iowa department of environmental quality
Water Quality Management Division

IOWA RIVER BASIN

WASTE LOAD ALLOCATION STUDY

STANLEY CONSULTANTS
INTERNATIONAL CONSULTANTS IN ENGINEERING, ARCHITECTURE, PLANNING, AND MANAGEMENT

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December 16, 1974

Iowa Department of Environment
Quality
3920 Delaware Avenue
P. O. Box 3326
Des Moines, Iowa 50316

Gentlemen:

We are pleased to submit our report entitled "Iowa River Basin - Waste Load Allocation Study." This report has been prepared in accordance with our contract dated November 12, 1973, and Amendment No. 1 dated April 8, 1974, with the Iowa Department of Environmental Quality for a series of waste load allocation studies.

Respectfully submitted,

STANLEY CONSULTANTS, INC.

R. J. Gear

Ronald J. Gear
Vice President

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SYNOPSIS

The study area of the Iowa River Basin encompasses an area of approximately 2,150 square miles in the central section of Iowa. The topography varies from flat to rolling and the drainage pattern of the basin is tree-shaped (dendritic). Stream flows per square mile in the Iowa River Basin through the study area are generally greater than those of the state of Iowa as a whole, except the 7-day, 1-in-10 year low flow is equal to that for the entire state.

Within the study area, Bear Creek, South Fork Iowa River, and the Iowa River have a Class B (warm water fisheries) water quality classification. The Iowa River impoundment upstream of Steamboat Rock has a Class A classification. The limited water quality data available have been obtained during high flow periods and cannot be used to characterize water quality of low flows.

There are 37 incorporated communities within the study area. Of these, 27 have wastewater treatment facilities. Also, there are 22 industrial and 7 semipublic wastewater dischargers. Thirteen communities and 4 industries maintain wastewater treatment facilities which will not be required to adopt a controlled discharge mode of operation under the National Pollutant Discharge Elimination System (NPDES).

To determine allowable waste load allocations for these dischargers, a computer model based upon a modified Streeter-Phelps equation was utilized. Input data to the model included such physical characteristics as length of reach, water temperature, channel slope, river width, roughness coefficient, deoxygenation rate constants, wastewater discharge characteristics, and flow and characteristics of groundwater and tributaries. The model approximates the impact of dischargers on stream quality for the specified winter and summer low flow conditions. Wherever stream quality criteria were not met by secondary treatment, reductions were made in the allowable wastewater discharges until satisfactory conditions prevailed.

Under summer low flow conditions, Farm Best (Iowa Falls), Packing Corporation of America (Tama), Tama Meat Packing (Tama), and the communities of Brooklyn, Iowa Falls, Marshalltown, Tama, and Victor must all provide better than secondary treatment to meet stream quality standards. The community of Eldora, in addition to the above mentioned communities and industries, must provide better than secondary treatment under winter low flow conditions. Ammonia nitrogen removal is required of all dischargers required to meet better than secondary treatment under winter conditions.

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FIGURES

Bottomland soils are formed from alluvial materials. The Wabash soil series is found on bottomlands.

The surficial aquifer overling the bedrock aquifer is formed by alluvium, glacial drift, and loess. Although surficial aquifers of glacial drift do not generally produce large enough quantities of water for public or industrial water uses, sufficient quantities of water are produced for farmsteads and rural residences.

A portion of the north central Mississipian aquifer outcrop area occurs in the basin. The aquifer is exposed or overlain only by soil material consisting of semipermeable loess, glacial drift, and locally by permeable water-bearing alluvium. The permeability of these soil materials creates a potential groundwater contamination hazard because the aquifer is recharged at an estimated rate of 45,000 gallons per day per square mile.

Soil conditions on the uplands are variable. Potential problems exist for unsealed sewage lagoons, because soils have moderate permeability. On flat and depressional areas, slow permeability and a water table which may be high at certain times during the year, create a potential hazard for both unsealed sewage lagoon and septic tank filter fields.

Alluvial aquifers in river bottoms, especially those along major river valleys, and on terraces produce larger quantities of water. These aquifers are recharged by local precipitation. Water quality is variable, even in local areas, but generally fair to good.

Potential contamination of groundwater in alluvial aquifers is great. Terrace soils which have high permeability can transmit to streams any pollutants. Bottomlands have slow permeability, a high water table, and are subject to flooding. Both terrace and bottomlands have severe limitations for wastewater disposal.

All sites for wastewater disposal should be carefully evaluated on an individual basis.

<u>Streams</u>

Water contains oxygen required by microorganisms for degradation of organic material. The quantity of oxygen available for waste assimilation is a direct function of the flow volume. In addition, physical characteristics of the channel establish velocity and turbulence, and determine the reoxygenation capability of a stream. Therefore, physical conditions in a stream influence the available oxygen supply, and the biological degradation of organic matter and ammonia which occurs naturally.

Water quality criteria of the state of Iowa must be met at all times when the flow of the stream equals or exceeds the statistical seven-day, one-in-ten year (7-day, 1-in-10 year) low flow. Based upon this flow information and the physical characteristics of the stream, the assimilative capacity may be analyzed and allowable discharges determined.

Low Flow Characteristics - The United States Geological Survey (USGS) maintains an extensive nationwide network of stream gaging stations. Stream flow and certain water quality parameters are monitored continuously at some stations and periodically at others. By extrapolation of data from this established network and review of partial-record stations, additional flow information may be determined for streams where continuous-record stations are not provided.

Low flow in the Iowa River Basin above the gaging station near Marengo is greater than the state average when results are reduced to the common basis of discharge per square mile. The gaging station near Marengo is near the lower limits of the study area, and thus is representative of stream flows within the study area. The following tabulation gives a comparision of the flow at the gaging station near Marengo to the average of 84 continuous-record stations within the state of Iowa.

	Percentage of Time Flow Equalled or Exceeded[1]				
	50	90	95	98	99
State of Iowa Average (cfs/sq mi)	0.150	0.033	0.024	0.018	0.015
Iowa River near Marengo (cfs/sq mi)	0.286	0.057	0.041	0.029	0.025

[1] Iowa Natural Resources Council, Low-Flow Characteristics of Iowa Streams Through 1966, Bulletin No. 10, 1970.

The preceeding table refers to daily average discharges recorded at each gaging station regardless of chronological sequence. The period of record for the Marengo gaging station is 18 years, beginning in 1956.

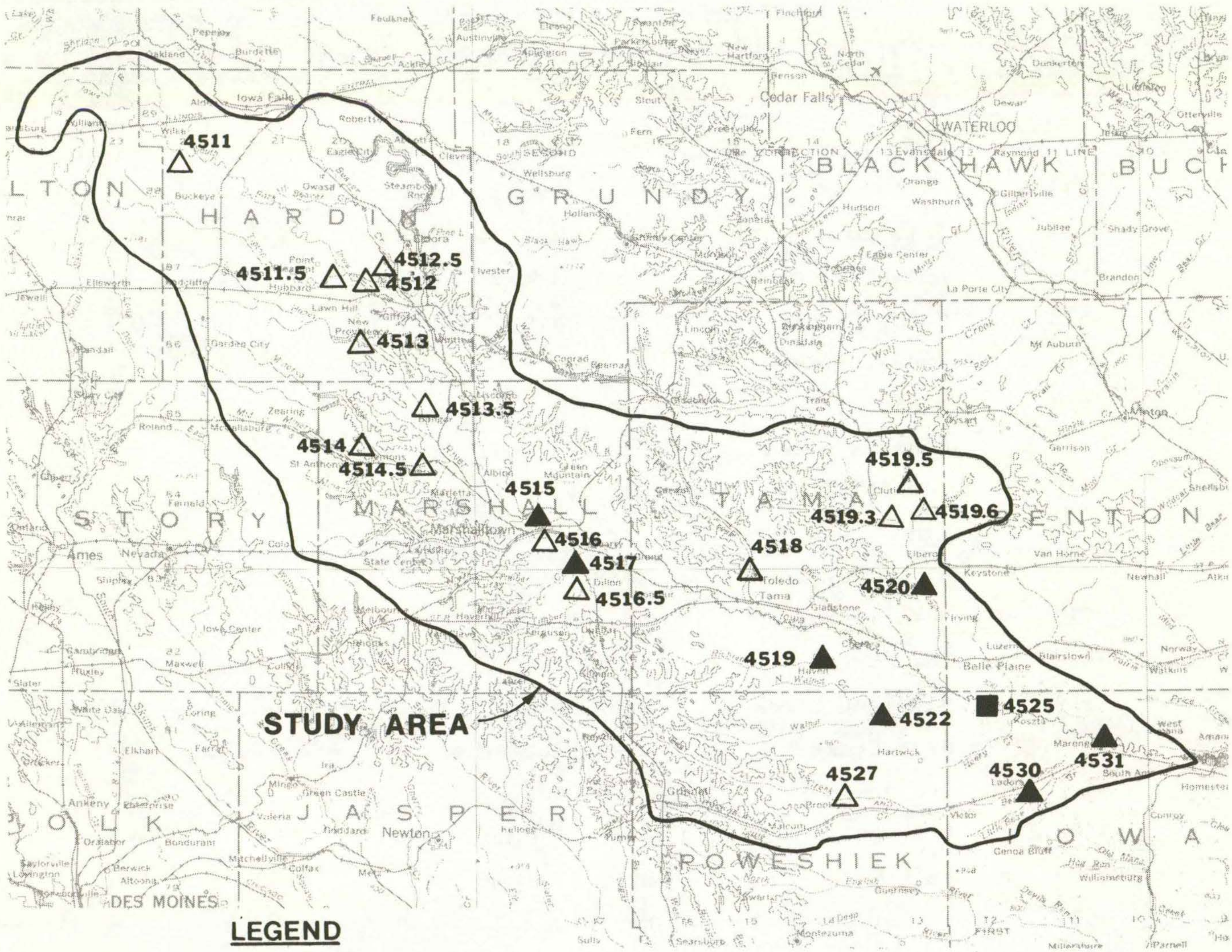
Unlike the daily flow data presented, the average 7-day, 1-in-10 year low flow for the gage near Marengo is essentially identical to that for the entire state. The Iowa River at Marengo averages 0.0197 cfs/sq mi, while the state of Iowa averages 0.020 cfs/sq mi.

Specific USGS gaging station locations are identified on Figure 1. Both partial-record and continuous-record stations are identified. Table 2 identifies a specific gaging station by number, tributary drainage areas above the station, and the 7-day, 1-in-10 year low flow (where available) for each station.

As indicated in Table 2, insufficient data are available for identification of low flow at each gaging station. In order to conduct waste load allocation analyses, determination of 7-day, 1-in-10 year low flow was conducted for specific gaging stations. These values were obtained utilizing the same procedure conducted by the USGS, but based upon less than 10 years of recorded data in some instances. For these reasons, verification of these values, as additional flow information becomes available, is required.

The frequency of extreme low flows is cyclic within the basin. Due to the climatological and geological characteristics of the basin, low flows can occur either during August and September or during January and February of any given year. In addition, long-term climatological cycles have an influence on stream flow. Based upon this information, analyses of critical conditions for defining waste load allocations must be conducted for both warm and cold water temperatures.

Stream Hydrodynamics - The term hydrodynamics refers to the characteristics of motion associated with a body of water. As is discussed in further detail in PART V - WASTE LOAD ALLOCATION METHODOLOGY, stream velocity and slope are of major interest. The relationship between these two characteristics allows definition of reaeration rate constants within particular reaches of streams based upon cross section and slope information. The two



LEGEND

▲ CONTINUOUS-RECORD STATION

■ DISCONTINUED CONTINUOUS-RECORD STATION

△ PARTIAL-RECORD STATION

4356 U.S.G.S. STATION NUMBER

N

0 5 10 20
MILES

U.S.G.S. GAGING STATIONS

FIG. 1

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TABLE 2

USGS GAGING STATION INFORMATION

Station No.	Stream[1]	Location	Drainage Area (sq mi)	7-Day, 1-in-10 Year Low Flow (cfs)	(mgd)
4511	S.F. Iowa River	Near Alden	79.5	---	---
4511.5	Tipton Creek	Near New Providence	81.4	---	---
4512	S.F. Iowa River	Near New Providence	223	---	---
4512.5	Beaver Creek	Near Eldora	69.4	---	---
4513	Honey Creek	Near New Providence	65.5	<0.1	<0.065
4513.5	Honey Creek	Bangor	95.6	---	---
4514	Minerva Creek	Clemons	69.6	<0.1	<0.065
4514.5	Minerva Creek	Near Clemons	148	<0.1	<0.065
4515	Iowa River	Marshalltown	1,546	22	14
4516	Linn Creek	Marshalltown	60.5	---	---
4516.5	S. Timber Creek	Near LeGrand	62.0	---	---
4517	Timber Creek	Near Marshalltown	118	0.13	0.08
4518	Deer Creek	Toledo	76.4	---	---
4519	Richland Creek	Near Haven	56.1	---	---
4519.3	Salt Creek	Near Clutier	85.2	---	---
4519.55[2]	Stein Creek	Near Clutier	23.4	---	---
4519.6	E.B. Salt Creek	Near Elberon	71.3	---	---
4520	Salt Creek	Near Elberon	201	2.8	1.8
4522	Walnut Creek	Hartwick	70.9	---	---
4525	Iowa River	Near Belle Plaine	2,455	41	26
4527	Bear Creek	Brooklyn	77.9	---	---
4530	Big Bear Creek	Ladora	189	0.16	0.10
4531	Iowa River	Marengo	2,794	55	35

1 Iowa Natural Resources Council, Low-Flow Characteristics of Iowa Streams Through 1966, Bulletin No. 10, 1970.

2 Water Resource Data for Iowa, USGS, 1972

physical characteristics which are required to define reaeration rate constants are the slope of the water surface and time of travel for each reach.

Information on the actual slope of the water surface is not available for this river basin. Surface water slope varies with the amount of flow in the stream and at 7-day, 1-in-10 year low flows, the assumption is made that the slope of the water surface is essentially the same as the slope of the stream bottom. Stream bed slopes have been obtained from the information on USGS topographic maps. Channel slopes in the streams to be modeled ranged from approximately 1.1 ft/mi to approximately 6.8 ft/mi.

Determination of time of travel is dependent only upon distance traveled and stream velocity. Distance is measured from USGS topographic maps. Determination of stream velocity is described in detail in PART V. The two physical characteristics required to calculate a stream velocity are the width of the stream and value of the Manning coefficient ("n"). Width of the stream would be the width of the water at 7-day, 1-in-10 year low flow. The only available data which allows approximation of widths at these flow conditions are taken at continuous-record stations. The 7-day, 1-in-10 year low flow widths for reaches other than those which have USGS gaging stations must be estimated on the basis of the widths at the gaging stations, and by field measurements of stream widths at low flows. Similarly, the only locations at which the Manning "n" can be determined is at the location of continuous-record gages. The value of the coefficient for a single location varies with a number of factors, one of which is the amount of flow. The approximate "n" values for other reaches of the stream are made on the basis of the calculated "n" values, and visual examination of the stream.

PART III

WATER QUALITY

General

The main objective of determining allowable waste loads is protection and enhancement of water resources to ensure acceptable conditions for designated uses. Identification of realistic waste load allocations requires knowledge of the existing water quality resulting from the interaction of man with nature within the Iowa River Basin study area.

Iowa Water Quality Standards establish a baseline for evaluating adequate stream quality under existing and projected discharge conditions. The National Water Quality Criteria, as proposed by the Federal Environmental Protection Agency (EPA), provide an additional measure of the adequacy of existing water quality.

Existing water quality for that portion of the Iowa River within the study area has been identified based upon analyses of available data obtained from various sources. These results emphasize areas with degraded water quality and provide information which defines the assimilative capacity of a stream.

In addition, review of existing data shows the extent of water quality monitoring in the basin. Monitoring system deficiencies are apparent and recommendations for a system which will better assess characteristics of the aquatic environment are proposed. Suggested alterations will provide a system capable of furnishing data necessary for establishing and monitoring waste load allocations.

Water Quality Criteria

Water quality criteria define the constituent levels which will protect the utility of the water resource for multiple uses. Concentrations of water quality parameters in a "pristine" state are impossible to locate or estimate because of the activities of man within the basin. Existing criteria are the standard against which water quality parameters are compared to determine the quality of a stream. Differences between existing quality and criteria establish a basis for defining waste load allocations.

Iowa Department of Environmental Quality Regulations - Regulations promulgated by the Iowa Water Quality Commission specify water quality for all surface waters within Iowa. Powers and authorities of IDEQ are defined in the Code of Iowa, 1973, Sections 455B.32(2) and 455B.35. Specific regulations are given in the "Iowa Departmental Regulations - Department of Environmental Quality" (IDR-DEQ).

The most important regulations applicable to the study area are identified in Chapter 16, Sections 1 and 2, "Water Quality Standards" of the IDR-DEQ. This document specifies the stream quality requirements for the following use classifications:

Class A - Body Contact Recreation

Class B - Wildlife, Non-body Contact Recreation and Aquatic Life

Class C - Potable Water Supply

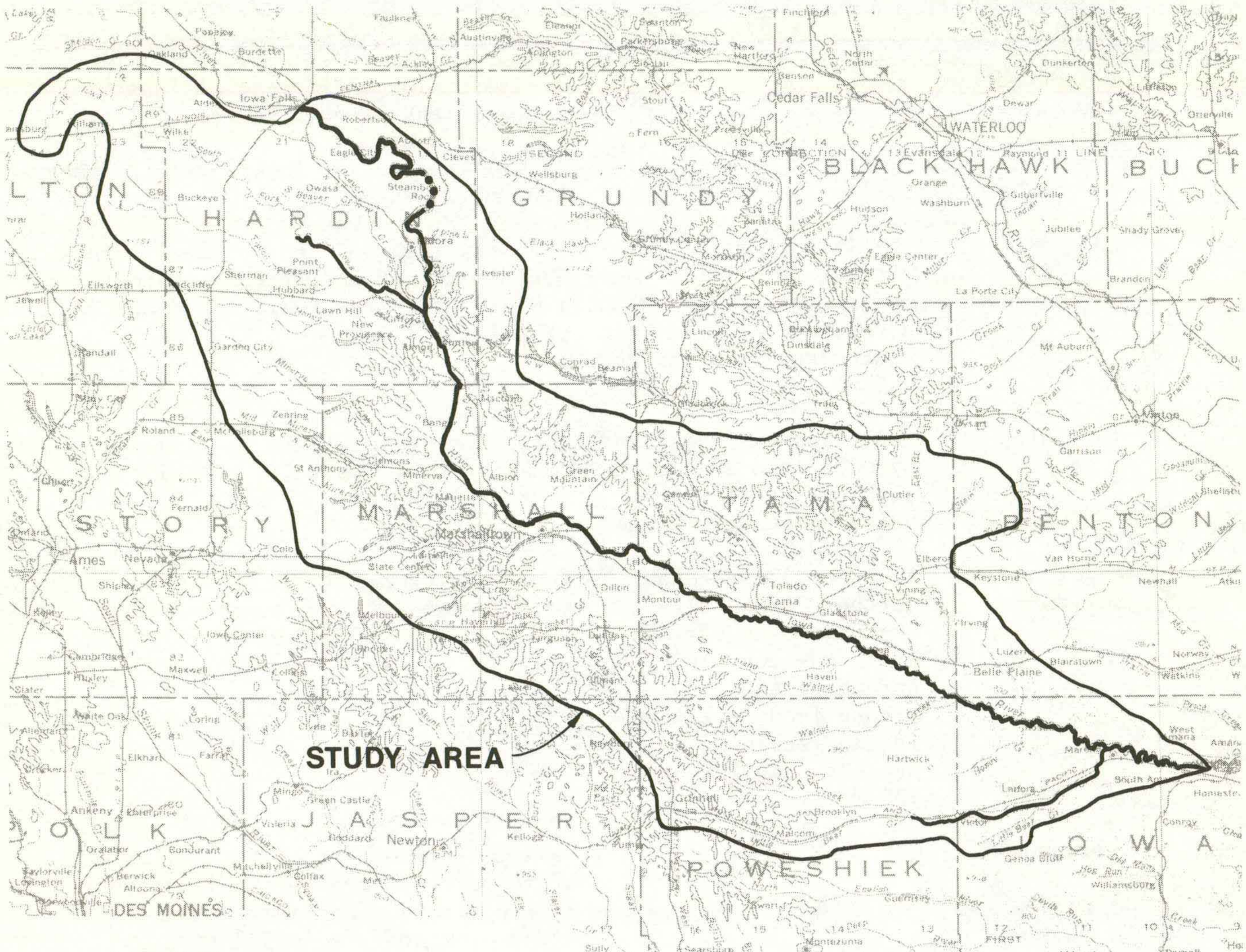
In accordance with use classifications, certain streams within the basin must satisfy the water quality standards for Class B (warm water) and certain designated areas must satisfy the Class A requirements. Figure 2 indicates which streams within the study area must satisfy Class A and Class B requirements. Other streams have not been classified and must satisfy General Water Quality Criteria. Tables 3 and 4 summarize the applicable standards for the A and B classifications, while Table 5 presents General Criteria.

Class B uses apply to waters which will support both cold and warm water fisheries, and different sets of criteria are enumerated for each use. All Class B streams within the basin study area must satisfy criteria for warm water fisheries. Therefore, Table 3 contains stream standards applicable for warm water fisheries. Table 4 identifies the concentration of chemical constituents allowable in Class B streams.

Federal EPA Regulations - In conformance with 1972 Federal Water Pollution Control Act Amendments [Section 304(a)(1) and (2), Public Law 92-500], EPA has published "Proposed Criteria for Water Quality." Under existing legislation, major programs which will be affected by the criteria are:

Water Quality Standards

Toxic and Pretreatment Standards



LEGEND

- • • • • • CLASS A WATERS
- ——— CLASS B (WARM WATERS) WATERS
- ○○○○ CLASS C WATERS

N

0 5 10 20
MILES

SURFACE WATER CLASSIFICATION

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FIG. 2

TABLE 3

WATER QUALITY STANDARDS
IOWA RIVER

Water Quality Parameter	Class A	Class B
Dissolved Oxygen		At least 5.0 mg/l during at least 16 hours of any 24-hour period. At all times equal to or greater than 4.0 mg/l.
pH	Not less than 6.5, nor greater than 9.0. Maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units.	Not less than 6.5, nor greater than 9.0. Maximum change permitted as a result of a waste discharge shall not exceed 0.5 pH units.
Turbidity	Shall not be increased by more than 25 Jackson turbidity units by any point source discharge.	Shall not be increased by more than 25 Jackson turbidity units by any point source discharge.
Fecal Coliforms	From April 1 through October 31 the discharge of any effluent which may contain human pathogens shall not increase fecal coliforms in the receiving waters by more than 200 per 100 ml.	Shall not exceed 2,000 per 100 ml, except when waters are materially affected by surface runoff.
Temperature		Maximum increase of 5° F. The rate of temperature change shall not exceed 2° F per hour. Maximum allowable stream temperature is 90° F. Maximum increase for lakes and reservoirs is 3° F. The rate of temperature change shall not exceed 2° F per hour. Maximum allowable temperature is 90° F.
Chemical Constituents		The concentrations given in Table 4 shall not be exceeded at any time the flow equals or exceeds the 7-day, 1-in 10 year low flow unless it is known that the material is from uncontrollable non-point sources. All substances toxic or detrimental to aquatic life shall be limited to non-toxic or non-detrimental concentrations in the surface water.

TABLE 4

WATER QUALITY STANDARDS

IOWA RIVER

CHEMICAL CONSTITUENTS - CLASS B

Chemical Constituent	Allowable Concentration** (mg/l)
Ammonia Nitrogen-N	2.0
Phenols (other than natural sources)	0.001
Total Dissolved Solids	750.
Arsenic	1.00
*Barium	1.00
*Cadmium	0.05
*Chromium (hexavalent)	0.05
*Chromium (trivalent)	1.00
*Copper	0.02
Cyanide	0.025
*Lead	0.10
*Mercury	0.005
*Selenium	1.00
*Zinc	1.0

*The sum of the entire heavy metal group shall not exceed 1.5 mg/l.

**Not to be exceeded when flow is equal to or greater than the 7-day, 1-in-10 year low flow unless from uncontrollable non-point sources.

TABLE 5

WATER QUALITY STANDARDS

GENERAL WATER QUALITY CRITERIA

Such waters shall be free from substances attributable to municipal, industrial or other discharges, or agricultural practices that will settle to form objectionable sludge deposits.

Such waters shall be free from floating debris, oil, grease, scum, and other floating materials attributable to municipal, industrial or other discharges, or agricultural practices in amounts sufficient to be unsightly or deleterious.

Such waters shall be free from materials attributable to municipal, industrial or other discharges, or agricultural practices producing color, odor, or other conditions in such degree as to create a nuisance.

Such waters shall be free from substances attributable to municipal, industrial or other discharges, or agricultural practices in concentrations or combinations which are toxic or harmful to human, animal, plant, or aquatic life.

The turbidity of the receiving water shall not be increased by more than 25 Jackson turbidity units by any point source discharge.

Water Quality Inventory (monitoring)

Toxic and Pretreatment Effluent Standards

National Pollutant Discharge Elimination System

Ocean Discharge Criteria

The major objectives of the EPA water quality criteria are to provide protection of all waters and improve natural water quality. The means by which this will be accomplished is best described by the following:

> "EPA Water Quality Criteria will be incorporated into revised State water quality standards under the direction of EPA Regions by means of policy guidelines developed by the EPA Office of Water Planning and Standards. Those guidelines have provisions for waters to be exempted from specific criteria on a case-by-case basis for specified periods when naturally occurring conditions exceed limits of the EPA criteria or other extenuating conditions prevail to warrant such exemptions."[1]

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[1] "Proposed Criteria for Water Quality," Volume 1, U. S. Environmental Protection Agency, Washington, D. C., October, 1973, p. 17.

These criteria are to provide the protection necessary to sustain recreational uses in/on the water, and for the preservation and propagation of desirable aquatic biota. This level of protection ensures the suitability of all waters for other uses. Based upon the latest scientific information, these criteria define the water quality necessary to satisfy 1983 interim goals [Section 101(a)(2), Public Law 92-500].

The "Proposed Criteria for Water Quality" are not used in evaluating water quality for this study. However, a comparison between proposed EPA criteria and IDEQ water quality standards for Class B streams (warm water fisheries) is presented in Table 6 for reference.

Water Quality Criteria Summary - Examination of Table 6 indicates both differences and similarities between proposed EPA criteria and Iowa water quality standards. Many parameters not limited by Iowa criteria are to be regulated by EPA. Since proposed EPA criteria must be incorporated into Iowa criteria through resolution of differences with the state of Iowa, evaluation of existing stream quality using EPA criteria would not provide meaningful results. Thus, for purposes of this study, IDEQ standards will be utilized.

Iowa standards are either more stringent or comparable to proposed EPA criteria for all parameters except trivalent chromium, lead, mercury, and dissolved oxygen (DO). Differences may exist between the two agencies for other toxic materials; however, since EPA values are based upon bio-assay determinations of toxic concentrations, a direct comparison is not possible.

Initial review of ammonia levels suggests EPA criteria are much more stringent than Iowa standards. However, EPA criteria refer to the concentration of un-ionized ammonia while Iowa standards specify total ammonia concentration. The differences between the Iowa 2.0 mg/l total ammonia standard and EPA criteria depend on stream pH as evidenced below:

pH	(NH_4^+) (mg/l-N)	(NH_3) (mg/l-N)	Total Ammonia (mg/l-N)
6	39.98	0.02	40.00
7	3.62	0.02	3.64
8	0.36	0.02	0.38

Note: Values based upon the dissociation constant at 25° C.

TABLE 6

COMPARISON OF WATER QUALITY CRITERIA

Water Quality Parameter	IDEQ Class B Water Quality Standards	EPA Proposed Criteria for Water Quality
pH	6.5 - 9.0	6.0 - 9.0
Alkalinity	--	30 - 130 mg/l
Acidity	--	Addition of acids unacceptable
Ammonia	2.0 mg/l-N (ammonia plus ammonium ion)	0.02 mg/l-N maximum (ammonia only) or 0.05 of the 96-hour LC_{50} [1]
Cadmium	0.05 mg/l	0.03 mg/l - hard water[2] 0.004 mg/l - soft water
Chlorine (free)	--	0.003 mg/l - chronic exposure 0.05 mg/l - 30 minute exposure
Chromium (hexavalent)	0.05 mg/l	0.03 mg/l
Chromium (trivalent)	1.0 mg/l	0.03 mg/l
Copper	0.02 mg/l	0.10 of the 96-hour LC_{50} [1]
Cyanide	0.025 mg/l	0.05 of the 96-hour LC_{50} [1]
Lead	0.10 mg/l	0.03 mg/l
Mercury	5.0 ug/l	0.2 ug/l - single occurrance 0.5 ug/l - average concentration
Nickel	--	0.02 of the 96-hour LC_{50} [1]
Phosphorus	--	25 ug/l-P lakes and reservoirs[3] 100 ug/l-P - streams[3]
Zinc	1.0 mg/l	0.003 of the 96-hour LC_{50} [1]

Water Quality Parameter	IDEQ Class B Water Quality Standards	EPA Proposed Criteria for Water Quality
Fecal Coliforms	200 per 100 ml - Class A waters 2,000 per 100 ml - Class B waters	2,000 per 100 ml average - non-recreational waters 200 per 100 ml average - recreational waters.
Dissolved Solids	750 mg/l	Bio-assay to be used to determine limits of tolerance of aquatic ecosystem.
Temperature	4	5
Pesticides	--	0.01 of the 96-hour LC_{50} [1] for those pesticides not listed in Reference [7]
Turbidity	Less than 25 Jackson Turbidity Unit increase from any point source.	Compensation point may not be changed by more than 10 percent.
Radioactivity	--	8
Dissolved Oxygen	5.0 mg/l for at least 16 hours of any 24-hour period. Never less than 4.0 mg/l at any time.	6.8 mg/l at 1.5° C 6.8 mg/l at 7.7° C 6.5 mg/l at 16.0° C 6.2 mg/l at 21.0° C 5.8 mg/l at 27.5° C 5.8 mg/l at 36.0° C Never less than 4.0 mg/l for a 24-hour or less period when water temperatures exceed 31.0° C.
Sulfides	--	0.002 mg/l
Detergents (as LAS)	--	0.2 mg/l - maximum or 0.05 of the 96-hour LC_{50} [1]
Oils	--	No visible oil 0.05 of the 96-hour LC_{50} [1]
Phthalate Esters	--	0.3 ug/l
Polychlorinated Biphenyls	--	0.002 ug/l
Tainting Substances	--	6

1 LC_{50} identifies the concentration at which 50 percent of the test organisms die within the stated time period.
2 Hard water is defined as having a total hardness of 100 mg/l as $CaCO_3$ or more.
3 Concentrations required to prevent nuisance aquatic plant growths where phosphorus is the limiting constituent.
4 Refer to Table 3
5 Refer to "Proposed Criteria for Water Quality," EPA, p. 144-170.
6 Refer to "Proposed Criteria for Water Quality," EPA, p. 141-143.
7 Refer to "Proposed Criteria for Water Quality," EPA, p. 125.
8 "Water Quality and Treatment," American Waterworks Association, Inc., 1971, p. 27-32.

Existing Water Quality

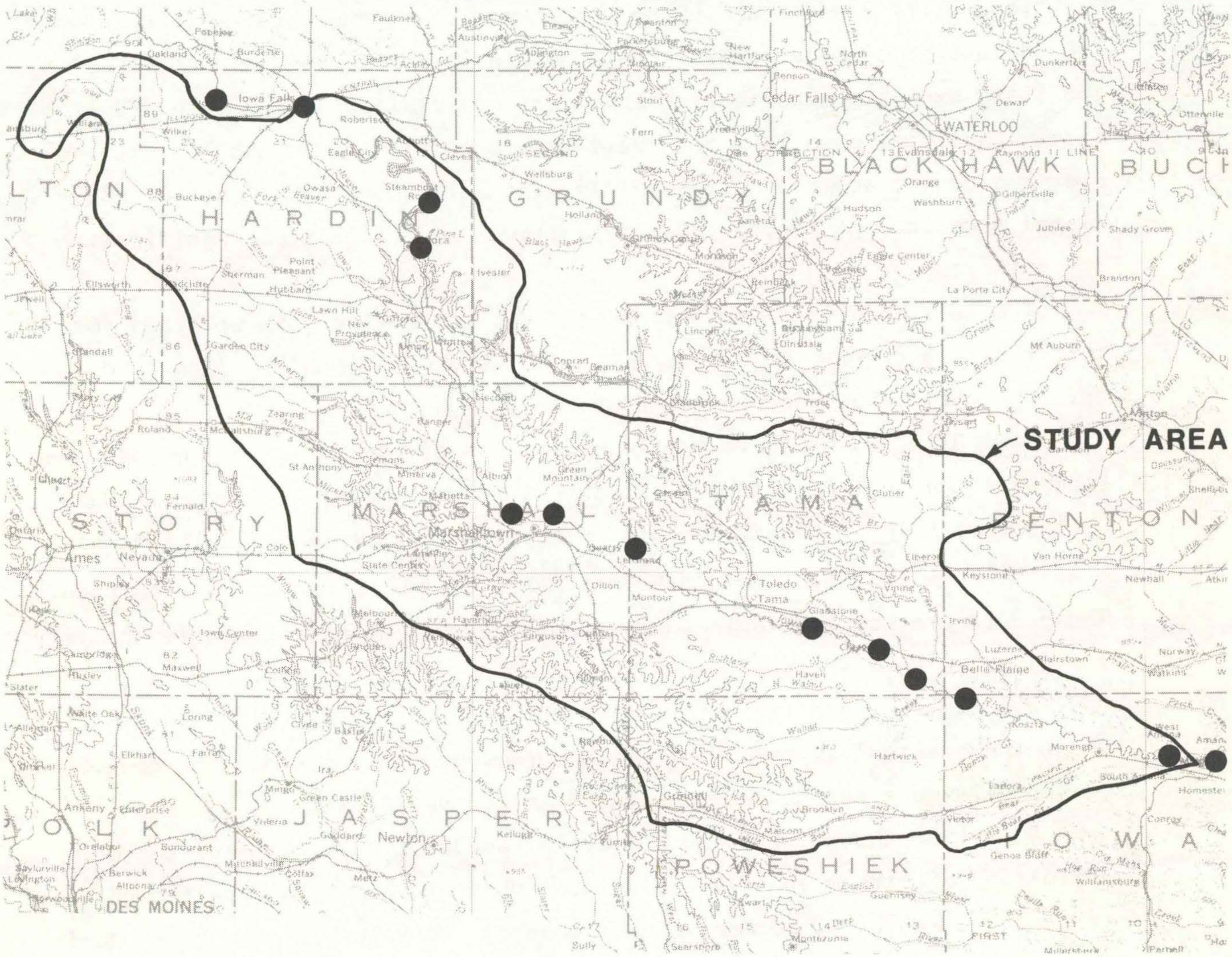
Data Sources - The study area is that portion of the Iowa River Basin from Iowa Falls downstream to the upper reaches of the Coralville Reservoir. The evaluation of water quality data herein is based upon data collected by the State Hygienic Laboratory. Some data are available from other Federal, State, and local agencies; but these data are scattered, both in time and over the basin, and are not useful in evaluating water quality. No additional sampling, gaging, or quality analyses were initiated specifically for this program.

The locations of all sampling stations collecting data utilized for this report are shown on Figure 3. All of the water quality data used in this evaluation have been obtained since 1971.

Iowa River - The above mentioned portion of the Iowa River within the study area has not been subject to extensive water quality surveys. Data on the Iowa River Basin as a whole is scanty. Definition of existing water quality above Iowa Falls would be desirable as input into the stream model. These data are not available and assumptions made on upstream water quality are given in PART V - WASTE LOAD ALLOCATIONS.

Usable water quality data within the study area consist of samples taken under the quarterly stream monitoring survey program near Marshalltown, and an unpublished stream survey conducted in February, 1971.

Data from the unpublished survey in February, 1971, provide the only definition of stream quality along the length of the stream. Although water temperature was 0° C, no mention was made of the extent of ice cover during the survey. There are no violations of stream quality criteria other than the fecal coliform count, which may or may not be caused by surface runoff. Although falling within stream standards, increased levels of ammonia nitrogen and well below saturation dissolved oxygen values indicate pollution of the stream. Figure 4 shows dissolved oxygen concentrations obtained by the survey, while Figure 5 shows ammonia nitrogen concentrations obtained. Other water quality data obtained during the survey are summarized in Table 7. During this stream survey, the flow at the USGS gage near Marengo was 500 cfs as compared to the 7-day, 1-in-10 year low flow of 55 cfs.



● WATER QUALITY SAMPLING STATIONS

N

0 5 10 20
MILES

WATER QUALITY SAMPLING STATIONS

FIG. 3

FIGURE 4
IOWA RIVER
DISSOLVED OXYGEN CONCENTRATIONS
IOWA RIVER - FEBRUARY, 1971

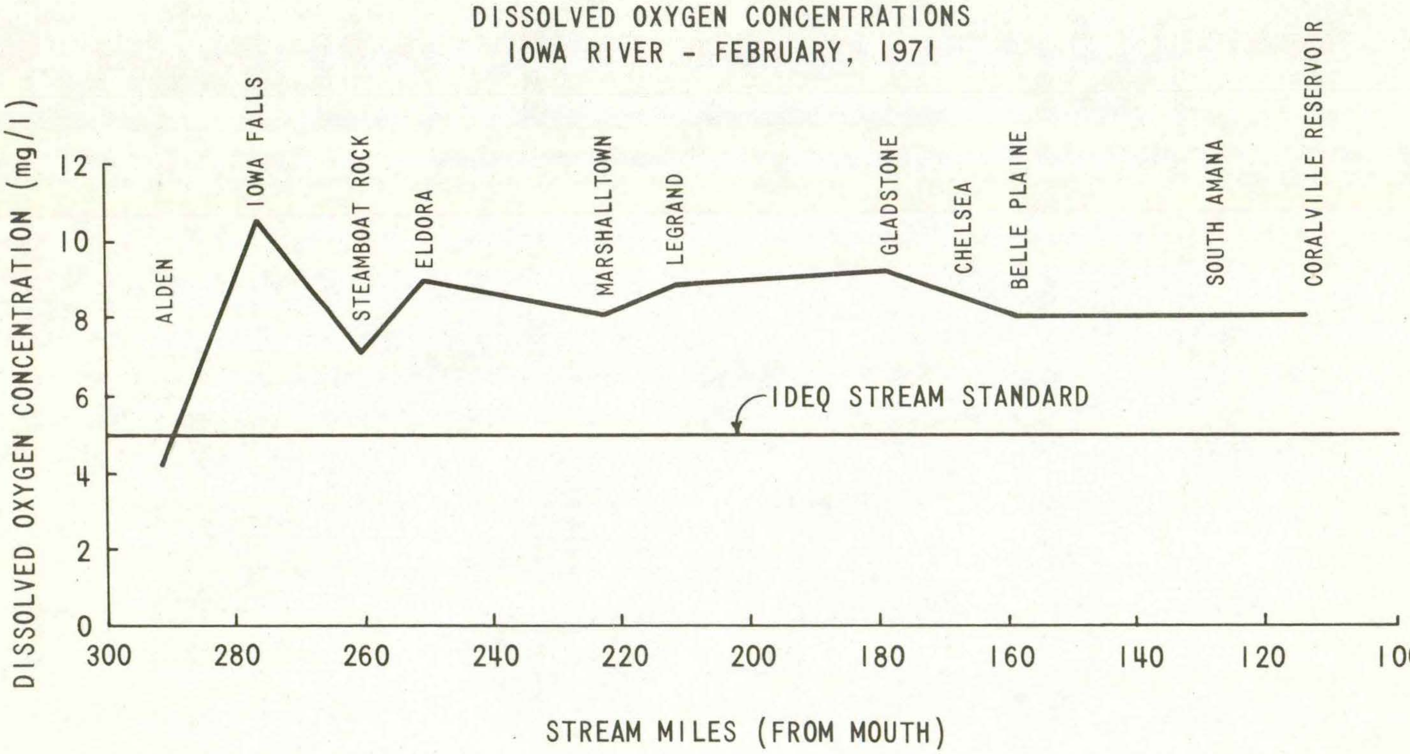


FIGURE 5
IOWA RIVER
AMMONIA NITROGEN CONCENTRATIONS
IOWA RIVER - FEBRUARY, 1971

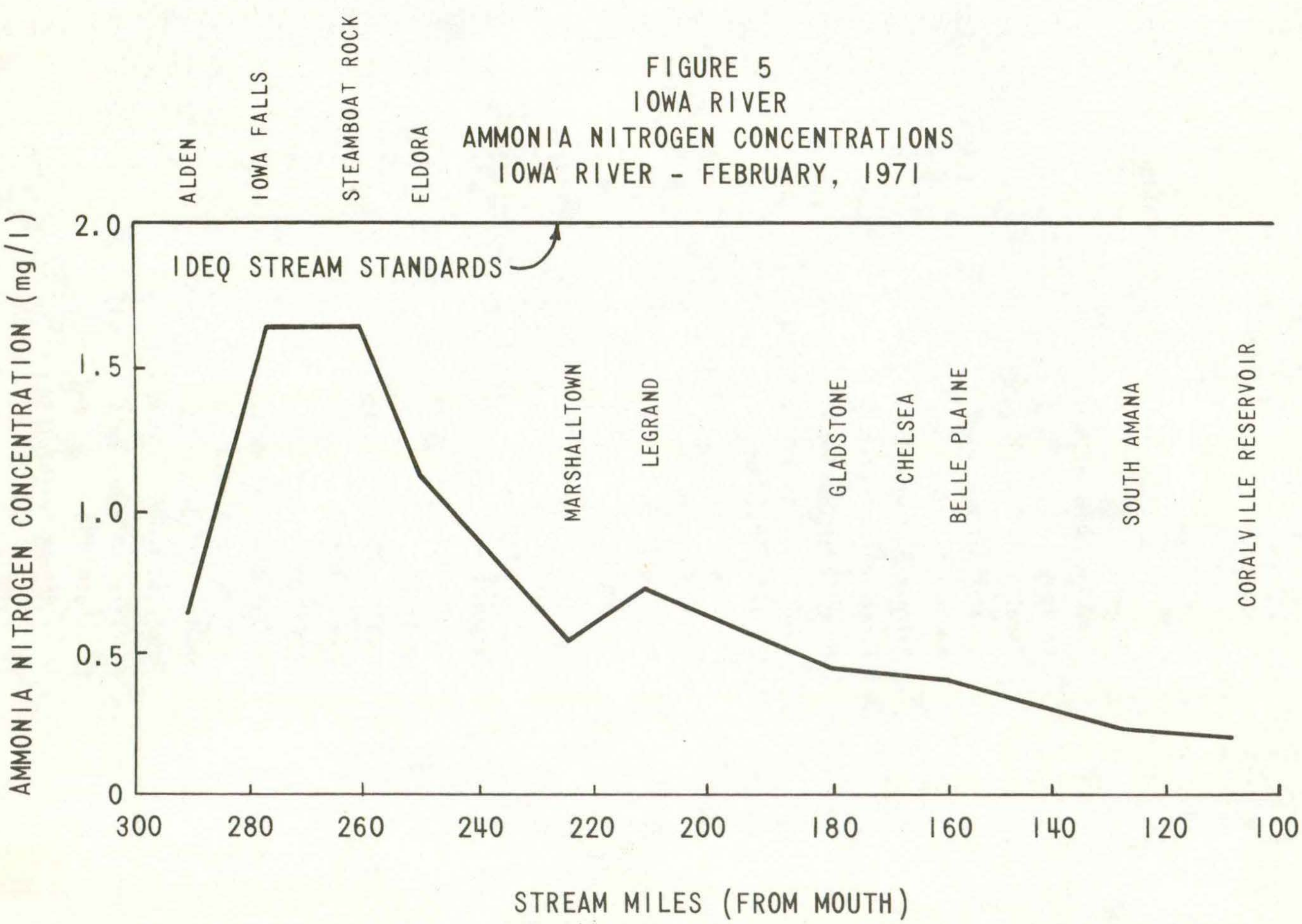


TABLE 7

WATER QUALITY DATA

IOWA RIVER

Parameter	Alden	Iowa Falls	Steamboat Rock	Eldora	Marshalltown	Le Grand
Temperature (° C)	0.	0.	0.	---	0.	0.
Dissolved Oxygen (mg/l)	4.2	10.4	7.2	9.0	8.0	8.7
pH (SU)	7.2	7.5	7.25	7.35	7.4	7.35
Fecal Coliforms (MPN/100 ml)	1,100.	17,000.	450.	3,500.	1,500.	11,000.
Organic Nitrogen (mg/l)	0.45	0.68	0.52	0.47	0.43	0.51
Ammonia Nitrogen (mg/l)	0.60	1.6	1.6	1.1	0.55	0.77
Nitrate Nitrogen (mg/l)	4.0	4.0	4.6	4.6	5.4	5.2
Total Solids (mg/l)	576.	550.	---	---	512.	501.
Volatile Solids (mg/l)	165.	185.	---	---	191.	182.
Total Suspended Solids (mg/l)	15.	0.	---	---	13.	8.
Volatile Suspended Solids (mg/l)	15.	0.	---	---	3.	2.
Phosphate (filtrable) (mg/l)	1.7	1.9	2.1	1.9	1.1	1.2
Total Phosphate (mg/l)	1.7	2.1	2.1	1.9	1.1	1.3
BOD_5 (mg/l)	<1.	4.	3.	2.	3.	3.
COD (mg/l)	10.3	12.3	12.3	12.3	8.2	10.3

Parameter	Gladstone	Chelsea	Belle Plain (West)	Belle Plain (South)	South Amana	Above Coralville Reservoir
Temperature (° C)	0.	0.	0.	0.	0.	0.
Dissolved Oxygen (mg/l)	9.2	8.6	8.3	8.1	7.9	8.0
pH (SU)	7.3	---	---	7.2	7.1	7.2
Fecal Coliforms (MPN/100 ml)	4,900.	1,600.	1,600.	2,300.	680.	500.
Organic Nitrogen (mg/l)	0.52	---	---	0.49	0.49	0.43
Ammonia Nitrogen (mg/l)	0.45	---	---	0.43	0.25	0.23
Nitrate Nitrogen (mg/l)	5.2	---	---	4.8	4.4	4.2
Total Solids (mg/l)	---	---	---	452.	---	444.
Volatile Solids (mg/l)	---	---	---	92.	---	88.
Total Suspended Solids (mg/l)	---	---	---	1.	---	15.
Volatile Suspended Solids (mg/l)	---	---	---	1.	---	0.
Phosphate (filtrable) (mg/l)	0.9	---	---	0.6	0.5	0.4
Total Phosphate (mg/l)	0.9	---	---	0.7	0.5	0.5
BOD_5 (mg/l)	4.0	3.	3.	2.	2.5	2.
COD (mg/l)	12.3	---	---	8.2	8.2	6.2

Data for the quarterly stream monitoring survey are obtained from a sampling station near Marshalltown. No violation of stream quality criteria other than high fecal coliform counts is indicated. The sampling station is located above the Marshalltown STP, so facts of the wastewater discharge on stream water quality are not known. Data from the quarterly samples are summarized in Table 8.

Summary

Only limited water quality data are available for the portion of the Iowa River within the study area. The available data have been taken at times of relatively high flow, and thus little is known of water quality under low flow conditions. Additional sampling locations and more frequent sampling will be required to assess the facts of the waste load allocations.

TABLE 8

WATER QUALITY DATA

IOWA RIVER - NEAR MARSHALLTOWN

Parameter	Date of Sampling: May 19, 1969	Sept. 23, 1969	Oct. 11, 1971	Nov. 29, 1972	Feb. 28, 1973	Aug. 29, 1973	Nov. 28, 1973
Temperature (° C)	---	17.5	11.	1.	2.	27.	5.
Dissolved Oxygen (mg/l)	10.3	10.2	10.1	13.0	12.6	13.6	11.6
Fecal Coliforms (MPN/100 ml)	2,400.	3,100.	60.	660.	750.	450.	550.
Conductance (micromhos)	---	---	---	---	460.	440.	750.
pH (SU)	---	8.3	7.8	---	7.8	8.35	8.2
Organic Nitrogen (mg/l)	0.92	1.7	0.71	0.51	2.5	2.4	1.2
Ammonia Nitrogen (mg/l)	0.18	0.04	<0.01	<0.01	0.76	0.03	<0.01
Nitrate Nitrogen (mg/l)	6.8	0.7	<0.1	9.8	3.9	<0.1	<0.1
Total solids (mg/l)	471.	362.	361.	546.	330.	364.	560.
Total Volatile Solids (mg/l	138.	126.	124.	131.	86.	128.	208.
Total Suspended Solids (mg/l)	36.	32.	20.	42.	57.	88.	49.
Volatile Suspended Solids (mg/l)	10.	12.	0.	6.	21.	28.	18.
Phosphate (filtrable) (mg/l)	0.2	<0.1	0.2	0.11	0.37	0.02	0.13
Total Phosphate (mg/l)	0.3	0.2	0.3	0.13	0.44	0.13	0.17
BOD_5 (mg/l)	3.	7.	6.	2.	6.	20.	2.
COD (mg/l)	8.1	28	12.7	8.	25.	44.	22.
Barium (mg/l)	---	0.9	---	---	---	---	---
Cadmium (mg/l)	---	<0.01	---	---	---	---	---
Chromium (mg/l)	---	<0.01	---	---	---	---	---
Copper (mg/l)	---	<0.01	---	---	---	---	---
Nickel (mg/l)	---	<0.01	---	---	---	---	---
Lead (mg/l)	---	<0.01	---	---	---	---	---
Zinc (mg/l)	---	<0.01	---	---	---	---	---

PART IV

POINT SOURCE WASTEWATER DISCHARGES

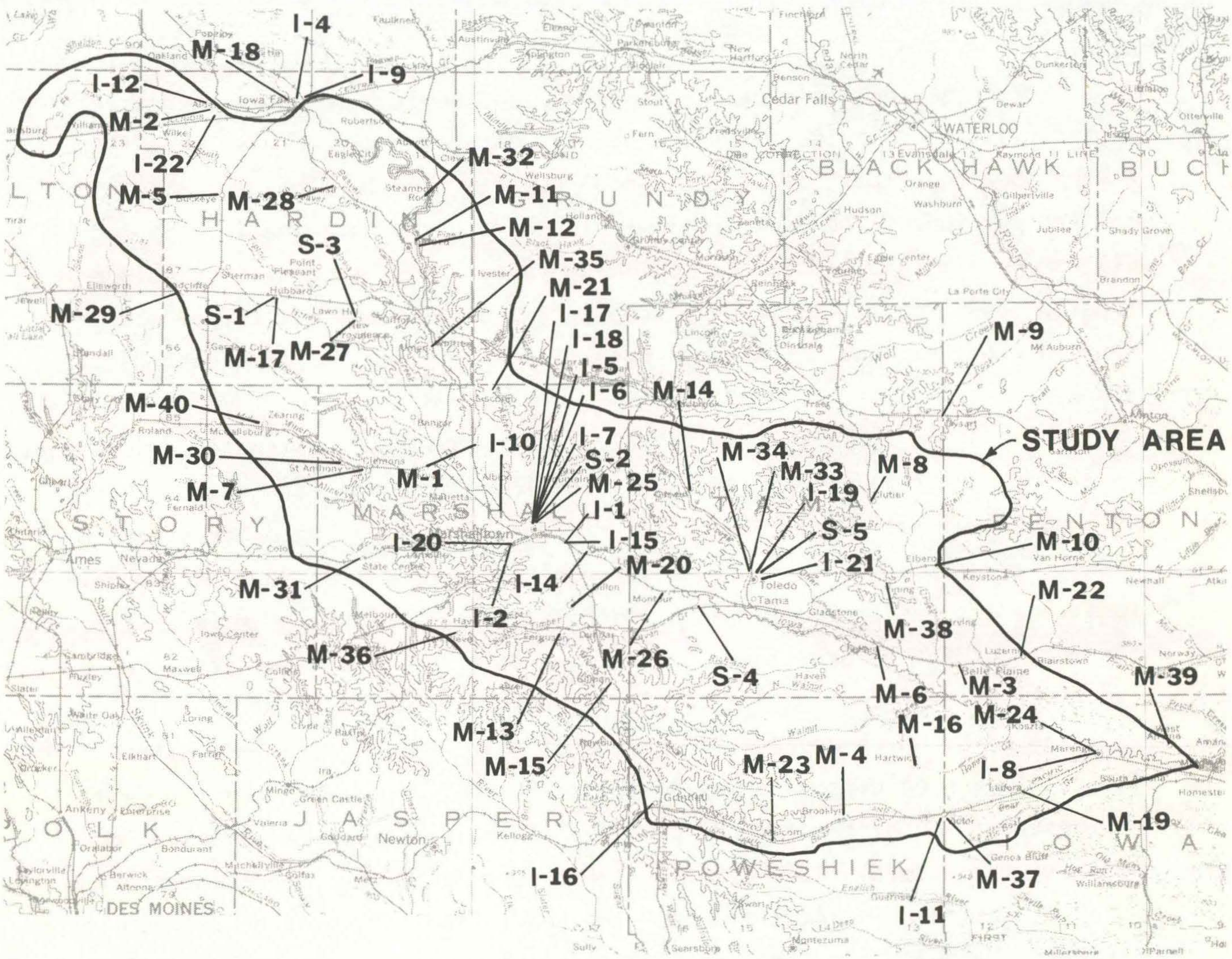
General

Effluents from municipal, industrial, and semipublic wastewater treatment facilities comprise the point source wastewater discharges identified in the Iowa Department of Environmental Quality (IDEQ) files as discharging to that portion of the Iowa River within the study area. The inventoried discharges are compiled in the following tables. The tabulations include location and identification of dischargers, quantity and quality of wastewater discharged, and operational data and descriptions of treatment facilities.

Table 9, at the end of this PART, lists individual wastewater discharges, locations, and river mile. An identification system has been established with municipal wastewater discharge reference numbers being preceded by "M," industrial discharges by "I," and semipublic discharges by "S." River mile locations are identified for each discharge with reference to mile zero at the mouth of the major stream. Discharges to tributaries are referenced by the river mile of the confluence of tributary and main stream.

Table 10, which appears at the end of this PART, identifies characteristics of each point source wastewater discharge, in order, beginning with the upstream end of the Iowa River above the city of Iowa Falls to the upper reaches of the Coralville Reservoir. For each tributary, the point source furthest upstream is identified and the tabulation continues downstream to the main channel. The location of each point source is shown on Figure 6.

Available wastewater quantity and quality information is tabulated in Table 10. Average flow, BOD_5, suspended solids, ammonia nitrogen, phosphorus, total dissolved solids, temperature, and other miscellaneous constituents are reported in Table 10. Where sufficient data are available, BOD_5, ammonia nitrogen, and temperature values have been indicated for both summer and winter conditions. Discharge quantities are tabulated in both milligrams per liter (mg/l) and pounds per day (lb/day) unless otherwise stated.



LEGEND

M-3 MUNICIPAL
I-6 INDUSTRIAL
S-2 SEMIPUBLIC

POINT SOURCE WASTEWATER DISCHARGES

FIG. 6

STANLEY CONSULTANTS

Municipal

Sewage flow and quality data for 27 municipalities were extracted from IDEQ records and files. Average sewage flow values contained in reports submitted by treatment plant operators have been extracted by IDEQ and published in "Wastewater Treatment Plant Flow Data - 1970, 1971, and 1972." Flow values shown in Table 10 are the average obtained for the last full year of record; in most instances 1972.

Most quality data were collected from "Effluent Quality Analysis Program" (EQAP) by IDEQ. These data were supplemented by a review of treatment facility reports supplied by the operators. Data reported through EQAP are results of tests conducted by the Iowa State Hygienic Laboratory on wastewater samples supplied by the individual dischargers. In most instances, the number of BOD_5, ammonia nitrogen, and total phosphorus values reported each year was minimal. Because of large seasonal variations in BOD_5, ammonia nitrogen, and temperature, both summer and winter values have been tabulated, where available.

BOD_5 analysis results from the Iowa State Hygienic Laboratory (reported in EQAP) are reported between 25 mg/l and 150 mg/l. For some communities, a large percentage of the values reported are 25 or "25-" mg/l. Values designated "25-" are less than 25 mg/l, thus lower average summer BOD_5 values would result. The adequacy of this reporting procedure should be reviewed since some dischargers are, or soon will be, required to provide BOD_5 removals of less than 25 mg/l. In some instances, due to the scarcity and scatter of data, engineering judgment was applied to arrive at representative values rather than taking averages of the available data.

Industrial

Information for 18 industries discharging wastewater to streams within the study area was obtained. The best sources of available discharge information utilized were U. S. Army Corps of Engineers discharge permit applications (Discharge Permit Program, River and Harbors Act of 1899), IDEQ industrial files, and the National Pollutant Discharge Elimination Systems (NPDES).

Although these sources provide the best available discharge information, caution must be exercised in data interpretation. Information tabulated in Table 10 has been submitted by the individual industries with very little verification.

Semipublic

Information for only two semipublic facilities within the study area was obtained from IDEQ files. Description of semipublic facility discharges is difficult due to the minimal surveillance provided. Quantity and quality relationships are practically nonexistent and, in most cases, design information is all that is available. Therefore, values in Table 10 are based upon design characteristics and may not reflect actual operating conditions.

Existing Wastewater Treatment Facilities

Inventory information for existing wastewater treatment facilities has been compiled in Table 11 at the end of this PART. The order of presentation in Table 11 is identical to that utilized in Table 10. Facilities are listed beginning with upstream reaches and continuing downstream.

Table 11 contains existing design average day capacity, present average day flow, both influent and effluent concentrations of BOD_5 and suspended solids, type of treatment processes, and comments about the facility or process. Influent values are only available for the larger treatment facilities. Specific processes identify primary treatment, secondary treatment, and solids handling operations. The treatment abbreviations are those presently used by IDEQ and are listed at the end of the table. The "Comments" column includes information obtained by IDEQ personnel on existing operation, age of existing facilities, specific IDEQ permit requirements, IDEQ orders for additional treatment, and delineation of proposed facilities.

A total of 27 municipal, 22 industrial, and 7 semipublic treatment facilities have been identified in the study area. In addition, 13 incorporated communities presently without municipal collection or treatment systems are included in Table 11.

Summary

Distribution of hydraulic and organic loads upon the streams in the Iowa River Basin from the three point source wastewater discharge classifications is summarized in Table 12.

TABLE 12

REPORTED POINT SOURCE

WASTEWATER DISCHARGE SUMMARY

	Total	Municipal	Industrial	Semipublic
Flow, mgd	8.847	6.246	2.571	0.031
Percent	100	71	29	<1
BOD_5, lb/day	2,605	2,130	465	10
Percent	100	82	18	<1
Ammonia-N, lb/day	784	764	20	N.A.
Percent	100	97	3	---
Phosphorus-P, lb/day	573	566	7	N.A.
Percent	100	99	1	---

Table 13 summarizes the classifications of municipal treatment facilities and populations served. The smaller communities are typically served by waste stabilization pond systems, while most larger cities utilize trickling filter plants. Only one community having a population of greater than 1,000 maintains a waste stabilization pond. One community having a population of less than 1,000 is served by trickling filters.

TABLE 13

WASTEWATER TREATMENT FACILITIES

PROCESS SUMMARY

Type of Plant	Communities Served	Population Served
Trickling Filter	10	22,135
Waste Stabilization Pond	14	8,827
Imhoff Tank	1	563
Extended Aeration	1	949
Activated Sludge	1	26,219

None of the communities in the study area presently operates advanced waste treatment facilities.

TABLE 9

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal						
Albion	M-1	Marshall	223	Chicken Creek	37	40
Alden	M-2	Hardin	286	Iowa River	37	39
Belle Plain	M-3	Benton	160	Salt Creek	38	42
Brooklyn	M-4	Poweshiek	139.9	Little Bear Creek	38	42
Buckeye	M-5	Hardin		South Fork Iowa River	NEMTF	
Chelsea	M-6	Tama		Otter Creek	NEMTF	
Clemons	M-7	Marshall	232	Little Minerva Creek	37	40
Clutier	M-8	Tama	160	Salt Creek	38	41
Dysart	M-9	Tama	160	East Branch Salt Creek	38	42
Elberon	M-10	Tama		Salt Creek	NEMTF	
Eldora #1	M-11	Hardin	255	Iowa River	37	39
Eldora #2 (Reformatory)	M-12	Hardin	255	Iowa River	37	39
Ferguson	M-13	Marshall	214	South Timber Creek	-	41
Garwin	M-14	Tama	188.9	Deer Creek	38	41
Gilman	M-15	Marshall	214	Brush Creek	38	41
Hartwick	M-16	Poweshiek		Honey Creek	NEMTF	
Hubbard	M-17	Hardin	234	Honey Creek	37	39
Iowa Falls	M-18	Hardin	280	Iowa River	37	39
Ladora	M-19	Iowa	139.9	Bear Creek	-	42
LeGrand	M-20	Marshall	209.2	Iowa River	38	41
Liscomb	M-21	Marshall	236	Iowa River	37	39
Luzerne	M-22	Benton		Buckeye Creek	NEMTF	
Malcolm	M-23	Poweshiek	139.9	Little Bear Creek	38	42
Marengo	M-24	Iowa	139.4	Iowa River	38	42
Marshalltown	M-25	Marshall	222.0	Iowa River	37	40
Montour	M-26	Tama	201.6	Iowa River	38	41
New Providence	M-27	Hardin		Honey Creek	NEMTF	
Owasa	M-28	Hardin		Beaver Creek	NEMTF	

* River mile of discharge or tributary confluence with the main stream.

NEMTF: No Existing Municipal Treatment Facility.

TABLE 9 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Municipal (cont.)						
Radcliffe	M-29	Hardin	234	Honey Creek	37	39
St. Anthony	M-30	Marshall		Middle Minerva Creek	NEMTF	
State Center	M-31	Marshall	214	North Timber Creek	38	40
Steamboat Rock	M-32	Hardin	260	Iowa River	37	39
Tama	M-33	Tama	188.5	Iowa River	38	41
Toledo	M-34	Tama	188.9	Deer Creek	38	41
Union	M-35	Hardin	243	Iowa River	37	39
Van Cleave	M-36	Marshall		South Timber Creek	NEMTF	
Victor	M-37	Iowa	139.9	Bear Creek	38	42
Vining	M-38	Tama		Salt Creek	NEMTF	
West Amana	M-39	Iowa		Price Creek	NEMTF	
Zearing	M-40	Story	232	Middle Minerva Creek	37	39
Industrial						
Cambridge Mobile Home Park	I-1	Marshall	214	Timber Creek	38	41
Central Iowa Rendering	I-2				Note: No information as to location or discharge	
Chicago & North-western R.R.	I-3	Marshall	219	Linn Creek	38	40
Farm Best	I-4	Hardin	280	Iowa River	37	39
Fischer Controls Co.-Center Street Facility	I-5	Marshall	220	Marshalltown City Storm Sewer - Iowa River	37	40
Fischer Controls Co.-General Building	I-6	Marshall	220	Marshalltown City Storm Sewer - Iowa River	37	40
Fischer Controls Co.-Governor Rd. Facility	I-7	Marshall	220	Marshalltown City Storm Sewer - Iowa River	37	40
Hallet Construction Company	I-8	Iowa	139.4	Iowa River	38	42

* River Mile of discharge or tributary confluence with main stream.
NEMTF: No Existing Municipal Treatment Facility.

TABLE 9 (Cont.)

POINT SOURCE WASTEWATER DISHCARGE POINTS

Discharger	Reference Number	County	River* Mile	Discharge To	Page Reference Quantity	Page Reference Treatment
Industrial (cont.)						
Iowa Electric Light & Power	I-9	Hardin	277.5	Iowa River	37	39
Iowa Electric Light & Power Southerland St.	I-10	Marshall	225.4	County Ditch	37	40
Iowa Highway Commission - North Rest Area I-80	I-11	Iowa	139.9	Little Bear Creek	38	42
Iowa Limestone Company	I-12	Hardin	286	Iowa River	37	39
Kiowa Corporation	I-13			Iowa River	Note:	No information as to location or discharge
Lennox Industries, Inc.	I-14	Marshall	223	Asher Creek	37	40
Lincoln Estates	I-15	Marshall	214	Timber Creek	38	41
Malcolm Stone Co.	I-16	Poweshiek	139.9	Bear Creek	38	42
Martin Marietta Corp. - Concrete Materials Div.	I-17	Marshall	223	Asher Creek	37	40
Martin Marietta Corp. - Marshalltown Sand Plant	I-18	Marshall	221	Iowa River	37	40
Packing Corp. of America	I-19	Tama	188.9	Deer Creek	38	41
Swift Fresh Meats Corp.	I-20	Marshall	218	Linn Creek	38	40
Tama Meat Packing Corp.	I-21	Tama	188.5	Iowa River	38	41
Weaver Construction Co. - Alden Quarry	I-22	Hardin	286	Iowa River	38	40
Semipublic						
Hubbard School	S-1	Hardin	234	Honey Creek via drainage ditch	37	39
Marshall County Home	S-2	Marshall	221	Iowa River	37	40
Quakerdale County Home	S-3	Hardin	246	South Fork of Iowa River	37	39
South Tama School District	S-4	Tama			38	41
Tama County Home	S-5	Tama	188.9	Deer Creek	-	41
Edrich Addition	S-6	Hardin	234	Honey Creek	37	39
Sudbury Court	S-7	Iowa			Note:	No information as to location or discharge

* River mile of discharge or tributary confluence with main stream.
NEMTF: No Existing Municipal Treatment Facility.

TABLE 10

POINT SOURCE WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD_5 Summer (mg/l)	BOD_5 Summer (lb/day)	BOD_5 Winter (mg/l)	BOD_5 Winter (lb/day)	Suspended Solids (mg/l)	Suspended Solids (lb/day)	Ammonia Nitrogen (N) Summer (mg/l)	Ammonia Nitrogen (N) Summer (lb/day)	Ammonia Nitrogen (N) Winter (mg/l)	Ammonia Nitrogen (N) Winter (lb/day)	Phosphorus (Total P) (mg/l)	Phosphorus (Total P) (lb/day)	Total Dissolved Solids (mg/l)	Total Dissolved Solids (lb/day)	Temperature Summer (F)	Temperature Winter (F)	Other (mg/l unless noted otherwise)
Iowa River																		
M-2	0.060	25	13	40	20					21	11	25	13					Ortho-P = 25
I-12	0.008													349	23			pH = 8.2 SU
I-22	0.002															52	48	pH 6.9 SU
M-18	0.841	25	175	45	316			10	70	15	105	16	112					Ortho-P = 16
I-4																		
I-9	0.017															99	51	pH = 7.79 SU
M-32	0.018	35	5	55	8			20	3	30	5	40	6					Ortho-P = 40
M-11		25		25				7		10		15						
M-12	0.175							11	16									
South Fork Iowa River																		
S-3	0.01																	
Iowa River																		
M-35	0.049	25	10	25	10			1	0.4	6	2	4	2					Ortho-P = 8
M-21		25		25				25										
Honey Creek																		
M-29	0.048	40	16	25	10					9	4	8	3					Ortho-P = 8
M-17	0.013	35	4	25	3			1	0.1	1	0.1	3	0.3					Ortho-P = 3
S-1																		
S-6	0.021			25														
Minerva Creek																		
Middle Minerva Creek																		
M-40	0.043	25	9															
Little Minerva Creek																		
M-7	0.029	26	6															
Iowa River																		
I-10	0.388													1600	5177	80	60	pH = 7.6 SU TVS = 190
Asher Creek																		
I-17	0.0015															64	32	pH = 8.0 SU
I-14												0.01		227				pH = 8.4 SU
Chicken Creek																		
M-1	0.033	25	7	25	7					10	3	10	3					Ortho-P = 10
Iowa River																		
I-18	0.070																	
S-2								7										pH = 7.3 SU
M-25	3.756	25	783	28	877			12	376	19	595	8	251					Ortho-P = 10
I-5	0.66							2.77	15			0.4	2	936	5152	70	66	pH = 8.5 - 9.0 SU
I-6	0.0017							1.32	0			0.2	0	330	5	75	22	pH = 8.5 - 9.0 SU
I-7	0.170							0.59	0.8			0.2	0.2	225	319	63	63	pH = 8.8 - 9.0 SU

TABLE 10 (Cont.)

POINT SOURCE WASTEWATER DISCHARGE QUANTITIES

Ref. No.	Average Flow (mgd)	BOD_5 Summer (mg/l)	BOD_5 Summer (lb/day)	BOD_5 Winter (mg/l)	BOD_5 Winter (lb/day)	Suspended Solids (mg/l)	Suspended Solids (lb/day)	Ammonia Nitrogen (N) Summer (mg/l)	Ammonia Nitrogen (N) Summer (lb/day)	Ammonia Nitrogen (N) Winter (mg/l)	Ammonia Nitrogen (N) Winter (lb/day)	Phosphorus (Total P) (mg/l)	Phosphorus (Total P) (lb/day)	Total Dissolved Solids (mg/l)	Total Dissolved Solids (lb/day)	Temperature Summer (F)	Temperature Winter (F)	Other (mg/l unless noted otherwise)
Linn Creek																		
I-3	0.038															63		pH = 6.8 SU
I-20	0.120															58	56	pH = 7.4 SU
North Timber Creek																		
M-31	0.157	25	33	30	39			17	22	20	26	35	46	35	46	1046	1370	pH = 7.4 SU Ortho-P = 50
Timber Creek																		
I-15	0.0064																	
I-1																		
South Timber Creek																		
Brush Creek																		
M-15	0.020	25	4	25	4			2	0.3	1	0.2	4	0.7					Ortho-P = 4
Iowa River																		
M-20	0.063	28	15	26	14			1	0.5	1	0.5	8	4					Ortho-P = 10
M-26	0.028	25	6	50	12					1	0.2	6	1					
Indian Creek																		
S-4																		
Deer Creek																		
M-14	0.029	30	7	90	22			12	3	25	6	10	2					
M-34		25		25				12		15								Ortho-P - 5.7
I-19		75						2										
Iowa River																		
M-33	0.280	30	70	35	82			15	35	17	40	21	49					
I-21	0.70																	
Salt Creek																		
M-8																		
M-3	0.150	25	31	25	31					6	8							
East Branch Salt Creek																		
M-9	0.204	25	43	65	111			4	7	4	7	9	15					
Bear Creek																		
I-16	0.384	25	80	25	80	352	1127									60		pH = 8.5 SU
M-37								5		4		18		934				Ortho-P = 18
Little Bear Creek																		
M-23	0.015	25	3	25	3			3	0.4	4	0.5	9	1					Ortho-P = 50
M-4	0.097	35	28	40	32					25	20	20	16					
I-11	0.003															80		
Iowa River																		
I-8	0.0015													329				
M-24	0.142	25	30	30	36			3	4	10	12							

TABLE 11

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD_5 Influent Conc. (mg/l)	BOD_5 Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment Primary	Type of Treatment Secondary	Type of Treatment Solids Treatment	Comments
Iowa River										
Alden (M-2)	0.090	0.060		47			Lo	Lo		New plant under construction.
Iowa Limestone Co.(I-12)		0.008				17				
Weaver Construction Co. Alden Quarry (I-22)		0.002				4				
Iowa Falls (M-18)	0.775	0.841		29			SchGmwCm	FtrCm	DfhDoBoXl	
Farm Best (I-4)							La			
Iowa Electric Light & Power (I-9)		0.017								
Steamboat Rock (M-32)	0.088	0.018		45			Sch(CpDo)	FthCp	Xl	
Eldora Plant No. 1 (M-11)	0.163			25			SchGhCm	FtrCp	DfhBoXl	
Eldora Plant No. 2 (M-12)	0.199	0.175		45			ScCm	FtrCp	Dcr	
Beaver Creek										
Owasa (M-28)										No existing municipal treatment facility.
South Fork Iowa River										
Buckeye (M-5)										No existing municipal treatment facility.
Quakerdale County Home (S-3)		0.01					Cs			
Iowa River										
Union (M-35)	0.053	0.049		26			Lo	Lo		Total surface area equals 3.35 acres. Plant constructed in 1971. Total surface area equals 3.5 acres.
Liscomb (M-21)				27			Lo	Lo		
Honey Creek										
Radcliffe (M-29)		0.048		35			Lo	Lo		
Hubbard (M-17)	0.109	0.013		29			Lo	Lo		
Hubbard School (S-1)							Gs			
Edrich Addition (S-6)		0.021		55				Ae		
New Providence (M-27)										No existing municipal treatment facility.
Minerva Creek										
Middle Minerva Creek										
Zearing (M-40)	0.080	0.043		56			Lo	Lo		
St. Anthony (M-30)										No existing municipal treatment facility.

TABLE 11 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD_5 Influent Conc. (mg/l)	BOD_5 Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
Little Minerva Creek										
Clemons (M-7)	0.030	0.029		26			Lo	Lo		
Iowa River										
Iowa Electric Light & Power - Southerland Station (I-10)		0.388				39				
Asher Creek										
Martin Marietta Corp. Concrete Material Div. (I-17)		0.0015								
Lennox Industries, Inc. (I-14)				5		0				
Chicken Creek										
Albion (M-1)	0.060	0.033		25		0	Lo	Lo		
Iowa River										
Martin Marietta Corp. Marshall Town Sand Plant (I-18)	0.070	0.070								
Marshall County Home (S-2)	0.066			150				(FoLo)	Ls	
Marshalltown (M-25)	4.5	3.756		46			ScGawCm	AaCmEcg	DfhetDsLs	Plant constructed in mid-1930's and revised in 1970.
Fischer Controls Co. Center St. Facility (I-5)		0.660		5		17	La			
Fischer Controls Co. General Buildings (I-6)		0.0017		5	11					
Fischer Controls Co. Governor Rd. Facility (I-7)		0.170		5		25				
Linn Creek										
Chicago & Northwestern Railway (I-3)		0.038					L			
Swift Fresh Meats Corp. (I-20)		0.120								
North Timber Creek										
State Center (M-31)	0.171	0.157		26		46	ShGhKmLm	FtocCpFth CpFthCp	DfhBo	

TABLE II (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD$_5$ Influent Conc. (mg/l)	BOD$_5$ Effluent Conc. (mg/l)	Suspended Solids Influent Conc. (mg/l)	Suspended Solids Effluent Conc. (mg/l)	Type of Treatment: Primary	Type of Treatment: Secondary	Type of Treatment: Solids Treatment	Comments
Iowa River (cont.)										
Timber Creek										
Lincoln Estates (I-15)		0.0064					La			
Cambridge Mobile Home Park (I-1)							L			
South Timber Creek										
Van Cleave (M-36)										No existing municipal treatment facility.
Ferguson (M-13)										Constructing new plant.
Brush Creek										
Gilman (M-15)	0.058	0.020		28			Lo	Lo		
Iowa River										
Le Grand (M-20)	0.063	0.063		26			Lo	Lo		
Montour (M-26)		0.028		50			Lo	Lo		
Indian Creek										
South Tama School District (S-4)							CsFr			
Deer Creek										
Garwin (M-14)	0.051	0.029		71			Cs	Fs	Bo	Waste stabilization lagoon has been proposed for 1974.
Toledo (M-34)	0.172			25			ShGhCm	FtrCp	DoBoXl	
Packing Corp. of America (I-19)				118						Presently designing a no discharge system.
Tama County Home (S-5)							Cs			
Tama (M-33)	0.233	0.280		28			SchGamwCm	FtrCm	DfhHoBo	In process of constructing a new plant.
Tama Meat Packing Corp. (I-21)		0.700		60			L			
Otter Creek										
Chelsea (M-6)										No existing municipal treatment facility.
Salt Creek										
Clutier (M-8)	0.03						Lo	Lo		

TABLE 11 (Cont.)

WASTEWATER TREATMENT FACILITIES

Discharge (Ref. No.)	Existing Design Average Day Capacity (mgd)	Present Average Day Flow (mgd)	BOD$_5$ Influent Conc. (mg/1)	BOD$_5$ Effluent Conc. (mg/1)	Suspended Solids Influent Conc. (mg/1)	Suspended Solids Effluent Conc. (mg/1)	Type of Treatment Primary	Type of Treatment Secondary	Type of Treatment Solids Treatment	Comments
Iowa River (cont.)										
Salt Creek (cont.)										
Elberon (M-10)										No existing municipal treatment. A new sewage treatment facility has been proposed.
Vining (M-38)										No existing municipal treatment facility.
Belle Plaine (M-3)	0.50	0.15		40			GhScCm	FtrCp	DfhHoBo	
East Branch Salt Creek										
Dysart (M-9)	0.078	0.204		36			SchCi	FtrCp	Bo	
Buckeye Creek										
Luzerne (M-22)										No existing treatment facility.
Iowa River										
Honey Creek										
Hartwick (M-16)										No existing treatment facility.
Bear Creek										
Little Bear Creek										
Malcom Stone Co. (I-16)		0.384		25		13	L	L		
Malcom (M-23)	0.043	0.015		25			Lo	Lo		
Brooklyn (M-4)	0.156	0.097		37			Cm	FtrCp	DcpHoBo	A new waste stabilization lagoon has been proposed to IDEQ.
Bear Creek										
Victor (M-37)						16	SchAe	AeCpLp		
Ladora (M-19)										No existing municipal treatment facility. Preliminary plans for treatment facility have been submitted to IDEQ.
Iowa Highway Commission North Rest Area I-80 (I-11)		0.003								
Iowa River										
Hallett Construction (I-8)		0.0015				38				
Marengo (M-24)	0.261	0.142		33			Lo	Lo		
Price Creek										
West Amana (M-39)										No existing municipal treatment facility.

ABBREVIATIONS

WASTEWATER TREATMENT FACILITIES

A ----Aeration (in tanks or basins)
Aa----Activated sludge, diffused air aeration
Ac----Contact stabilization
Ad----Aerobic digestion
Ae----Extended aeration
Af----Air flotation
Am----Activated sludge, mechanical aeration
Ao----Oxidation ditch
Ap----Aeration, plain, without sludge return

B ----Sludge beds
Bo----Open
Bc----Glass covered

C ----Settling tanks
Ci----Two-story (Imhoff)
Cm----Mechanically equipped
Cp----Plain, hopper bottom, or intermittently drained for cleaning
Cs----Septic tank
Ct----Multiple tray, mechanically equipped
CmDm--Two-story "Clarigester"
CpDo--Two-story "Spiragester"

D ----Digesters, separate sludge
Dc----With cover (fixed if not otherwise specified)
D(cg)-Gasometer in fixed cover
De----Gas used in engines (heat usually recovered)
Df----With gasometer cover
Dh----Gas used in heating
Dm----Mixing
Do----Open top
Dp----Unheated
Dr----Heated
Ds----Gas storage in separate holder
Dt----Stage digestion

E ----Chlorination
Ec----With contact tank
Eg----By chlorine gas
Eh----By hypochlorite

F ----Filters
Fc----Covered filter
Fo----Roughing Filter
Fr----Rapid sand or other sand straining
Fs----Intermittent sand
Ft----Trickling (no further details)
Fth---High capacity
Ft2H--High capacity, two-stage
Ftn---Fixed nozzle, standard capacity
Ftr---Rotary distributor, standard capacity
Ftt---Traveling distributor, standard capacity

G ----Grit chambers
Ga----Aerated grit removal
Gh----Without continuous removal mechanism
Gm----With continuous removal mechanism
Gp----Grit pocket at screen chamber
Gw----Separate grit washing device

H ----Sludge storage tanks (not second-stage digestion units)
Ha----Aerated
Hc----Covered
Hm----With stirring or concentrating mechanism
Ho----Open

I ----Sewage application to land
If----Ridge and furrow irrigation
Is----Subsurface application
Iu----Land underdrained
Iy----Spray irrigation

ABBREVIATIONS

WASTEWATER TREATMENT FACILITIES

K ----Chemical treatment-flocculation. Chemical treatment-type units or equipment not necessarily complete or operated as chemical treatment.
Ka----Flocculation tank, air agitation
Kc----Chemicals used
Km----Flocculation tank, mechanical agitation
Kx----No chemicals used

L ----Lagoons
La----Aerated lagoon
Le----Evaporation lagoon
Ln----Anaerobic lagoon
Lo----Waste stabilization lagoon
Lp----Polishing lagoon
Ls----Sludge lagoon - not for treatment of sewage

O ----Grease removal or skimming tanks - not incidental to settling tanks
Oa----Aerated tank (diffused air)
Om----Mechanically equipped tank
Ov----Vacuum type

S ----Screens
Sc----Comminutor (screenings ground in sewage stream)
Sf----Fine screen (less than 1/8" opening)
Sg----Screenings ground in separate grinder and returned to sewage flow
Sh----Bar rack, hand cleaned 1/2" to 2" openings
Si----Intermediate screen 1/8" to 1/2" openings
Sm----Bar rack mechanically cleaned 1/2" to 2" openings
Sr----Coarse rack (openings over 2")
St----Garbage ground at plant and returned to sewage flow

T ----Sludge thickener
Tc----Covered
Tm----Stirring mechanism
Tp----Open top

V ----Mechanical sludge dewatering
Vc----Sludge centrifuge
Vp----Pressure filter
Vv----Rotary vacuum filter
Vo----Other

X ----Sludge drying or incineration
Xd----Used for fertilizer
Xf----Sludge burned for fuel
Xl----Disposal to land
Xn----Incinerated
Xp----Used for fill

Z ----Sludge conditioning
Za----Chemicals used, alum
Zc----Chemical used (unidentified)
Zi----Chemicals used, iron salts
Zl----Chemicals used, lime
Zp----Polyelectrolytes used
Zx----No chemicals used
Zy----Elutriation

PART V

WASTE LOAD ALLOCATION METHODOLOGY

The most important consideration in determining the capacity of a stream to assimilate wastewater discharges is the ability to maintain an acceptable dissolved oxygen (DO) concentration. Microbial oxidation of organics and certain inorganics present in wastewater creates an oxygen demand. Oxygen is supplied to a stream principally by reaeration from the atmosphere. If the rate of deoxygenation exceeds the rate of reoxygenation, DO concentrations may decrease below minimum allowable standards.

To assess the variations in DO and ammonia nitrogen concentrations in the Iowa River Basin, a computer-based mathematical model was utilized. Model input data was developed from available information. In most cases data were lacking and more extensive data would improve the validity of the model. However, it is felt that the developed methodology is an equitable method for establishing waste load allocations.

It is recommended that the computer-based mathematical modeling techniques should be dated and improved as more information is obtained for the Iowa River Basin to more accurately predict water quality.

Theory and Methodology

General - Dissolved oxygen concentrations in streams are controlled by atmospheric reaeration, biochemical oxygen demands (carbonaceous and nitrogenous), algal photosynthesis and respiration, benthal demands, temperature, and the physical characteristics of the stream. Many of these factors are difficult, if not impossible, to accurately define.

Photosynthesis can produce large quantities of oxygen during the day if algae are present in the stream. Conversely, at night algal respiration creates an oxygen demand. Research efforts have attempted to fit harmonic functions to this phenomenon, but with limited success. Therefore, allowance for diurnal fluctuations in oxygen levels is not included in the computer model.

Benthal demands result from anaerobic decomposition of settled organic material at the bottom of the stream. These reactions release carbonaceous and nitrogenous organic materials which create biochemical oxygen demands.

The inclusion of benthal demands in the model requires extensive field surveys to determine the areal extent of sludge deposits within a stream and coefficients that describe the release into the water. Since the impact is minor in most instances and no data are available describing sludge deposition areas, no benthal oxygen demands are included in the model formulation.

Model Equation - A complete mathematical model to describe DO concentrations within the stream would include all significant factors. Natural systems cannot presently be expressed mathematically with absolute certainty, but reasonably accurate predictions can be made through realistic assumptions of the reaeration phenomenon and deoxygenation caused by carbonaceous and nitrogenous biochemcial oxygen demands.

The nitrogenous biochemical oxygen demand is due to the oxidation of ammonia to nitrates by certain species of bacteria. This oxidation process is called nitrification. Nitrification is a two-step process whereby a specific bacterial species oxidizes ammonia to nitrite and a different bacterium oxidizes the nitrite to nitrate. Approximately 4.5 mg/l of oxygen are required to oxidize 1 mg/l of ammonia (expressed as nitrogen) to nitrate, although this value may vary between 3.8 and 4.5 mg/l. Since secondary wastewater effluents quite commonly contain ammonia nitrogen levels of 10 mg/l, the equivalent nitrogenous biochemical oxygen demand (should all the ammonia be converted to nitrates) is approximately 45 mg/l. This is equivalent to the carbonaceous biochemical oxygen demand of most secondary wastewater effluents.

For the modeling program, a modified version of the Streeter-Phelps equation for DO deficit within the stream was utilized. This approach recognizes both carbonaceous and nitrogenous biochemical oxygen demands, and atmospheric reaeration. Effects of photosynthesis and benthal demands are not considered. The rate of deoxygenation is as follows:

$$\frac{dD}{dt} = K_1L + K_nN - K_2D$$

Integrated this equation becomes the modified Streeter-Phelps equation as follows:

$$D(t) = \frac{K_1 L_o}{K_2 - K_1} \left(e^{-K_1 t} - e^{-K_2 t}\right) + \frac{K_n N_o}{K_2 - K_n} \left(e^{-K_n t} - e^{-K_2 t}\right) + D_o e^{-K_2 t}$$

Where:

$D(t)$ = DO deficit at time t.

D_o = Initial DO deficit.

L_o = Initial ultimate carbonaceous BOD.

N_o = Initial nitrogenous BOD.

K_1 = Carbonaceous deoxygenation rate constant.

K_n = Nitrogenous deoxygenation rate constant.

K_2 = Reaeration rate constant.

In this equation, the rates of oxygen utilization due to both carbonaceous and nitrogenous biochemical oxygen demands are expressed as first order reactions.

Ultimate BOD and ammonia nitrogen concentrations are calculated as follows:

$$L(t) = L_o e^{-K_1 t}$$

$$N(t) = N_o e^{-K_n t}$$

Where:

$L(t)$ = Ultimate carbonaceous BOD at time t.

$N(t)$ = Nitrogenous BOD at time t.

and nitrogenous oxygen demand (N) equals 4.5 times the ammonia nitrogen concentration.

Since nitrification is a two-step process, many researchers have proposed that it is a second order reaction, although no practical DO prediction equation has been developed in this form. Since nitrogenous biochemical oxygen demands are too great to ignore, most developed models assume that it is a first order reaction. The present investigation has also utilized this assumption.

Nitrifying bacteria are generally present in relatively small numbers in untreated wastewaters. The growth rate at 20° C (68° F) is such that the organisms do not exert an appreciable oxygen demand until about 8 to

10 days have elapsed. This lag period may be reduced or practically eliminated in a stream receiving large amounts of secondary effluent containing seed organisms. In biological treatment systems, substantial nitrification can take place with a resultant buildup of nitrifying organisms. These nitrifying bacteria can immediately begin to oxidize the ammonia nitrogen present and exert a significant oxygen demand in a stream.

In addition to dispersed bacteria, there can be considerable nitrification by nitrifying organisms that are attached to sediments, rocks, weeds, etc., along the stream bottom. These organisms oxidize the ammonia nitrogen in the stream as it passes by them. Such attached growths can build up below treatment plant discharges where the stream is enriched with ammonia nitrogen.

It is known that the nitrification biological process is generally more sensitive to environmental conditions than carbonaceous decomposition. The optimal temperature range for growth and reproduction of nitrifying bacteria is 26° to 30° C (79° to 86° F). It is generally concluded that the nitrogenous BOD will assume greatest importance in small streams which receive relatively large volumes of secondary wastewater effluents, and during the low flow, warm weather periods of the year (August and September). These conditions were utilized for the low flow determination of allowable effluent characteristics during summer periods. During winter low flow periods (January and February), nitrification will probably have limited influence upon the oxygen demand due to the intolerance of the nitrifying bacteria to low temperatures; thus, for winter conditions, it was assumed nitrification did not occur.

To assume that nitrification, during summer conditions, proceeds immediately following a wastewater discharge, and simultaneously with carbonaceous oxidation, is to generally assume the worst possible conditions in regards to downstream dissolved oxygen concentrations. Therefore, waste load allocations identified in this manner will generally be on the conservative side.

In addition, to assume no nitrification occurs during winter flow conditions is to treat ammonia nitrogen as a conservative (nondegrading) pollutant.

In many streams during winter conditions, the water quality criteria of 2 mg/l of ammonia nitrogen becomes the determining factor in waste load allocations. During summer conditions, the critical water quality factor is generally dissolved oxygen.

Rate Constant Determination - The carbonaceous deoxygenation rate constant (K_1) for most streams will vary from 0.1 to 0.5 per day. Early work by Streeter and Phelps determined an average value for the Ohio River of 0.23/day (0.1/day, base 10). This value has been accepted and commonly used for years with reasonable results.

Deoxygenation rates higher than 0.23/day have been reported for various streams in the United States. No measurements of deoxygenation rates for the streams under investigation are available. For this study a carbonaceous deoxygenation rate of 0.2/day (base e) was used. Field measurements of typical deoxygenation rates for streams in Iowa are needed to verify this value and would greatly improve the predictability of the modeling.

Information on nitrogenous deoxygenation rates is extremely limited. Available information indicates that nitrification rates (when active nitrification does occur) are somewhat greater than carbonaceous oxidation rates. Therefore a nitrogenous deoxygenation rate (K_n) of 0.3/day (base e) was selected for the study. Again, field measurements of typical nitrogenous deoxygenation rates in Iowa streams would greatly enhance the accuracy of the modeling effort.

Many predictive formulations have been used for stream reaeration. For this study, reaeration rate constants were predicted by a method developed by Tsivoglou ("Characterization of Stream Reaeration Capacity," Tsivoglou and Wallace, EPA-R3-72-012, October, 1972). Tsivoglou's method is based on the premise that the reaeration capacity of nontidal fresh water streams is directly related to the energy expended by the flowing water, which in turn is directly related to the change in water surface elevation.

The change in water surface elevation divided by the time of flow is the average rate of energy expenditure. This relationship is expressed by:

$$K_2 = 0.048 \left(\frac{h}{t}\right) \text{ @ } 20° \text{ C}$$

Where:

K_2 = Reaeration rate constant (base e) per day.

h = Water surface elevation change in feet.

t = Time of flow in days.

Tsivoglou's method was derived from actual measurement of stream reaeration rates by a new field tracer procedure in which a radioactive form of the noble gas krypton serves as a tracer for oxygen.

The reaeration rate predictive model has been verified for streams ranging in flow from 5 to 3,000 cfs. It can also be used to quite accurately predict reaeration effects of dams and waterfalls.

In development of Tsivoglou's procedure, other reaeration rate predictive formulas were compared with results obtained from the field tracer technique, but none appeared to predict stream reaeration rates as accurately as the Tsivoglou model.

Under winter ice conditions, the reaeration rate constant is reduced in direct proportion to the percentage of ice cover up to 95 percent. For instance, if it is estimated that there is 90 percent ice cover, then the reaeration rate constant is reduced by 90 percent. With 100 percent ice cover, the reaeration rate is reduced only by 95 percent, for it is estimated that there will always be a small amount of reaeration taking place.

Temperature corrections for the carbonaceous and nitrogenous deoxygenation rate constants and also the reaeration rate constants are subroutines within the computer model. The following formulations define the specific temperature corrections utilized in the program:

$$K_{1(T)} = K_{1(20)} \times 1.047^{T-20}$$

$$K_{2(T)} = K_{2(20)} \times 1.0241^{T-20}$$

$$K_{n(T)} = K_{n(20)} \times (0.058T - 0.16) \qquad T > 3° \text{ C}$$

Where T = water temperature, ° C.

Temperature corrections for K_1 and K_2 are generally accepted formulations. Information on the effects of temperature on K_n is lacking. The formula given was derived from information on temperature effects on nitrification rates in biological treatment systems. The formula predicts nitrification rates of zero at approximately 3° C (37° F). The rate constant is set to zero at all temperatures below 3° C (37° F).

The principal factor affecting the solubility of oxygen is the water temperature. Dissolved oxygen saturation values at various temperatures are calculated as follows:

$$C_s = 24.89 - 0.426t + 0.00373t^2 - 0.0000133t^3$$

Where:

t = Water temperature, ° F.

C_s = Saturation value for oxygen at temperature, t (° F), at standard pressure.

Stream Velocity Calculations - Stream velocities are important in determining reaeration rates and the downstream dispersion of pollutants. The computer model utilized calculates velocity based on a variation of the Manning formula for open channel flow. The Manning formula for open channel flow is:

$$v = \frac{1.5R^{2/3}S^{1/2}}{n}$$

Where:

v = Velocity, fps.

R = Hydraulic radius, ft = wetted perimeter/cross sectional area which approximately equals the mean depth for rivers.

S = Channel slope, ft/ft.

n = Roughness coefficient.

By multiplying both sides of the equation by the cross sectional area, which is equal to the mean depth times the water surface width, and solving for the mean depth, the following relationship is obtained:

$$d = \left(\frac{Qn}{1.5WS^{1/2}}\right)^{3/5}$$

Where:

d = Mean river depth, ft.

Q = Discharge, cfs.

W = Water surface width, ft.

S = Slope, ft/ft.

n = Roughness coefficient.

Once mean depths were calculated, velocities were determined from the relationship:

$$v = Q/A = Q/W \cdot d \quad .$$

River slopes were obtained from existing profiles when available, but usually were taken from USGS topographic maps. Slopes obtained from USGS maps are rather generalized, and more accurate river profiles would greatly improve the accuracy of velocity determinations.

River widths and roughness coefficients were estimated from information obtained from field observations, and flow and cross section data at each USGS gaging station.

Computer Input and Output Data - In order to calculate water quality at various points in the river, the river length to be modeled was divided into reaches. River characteristics such as mean velocities and depths, river widths, deoxygenation and reaeration rate constants, and water temperature were considered constant for each reach. The location of the reaches was set by one or more of the following:

1. A tributary.
2. A wastewater discharge.
3. A change in river characteristics such as river width or slope.
4. A dam.

In order to calculate water quality characteristics at various points within each reach, the reaches were divided into segments called sections.

Mixing and dispersion assumptions inherent in the model are:

1. Complete and instantaneous mixing of wastewater and tributary flows with the main river flow.
2. Uniform lateral and logitudinal dispersion (plug flow) of the stream constituents as they move downstream.

Flows that could not be allocated to tributary inflows or wastewater discharges were distributed uniformly along the main river stem and are called groundwater contributions.

Actual data input into the computer program are as follows:

1. Initial river conditions such as flow and concentrations of ultimate carbonaceous BOD, ammonia nitrogen, and DO.
2. Uniform groundwater contributions for each reach and concentrations of ultimate carbonaceous BOD, ammonia nitrogen, and DO.
3. The number of reaches and the following for each reach:
   a. Length.
   b. Number of sections.
   c. Water temperature.
   d. Channel slope.
   e. River width.
   f. Deoxygenation rate constants.
   g. Roughness coefficient.
4. Wastewater or tributary inflows consisting of inflow rates, ultimate carbonaceous BOD, ammonia nitrogen, and DO concentrations.

After calculations, computer output data consists of the following for each reach:

1. Mean river velocities.
2. Mean river depths.
3. Reaeration rate constants.
4. Temperature corrected reaeration and deoxygenation rate constants.
5. Saturation DO concentrations for the given temperature.

and the following at the beginning of every section within a reach:

1. Summation of the river miles evaluated.
2. Cumulative discharge.
3. Cumulative travel time in days.
4. Ammonia nitrogen concentrations.
5. Ultimate carbonaceous BOD concentrations.
6. DO concentrations.
7. DO deficits.

PART VI

WASTE LOAD ALLOCATIONS

Utilizing the previously defined computer methodology, waste load allocations required for dischargers to meet state water quality standards for that portion of the Iowa River Basin within the study area were determined. The evaluation procedure considered the situation with 1990 wastewater discharges under both summer and winter low flow conditions. The following sections describe specific results for these evaluations and a tabulation of the waste load allocation for each discharger is presented for both summer and winter conditions. Analyses were conducted for all streams with a water quality classification and a wastewater discharger.

Evaluation Assumptions

In order to define waste load allocations for dischargers within the study area, specific assumptions are required. Identification of the major items required to evaluate and determine waste load allocations are identified in the following list.

1. The major objective of the present investigation is to satisfy Iowa Water Quality Standards with future effluent discharges. Determination of allowable effluent concentrations was based upon varying the effluent quality from point source dischargers until the model maintained dissolved oxygen concentrations above 5.0 mg/l and ammonia nitrogen concentrations below 2.0 mg/l in all water quality classified sections of the stream. Because NPDES permits are requiring dischargers with stabilization ponds to utilize controlled discharge of the effluent, no discharge from stabilization pond treatment facilities to the stream was assumed for the low flow conditions.
2. Definition of 7-day, 1-in-10 year low flow was required for each stream modeled. For the Iowa River, the low flow exceeded the total present average daily wastewater discharges from all entities within their respective basins. The difference between the 7-day, 1-in-10

year low flow and the wastewater discharges was assumed to be the result of groundwater inflow to the stream. This amount of groundwater inflow was assumed to remain constant over the planning period. Since most wastewater discharges will increase during this time period, the 7-day, 1-in-10 year low flow in 1990 is greater by the amount of this increase. Groundwater contribution to the stream flow was distributed throughout the drainage basin in relationship to the area contributing to the stream along the length of the channel. Values of 4.0 mg/l BOD_5, 0.0 mg/l ammonia nitrogen, and 2.0 mg/l dissolved oxygen concentration were assumed as the water quality of the groundwater contribution.

3. Ultimate carbonaceous BOD was assumed to be 1.5 times the BOD_5.
4. Since no data are available describing effluent dissolved oxygen concentrations or temperatures, the following values were assumed for each class of wastewater discharge.

Discharger	Summer Condition: Dissolved Oxygen (mg/l)	Summer Condition: Temperature (°C)	Summer Condition: Temperature (°F)	Winter Condition: Dissolved Oxygen (mg/l)	Winter Condition: Temperature (°C)	Winter Condition: Temperature (°F)
Trickling Filter	3.0	20	68	4.0	9	48
Activated Sludge	3.0	20	68	4.0	9	48
Industrial	Each Discharger Handled Individually					

5. In order to assess the reaeration rate constants under wintertime conditions, the amount of ice cover on the stream was estimated. Then the winter reaeration rate constant for each reach of stream was determined by multiplying the predicted constant by the percentage of open water in the reach. Ice cover estimates were based upon general climatological conditions for the basin and upon personal observations of persons familiar with the area. Complete ice cover was assumed to be non-coincidental with the 7-day, 1-in-10 year low flow.
6. Deoxygenation rate coefficients were assumed to be 0.2/day for carbonaceous demand and 0.3/day for nitrogenous demand.

7. Best practicable treatment (BPT) effluent limitations described by EPA guidelines were utilized for industrial discharges when available. Otherwise, the actual allowable waste load which could be discharged into the stream was determined and identified as the waste load allocation for that discharger.
8. Tributaries (without wastewater sources) discharging to the streams being modeled were assumed to have saturated dissolved oxygen concentrations, an ultimate BOD of 6.0 mg/l, and ammonia nitrogen concentrations of 0.0 mg/l in the summer and 0.5 mg/l in the winter.
9. Water quality of the Iowa River entering the study area has been assumed to have the same water quality as that of tributaries given above, with the exception that the wintertime concentration of ammonia nitrogen is 0.0 mg/l.
10. Because Steamboat Rock Pool is a shallow impoundment, the model has been carried through the impoundment and over the dam. The actual water surface slope has been estimated through the impoundment reach of the Iowa River. Width of stream is also increased through the impoundment area. The dam is assumed to take up a reach of the stream equal to 0.001 miles with a change in head equal to the height of the dam. This results in a high reaeration rate constant for the stream flow over the dam.

Discussion of Results

The waste load allocations are based on a computer model that utilizes the best available information for the study portion of the Iowa River Basin. Some of the input data provided are approximations, and model predictability could be considerably improved with more accurate field information. Based on the available data, the model computes stream quality for the assigned wastewater discharges. For the initial run, all discharges were assumed to meet either secondary treatment (municipalities) or BPT (industries). Where the model indicated violation of IDEQ stream quality criteria, more stringent effluent requirements were imposed until satisfactory levels were achieved. Whenever more than one entity was required to meet more stringent effluent limitations in a particular stream reach to maintain quality, approximately the same requirements were established for all of the entities regardless of size or whether they were municipal or industrial discharges. Other possible combinations of effluent limitations on BOD, ammonia nitrogen, and dissolved oxygen could result in meeting stream quality criteria.

Summer Conditions - Waste load allocations for each discharger for summer conditions are given in Table 14. The upper limit for municipal wastewater discharges is secondary treatment and best practicable treatment for industrial discharges. IDEQ has set the allowable ammonia nitrogen level for secondary treatment as 10 mg/l in summer.

Within the study area, the water quality classified streams are the Iowa River, Bear Creek, and the South Fork Iowa River. The South Fork Iowa River has only controlled discharge wastewater treatment facilities, and thus no analysis of this stream is necessary. Stream modeling is necessary on Bear Creek because of the impact of wastewater discharges from Victor and Brooklyn (via Little Bear Creek).

Dissolved oxygen concentration profiles for Bear Creek and Iowa River for 1990 discharges are shown on Figure 7. Profiles for both secondary treatment conditions and waste load allocations, as given in Table 14, are shown. The waste load allocations allow the stream quality criteria of 5.0 mg/l to be met in all sections of the streams which are water quality classified. Significant stream water quality violations occur when only secondary treatment and best practicable treatment conditions prevail.

Summer ammonia nitrogen concentrations are shown on Figure 8 for Bear Creek and the Iowa River. The allocations given in Table 14 maintain ammonia nitrogen concentrations below 2.0 mg/l for all classified sections of the streams. With few exceptions, only secondary treatment removal levels are required for ammonia nitrogen.

To meet water quality criteria under summer low flow conditions, the communities of Brooklyn, Iowa Falls, Marshalltown, Tama, and Victor must provide a level of wastewater treatment exceeding that of secondary treatment. In addition, the following industrial wastewater dischargers must provide better than BPT: Farm Best (Iowa Falls), Packing Corporation of America (Tama), and

TABLE 14

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Iowa River							
Iowa Limestone Co. (I-12)	5.73	0.008	No Discharge Limitations Necessary[3]				
Weaver Construction Co. Alden Quarry (I-22)	5.73	0.002	No Discharge Limitations Necessary[3]				
Iowa Falls (M-18)[4]	5.73	1.240	15	155	4	41	3.0
Farm Best (I-4)	5.73	0.370	15	46	4	12	3.0
Iowa Electric Light & Power (I-9)	6.00	10.247	No Discharge Limitations Necessary[3]				
Steamboat Rock (M-32)	6.46	0.019	45[5]	7	10[5]	2	3.0
Eldora Plants No. 1 & No. 2 (M-11 & M-12)	7.20	0.600	45[5]	225	10[5]	50	3.0
Beaver Creek							
Owasa (M-28)		---	No Existing Municipal Facility				
South Fork Iowa River							
Buckeye (M-5)		---	No Existing Municipal Facility				
Quakerdale County Home (S-3)	7.56	0.010	No Discharge Data Available				

TABLE 14 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Iowa River							
Union (M-35)		0	Controlled Discharge				
Liscomb (M-21)		0	Controlled Discharge				
Honey Creek							
Radcliffe (M-29)		0	Controlled Discharge				
Hubbard (M-17)		0	Controlled Discharge				
Edrich Addition (S-6)	31.02	0.021	45[5]	8	10[5]	2	3.0
New Providence (M-27)		---	No Existing Municipal Facility				
Minerva Creek							
Middle Minerva Creek							
Zearing (M-40)		0	Controlled Discharge				
St. Anthony (M-30)		---	No Existing Municipal Facility				
Little Minerva Creek							
Clemons (M-7)		0	Controlled Discharge				
Iowa River							
Iowa Electric Light & Power - Southerland Station (I-10)			No Discharge Limitations Necessary[3]				

TABLE 14 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Asher Creek							
Martin Marietta Corp., Concrete Material Industries (I-14)			No Discharge Limitations Necessary[3]				
Lennox Industries (I-14)			No Discharge Data Available				
Chicken Creek							
Albion (M-1)		0	Controlled Discharge				
Iowa River							
Martin Marietta Corp., Marshalltown Sand Plant (I-18)			No Discharge Limitations Necessary[3]				
Marshall County Home (S-2)			No Discharge Data Available				
Marshalltown (M-25)	13.98	5.217	15	653	2	87	3.0
Fisher Controls Co., Center St. Facility (I-5)	19.52	0.660	No Discharge Limitations Necessary[3]				
Fisher Controls Co., General Buildings (I-6)	19.52	0.002	No Discharge Limitations Necessary[3]				
Fisher Controls Co., Governor Rd. Facility (I-7)	19.52	0.170	No Discharge Limitations Necessary[3]				

TABLE 14 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Linn Creek							
Chicago & Northwestern Railway (I-3)		0	Controlled Discharge				
Swift Fresh Meats Corp. (I-20)	20.40	0.120	No Discharge Limitations Necessary[3]				
North Timber Creek							
State Center (M-31)	21.07	0.207	45[5]	78	10[5]	17	3.0
Timber Creek							
Lincoln Estates (I-15)	21.07	0.006	45[6]	2	10[5]	1	3.0
Cambridge Mobile Home Park (I-1)		0	Controlled Discharge				
South Timber Creek							
Van Cleave (M-36)		---	No Existing Municipal Facility				
Ferguson (M-13)		0	Controlled Discharge				
Brush Creek							
Gilman (M-15)		0	Controlled Discharge				
Iowa River							
Le Grand (M-20)		0	Controlled Discharge				
Montour (M-26)		0	Controlled Discharge				
Indian Creek							
South Tama School District (S-4)	22.72	0.045	45[5]	17	10[5]	4	3.0

TABLE 14 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITIONS

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
Deer Creek							
Garwin (M-14)		0	Controlled Discharge				
Toledo (M-34)	23.30	0.300	45[5]	113	10[5]	25	3.0
Packing Corp. of America (I-19)	23.30	0.634	No Discharge Limitations Necessary[3]				
Tama County Home (S-4)	23.30		No Discharge Data Available				
Iowa River							
Packing Corp. of America (I-19)	24.73	0.550	100	459	10[5]	46	3.0
Tama (M-33)	25.29	0.355	45[5]	133	10	30	3.0
Tama Meat Packing Corp. (I-21)	25.29	0.770	51[5]	328	7	45	3.0
Otter Creek							
Chelsea (M-6)		---	No Existing Municipal Facility				
Salt Creek							
Clutier (M-8)		0	Controlled Discharge				
Elberon (M-10)		---	No Existing Municipal Facility				
Vining (M-38)		---	No Existing Municipal Facility				
Belle Plaine (M-3)	27.93	0.174	45[5]	65	10[5]	15	3.0

TABLE 14 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
East Branch Salt Creek							
Dysart (M-9)	27.93	0.226	45[5]	85	10[5]	19	3.0
Buckeye Creek							
Luzerne (M-22)		---	No Existing Municipal Facility				
Iowa River							
Honey Creek							
Hartwick (M-16)		---	No Existing Municipal Facility				
Bear Creek							
Little Bear Creek							
Malcolm Stone 6 (I-16)		0	Controlled Discharge				
Malcolm (M-23)		0	Controlled Discharge				
Brooklyn (M-4)	0.00	0.103	3	3	1	1	3.0
Bear Creek							
Victor (M-37)	0.10	0.078	3	2	1	1	3.0
Ladora (M-19)		---	No Existing Municipal Facility				
Iowa Highway Commission North Rest Area I-80 (I-11)		0	Controlled Discharge				
Hallett Construction (I-8)			No Discharge Limitations Necesaary[3]				

TABLE 14 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 SUMMER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Iowa River							
Marengo (M-24)		0	Controlled Discharge				
Price Creek							
West Amana (M-39)		---	No Existing Municipal Facility				

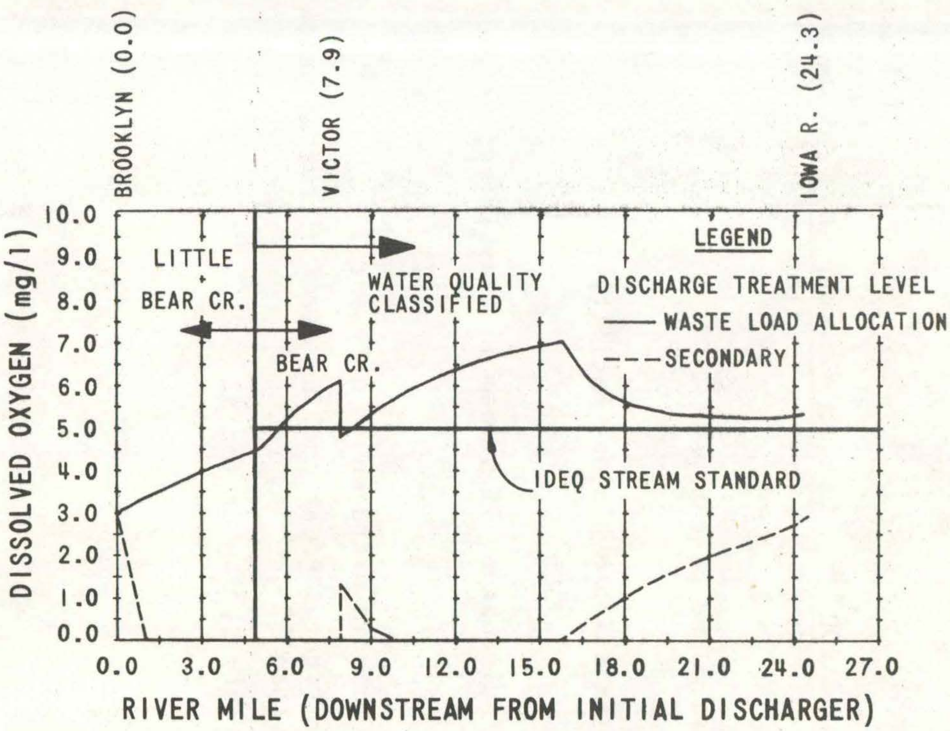
[1] Seven-day, 1-in-10 year low flow in stream just above point of discharge, if stream is classified; or flow of classified stream at confluence with tributary.

[2] UBOD = 1.5 (BOD_5).

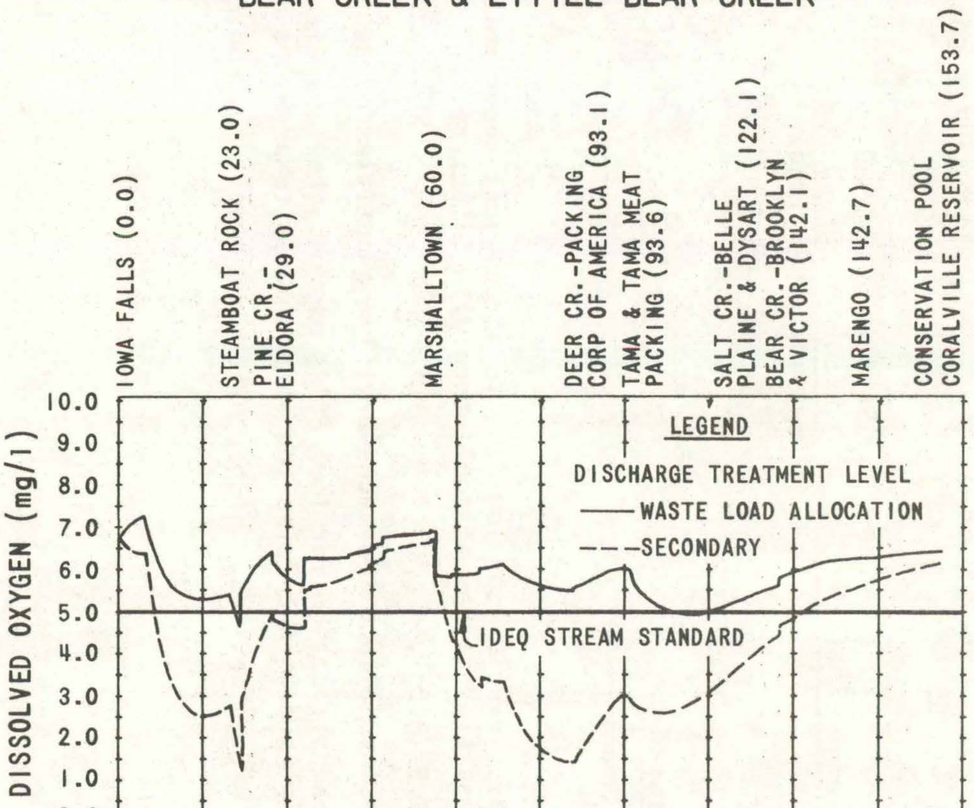
[3] No waste load allocation necessary; low quantities of BOD and ammonia nitrogen in effluent.

[4] Waste load allocation for Iowa Falls assumes the Iowa Electric Light & Power cooling water discharge below Iowa Falls does not raise the stream water temperature more than 5° C.

[5] Meets BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.

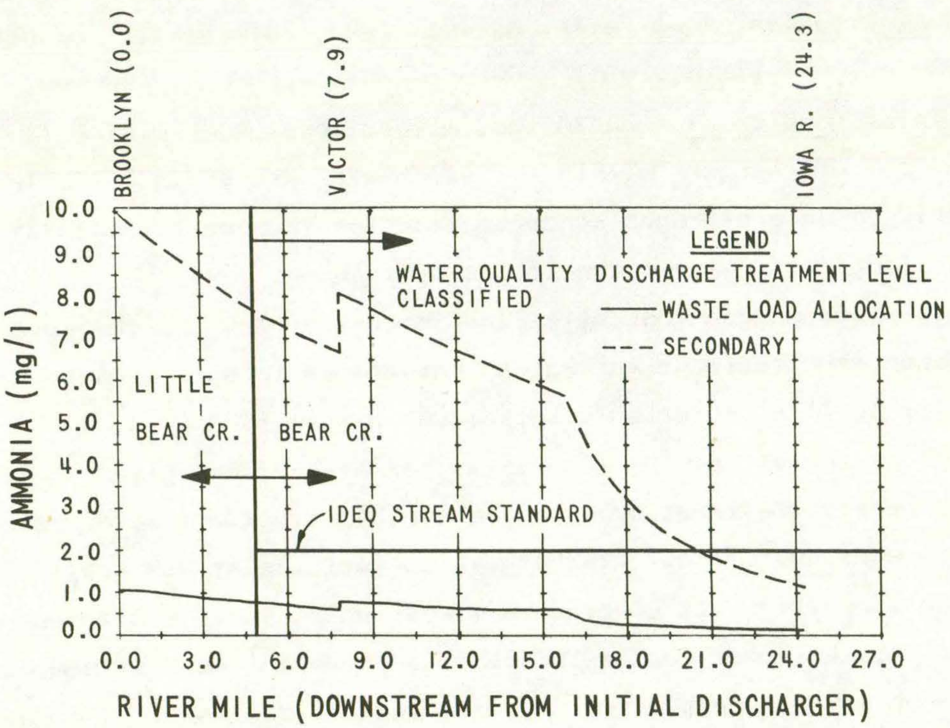


BEAR CREEK & LITTLE BEAR CREEK

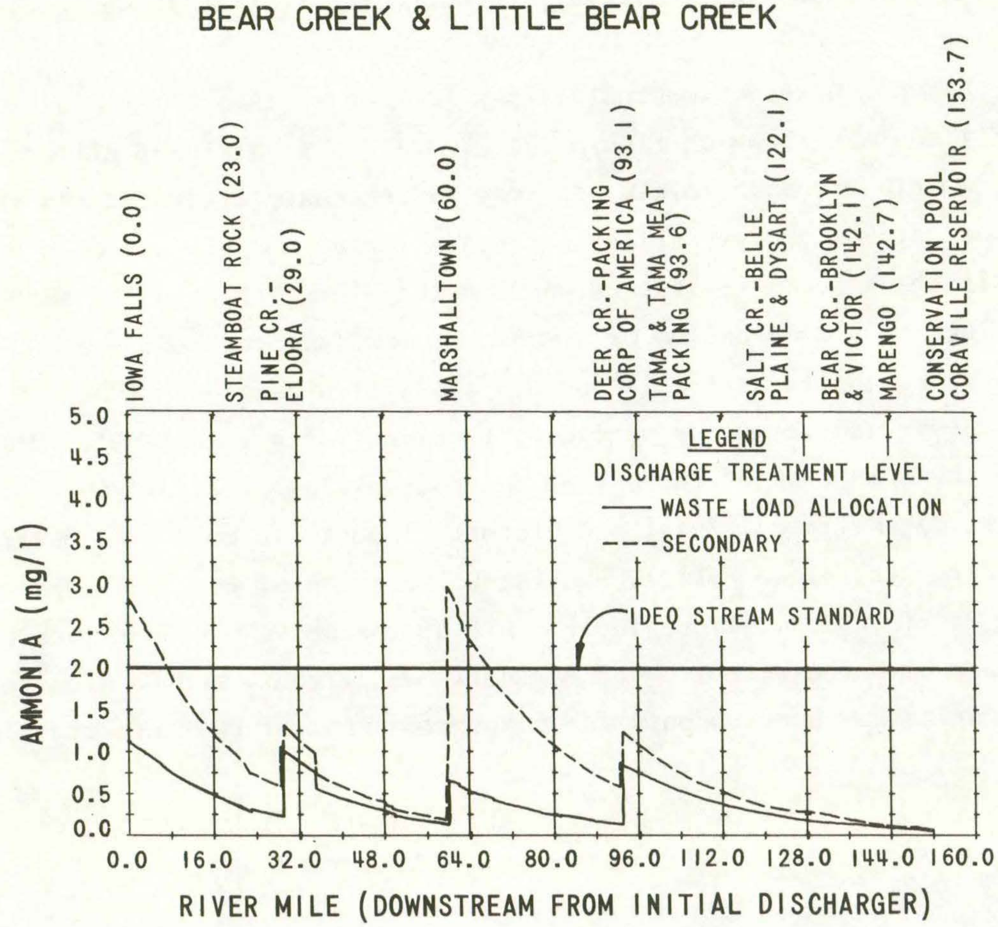


IOWA RIVER

FIGURE 7
DISSOLVED OXYGEN
CONCENTRATIONS
SUMMER CONDITIONS



BEAR CREEK & LITTLE BEAR CREEK



IOWA RIVER

FIGURE 8
AMMONIA NITROGEN
CONCENTRATIONS
SUMMER CONDITIONS

Tama Meat Packing Corporation (Tama). Ammonia nitrogen removal will be required of Brooklyn, Iowa Falls, Marshalltown, Farm Best, Tama Meat Packing Corporation, and Victor.

Winter Conditions - Waste load allocations under winter low flow conditions for dischargers within the study area are given in Table 15. The allowable ammonia nitrogen concentration for secondary treatment has been set as 15 mg/l for winter conditions by IDEQ.

Dissolved oxygen concentrations for Bear Creek and the Iowa River for both secondary treatment and waste load allocations are shown on Figure 9. The water quality criteria for dissolved oxygen is met in all classified portions of the streams by the waste load allocations given in Table 15. Only secondary treatment or best practicable treatment level removals of BOD are required for most dischargers to meet the stream quality criteria.

Due to partial ice cover conditions, which lower the amount of stream reaeration, the lower reaches of Bear Creek cannot meet stream quality standards with any reasonable set of waste load allocations. The waste load allocations specified in Table 15 produce the results shown on Figure 9 when modeled.

Ammonia nitrogen concentrations for the streams under winter low flow conditions are shown on Figure 10. There are significant differences between the ammonia nitrogen levels provided by secondary treatment and those necessary to meet stream quality criteria. Reduction of ammonia nitrogen concentrations within the streams is less evident in the winter than in the summer because of the lack of bio-oxidation of ammonia at low temperatures.

Water quality criteria for all classified sections of Bear Creek and Iowa River can be met by secondary treatment of all wastewater discharges with the exception of those from the communities of Brooklyn, Eldora, Iowa Falls, Marshalltown, Tama, and Victor. Industries requiring better than BPT are Farm Best (Iowa Falls), Packing Corporation of America (Tama), and Tama Meat Packing Corporation (Tama). All of the above mentioned wastewater discharges with the exception of Marshalltown, Victor, and Packing Corporation of America may provide only secondary treatment or best practicable treatment

TABLE 15

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Iowa River							
Iowa Limestone Co. (I-12)	5.73	0.008	No Discharge Limitations Necessary[3]				
Weaver Construction Co. Alden Quarry (I-22)	5.73	0.002	No Discharge Limitations Necessary[3]				
Iowa Falls (M-18)[4]	5.73	1.240	45[5]	465	6	62	4.0
Farm Best (I-4)	5.73	0.370	45[5]	139	6	19	4.0
Iowa Electric Light & Power (I-9)	6.00	10.247	No Discharge Limitations Necessary[3]				
Steamboat Rock (M-32)	6.46	0.019	45[5]	7	15[5]	2	4.0
Eldora Plants No. 1 & No. 2 (M-11 & M-12)	7.20	0.600	45[5]	225	8	40	4.0
Beaver Creek							
Owasa (M-28)		---	No Existing Municipal Facility				
South Fork Iowa River							
Buckeye (M-5)		---	No Existing Municipal Facility				
Quakerdale County Home (S-3)	7.56	0.010	No Discharge Data Available				

TABLE 15 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Iowa River							
Union (M-35)		0	Controlled Discharge				
Liscomb (M-21)		0	Controlled Discharge				
Honey Creek							
Radcliffe (M-29)		0	Controlled Discharge				
Hubbard (M-17)		0	Controlled Discharge				
Edrich Addition (S-6)	31.02	0.021	45[5]	8	15[5]	3	4.0
New Providence (M-27)		---	No Existing Municipal Facility				
Minerva Creek							
Middle Minerva Creek							
Zearing (M-40)		0	Controlled Discharge				
St. Anthony (M-30)		---	No Existing Municipal Facility				
Little Minerva Creek							
Clemons (M-7)		0	Controlled Discharge				
Iowa River							
Iowa Electric Light & Power - Southerland Station (I-10)			No Discharge Limitations Necessary[3]				

TABLE 15 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Asher Creek							
Martin Marietta Corp., Concrete Material Industries (I-14)			No Discharge Limitations Necessary[3]				
Lennox Industries (I-14)			No Discharge Data Available				
Chicken Creek							
Albion (M-1)		0	Controlled Discharge				
Iowa River							
Martin Marietta Corp., Marshalltown Sand Plant (I-18)			No Discharge Limitations Necessary[3]				
Marshall County Home (S-2)			No Discharge Data Available				
Marshalltown (M-25)	13.98	5.217	20	871	3	131	4.0
Fisher Controls Co., Center St. Facility (I-5)	19.52	0.660	No Discharge Limitations Necessary[3]				
Fisher Controls Co., General Buildings (I-6)	19.52	0.002	No Discharge Limitations Necessary[3]				
Fisher Controls Co., Governor Rd. Facility (I-7)	19.52	0.170	No Discharge Limitations Necessary[3]				

TABLE 15 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Linn Creek							
Chicago & Northwestern Railway (I-3)		0	Controlled Discharge				
Swift Fresh Meats Corp. (I-20)	20.40	0.120	No Discharge Limitations Necessary[3]				
North Timber Creek							
State Center (M-31)	21.07	0.207	45[5]	78	15[5]	26	4.0
Timber Creek							
Lincoln Estates (I-15)	21.07	0.006	45[5]	2	15[5]	1	4.0
Cambridge Mobile Home Park (I-1)		0	Controlled Discharge				
South Timber Creek							
Van Cleave (M-36)		---	No Existing Municipal Facility				
Ferguson (M-13)		0	Controlled Discharge				
Brush Creek							
Gilman (M-15)		0	Controlled Discharge				
Iowa River							
Le Grand (M-20)		0	Controlled Discharge				
Montour (M-26)		0	Controlled Discharge				
Indian Creek							
South Tama School District (S-4)	22.72	0.045	45[5]	17	15[5]	6	4.0

TABLE 15 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
Deer Creek							
Garwin (M-14)		0	Controlled Discharge				
Toledo (M-34)	23.30	0.300	45[5]	113	15[5]	38	4.0
Packing Corp. of America (I-19)	23.30	0.634	No Discharge Limitations Necessary[3]				
Tama County Home (S-4)	23.30		No Discharge Data Available				
Iowa River							
Packing Corp. of America (I-19)	24.73	0.550	30	138	4	18	4.0
Tama (M-33)	25.29	0.355	45	133	10	30	4.0
Tama Meat Packing Corp. (I-21)	25.29	0.770	51	328	6	38	4.0
Otter Creek							
Chelsea (M-6)		---	No Existing Municipal Facility				
Salt Creek							
Clutier (M-8)		0	Controlled Discharge				
Elberon (M-10)		---	No Existing Municipal Facility				
Vining (M-38)		---	No Existing Municipal Facility				
Belle Plaine (M-3)	27.93	0.174	45[5]	65	15[5]	22	4.0

TABLE 15 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	(lb/day)	Ammonia Nitrogen (N) (mg/l)	(lb/day)	Effluent Dissolved Oxygen (mg/l)
East Branch Salt Creek							
Dysart (M-9)	27.93	0.226	45[5]	85	15[5]	28	4.0
Buckeye Creek							
Luzerne (M-22)		---	No Existing Municipal Facility				
Iowa River							
Honey Creek							
Hartwick (M-16)		---	No Existing Municipal Facility				
Bear Creek							
Little Bear Creek							
Malcolm Stone 6 (I-16)		0	Controlled Discharge				
Malcolm (M-23)		0	Controlled Discharge				
Brooklyn (M-4)	0.00	0.103	6	5	2	2	6.0[6]
Bear Creek							
Victor (M-37)	0.10	0.078	6	4	2	1	8.0[6]
Ladora (M-19)		---	No Existing Municipal Facility				
Iowa Highway Commission North Rest Area I-80 (I-11)		0	Controlled Discharge				
Hallett Construction (I-8)			No Discharge Limitations Necesaary[3]				

TABLE 15 (Cont.)

WASTE LOAD ALLOCATION

7-DAY, 1-IN-10 YEAR LOW FLOW

1990 WINTER CONDITION

Discharger (Ref. No.)	Stream Flow[1] (mgd)	1990 Discharge (mgd)	Ultimate BOD[2] (mg/l)	Ultimate BOD[2] (lb/day)	Ammonia Nitrogen (N) (mg/l)	Ammonia Nitrogen (N) (lb/day)	Effluent Dissolved Oxygen (mg/l)
Iowa River							
Marengo (M-24)		0	Controlled Discharge				
Price Creek							
West Amana (M-39)		---	No Existing Municipal Facility				

1 Seven-day, 1-in-10 year low flow in stream just above point of discharge, if stream is classified; or flow of classified stream at confluence with tributary.

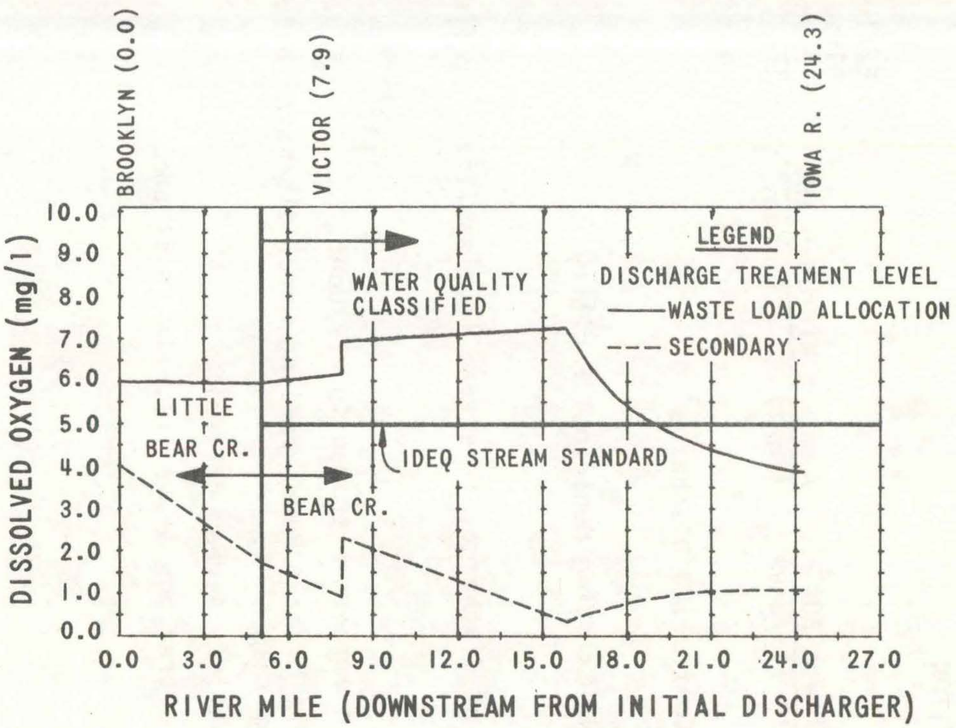
2 UBOD = 1.5 (BOD_5).

3 No waste load allocation necessary; low quantities of BOD and ammonia nitrogen in effluent.

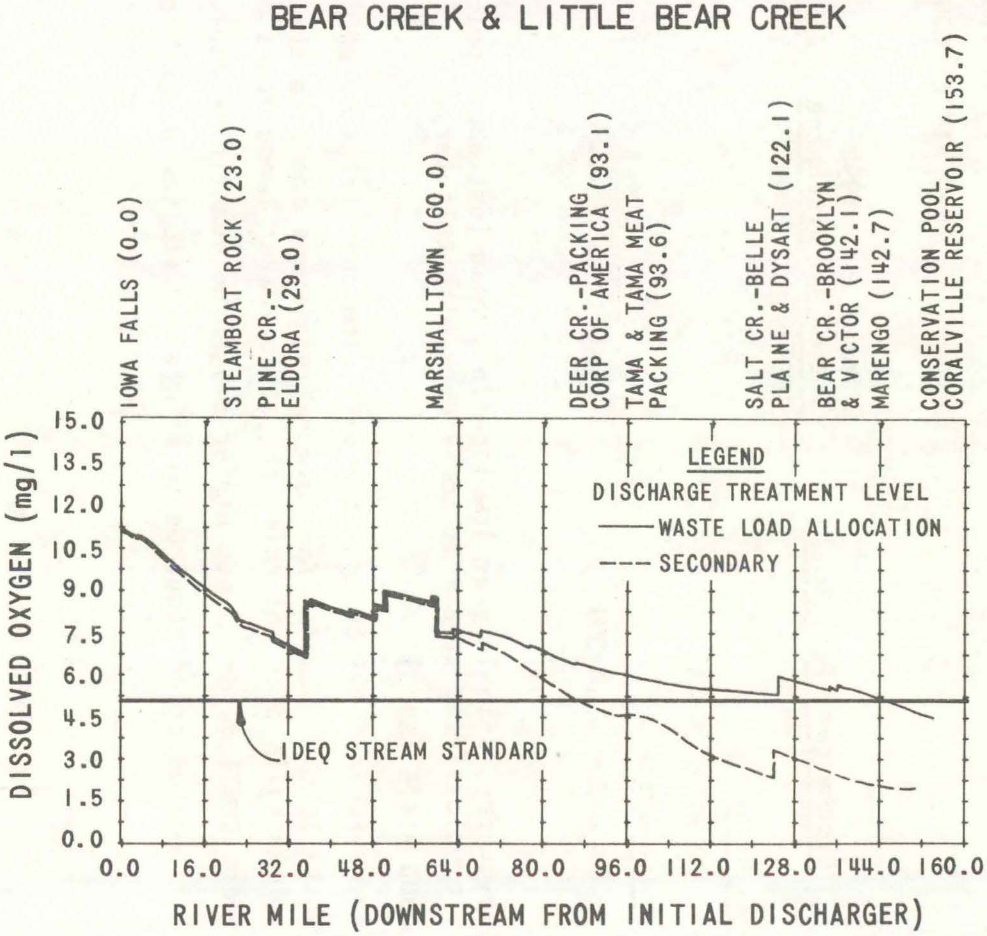
4 Waste load allocation for Iowa Falls assumes the Iowa Electric Light & Power cooling water discharge below Iowa Falls does not raise the stream water temperature more than 5° C.

5 Meets BPWTT guidelines. Higher discharge quantities could satisfy stream criteria.

6 Effluent aeration required to maintain dissolved oxygen concentrations above criteria in stream.

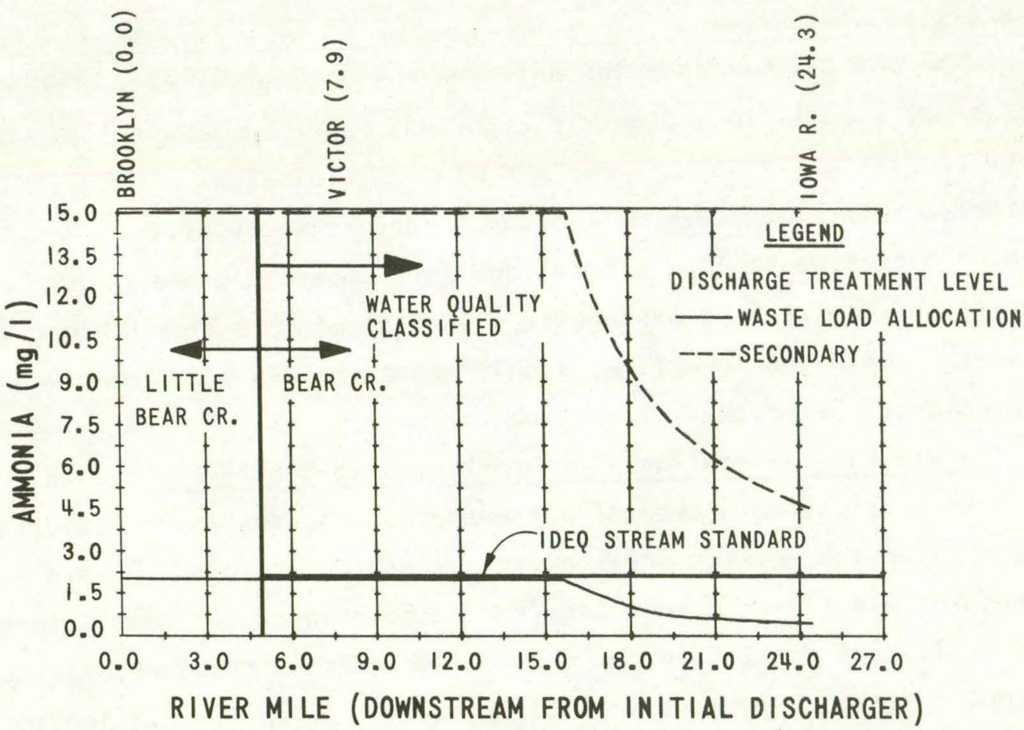


BEAR CREEK & LITTLE BEAR CREEK

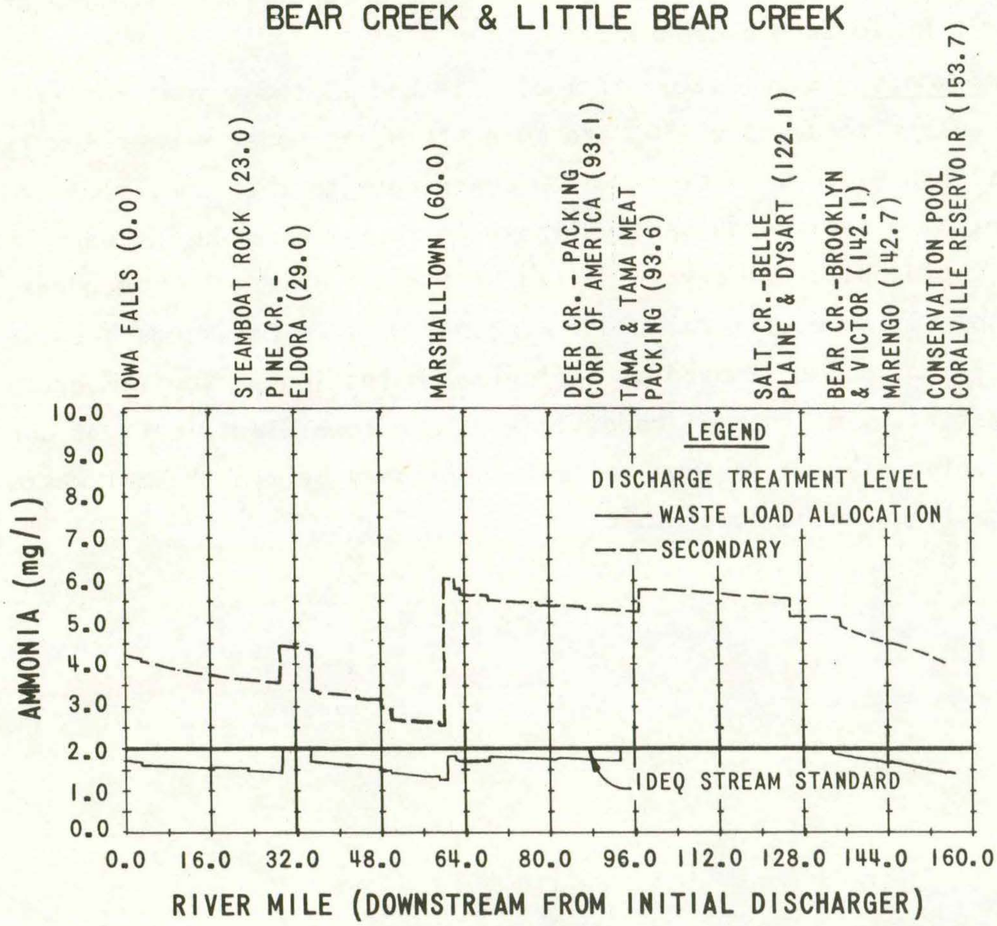


IOWA RIVER

FIGURE 9
DISSOLVED OXYGEN
CONCENTRATIONS
WINTER CONDITIONS



BEAR CREEK & LITTLE BEAR CREEK



IOWA RIVER

FIGURE 10
AMMONIA NITROGEN
CONCENTRATIONS
WINTER CONDITION

BPT levels of BOD removal, but ammonia nitrogen removal is required of all the listed dischargers.

Thermal Discharges - The only thermal discharger of any magnitude within the study area is Iowa Electric Light and Power in Iowa Falls. Under low flow conditions in both summer and winter, violations of the stream quality criteria for temperature will occur. Further study of the situation is recommended before waste load allocations for temperature are given. The existing water use results in a wastewater discharge of more than 10 mgd, while the 7-day, 1-in-10 year low flow is only approximately 6 mgd in the stream at the point of withdrawal of the cooling water.

Waste Load Allocations for Non-regulated Substances - Within the Iowa River Basin, the main type of wastewater discharges which could have an impact upon the aquatic environment but are not covered by water quality standards are sludge discharges from potable water treatment plants. The main pollutant constituent of these discharges is suspended solids, which is not covered by Iowa water quality standards. No identification of these discharges has been done as they will be effluent limited and usually restricted to zero discharge.

Summary - Examination of Tables 14 and 15 shows that restrictions on allowable discharges of BOD are more stringent under summer low flow conditions than winter. Factors which contribute to this condition are the lower amount of dissolved oxygen available in the streams during warm weather, and more rapid uptake of oxygen during biological oxidation. Removal of ammonia nitrogen is more critical under winter low flow conditions because the pollutant is not being removed by biological oxidation at low temperatures. Further study of thermal conditions at the Iowa Electric Light and Power generating station in Iowa Falls is necessary before thermal waste load allocations can be determined.

Respectfully submitted,

STANLEY CONSULTANTS, INC.

By ______________________
Douglas A. Wallace

By ______________________
R. John Tagg

Approved by ______________________
Robert L. Thoem

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Iowa.

____
Robert L. Thoem

December 16, 1974 Reg. No. 5802

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