their emphasis had been on monitoring soluble organics, because they believed that suspended solids and oils were almost completely removed in the primary lagoons. They had, however, recently established the BOD(5) and TOC ratio on current wastewaters and applied it to estimated raw BOD loads for 1971 (Table G-7).

The samples taken and analyses made do not provide good data for evaluating removal efficiencies. It was necessary, because of a concurrent sampling load at nearby plants on the Kanawha, to do all the Monsanto sampling (as at the other plants) during one 24-hour period.

Future Plans

(Monsanto recently expanded the wastewater treatment plant, as indicated in Figure G-8, to comply with the State's Phase III requirements. Construction started in July and was completed in December 1972. The salient features are a five-fold increase in retention time, additional aeration capacity, and improved flexibility in operation. Construction of a new skimmer pond for removal of fatty acids by flotation from the tall oil stream was completed in August 1972. These improvements will provide capacity for increased loads.

New facilities for removal of ammonia nitrogen from the major source began operation in January 1973. The ammonia is stripped under alkaline conditions and is incinerated.

Research work toward a major improvement in the largest single process source (25 to 30 percent of the treatment plant load) recently passed a critical point and is reported as highly encouraging. It is anticipated by the company that this reduction will be achieved by late 1974.

A continuing program is being carried out by Monsanto to review the contribution from each individual process and institute new control methods.)

Spill Potential

Monsanto had an exemplary system for minimizing the effects of process spills on the river. All wastes, except tall oil and cooling water, flowed to the treatment plant. The primary lagoons provided equalization to reduce the shock of any spill on the biological

TABLE G-7

MONSANTO NITRO, WEST VIRGINIA, PLANT, 1971 TREATMENT

Plant Efficiency

	Five-Day BOD Load		
	Est. Input Pounds Per day	Discharge Pounds per Day	% Removal
January	12,592	3,363	73.5
February	16,301	4,324	76.1
March	15,613	4,257	79.6
April	14,933	2,189	83.2
May	22,858	2,543	86.1
June	12,477	2,458	81.7
July	9,689	2,076	76.1
August	9,923	1,832	81.4
September	12,221	2,117	82.8
October	11,705	1,544	83.6
November	12,131	3,377	71.0
December	11,947	4,094	65.7
Average	13,533	2,765	78.45

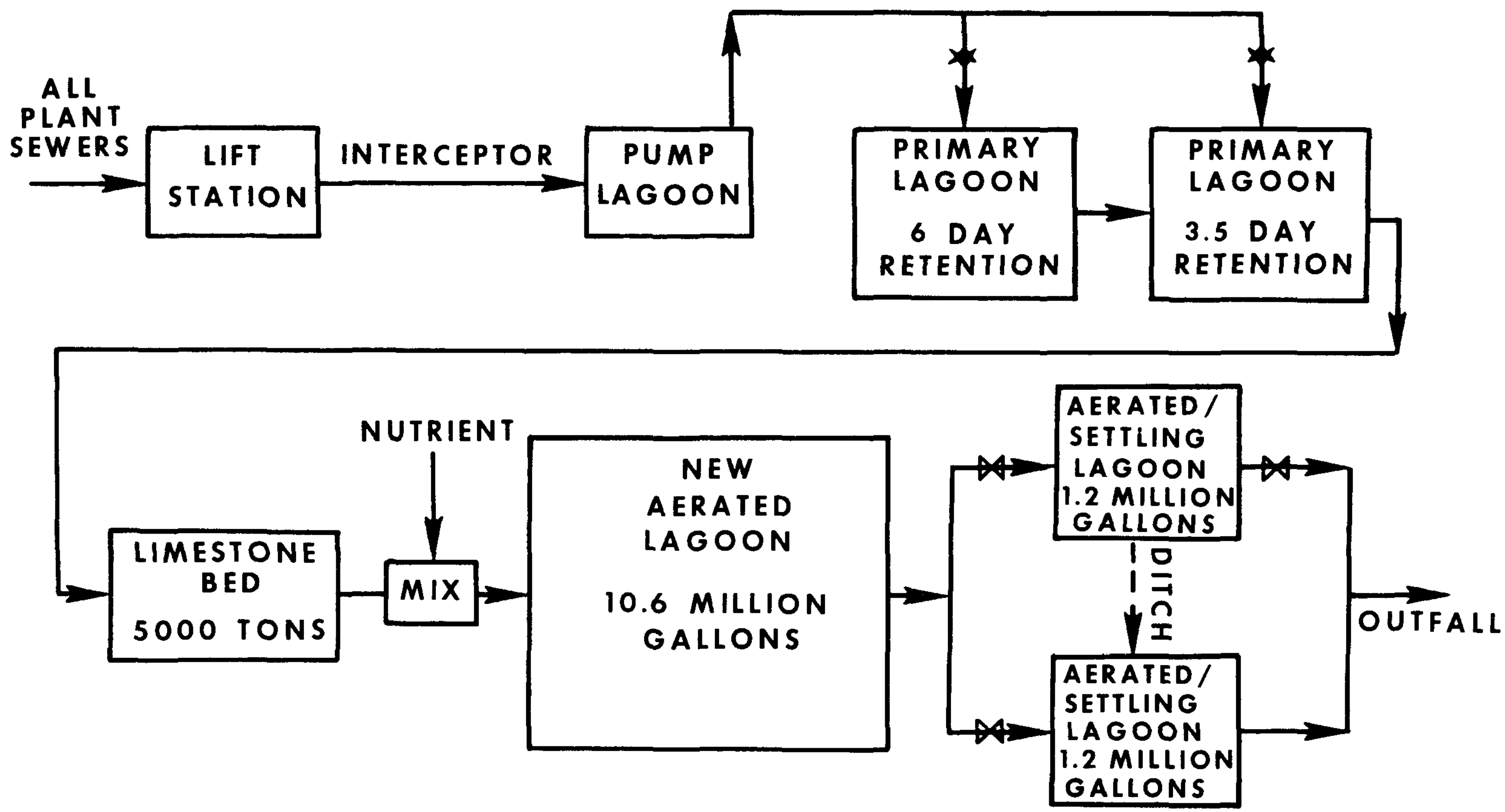


FIGURE G-8
MODIFICATIONS TO WASTE TREATMENT PLANT
MONSANTO NITRO W. VA. PLANT

treatment system. The potential pollution of the river from in-plant spills was, therefore, considered to be minimal.

NFIC-Cincinnati Field Survey

Sampling

The two outfalls were sampled for a 24-hour period on February 16 and March 12, 1972. Water purchased from the city and raw river water were also sampled. Samples were taken at two-hour intervals for 24-hour composites. NFIC-Cincinnati collected split samples for the State and Monsanto collected its own.

The second date for sampling was scheduled because the tall oil process was unexpectedly not operating on February 16. The March 21 effort was expanded at the company's request to include the waste treatment plant. The request was made because officials did not consider that the treatment plant had not completely recovered from the reported sulfa drug upset at the time of the February 16 sampling.

Analytical Results

Analytical results are presented in Tables G-8 and G-9. A portion of the March 21 data, converted to loads in pounds per day, is shown in Table G-10.

For the purposes of this survey, reasonable agreement of the data from EPA, State, and Monsanto sources was obtained, but certain significant exceptions have been noted.

The Company has stated that the BOD(5) loads for the tall oil discharge on March 21 are too high.

The NFIC-Cincinnati tall oil discharge analytical results for phenol and oil and grease have also been questioned by the company. The EPA analysis for oil and grease was 36 mg/l, the company's was zero. The skimmer pond was not yet in operation, therefore, the zero value is certainly questionable. The NFIC-Cincinnati phenol analysis of the March 21 tall oil wastewater sample is much higher than those of the State and company. It should be noted, however, that the State's analysis would indicate a phenol load of 28 pounds per day as compared with its limit of 4 pounds per day under minimum flow conditions, and that the company's phenol analyses shows the same value of 0.30 mg/l for city water, river water, and the tall oil discharge.

TABLE G-8

ANALYTICAL RESULTS FOR 2/16/72 SAMPLING

MONSANTO NITRO, WEST VIRGINIA, PLANT

Sample Point		1 WTP Inlet			2 WTP Discharge			3 City Water		
		EPA	W.VA.	CO.	EPA	W.Va.	CO.	EPA	W.VA.	CO.
Flow	mgd			2.31			2.18			
BOD_5	mg/l	2250		345	387	240	264			2.44
BOD_{20}	mg/l			300	608		270			1.6
COD	mg/l	1600	1862	2034	1080	992	1363		1	1
TOC	mg/l	450		420	240		325			40
pH							7.1		7.3	7.5
Total Solids	mg/l	6900	6300	3993	6420	6587	5081		148	146
Suspended Solids	mg/l	503	265	599	72	142	59			
Volatile Solids	mg/l									
TKN	mg/l					194	157			1.2
NH_3-N	mg/l	160	140	95	210	174	130			0.3
Nitrite & Nitrate	mg/l	1.3			0.7					
Tot. Phosphorus	mg/l		2.2	0		1.8	1		3.0	0
Chloride	mg/l		2340	2002		2540	2213		30	14
Sulfate	mg/l			1305		1700	1676		29	32
Oil & Grease	mg/l	1600	232	123	35	66	35			2.4
Phenols	mg/l	Lost (Low)		3.68	0.26		0.44		.007	0
Cyanide	mg/l	< 0.01		0.2	< 0.01		0			0
Mercury	µg/l	1.2								
Arsenic	µg/l									
Lead	mg/l									
Zinc	mg/l									
Aluminum	mg/l									
Cadmium	mg/l									
Chromium	mg/l				0.07					
Copper	mg/l									
Iron	mg/l									
Magnesium	mg/l									
Manganese	mg/l									
Nickel	mg/l									
Bacti	No./100 ml									
Total Coliform		> 100			560					
Fecal Coliform		10			10					

NOTE: Metals analyses showed values below detectable or normal reporting limits except as shown.

TABLE G-9

MONSANTO NITRO W. VA. PLANT - ANALYTICAL RESULTS FOR 3/21/72 SAMPLING

Sample Point		1 WWTP Inlet			2 WWTP Discharge			3 Tall Oil Discharge			4 River Water			5 City Water		
		EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.	EPA	W.Va.	Co.
Flow	MGD			2.005			1.712			7.92						
BOD_5	mg/l	330	801	411	230	217	271	39	52	28	3.2	3.5	11.5			2.76
BOD_{20}	"		1021	837	544	493	426		75	35.7		4.4	13.5			4.74
COD	"	1670		1550	1300		1094 1176	133		14.8	13		15	< 5		57.4
TOC	"	480		595	290		335	29		40	6		25	5		35
pH		2.5	2.8	2.85	6.6	6.6	6.4	5.7	5.8	6.2	6.1	6.2	6.2	7.3		7.4
Tot. Solids	mg/l	4700	4853	4540	8660	8774	8648	210	230	202	254	236	236	48		150
Sus. Solids	"	48			142		80	20		202	21		16	6		
Vol. Solids	"	818			1100		9	26		40	100			30		
TKN	"	37	174	262	220	240	267	1.0	1.3	28	0.8	1.2	3.9	0.2		2.60
NH_3-N	"	36	157	230	190	215	215	1.0	0.49	20	0.5	0.49	1.2	<0.5		0.87
Nitrite & Nitrate	"	0.8			0.4			0.8			0.9			1.1		
Tot.Phosphorus	"	5.5	4.0	7.	18	17	16	0.1	0.5	0	1.0	0.27	0			0
Chloride	"		3600	2540			3180	40	100	35	40	49	35			35.
Sulfate	"		1000	1075	2620		2510	68	80	111	87	80	102			78.
Oil & Grease	"	350		34.2	22		4	36		0	1		0			0
Phenols	"	1.3	0.045	1.3	0.33	0.074	0.6	2.6	0.54	0.30	0.1	0.110	0.30	<0.01		0.30
Cyanide	"	<0.01			<0.01			<0.01			<0.01					
Mercury	µg/l															
Arsenic	µg/l															
Lead	mg/l															
Zinc	"															
Aluminum	"															
Cadmium	"															
Chromium	"															
Copper	"															
Iron	"															
Manganese	"															
Magnesium	"															
Nickel	"															
Bioassay TL_m 24-hr.					10			39								
48-hr.					7.6			39								
96-hr.					7.6			39								

TABLE G-10

RESULTS OF 3/21/72 SAMPLING AND ANALYSES
MONSANTO NITRO, WEST VIRGINIA, PLANT

Outfall/ RAPP No.	Flow MGD	EPA	WVA	CO	EPA	WVA	CO
		LOAD IN POUNDS PER DAY					
		BOD_5			BOD_{20}		
WWTP Inlet	2.005	5500	13000	6800	-	17000	14000
WWTP Disch. 001	1.712	3300	3100	3800	7800	7000	6100
Tall Oil 002	7.92	2400	3200	1100	-	4700	1500
		COD			TOC		
WWTP Inlet		27900	-		7940	-	9360
WWTP Disch. 001		18600	-	16000	4070	-	4280
Tall Oil 002		7930	-	-	1520	-	990
		TS			SS		
WWTP Inlet		77800	-	73000	700	-	-
WWTP Disch. 001		12300	125000	121000	1940	-	1140
Tall Oil 002		-	-	-	-	-	-
		TKN			NH_3-N		
WWTP Inlet		600	2900	4300	600	2600	3800
WWTP Disch. 001		3100	3400	3800	2700	3100	3000
Tall Oil 002		13.	6.6	1600	33	-	1240
		PHENOL			OIL & GREASE		
WWTP Inlet		17.	0.7	17.	5900	-	570
WWTP Disch. 001		4.7	1.0	4.3	3.4	-	57
Tall Oil 002		160	28	20.	2400	-	0

Toxicity of Effluents

Static bioassays were conducted with fathead minnows using wastewater taken from the two outfalls. At least a portion of the toxicity measured may have been from a neighboring plant, FMC Organics. The toxicity measured at the treatment plant was significantly higher than the discharge from FMC Organic and test animals died immediately in a 56 percent test solution.

Bioassay test conditions for the treatment plant discharge were: DO range of 4.7 - 7.2 mg/l; pH range of 6.3 - 6.5; and temperature range of 23 - 27°C. The TL50 (median tolerance limit) was 10 percent at 24 hours and 7.6 percent at 48 and 96 hours. (TL50 is the concentration of effluent that would be lethal to 50 percent of the fish held in it for a specified time period, i.e., 24, 48, or 96 hours. Thus, the lower the TL50, the higher the toxicity of the effluent.)

For the tall oil discharge, the bioassay test conditions were: DO range of 4.7 - 6.7; pH range of 5.7 - 6.5; and temperature range of 23 - 27 °C. The TL50 at the FMC Organic plant discharge, about 200 yards upstream from the Monsanto intake, was 13 percent at 24, 48, 96 hours.

The high discharge BOD(5) load on February 16 was caused by an upset from which the treatment plant had not recovered, as mentioned earlier. The low input BOD(5) load to the treatment plant on March 21 is attributed to the fact that a production unit which ordinarily is a large source of the load was down on that date.

Summary and Conclusions

1. Pollution abatement programs carried out since the establishment of the 1958 baseload had reduced the load to the river despite large increases in production.

2. As shown by the records, BOD(5) loads discharged into the river had fluctuated widely.

3. Additional monitoring should be conducted at the treatment plant.

4. There is a need to establish the precision and accuracy of the company's analytical techniques, particularly in instances where its determinations vary widely from those of the State and NFIC-C.

5. Achievement of water quality improvement goals for the Kanawha will require significant additional abatement efforts over those existing at the time of the survey. (Although the recent

expansion of the treatment plant is expected to meet the State's Phase III requirements, its ability to meet future use criteria has not been appraised.)

6. Specific corrective action must be taken with regard to the toxic discharge problem.

7. The combined cooling water and tall oil barometeric condenser discharge contained significant amounts of process wastes measured as BOD(5), COD, oil and grease, and phenol.

8. The spill prevention and control system at the plant was very good.

Recommendations

It is recommended that:

1. The company reduce its BOD(5) load to the river to a total of no more than 320 pounds per day and its total nitrogen load to 1,400 pounds per day. These numbers are based on the maintenance of 4 mg/1 DO at the Kanawha River's sag point at a seven-day once-in-10 year low flow of 1,930 cfs at Charleston.

2. The toxicity of the effluent be reduced at least to the point that no discharge exceeds 1/20 of the 96-hour TL50.

3. The company maintain the pH of all discharges in the 6.0 - 8.5 range.

4. The company meets the State's phenol discharge limit of 4 pounds per day.

5. The company establish a monitoring system at the treatment plant which will include determination of inlet values for BOD(5), TOC, and TKN. This will provide for a way to improve the pollution abatement effort.

6. Improved monitoring, including continuous pH and temperature measurements, be effected for better characterization of the cooling water and tall oil process water streams.

7. Consideration be given to using the primary lagoon facilities as an anaerobic lagoon to meet future wastewater treatment requirements. This has been successfully demonstrated elsewhere in the treatment of organic chemical wastewaters. Neutralization of wastewaters before the primary lagoon would be required.

8. The Monsanto Company make every possible effort to further separate process wastes from cooling water and tall oil process water.